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Operating Experience with Nuclear Power Stations in Member States



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EDITORIAL NOTE

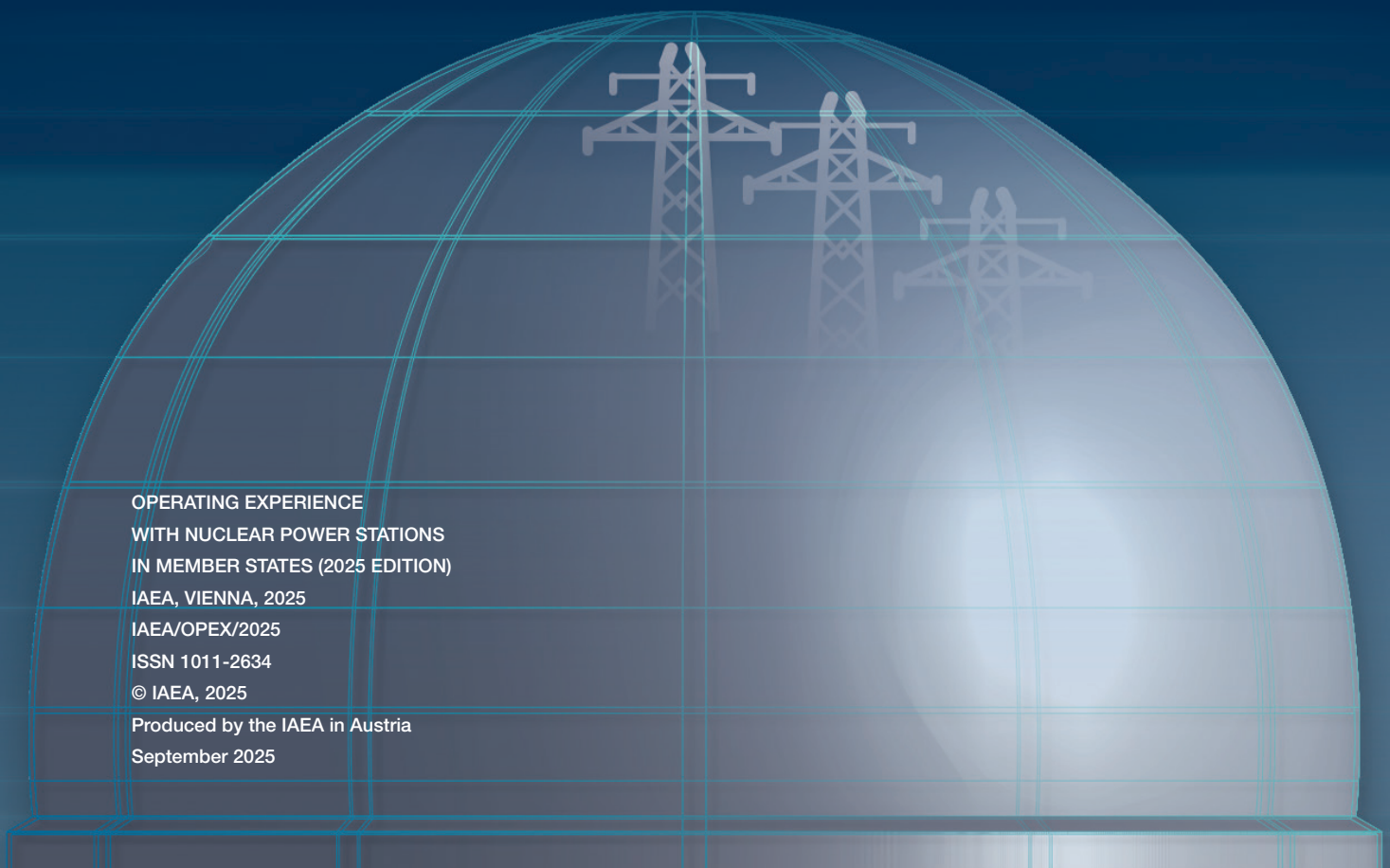
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FOREWORD

This report is the fifty-sixth in the IAEA's series of annual reports on operating experience with nuclear power stations worldwide.

As in previous years, in addition to annual performance data and outage information, the report contains statistical information on electricity production and overall performance of individual nuclear power plants that were in operation in the reporting year. In addition to annual information, the report contains a historical summary of performance during the lifetime of individual reactors and showcases worldwide performance data of the nuclear industry.

The intent behind this report, and all related IAEA publications, is to provide a useful tool for everyone concerned with nuclear power. Suggestions and queries from readers are most welcome.

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1. INTRODUCTION

The 2025 edition of this publication contains integrated reports combining nuclear reactor operating experience data with design characteristics and dashboards. The integrated report provides a general overview of each individual operating nuclear power reactor that was in operation in 2024.

The publication provides annual performance data and outage information for individual nuclear power plants. Summaries of historical performance and outages during the lifetimes of those plants are also included. In order to provide a broad picture of nuclear power usage, six figures illustrate global operational statistics up to and including 2024.

The data that form the basis of this publication are a direct output from the IAEA's Power Reactor Information System (PRIS), the database that contains all performance data published in the IAEA's operating experience annual reports since 1970, as well as basic information on power reactors, including design data. It presents operating experience data for all nuclear power plants worldwide from the start date of their commercial operation. The PRIS data are available free of charge to IAEA Member States through its public web site and on-line application, PRIS-Statistics. The web site www.iaea.org/pris contains publicly available information about reactor units and nuclear industry results. PRIS-Statistics (http://pris.iaea.org) provides direct access to the database. This application allows registered users to generate statistical outputs through predesigned reports and filters.

When analysing the performance of nuclear reactors, indicators such as energy production, load, operating and availability factors are often used. Energy unavailability factors, categorized separately for planned and unplanned unavailability (due either to causes under plant management control or to external causes out of plant management control), are used as a measure of energy loss when a unit is not available to the grid on full power. Despite efforts to properly classify unavailability data, some ambiguity remains in operator reports, as it is inherently difficult to find energy losses caused by load following operation and by grid limitation for externally facilitated unavailability. Therefore, for load, operation and unavailability factors, there may be differences between the data compiled in this report and data published elsewhere. For detailed information on data elements and performance indicators included in this publication, please refer to the definitions in Section 2.

Information and data received by the IAEA through 20 June 2025 are included in this publication. All commercially operating units reported data up to this date. Any modifications received at a later date, although not included in this publication, are available in the PRIS database.

The information contained in this publication was made available to the IAEA through designated national PRIS Data Providers and Liaison Officers. The IAEA appreciates the valuable assistance of the national authorities, official correspondents and various utilities in gathering the information for this report.

This publication was compiled by staff of the IAEA's Division of Nuclear Power, Nuclear Power Engineering Section. It is hoped that the publication will serve as a useful tool for nuclear power plant operators, nuclear system designers, nuclear power planners, professional engineers, scientists and others concerned with the operating experience of nuclear power reactors. Suggestions and corrections from readers are most welcome.

2. DEFINITIONS

1. Reference unit power, RUP [$MW_{(e)}$]

The maximum (electrical) power that could be maintained continuously throughout a prolonged period of operation under reference ambient conditions.

It is specified that this value must remain constant for a given unit unless, following permanent modification, or a new permanent authorization, the management decides to amend the original value.

The reference unit power may be gross or net:

– The gross RUP (P_g, $MW_{(e)}$) is deemed to be measured at the output terminals of all generator sets in the station.

– The net RUP (P_n, $MW_{(e)}$), indicating the maximum power that can be supplied, is measured at the station outlet terminals, i.e. after deducting the power taken by station auxiliaries and the losses in the transformers that are considered integral parts of the station.

2. Design net capacity [$MW_{(e)}$]

The net reference unit power as specified in an original unit design.

3. Reference period, T [hours]

For units in power ascension at the end of the period, the clock hours from the beginning of the period or the first electrical production, whichever comes last, to the end of the period.

For units in commercial operation at the end of the period, the clock hours from the beginning of the period or of commercial operation, whichever comes last, to the end of the period or permanent shutdown, whichever comes first.

4. On-line hours, t [hours]

The total clock hours in the reference period during which the unit operated with breakers closed to the station bus.

5. Reference energy generation, REG [$MW_{(e)}h$]

Net electrical energy which would have been supplied to the grid if the unit were operated continuously at the reference unit power during the whole reference period.

6. Energy generated (net), EG [$GW_{(e)}h$]

Net electrical energy produced during the reference period as measured at the unit outlet terminals, i.e. after deducting the electrical energy taken by unit auxiliaries and the losses in transformers that are considered integral parts of the unit. If this quantity is less than zero, zero is reported.

7. Load factor, LF [%]

$$LF = \frac{EG}{REG} \times 100$$

EG = energy generated (net), [$MW_{(e)}h$]
REG = reference energy generation [$MW_{(e)}h$]

Load factor is the ratio of the energy that the power unit has produced over a given period to the energy it would have produced at its reference power capacity over that period.

8. Operation factor, OF [%]

$$OF = \frac{t}{T} \times 100$$

t = number of hours on-line [h]
T = number of hours in the reference period

Operation factor is the ratio of the number of hours the unit was on-line to the total number of hours in the reference period, expressed as a percentage. It is a measure of the unit time availability on the grid and does not depend on the operating power level.

9. Available capacity, P [$MW_{(e)}$]

Maximum net capacity at a given moment at which the unit or station is able or is authorized to be operated at a continuous rating under the prevailing conditions assuming unlimited transmission facilities.

10. Energy loss, EL [$MW_{(e)}h$]

Energy that could have been produced during the reference period by using the unavailable capacity; it is categorized into three types:

- PEL: planned energy loss
- UEL: unplanned energy loss
- XEL: energy loss due to causes external to the plant

UEL comprises shutdowns, unplanned load reductions or outage extensions.

11. Unavailability

A status when the plant is not able to operate at its maximum capacity (reference power). This condition, which may be under or beyond plant management control, should only reflect lack of availability of the plant itself, regardless of energy demand, transmission grid condition or political situation in the country.

Unavailability is classified as planned if it is foreseen at least four weeks in advance, generally at the time when the annual overhaul programme is established, and if the beginning of the unavailability period can be largely controlled and deferred by management. Unavailability is classified as unplanned if not scheduled at least four weeks in advance. Power plant operation at lower than maximum capacity because of lower demand from the grid but occurring while the plant is available to operate at the maximum capacity does not constitute unavailability, either planned or unplanned.

12. Energy availability factor, EAF [%]

$$EAF = \frac{REG - PEL - UEL - XEL}{REG} \times 100$$

The energy availability factor is the ratio of the energy that the available capacity could have produced over a specified period to the energy that the reference unit power could have produced during the same period.

13. Energy unavailability factor, EUF [%]

$$EUF = \frac{EL}{REG} \times 100$$

The unavailability factor is the ratio of the energy losses, EL, that have not been produced during a specified period due to the unavailable capacity, to the energy that the reference unit power could have produced during the same period.

The energy unavailability factor EUF over a specified period can be divided into:

PUF = planned unavailability factor
UUF = unplanned unavailability factor due to causes in the plant
XUF = unplanned unavailability factor due to causes external to the plant.

The unavailability factor can be expressed as: EUF = 100 – EAF

14. Unit capability factor, UCF [%]

$$UCF = \frac{REG - PEL - UEL}{REG} \times 100$$

Unit capability factor is defined as the ratio of the energy that the unit was capable of generating over a given time period considering only limitation under the plant management control to the reference energy generation over the same time period, expressed as a percentage. Both of these energy generation terms are determined relative to reference ambient conditions.

15. Unplanned capability loss factor, UCL [%]

$$UCF = \frac{UEL}{REG} \times 100$$

Unplanned capability loss factor is defined as the ratio of the unplanned energy losses during a given period of time to the reference energy generation, expressed as a percentage. Unplanned energy loss is energy that was not produced during the period because of unplanned shutdowns, outage extensions or unplanned load reductions due to causes under plant management control. Causes of energy losses are considered to be unplanned if they are not scheduled at least four weeks in advance.

16. Construction start

Date when first major placing of concrete, usually for the base mat of the reactor building, is carried out.

17. First criticality

Date when the reactor is made critical for the first time.

18. Grid connection

Date when the plant is first connected to the electrical grid to supply power.

19. Commercial operation

Date when the plant is handed over by the contractors to the owner and officially declared to be in commercial operation.

20. Permanent shutdown

Date when the plant is officially declared shut down by the owner and taken out of operation permanently.

21. Long term shutdown (Suspended operation)

A unit is considered to be in the long term shutdown status if it has been shut down for an extended period (usually several years) without initially having any firm recovery schedule but if there is the intention of re-starting the unit eventually.

22. Outages

For the purpose of PRIS coding, the outage is defined as any status of a reactor unit, when its actual output power is lower than the reference unit power for a period of time. By this definition, the outage includes both power reduction and unit shutdown. The outage is considered significant if the loss in the energy production corresponds to at least ten hours of continuous operation at the reference unit power or if it has been caused by an unplanned reactor scram (even if the unit is shut down for less than ten hours).

23. Outage duration [h]

The total clock hours of the outage measured from the beginning of the reference period or the outage, whichever comes last, to the end of the reference period or the outage, whichever comes first.

24. Factors refer to the plants which were in commercial operation during the whole of the reference period.

25. Cumulative factors are given for the plants which were in commercial operation during full calendar years.

26. A blank and three periods (...), if used in tables, denote information that is not applicable or not available.

27. Types of outages

The outage type is a three-character code. The third character is for unplanned outages only:

Code_1 description:
(P) Planned outage due to causes under the plant management control
(U) Unplanned outage due to causes under the plant management control
(X) Outage due to causes beyond the plant management control ("external")

Code_2 description:
(F) Full outage
(P) Partial outage

Code_3 description:
(1) Controlled shutdown or load reduction that could be deferred but had to be performed earlier than four weeks after the cause occurred or before the next refuelling outage, whichever comes first
(2) Controlled shutdown or load reduction that had to be performed in the next 24 hours after the cause occurred
(3) Extension of planned outage
(4) Reactor scram, automatic
(5) Reactor scram, manual

28. Main causes of outages

(A) Plant equipment failure
(B) Refuelling without maintenance

(C) Inspection, maintenance or repair combined with refuelling
(D) Inspection, maintenance or repair without refuelling
(E) Testing of plant systems or components
(F) Major back-fitting, refurbishment or upgrading activities with refuelling
(G) Major back-fitting, refurbishment or upgrading activities without refuelling
(H) Nuclear regulatory requirements
(I) Grid limitation
(J) Grid failure or grid unavailability
(K) Load-following (frequency control, reserve shutdown due to reduced energy demand)
(L) Human factor related
(M) Governmental requirements or court decisions
(N) Environmental conditions (flood, storm, lightning, lack of cooling water due to dry weather, cooling water temperature limits, etc.)
(O) Load dispatching - prioritization
(P) Fire
(R) External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant, spare part delivery problems, etc.)
(S) Fuel management limitation (including high flux tilt, stretch out or coast-down operation)
(T) Heat supply (on-site to support next unit or desalination and off-site distribution)
(U) Security and access control and other preventive shutdown due to external threats
(Z) Others

29. Plant systems affected

Nuclear Systems

11.00 Reactor and Accessories
11.01 Reactor vessel and main shielding (including penetrations and nozzles)
11.02 Reactor core (including fuel assemblies)
11.03 Reactor internals (including steam separators/dryers – BWR, graphite, pressure tubes)
11.04 Auxiliary shielding and heat insulation
11.05 Moderator and auxiliaries (PHWR)
11.06 Annulus gas system (PHWR/RBMK)
11.99 None of the above systems

12.00 Reactor I&C Systems
12.01 Control and safety rods (including drives and special power supply)
12.02 Neutron monitoring (in-core and ex-core)
12.03 Reactor instrumentation (except neutron)
12.04 Reactor control system
12.05 Reactor protection system
12.06 Process computer
12.07 Reactor recirculation control (BWR)
12.99 None of the above systems

13.00 Reactor Auxiliary Systems
13.01 Primary coolant treatment and clean-up system
13.02 Chemical and volume control system
13.03 Residual heat removal system (including heat exchangers)

13.04 Component cooling system
13.05 Gaseous, liquid and solid radwaste treatment systems
13.06 Nuclear building ventilation and containment inerting system
13.07 Nuclear equipment venting and drainage system (including room floor drainage)
13.08 Borated or refuelling water storage system
13.09 CO_2 injection and storage system (GCR)
13.10 Sodium heating system (FBR)
13.11 Primary pump oil system (including RCP or make-up pump oil)
13.12 D_2O leakage collection and dryer system (PHWR)
13.13 Essential auxiliary systems (GCR)
13.99 None of the above systems

14.00 Safety Systems
14.01 Emergency core cooling systems (including accumulators and core spray system)
14.02 High pressure safety injection and emergency poisoning system
14.03 Auxiliary and emergency feedwater system
14.04 Containment spray system (active)
14.05 Containment pressure suppression system (passive)
14.06 Containment isolation system (isolation valves, doors, locks and penetrations)
14.07 Containment structures
14.08 Fire protection system
14.99 None of the above systems

15.00 Reactor Cooling Systems
15.01 Reactor coolant pumps/blowers and drives
15.02 Reactor coolant piping (including associated valves)
15.03 Reactor coolant safety and relief valves (including relief tank)
15.04 Reactor coolant pressure control system
15.05 Main steam piping and isolation valves (BWR)
15.99 None of the above systems

16.00 Steam Generation Systems
16.01 Steam generator (PWR), boiler (PHWR, AGR), steam drum vessel (RBMK, BWR)
16.02 Steam generator blowdown system
16.03 Steam drum level control system (RBMK, BWR)
16.99 None of the above systems

17.00 Safety I&C Systems (excluding reactor I&C)
17.01 Engineered safeguard feature actuation system
17.02 Fire detection system
17.03 Containment isolation function
17.04 Main steam/feedwater isolation function
17.05 Main steam pressure emergency control system (turbine bypass and steam dump valve control)
17.06 Failed fuel detection system (DN monitoring system for PHWR)
17.07 RCS integrity monitoring system (RBMK)
17.99 None of the above systems

Fuel and Refuelling Systems

21.00 Fuel Handling and Storage Facilities
21.01 On-power refuelling machine
21.02 Fuel transfer system
21.03 Storage facilities, including treatment plant and final loading and cask handling facilities
21.99 None of the above systems

Secondary plant systems

31.00 Turbine and Auxiliaries
31.01 Turbine
31.02 Moisture separator and reheater
31.03 Turbine control valves and stop valves
31.04 Main condenser (including vacuum system)
31.05 Turbine by-pass valves
31.06 Turbine auxiliaries (lubricating oil, gland steam, steam extraction)
31.07 Turbine control and protection system
31.99 None of the above systems

32.00 Feedwater and Main Steam System
32.01 Main steam piping and valves
32.02 Main steam safety and relief valves
32.03 Feedwater system (including feedwater tank, piping, pumps and heaters)
32.04 Condensate system (including condensate pumps, piping and heaters)
32.05 Condensate treatment system
32.99 None of the above systems

33.00 Circulating Water System
33.01 Circulating water system (pumps and piping/ducts excluding heat sink system)
33.02 Cooling towers/heat sink system
33.03 Emergency ultimate heat sink system
33.99 None of the above systems

34.00 Miscellaneous systems
34.01 Compressed air (essential and non-essential/high-pressure and low-pressure)
34.02 Gas storage, supply and cleanup systems (nitrogen, hydrogen, carbon dioxide, etc.)
34.03 Service water/process water supply system (including water treatment)
34.04 Demineralized water supply system (including water treatment)
34.05 Auxiliary steam supply system (including boilers and pressure control equipment)
34.06 Non-nuclear area ventilation (including main control room)
34.07 Chilled water supply system
34.08 Chemical additive injection and makeup systems
34.09 Non-nuclear equipment venting and drainage system
34.10 Communication system
34.99 None of the above systems

35.00 All Other I&C Systems
35.01 Plant process monitoring systems (excluding process computer)
35.02 Leak monitoring systems
35.03 Alarm annunciation system
35.04 Plant radiation monitoring system
35.05 Plant process control systems
35.99 None of the above systems

Electrical Systems

41.00 Main Generator Systems
41.01 Generator and exciter (including generator output breaker)
41.02 Sealing oil system
41.03 Rotor cooling gas system
41.04 Stator cooling water system
41.05 Main generator control and protection system
41.99 None of the above systems

42.00 Electrical Power Supply Systems
42.01 Main transformers
42.02 Unit self-consumption transformers (station, auxiliary, house reserve, etc.)
42.03 Vital AC and DC plant power supply systems (medium and low voltage)
42.04 Non-vital AC plant power supply system (medium and low voltage)
42.05 Emergency power generation system (e.g. emergency diesel generator and auxiliaries)
42.06 Power supply system logics (including load shed logic, emergency bus transfer logic, load sequencer logic, breaker trip logic, etc.)
42.07 Plant switchyard equipment
42.99 None of the above systems

Note: Detailed definitions of performance indicators and PRIS related terms can be found in IAEA Technical Reports Series No. 428, The Power Reactor Information System (PRIS) and its Extension to Non-electrical Applications, Decommissioning and Delayed Projects Information, IAEA, Vienna (2005)

3. ABBREVIATIONS

COUNTRY CODES

AE	UNITED ARAB EMIRATES
AM	ARMENIA
AR	ARGENTINA
BE	BELGIUM
BG	BULGARIA
BR	BRAZIL
BL	BELARUS
CA	CANADA
CH	SWITZERLAND
CN	CHINA
CZ	CZECH REPUBLIC
DE	GERMANY
ES	SPAIN
FI	FINLAND
FR	FRANCE
GB	UNITED KINGDOM
HU	HUNGARY
IN	INDIA
IR	IRAN, ISLAMIC REPUBLIC OF
JP	JAPAN
KR	KOREA, REPUBLIC OF
MX	MEXICO
NL	NETHERLANDS, KINGDOM OF THE
PK	PAKISTAN
RO	ROMANIA
RU	RUSSIAN FEDERATION
SE	SWEDEN
SI	SLOVENIA
SK	SLOVAKIA
UA	UKRAINE
US	UNITED STATES OF AMERICA
ZA	SOUTH AFRICA

Note: TW - Code for Taiwan, China.

REACTOR TYPES

BWR	BOILING LIGHT WATER COOLED AND MODERATED REACTOR
FBR	FAST BREEDER REACTOR
GCR	GAS COOLED, GRAPHITE MODERATED REACTOR
LWGR	LIGHT WATER COOLED, GRAPHITE MODERATED REACTOR
PHWR	PRESSURIZED HEAVY WATER MODERATED AND COOLED REACTOR
PWR	PRESSURIZED LIGHT WATER MODERATED AND COOLED REACTOR

OPERATORS

AEP	AMERICAN ELECTRIC POWER COMPANY, INC.
AmerenUE	AMEREN UE, UNION ELECTRIC COMPANY
ANAV	ASOCIACION NUCLEAR ASCO-VANDELLOS A.I.E. (ENDESA/ID)
ANPPCJSC	CLOSED JOINT STOCK COMPANY ARMENIAN NPP
APS	ARIZONA PUBLIC SERVICE CO.
Axpo AG	KERNKRAFTWERK BEZNAU
BKW	BKW ENERGIE AG
BRUCEPOW	BRUCE POWER
CCNPP	CALVERT CLIFFS NUCLEAR POWER PLANT INC.
CEZ	CZECH POWER CO., CEZ A.S.
CFE	COMISION FEDERAL DE ELECTRICIDAD
CHUBU	CHUBU ELECTRIC POWER CO., INC.
CHUGOKU	THE CHUGOKU ELECTRIC POWER CO., INC.
CIAE	CHINA INSTITUTE OF ATOMIC ENERGY
CNAT	CENTRALES NUCLEARES ALMARAZ-TRILLO
CNNO	CNNC NUCLEAR OPERARION MANAGEMENT COMPANY LIMITED.
DNMC	DAYA BAY NUCLEAR POWER OPERATIONS AND MANAGEMENT CO, LTD.
DOMINION	DOMINION ENERGY
DTEDISON	DETROIT EDISON CO.
DUKEENER	DUKE ENERGY CORP.
E.ON	E.ON KERNKRAFT GMBH
EDF	ELECTRICITE DE FRANCE
EDF UK	EDF ENERGY
ELECTRAB	ELECTRABEL
ELETRONU	ELETROBRAS ELETRONUCLEAR S.A.
ENERGYNW	ENERGY NORTHWEST
EnKK	ENBW KERNKRAFT GMBH
ENTERGY	ENTERGY NUCLEAR OPERATIONS, INC.
EPZ	N.V. ELEKTRICITEITS-PRODUKTIEMAATSCHAPPIJ ZUID-NEDERLAND
ESKOM	ESKOM
EXELON	EXELON GENERATION CO., LLC.
FENOC	FIRST ENERGY NUCLEAR OPERATING CO.
FKA	FORSMARK KRAFTGRUPP AB
FORTUMPH	FORTUM POWER AND HEAT OY (FORMER IVO)
FPL	FLORIDA POWER & LIGHT CO.
FQNP	CNNC FUJIAN FUQING NUCLEAR POWER CO., LTD.
GFNPC	GUANGXI FANGCHENGGANG NUCLEAR POWER COMPANY, LTD.
HEPCO	HOKKAIDO ELECTRIC POWER CO., INC.
HNPC	HAINAN NUCLEAR POWER COMPANY
HOKURIKU	HOKURIKU ELECTRIC POWER CO.
ID	IBERDROLA, S.A.
JAPCO	JAPAN ATOMIC POWER CO.
JNPC	JIANGSU NUCLEAR POWER CORPORATION
KEPCO	KANSAI ELECTRIC POWER CO.
KGG	KERNKRAFTWERK GUNDREMMINGEN GMBH
KHNP	KOREA HYDRO AND NUCLEAR POWER CO.

KKG	KERNKRAFTWERK GOESGEN-DAENIKEN AG
KKL	KERNKRAFTWERK LEIBSTADT
KLE	KERNKRAFTWERKE LIPPE-EMS GMBH
KOZNPP	KOZLODUY NPP, PLC.
KWG	GEMEINSCHAFTSKERNKRAFTWERK GROHNDE GMBH & CO. OHG.
KYUSHU	KYUSHU ELECTRIC POWER CO., INC.
LHNPC	LIAONING HONGYANHE NUCLEAR POWER CO. LTD. (LHNPC)
LUMINANT	LUMINANT GENERATION COMPANY, LLC.
NASA	NUCLEOELECTRICA ARGENTINA, S.A.
NBEPC	NEW BRUNSWICK ELECTRIC POWER COMMISSION
NDNP	FUJIAN NINGDE NUCLEAR POWER COMPANY, LTD.
NEK	NUKLERANA ELEKTRARNA KRŠKO
NEXTERA	NEXTERA ENERGY RESOURCES, LLC
NNEGC	NATIONAL NUCLEAR ENERGY GENERATING COMPANY ‘ENERGOATOM
NPCIL	NUCLEAR POWER CORPORATION OF INDIA, LTD.
NPPDCO	NUCLEAR POWER PRODUCTION & DEVELOPEMENT CO. OF IRAN
NPQJVC	NUCLEAR POWER PLANT QINSHAN JOINT VENTURE COMPANY, LTD.
NSP	NORTHERN STATES POWER CO. (SUBSIDIARY OF XCEL ENERGY)
OKG	OKG AKTIEBOLAG
OPG	ONTARIO POWER GENERATION
PAEC	PAKISTAN ATOMIC ENERGY COMMISSION
PAKS Zrt	PAKS NUCLEAR POWER PLANT, LTD.
PG&E	PACIFIC GAS AND ELECTRIC COMPANY
PPL_SUSQ	PPL SUSQUEHANNA, LLC.
PROGRESS	PROGRESS ENERGY
PSEG	PSEG NUCLEAR, LLC.
QNPC	QINSHAN NUCLEAR POWER COMPANY
RAB	RINGHALS, AB
REA	JOINT STOCK COMPANY 'CONCERN ROSENERGOATOM'
SCE&G	SOUTH CAROLINA ELECTRIC & GAS CO.
SE, plc	SLOVENSKÉ ELEKTRÁRNE, A.S.
SHIKOKU	SHIKOKU ELECTRIC POWER CO., INC.
SNN	SOCIETATEA NATIONALA NUCLEARELECTRICA S.A.
SOUTHERN	SOUTHERN NUCLEAR OPERATING COMPANY, INC.
STP	STP NUCLEAR OPERATING CO.
TEPCO	TOKYO ELECTRIC POWER COMPANY HOLDINGS, INC.
TOHOKU	TOHOKU ELECTRIC POWER CO., INC.
TPC	TAIWAN POWER CO.
TQNPC	THE THIRD QINSHAN JOINTED VENTURE COMPANY LTDA.
TVA	TENNESSEE VALLEY AUTHORITY
TVO	TEOLLISUUDEN VOIMA OYJ
WCNOC	WOLF CREEK NUCLEAR OPERATION CORP.
YJNPC	YANGJIANG NUCLEAR POWER COMPANY

REACTOR SUPPLIERS

ABBATOM	ABBATOM (FORMERLY ASEA-ATOM)
ACECOWEN	ACECOWEN (ACEC-COCKERILL-WESTINGHOUSE)
ACLF	(ACECOWEN - CREUSOT LOIRE - FRAMATOME)
AECL	ATOMIC ENERGY OF CANADA, LTD.
AECL/DAE	ATOMIC ENERGY OF CANADA, LTD./DEPARTMENT OF ATOMIC ENERGY(INDIA)
AECL/DHI	ATOMIC ENERGY OF CANADA, LTD./DOOSAN HEAVY INDUSTRY & CONSTRUCTION
AEE	ATOMENERGOEXPORT
APC	ATOMIC POWER CONSTRUCTION, LTD.
ASE	JSC ATOMSTROYEXPORT
ASEASTAL	ASEA-ATOM/STAL-LAVAL
B&W	BABCOCK & WILCOX CO.
CE	COMBUSTION ENGINEERING CO.
CFHI	CHINA FIRST HEAVY INDUSTRIES
CGE	CANADIAN GENERAL ELECTRIC
CNNC	CHINA NATIONAL NUCLEAR CORPORATION
DEC	DONGFANG ELECTRIC CORPORATION DEC-NPIC-FANP
DHICKAEC	DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO., LTD./KOREA ATOMICENERGY RESEARCH INSTITUTE/COMBUSTIONENGINEERING
DHICKOPC	DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO., LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING
FAEA	FEDERAL ATOMIC ENERGY AGENCY
FRAM	FRAMATOME
FRAMACEC	FRAMACECO (FRAMATOME-ACEC-COCKERILL)
GE	GENERAL ELECTRIC CO.
GETSCO	GENERAL ELECTRIC TECHNICAL SERVICES CO.
HITACHI	HITACHI, LTD.
IZ	IZHORSKIYE ZAVODY
KWU	SIEMENS KRAFTWERK UNION AG
MAEP	MINATOMENERGOPROM, MINISTRY OF NUCLEAR POWER AND INDUSTRY
MHI	MITSUBISHI HEAVY INDUSTRIES, LTD.
NNC	NATIONAL NUCLEAR CORPORATION
NPC	NUCLEAR POWER CO., LTD.
NPCIL	NUCLEAR POWER CORPORATION OF INDIA, LTD.
NPIC	NUCLEAR POWER INSTITUTE OF CHINA
OH/AECL	ONTARIO HYDRO/ATOMIC ENERGY OF CANADA, LTD.
PAA	PRODUCTION AMALGAMATION 'ATOMMASH', VOLGODONSK
PAIP	PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH, VOLGODONSK, RUSSIA
PPC	PWR POWER PROJECTS, LTD.
ROSATOM	STATE ATOMIC ENERGY CORPORATION "ROSATOM"
S/KWU	SIEMENS/KRAFTWERK UNION AG
SHE	SHANGHAI ELECTRIC
SIEMENS	SIEMENS AG, POWER GENERATION
SKODA	SKODA CONCERN NUCLEAR POWER PLANT WORKS
TNPG	THE NUCLEAR POWER GROUP, LTD.
TOSHIBA	TOSHIBA CORPORATION
WH	WESTINGHOUSE ELECTRIC CORPORATION
WH/MHI	WESTINGHOUSE ELECTRIC CORPORATION/MITSUBISHI HEAVY INDUSTRIES, LTD.

4. FIGURES

1. Years of operating experience of nuclear power reactors
2. Lifetime energy availability factors up to 2024
3. Reactors with high availability factors for years 1985–2024
4. Average energy availability factors for years 1985–2024
5. Number of reactors in operation (as of 31 December 2024)
6. Number of reactors by age (as of 31 December 2024)

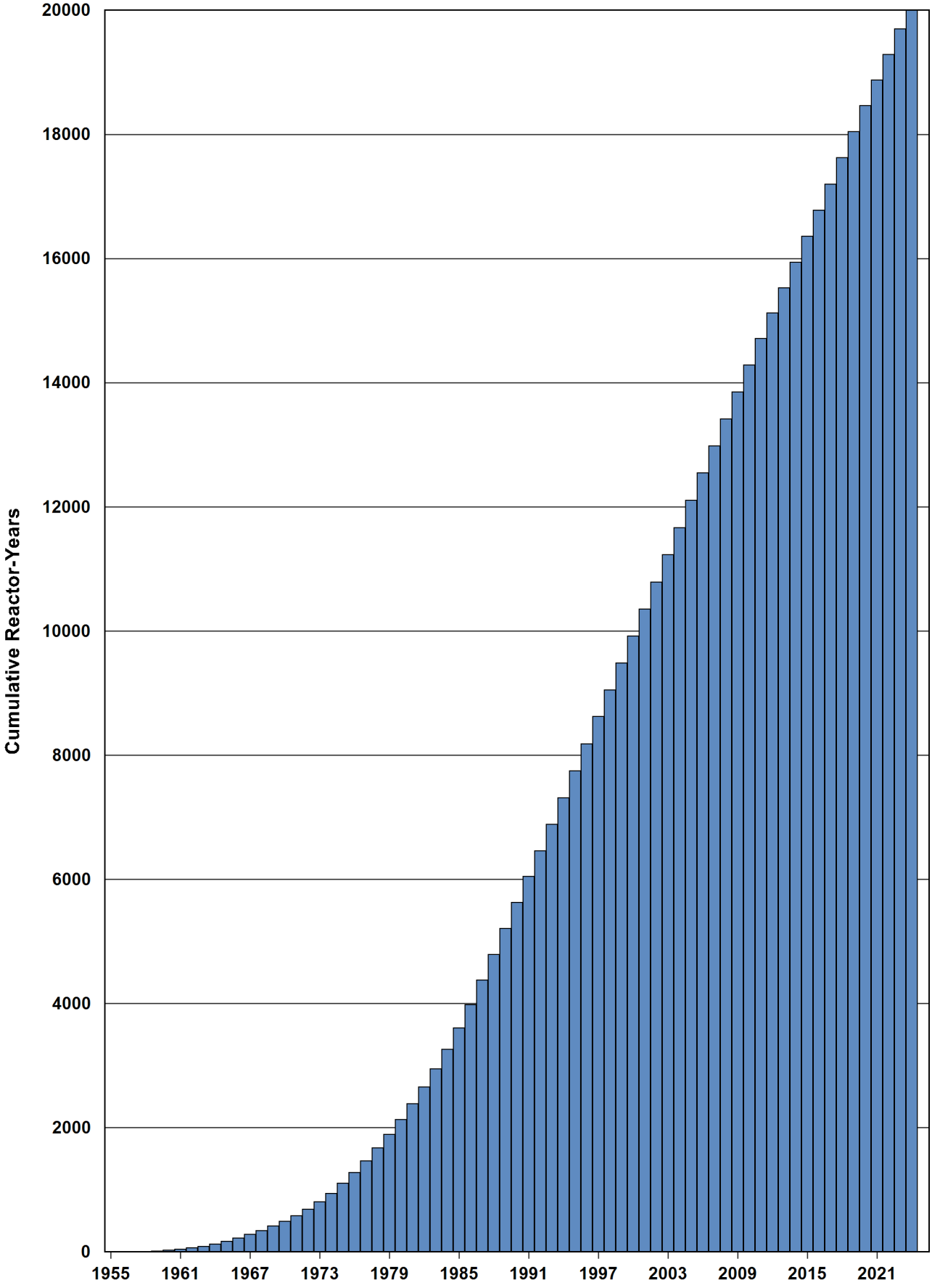


Figure 1 — Nuclear Power Reactors Operating Experience

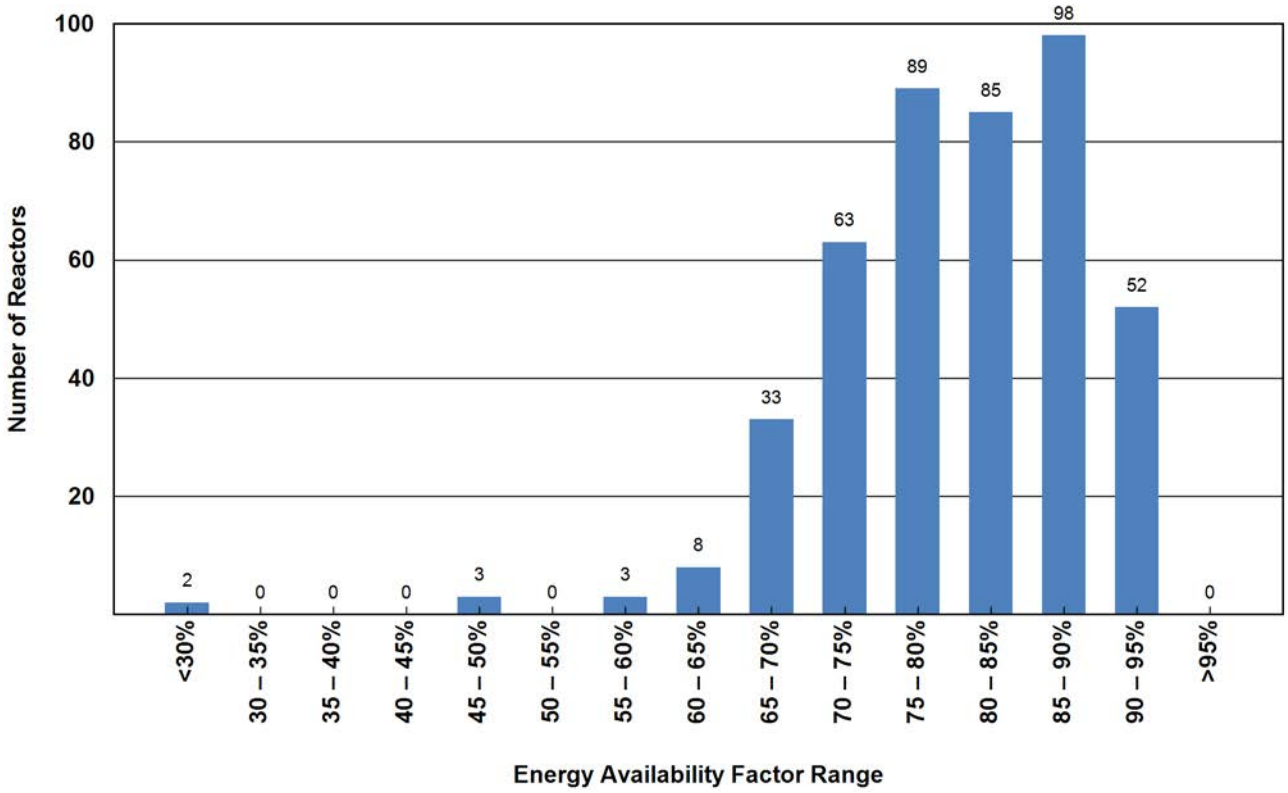


Figure 2 — Lifetime Energy Availability Factors up to 2024

(only reactors with capacity greater than 100 MW(e) and with more than one year of commercial operation)

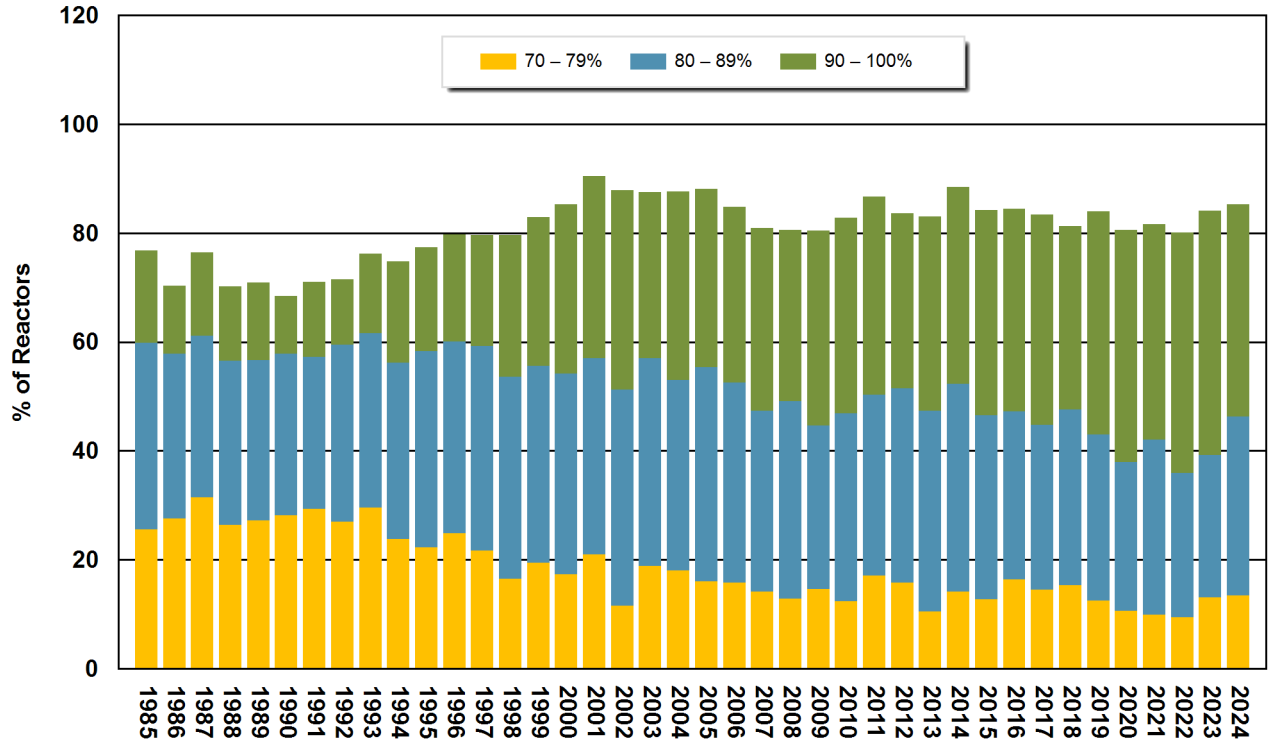


Figure 3 — Reactors with High Availability Factors

(only reactors with capacity greater than 100 MW(e) and with more than one year of commercial operation)

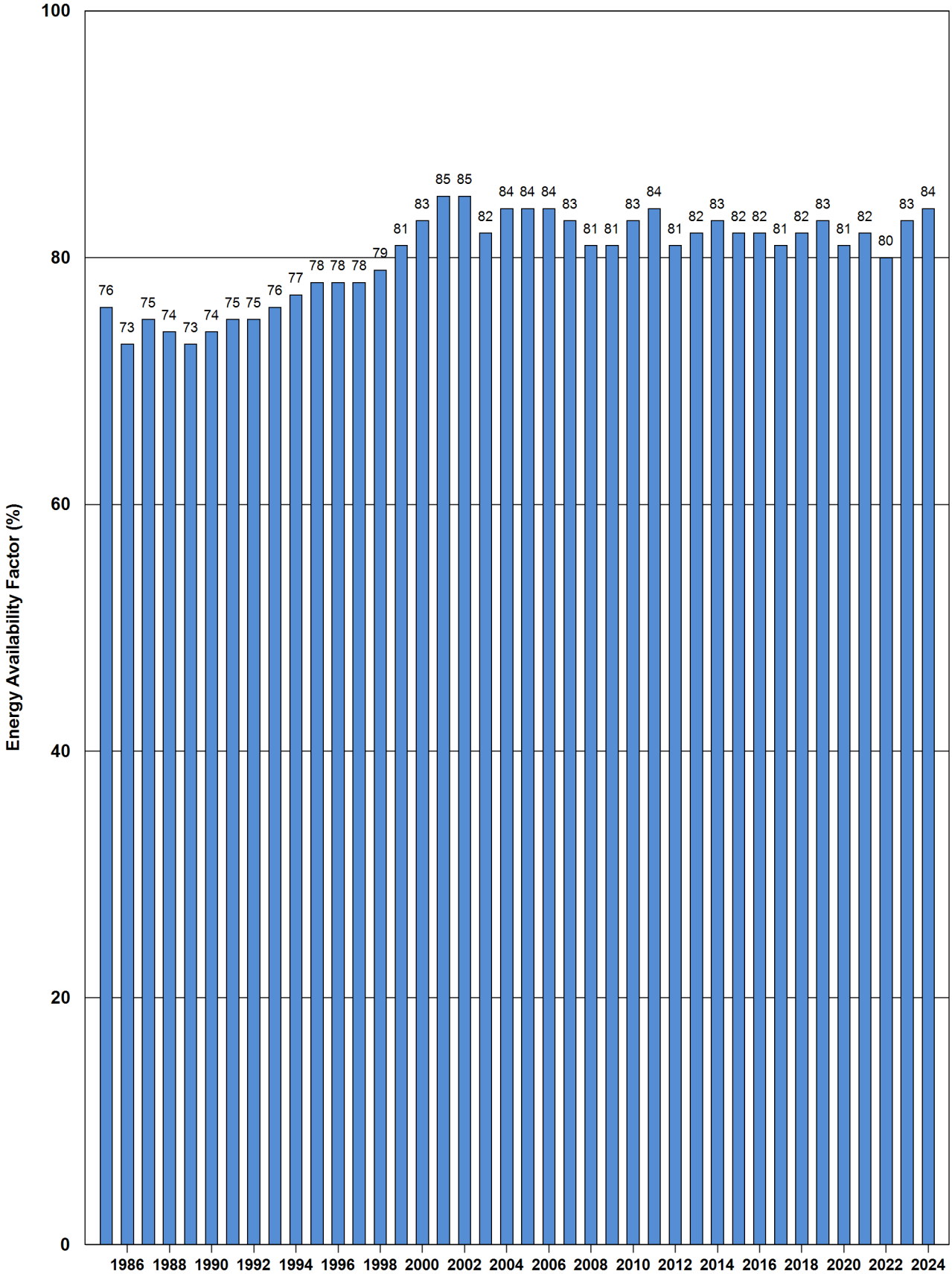


Figure 4 — Average Energy Availability Factors

(only reactors with capacity greater than 100 MW(e) and with more than one year of commercial operation)

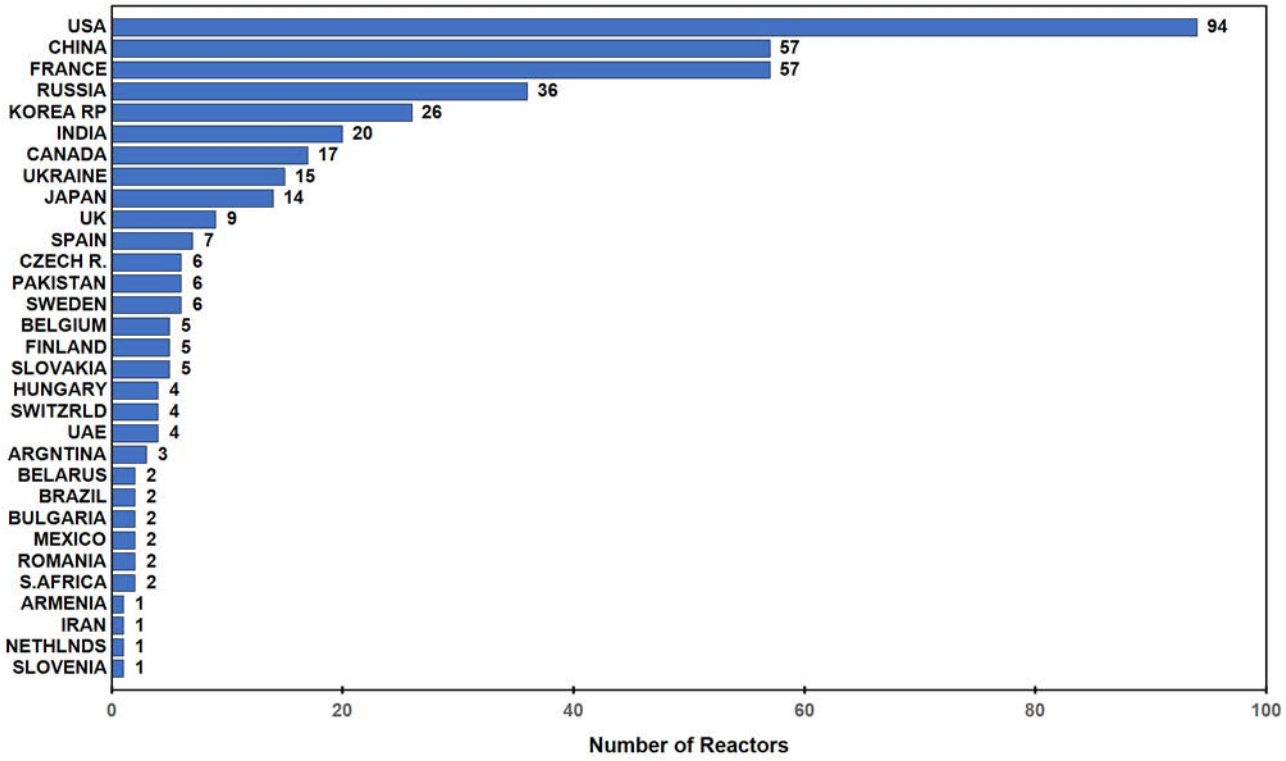


Figure 5 — Number of Reactors in Operation (as of 1 January 2025)

Note: There were 1 reactors in operation in Taiwan, China.

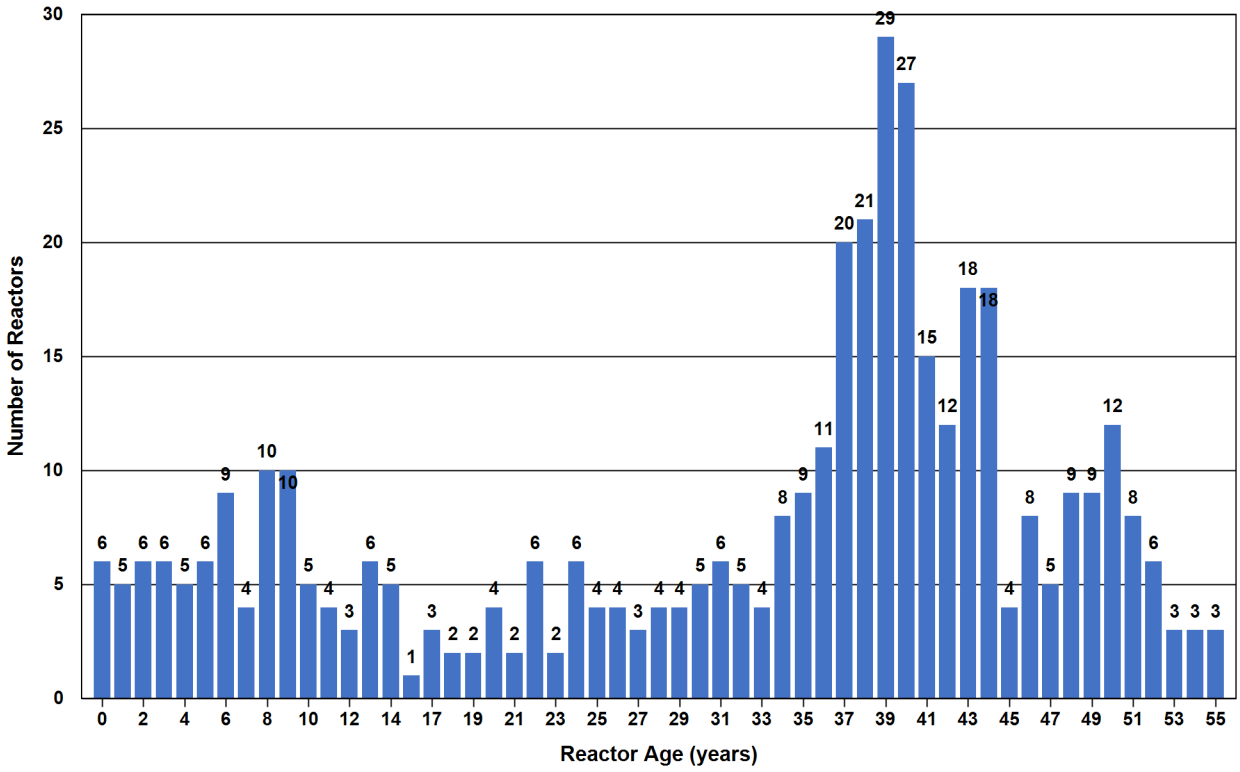


Figure 6 — Number of Reactors by Age (as of 1 January 2025)

5. DATA SHEETS ON INDIVIDUAL NUCLEAR POWER REACTORS

Table 5: Nuclear Power Reactors in Operations in 2024

COUNTRY	NUMBER OF REACTORS IN OPERATION IN 2024	CAPACITY (MW(e))
ARGENTINA	3	1 641
ARMENIA	1	416
BELARUS	2	2 220
BELGIUM	5	3 908
BRAZIL	2	1 884
BULGARIA	2	2 006
CANADA	17	12 714
CHINA	57	55 320
CZECH REPUBLIC	6	3 963
FINLAND	5	4 369
FRANCE	57	63 000
HUNGARY	4	1 916
INDIA	20	6 920
IRAN, ISLAMIC REPUBLIC OF	1	915
JAPAN	14	12 631
KOREA, REPUBLIC OF	26	25 609
MEXICO	2	1 552
NETHERLANDS, KINGDOM OF THE	1	482
PAKISTAN	6	3 262
ROMANIA	2	1 300
RUSSIA	36	26 802
SLOVAKIA	5	2 302
SLOVENIA	1	696
SOUTH AFRICA	2	1 854
SPAIN	7	7 123
SWEDEN	6	7 008
SWITZERLAND	4	2 973
UKRAINE	15	13 107
UNITED ARAB EMIRATES	4	5 348
UNITED KINGDOM	9	5 883
UNITED STATES OF AMERICA	94	96 952
TOTALS*:	**417**	**3 777 014**

* The total includes 1 reactor (938 MW(e)) in Taiwan, China.
The total above does not include the 23 reactors (Japan 19 reactors, and India 4 reactors) in Suspended Operation.

2024 Operating Experience

AR-1 ATUCHA-1 ARGENTINA

Status at end of year : **Operational**
Operator : NASA (NUCLEOELECTRICA ARGENTINA S.A.)
Owner : NASA (NUCLEOELECTRICA ARGENTINA S.A.)
Reactor Supplier : SIEMENS (Siemens AG, Power Generation)
Turbine Supplier : SIEMENS (Siemens AG, Power Generation)



Reactor Unit Details

Reactor type and model	:	PHWR / PHWR KWU
Thermal power	:	1179 MWth
Gross electrical power	:	362 MWe
Reference unit power (net)	:	340 MWe

Key Dates

Construction Date	:	1968-05-31
Grid Date	:	1974-03-19
Commercial Date	:	1974-06-24
Age at end of year	:	50 years

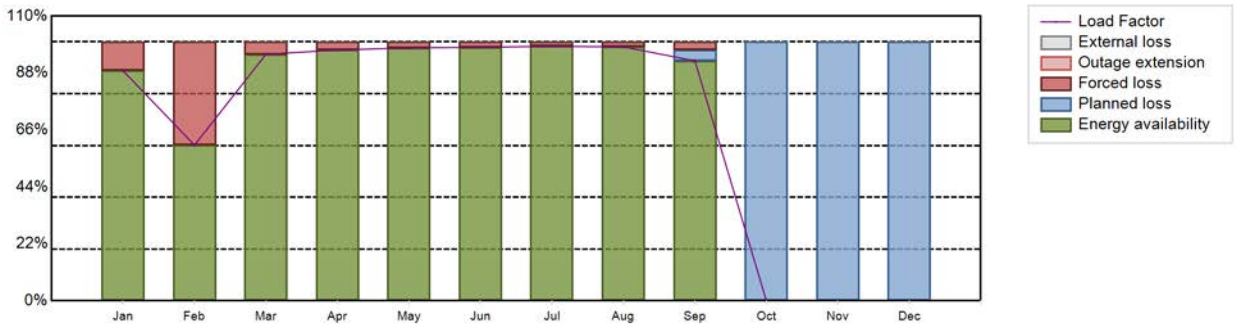
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	11.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	303.3
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	0.28
Average fuel enrichment [% of U235]	:	0.85	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	NA	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	14000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	4.51	HP cylinder inlet steam pressure [MPa]	:	4.26
Active core height/length [m]	:	5.3	Output voltage [kV]	:	21
Number of fissile fuel assemblies/bundles	:	250	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	22.73	Number of main condensate pumps	:	3
Number of control rod assemblies	:	29	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	3
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	2055.74 GW(e).h	Forced Loss Rate (FLR)	:	7.62 %
Energy Availability Factor (EAF)	:	68.83 %	Unplanned Capability Loss Factor (UCL)	:	5.68 %
Unit Capability Factor (UCF)	:	68.83 %	Planned Unavailability Factor (PUF)	:	25.49 %
Load Factor (LF)	:	68.83 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	71.54 %	Total off-line time	:	2500 hours

Annual Summary



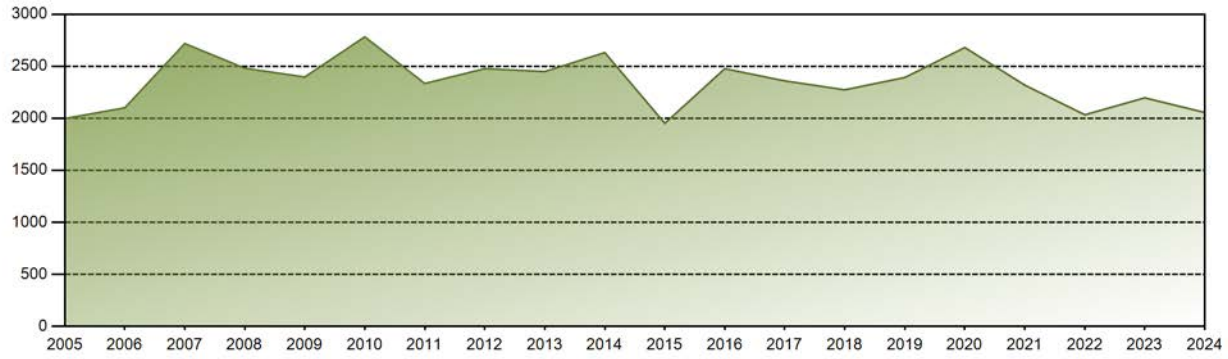
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	224.83	142.30	240.90	237.16	247.09	239.75	248.67	248.06	226.96	0.00	0.00	0.00	2055.74
EAF [%]	88.88	60.13	95.23	96.88	97.68	97.94	98.31	98.06	92.71	0.00	0.00	0.00	68.83
UCF [%]	88.88	60.13	95.23	96.88	97.68	97.94	98.31	98.06	92.71	0.00	0.00	0.00	68.83
LF [%]	88.88	60.13	95.23	96.88	97.68	97.94	98.31	98.06	92.71	0.00	0.00	0.00	68.83
OF [%]	93.15	69.83	100.00	100.00	100.00	100.00	100.00	100.00	95.69	0.00	0.00	0.00	71.54
FLR [%]	11.12	39.87	4.77	3.12	2.32	2.06	1.69	1.94	3.17	0.00	0.00	0.00	7.62
UCL [%]	11.12	39.87	4.77	3.12	2.32	2.06	1.69	1.94	3.03	0.00	0.00	0.00	5.68
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.25	100.00	100.00	100.00	25.49
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	107775.46 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	10.35 %
Cumulative Energy Availability Factor (EAF)	:	74.32 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	9.19 %
Cumulative Unit Capability Factor (UCF)	:	75.24 %	Cumulative Planned Unavailability Factor (PUF)	:	15.57 %
Cumulative Load Factor (LF)	:	72.47 %	Cumulative Externally cause unavailability (XUF)	:	0.92 %
Cumulative Operating Factor (OF)	:	77.74 %			

Electricity Production (net) [GWh]

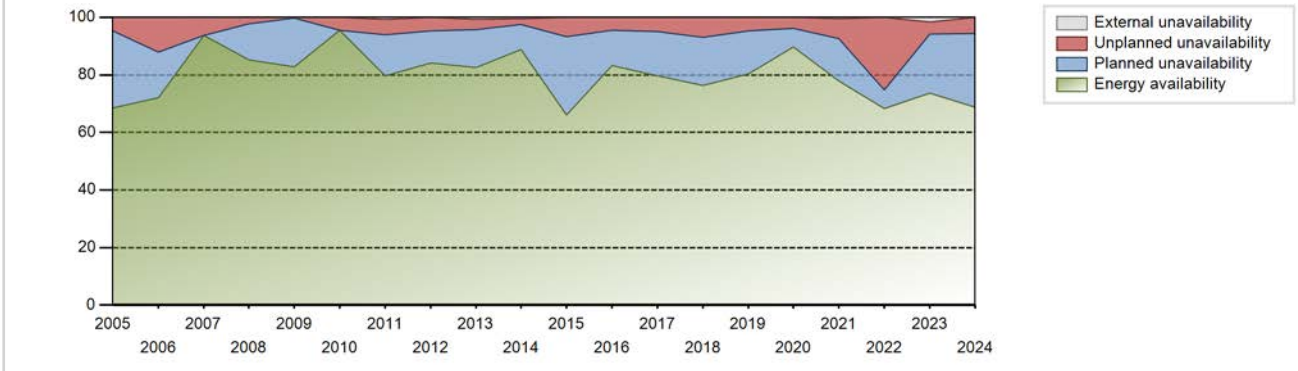


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1974	947.50	4458	321	50.27	51.01	50.29	65.96	16.06	9.76	39.23	0.73
1975	2357.80	7730	319	85.63	85.63	84.37	88.24	5.33	4.82	9.55	0.00
1976	2408.60	7808	319	86.89	86.89	85.96	88.89	10.93	10.66	2.45	0.00
1977	1537.00	4650	336	52.99	52.99	52.15	53.08	24.01	16.75	30.26	0.00
1978	2711.81	8026	345	90.89	90.89	89.73	91.62	8.88	8.85	0.26	0.00
1979	2503.70	7551	335	84.14	84.14	85.32	86.20	15.72	15.70	0.16	0.00
1980	2180.50	6947	335	73.51	73.51	74.10	79.09	8.40	6.74	19.74	0.00
1981	2647.60	8120	335	89.66	89.66	90.22	92.69	8.38	8.20	2.13	0.00
1982	1753.60	5600	335	59.17	59.17	59.76	63.93	13.18	8.98	31.85	0.00
1983	2356.00	8101	335	78.36	78.36	80.28	92.48	11.09	9.77	11.87	0.00
1984	1706.12	8678	335	98.74	98.74	57.98	98.79	1.26	1.26	0.00	0.00
1985	1470.45	7159	335	91.58	91.58	50.11	81.72	8.42	8.42	0.00	0.00
1986	2204.96	7532	335	75.83	75.83	75.14	85.98	10.36	8.76	15.40	0.00
1987	1405.80	4391	335	49.18	49.24	47.90	50.13	29.90	21.01	29.75	0.06
1988	808.10	2515	335	27.07	27.07	27.46	28.63	72.93	72.93	0.00	0.00
1989	0.00	0	335	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1990	1722.59	7201	335	58.70	84.89	58.70	82.20	6.76	6.15	8.96	26.19
1991	2721.89	8390	335	92.58	92.58	92.75	95.78	7.35	7.34	0.08	0.00
1992	2230.24	7089	335	76.33	76.33	75.79	80.70	7.71	6.38	17.29	0.00
1993	2403.66	7287	335	82.16	82.16	81.91	83.18	6.54	5.75	12.09	0.00
1994	2651.86	7916	335	90.37	90.37	90.37	90.37	1.19	1.08	8.55	0.00
1995	2671.71	8376	335	92.28	92.28	91.04	95.62	7.58	7.57	0.15	0.00
1996	2038.80	6990	335	70.62	70.62	69.28	79.58	6.80	5.15	24.23	0.00
1997	2720.14	8329	335	93.36	93.36	92.69	95.08	6.64	6.64	0.00	0.00
1998	2374.36	7242	335	81.32	81.40	80.91	82.67	6.76	5.90	12.69	0.08
1999	1395.50	4364	335	47.81	47.81	47.55	49.82	25.70	16.54	35.66	0.00
2000	1677.85	5038	335	56.85	72.76	57.02	57.35	27.24	27.24	0.00	15.92
2001	1425.96	4407	335	48.74	48.74	48.59	50.31	28.98	19.89	31.38	0.00
2002	1011.50	3030	335	34.58	34.58	34.47	34.59	16.39	6.78	58.64	0.00
2003	2020.60	6094	335	68.76	68.76	68.85	69.57	9.42	7.15	24.09	0.00
2004	2725.01	8250	335	92.17	92.17	92.60	93.92	7.83	7.83	0.00	0.00
2005	1997.96	7004	335	68.50	68.50	68.08	79.95	6.44	4.72	26.79	0.00
2006	2100.55	6403	335	72.10	72.10	71.58	73.09	14.45	12.18	15.72	0.00
2007	2718.74	8300	335	93.83	93.95	92.64	94.75	6.05	6.05	0.00	0.12
2008	2481.26	7562	335	85.27	85.27	84.32	86.09	2.49	2.18	12.55	0.00
2009	2397.18	7296	335	82.88	82.88	81.69	83.29	0.38	0.32	16.80	0.00
2010	2782.75	8560	335	95.52	95.52	94.83	97.72	4.48	4.48	0.00	0.00

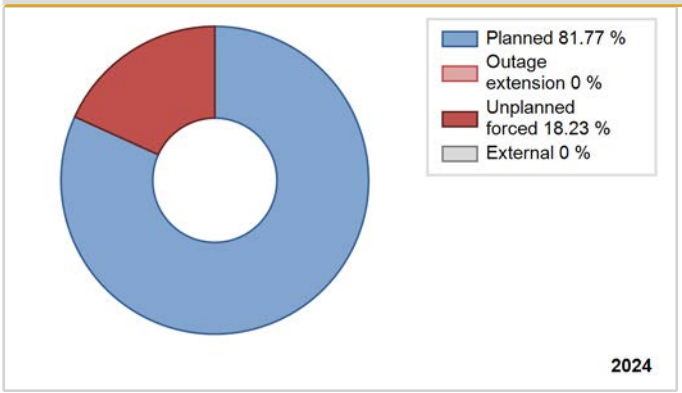
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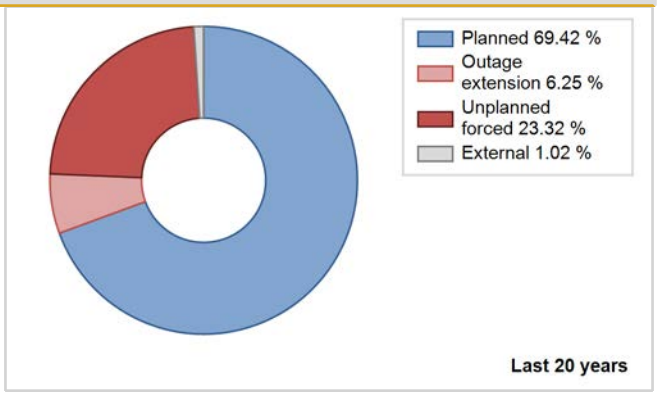
2011	2334.46	7289	335	79.63	80.28	79.55	83.21	4.07	5.45	14.27	0.65
2012	2477.36	7521	335	84.15	84.15	84.19	85.62	5.20	4.61	11.24	0.00
2013	2449.53	7310	340	82.55	83.29	82.75	83.45	2.94	3.49	13.22	0.73
2014	2631.71	7875	340	88.78	89.28	88.36	89.90	0.00	1.89	8.83	0.50
2015	1951.35	6109	340	66.00	66.03	65.52	69.74	6.26	6.69	27.28	0.03
2016	2476.82	7700	340	83.27	83.27	82.93	87.66	4.66	4.40	12.33	0.00
2017	2359.66	7832	340	79.70	79.70	79.23	89.41	5.87	4.97	15.33	0.00
2018	2274.09	7393	340	76.27	76.27	76.35	84.39	7.72	7.01	16.73	0.00
2019	2392.40	7341	340	80.33	80.33	80.33	83.80	5.48	4.66	15.01	0.00
2020	2680.41	8067	340	89.75	89.75	89.75	91.84	3.80	3.84	6.41	0.00
2021	2318.78	7243	340	77.85	78.38	77.85	82.68	7.80	6.90	14.72	0.53
2022	2034.01	6528	340	68.29	68.34	68.29	74.52	11.42	25.21	6.45	0.05
2023	2197.12	6855	340	73.77	75.26	73.77	78.25	5.46	4.34	20.40	1.49
2024	2055.74	6284	340	68.83	68.83	68.83	71.54	7.62	5.68	25.49	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1974 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		261			606	
C. Inspection, maintenance or repair combined with refuelling				27		
D. Inspection, maintenance or repair without refuelling	2239			1147	11	
E. Testing of plant systems or components				9		
G. Major backfitting, refurbishment or upgrading activities without refuelling				28		
H. Nuclear regulatory requirements					59	
J. Grid limitation, failure or grid unavailability						18
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						20
L. Human factor related					38	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						2
Subtotal	2239	261		1211	714	40
Total		**2500**			**1965**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1974 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		90
12. Reactor I&C Systems		43
13. Reactor Auxiliary Systems		121
14. Safety Systems		36
15. Reactor Cooling Systems	128	143
16. Steam generation systems		44
17. Safety I&C Systems (excluding reactor I&C)		9
21. Fuel Handling and Storage Facilities		18
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		20
33. Circulating Water System	47	10
35. All other I&C Systems		0
41. Main Generator Systems		7
42. Electrical Power Supply Systems	86	84
Total	**261**	**635**

Highlights (2024)

01/01/2024 00:00 to 29/01/2024 21:02 - Normal operation. Losses due to plant performance.
29/01/2024 21:02 to 04/02/2024 05:15 - Automatic Scram - turbine trip due low revolutions of QF01D001.
04/02/2024 05:15 to 05/02/2024 19:15 - Power ramp up.
05/02/2024 19:15 to 18/02/2024 20:39 - Normal operation. Losses due to plant performance.
18/02/2024 20:39 to 20/02/2024 19:37 - Manual Scram due to UC01/02/03D01 pumps trip
20/02/2024 19:37 to 22/02/2024 07:40 - Power ramp up.
22/02/2024 07:40 to 24/02/2024 01:17 - Normal operation. Losses due to plant performance.
24/02/2024 01:17 to 27/02/2024 15:04 - Manual shutdown due to transformer BT intervention.
27/02/2024 15:04 to 29/02/2024 06:30 - Power ramp up.
29/02/2024 06:30 to 29/09/2024 17:23 - Normal operation. Losses due to plant performance.
29/09/2024 17:23 to 01/01/2025 00:00 - Planned outage due to life extension.

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2024 Operating Experience

AR-3 ATUCHA-2 ARGENTINA

Status at end of year	:	**Operational**
Operator	:	NASA (NUCLEOELECTRICA ARGENTINA S.A.)
Owner	:	NASA (NUCLEOELECTRICA ARGENTINA S.A.)
Reactor Supplier	:	SIEMENS (Siemens AG, Power Generation)
Turbine Supplier	:	KWU (KRAFTWERK UNION, AG)



Reactor Unit Details

Reactor type and model	:	PHWR / PHWR KWU
Thermal power	:	2160 MWth
Gross electrical power	:	745 MWe
Reference unit power (net)	:	693 MWe

Key Dates

Construction Date	:	1981-07-13
Grid Date	:	2014-06-27
Commercial Date	:	2016-05-26
Age at end of year	:	10 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	NA
Refuelling frequency [month]	:	NA
Part of the core refuelled [%]	:	NA
Average discharge burnup [MWd/t]	:	7800
Active core diameter [m]	:	6.06
Active core height/length [m]	:	5.3
Number of fissile fuel assemblies/bundles	:	451
Fuel linear heat generation rate [kW/m]	:	23.2
Number of control rod assemblies	:	18
Number of external reactor coolant loops	:	2
Coolant type	:	D2O

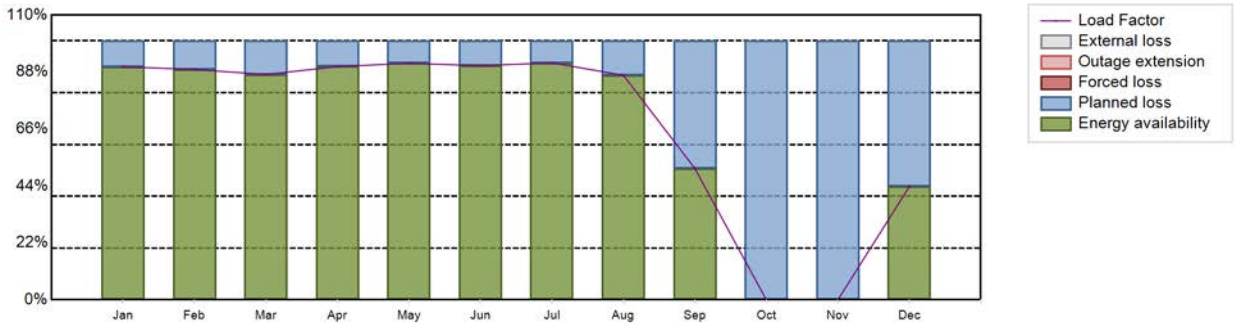
Operating coolant pressure [MPa]	:	11.4
Reactor outlet temperature [°C]	:	312.3
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.48
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	5.59
Output voltage [kV]	:	21
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4111.75 GW(e).h
Energy Availability Factor (EAF)	:	67.55 %
Unit Capability Factor (UCF)	:	67.55 %
Load Factor (LF)	:	67.55 %
Operating Factor (OF)	:	77.82 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	32.45 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1948 hours

Annual Summary



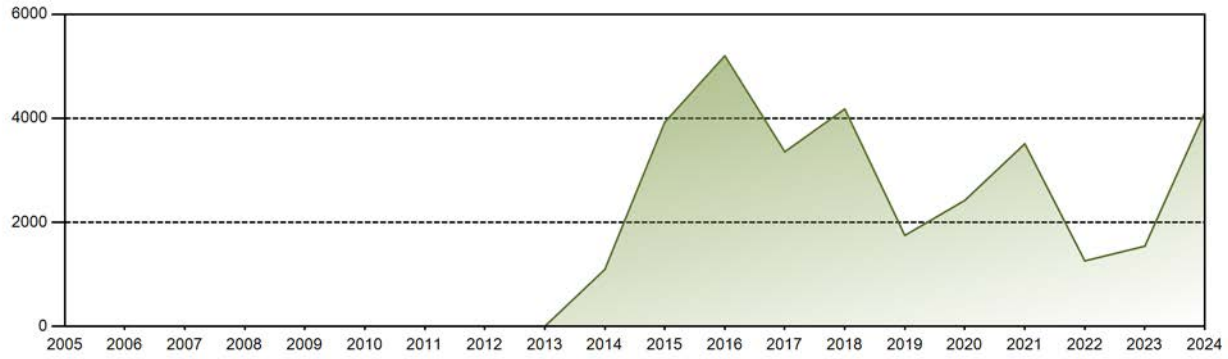
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	464.30	428.95	448.83	449.40	471.15	451.18	471.99	447.20	253.27	0.00	0.00	225.48	4111.75
EAF [%]	90.05	88.93	87.05	90.07	91.38	90.42	91.54	86.74	50.76	0.00	0.00	43.73	67.55
UCF [%]	90.05	88.93	87.05	90.07	91.38	90.42	91.54	86.74	50.76	0.00	0.00	43.73	67.55
LF [%]	90.05	88.93	87.05	90.07	91.38	90.42	91.54	86.74	50.76	0.00	0.00	43.73	67.55
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	66.67	0.00	0.00	67.20	77.82
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	9.95	11.07	12.95	9.93	8.62	9.58	8.46	13.26	49.24	100.00	100.00	56.27	32.45
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

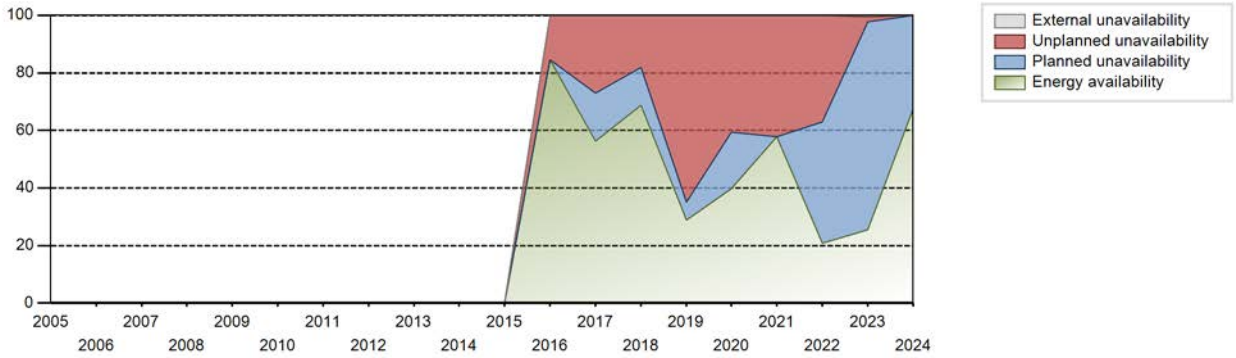
Lifetime energy generation	:	32348.85 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	33.67 %
Cumulative Energy Availability Factor (EAF)	:	48.32 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	27.97 %
Cumulative Unit Capability Factor (UCF)	:	48.39 %	Cumulative Planned Unavailability Factor (PUF)	:	23.64 %
Cumulative Load Factor (LF)	:	48.14 %	Cumulative Externally cause unavailability (XUF)	:	0.07 %
Cumulative Operating Factor (OF)	:	66.06 %			

Electricity Production (net) [GWh]

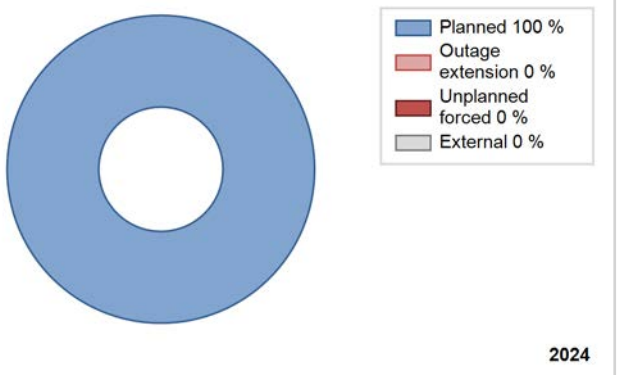


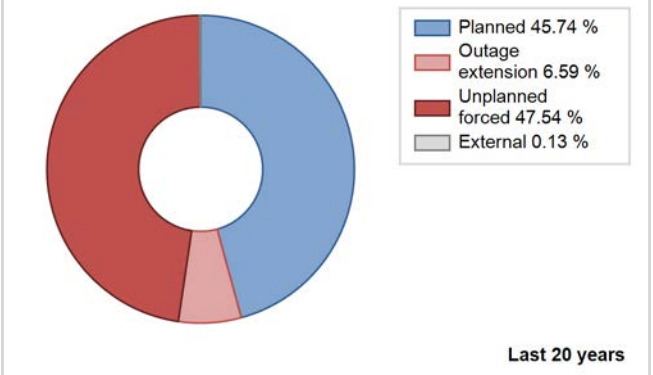
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	5200.54	8063	692	84.64	84.64	83.75	89.49	15.36	15.36	0.00	0.00
2017	3356.61	5130	693	56.27	56.27	55.29	58.56	7.12	27.04	16.68	0.00
2018	4178.88	6448	693	68.84	68.84	68.84	73.61	20.72	17.99	13.17	0.00
2019	1748.39	7001	693	28.85	28.85	28.80	79.92	68.93	64.83	6.32	0.00
2020	2421.87	6155	693	39.79	39.79	39.79	70.07	47.24	40.55	19.67	0.00
2021	3510.88	7217	693	57.83	57.83	57.83	82.39	41.72	42.16	0.00	0.00
2022	1259.03	3381	693	20.74	20.74	20.74	38.60	64.11	37.05	42.21	0.00
2023	1541.93	2958	693	25.40	25.99	25.40	33.77	5.70	1.57	72.44	0.59
2024	4111.75	6836	693	67.55	67.55	67.55	77.82	0.00	0.00	32.45	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					1168	
D. Inspection, maintenance or repair without refuelling	1947			1822		
J. Grid limitation, failure or grid unavailability						6
Subtotal	1947			1822	1168	6
Total	**1947**			**2996**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		279
12. Reactor I&C Systems		55
13. Reactor Auxiliary Systems		29
14. Safety Systems		46
15. Reactor Cooling Systems		427
16. Steam generation systems		8
21. Fuel Handling and Storage Facilities		15
31. Turbine and auxiliaries		224
32. Feedwater and Main Steam System		23
41. Main Generator Systems		1
42. Electrical Power Supply Systems		6
Total		**1113**

Highlights (2024)

01/01/2024 0:00 to 07/03/2024 14:00 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
07/03/2024 14:00 to 11/03/2024 21:00 - Operation at reduced power for maintenance of the condenser.
11/03/2024 21:00 to 15/05/2024 20:00 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
15/05/2024 20:00 - 16/05/2024 21:00 - Operation at reduced power for intervention of the condenser (box 4).
16/05/2024 21:00 - 07/06/2024 05:30 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
07/06/2024 05:30 to 10/06/2024 16:15 - Operation at reduced power for maintenance of the condenser.
10/06/2024 16:15 to 14/06/2024 13:48 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
14/06/2024 13:48 to 14/06/2024 20:14 - Operation at reduced power for maintenance of the condenser (box 1).
14/06/2024 20:14 to 15/06/2024 04:42 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
15/06/2024 04:42 to 15/06/2024 20:45 - Operation at reduced power for maintenance of the condenser (boxes 3 and 4).
15/06/2024 20:45 to 28/06/2024 04:30 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
28/06/2024 04:30 to 28/06/2024 21:40 - Operation at reduced power for maintenance of the condenser.
28/06/2024 21:40 to 07/07/2024 03:27 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
07/07/2024 03:27 to 07/07/2024 19:30 - Operation at reduced electric power (not thermal power) for maintenance of the condenser.
07/07/2024 19:30 to 12/07/2024 03:45 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
12/07/2024 03:45 to 12/07/2024 18:24 - Operation at reduced electric power (not thermal power) for maintenance of the condenser.
12/07/2024 18:24 to 17/07/2024 03:08 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
17/07/2024 03:08 to 17/07/2024 11:59 - Operation at reduced electric power (not thermal power) for maintenance of the condenser.
17/07/2024 11:59 to 22/07/2024 03:05 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
22/07/2024 03:05 to 22/07/2024 19:30 - Operation at reduced electric power (not thermal power) for maintenance of the condenser.
22/07/2024 19:30 to 24/07/2024 14:15 - Operation at reduced power. Debris removal strategy in the primary cooling system (95%).
24/07/2024 14:15 to 25/07/2024 04:22 - Power reduction to 90% to carry out preliminary works for planned outage.
25/07/2024 04:22 to 25/07/2024 18:29 - Operation at reduced electric power (not thermal power) for maintenance of the condenser.
25/07/2024 18:29 to 05/08/2024 04:38 - Power reduction to 90% to carry out preliminary works for planned outage.
05/08/2024 04:38 to 05/08/2024 18:52 - Operation at reduced electric power (not thermal power) for maintenance of the condenser.
05/08/2024 18:52 to 12/08/2024 04:00 - Power reduction to 90% to carry out preliminary works for planned outage.
12/08/2024 04:00 to 12/08/2024 12:02 - Operation at reduced electric power (not thermal power) for maintenance of the condenser.
12/08/2024 12:02 to 09/09/2024 10:08 - Power reduction to 90% to carry out preliminary works for planned outage.
09/09/2024 10:08 to 09/09/2024 21:08 - Power reduction to 84% to carry out preliminary works for planned outage.
09/09/2024 21:08 to 16/09/2024 00:19 - Power reduction to 80% to carry out preliminary works for planned outage.
16/09/2024 00:19 to 21/09/2024 00:00 - Power reduction to 70% to carry out preliminary works for planned outage.
21/09/2024 00:00 to 21/09/2024 00:16 - Power ramp down.
21/09/2024 00:16 to 11/12/2024 03:22 - Planned outage.
11/12/2024 03:22 to 01/1/2025 00:00 - Power ramp up.

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2024 Operating Experience

AR-2 EMBALSE ARGENTINA



Status at end of year	:	**Operational**
Operator	:	NASA (NUCLEOELECTRICA ARGENTINA S.A.)
Owner	:	NASA (NUCLEOELECTRICA ARGENTINA S.A.)
Reactor Supplier	:	AECL (ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	AMN (ANSALDO/Asgen)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 6
Thermal power	:	2064 MWth
Gross electrical power	:	656 MWe
Reference unit power (net)	:	608 MWe

Key Dates

Construction Date	:	1974-03-31
Grid Date	:	1983-04-25
Commercial Date	:	1984-01-20
Age at end of year	:	41 years

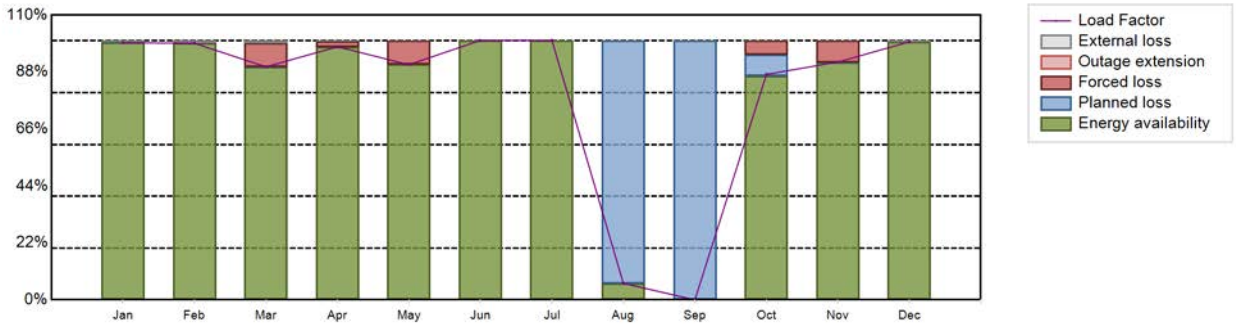
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	10.2
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	310
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	Confinement
Moderator material	:	D2O	Containment design pressure [MPa]	:	0.125
Average fuel enrichment [% of U235]	:	NA	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	NA	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	7190	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	6.28	HP cylinder inlet steam pressure [MPa]	:	4.62
Active core height/length [m]	:	5.94	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	4560	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24.75	Number of main condensate pumps	:	3
Number of control rod assemblies	:	28	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	4
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4281.61 GW(e).h	Forced Loss Rate (FLR)	:	3.43 %
Energy Availability Factor (EAF)	:	80.06 %	Unplanned Capability Loss Factor (UCL)	:	2.85 %
Unit Capability Factor (UCF)	:	80.29 %	Planned Unavailability Factor (PUF)	:	16.85 %
Load Factor (LF)	:	80.17 %	Externally cause unavailability (XUF)	:	0.24 %
Operating Factor (OF)	:	81.15 %	Total off-line time	:	1656 hours

Annual Summary



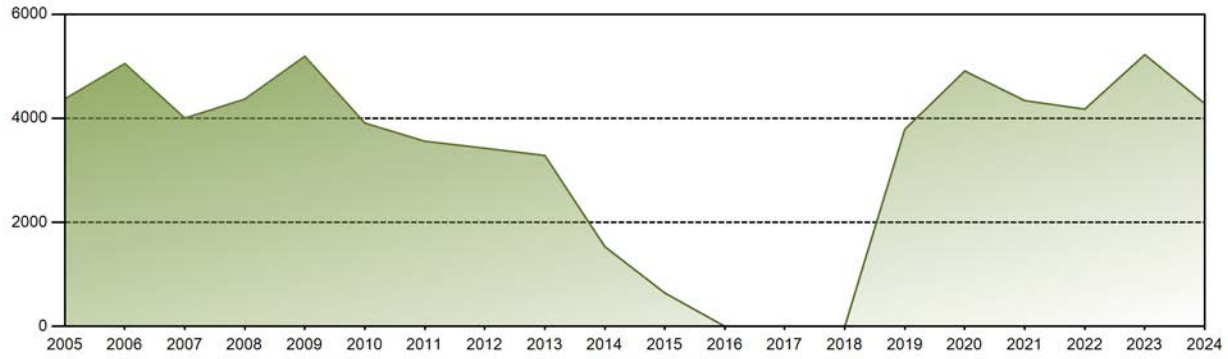
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	449.12	419.24	407.05	427.87	410.78	438.69	453.45	28.84	0.00	393.92	401.98	450.67	4281.61
EAF [%]	99.29	99.07	89.99	97.74	90.81	100.00	100.00	6.38	0.00	86.43	91.60	99.63	80.06
UCF [%]	99.72	99.97	90.92	97.94	90.81	100.00	100.00	6.38	0.00	86.43	91.60	100.00	80.29
LF [%]	99.29	99.07	89.99	97.74	90.81	100.21	100.24	6.38	0.00	87.08	91.83	99.63	80.17
OF [%]	100.00	100.00	91.67	99.31	91.26	100.00	100.00	6.59	0.00	93.01	92.08	100.00	81.15
FLR [%]	0.00	0.00	9.07	2.06	9.19	0.00	0.00	0.00	0.00	5.77	8.39	0.00	3.43
UCL [%]	0.00	0.00	9.07	2.06	9.19	0.00	0.00	0.00	0.00	5.30	8.39	0.00	2.85
PUF [%]	0.28	0.03	0.00	0.00	0.00	0.00	0.00	93.62	100.00	8.27	0.01	0.00	16.85
XUF [%]	0.44	0.90	0.94	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.24

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Historical Summary

Lifetime energy generation	:	160343.53 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.97 %
Cumulative Energy Availability Factor (EAF)	:	79.17 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.46 %
Cumulative Unit Capability Factor (UCF)	:	79.52 %	Cumulative Planned Unavailability Factor (PUF)	:	18.02 %
Cumulative Load Factor (LF)	:	73.65 %	Cumulative Externally cause unavailability (XUF)	:	0.36 %
Cumulative Operating Factor (OF)	:	77.72 %			

Electricity Production (net) [GWh]

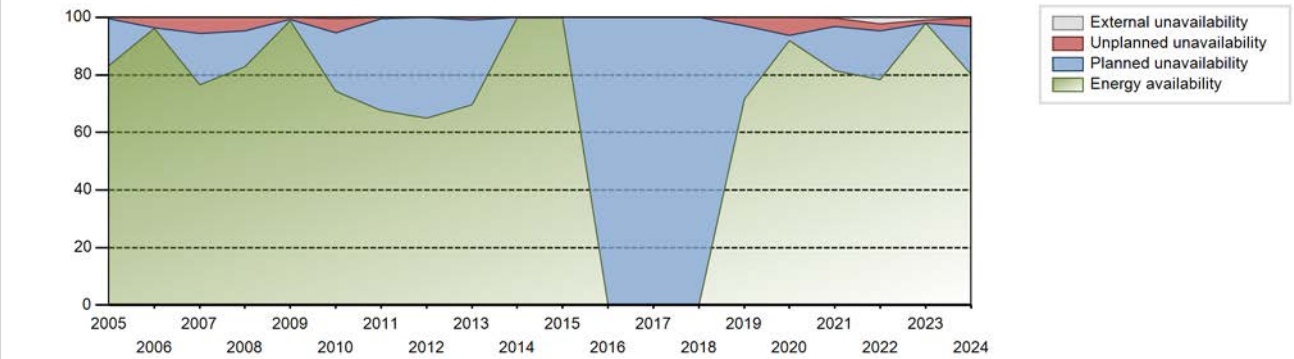


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	2527.07	6355	600	68.74	68.74	44.29	70.56	5.92	4.32	26.93	0.00
1985	3778.57	8170	600	93.44	93.44	71.89	93.26	6.15	6.13	0.43	0.00
1986	3061.67	5847	600	66.34	67.12	58.25	66.75	1.85	1.27	31.62	0.78
1987	4577.05	7951	600	87.92	87.92	87.08	90.76	5.89	5.50	6.58	0.00
1988	4560.58	7798	600	88.78	88.79	86.53	88.78	11.21	11.21	0.00	0.01
1989	4658.98	7804	600	89.11	90.09	88.64	89.09	1.00	0.91	9.00	0.98
1990	5000.74	8404	600	95.10	96.49	95.14	95.94	1.87	1.84	1.67	1.38
1991	4498.81	7855	600	85.76	89.68	85.59	89.67	0.00	0.00	10.32	3.92
1992	4353.98	7440	600	81.59	83.42	82.61	84.70	1.12	0.95	15.64	1.83
1993	4773.27	7956	600	90.60	90.68	90.82	90.82	0.73	0.67	8.65	0.08
1994	5157.89	8575	600	97.78	98.27	98.13	97.89	1.69	1.69	0.03	0.49
1995	3897.91	6541	600	74.34	74.34	74.16	74.67	5.54	4.36	21.30	0.00
1996	4891.97	8176	600	92.77	92.77	92.82	93.08	1.38	1.30	5.94	0.00
1997	4737.03	7821	600	89.27	89.27	90.13	89.28	0.54	0.48	10.25	0.00
1998	4555.43	7629	600	86.87	86.88	86.67	87.09	4.13	3.75	9.38	0.01
1999	5201.79	8700	598	99.14	99.14	99.30	99.32	0.73	0.73	0.14	0.00
2000	4064.48	6837	643	78.08	78.19	71.96	77.83	8.13	6.92	14.89	0.10
2001	5128.11	8564	600	97.45	97.47	97.57	97.76	2.29	2.28	0.25	0.02
2002	4385.52	7401	600	83.40	84.00	83.44	84.49	0.86	0.72	15.28	0.59
2003	5004.14	8367	600	95.07	95.13	95.21	95.51	4.58	4.57	0.30	0.05
2004	4589.57	7704	600	87.51	87.54	87.08	87.70	1.27	1.12	11.33	0.03
2005	4372.48	7341	600	83.32	83.32	83.19	83.80	0.00	0.43	16.25	0.00
2006	5052.10	8455	600	96.23	96.23	96.12	96.52	3.66	3.66	0.11	0.00
2007	4003.72	6771	600	76.51	76.51	76.17	77.29	6.19	5.53	17.96	0.00
2008	4368.61	7382	600	82.89	82.89	82.89	84.04	5.24	4.65	12.46	0.00
2009	5192.43	8705	600	98.79	98.79	98.78	99.36	0.78	0.78	0.44	0.00
2010	3908.69	6701	600	74.37	74.86	74.37	76.50	6.11	4.87	20.26	0.50
2011	3559.35	7405	600	67.72	67.72	67.72	84.53	0.69	0.47	31.81	0.00
2012	3425.53	7214	600	65.07	65.07	65.00	82.13	0.11	0.07	34.86	0.00
2013	3285.69	6841	600	69.65	69.65	62.51	78.09	1.31	0.92	29.43	0.00
2014	1533.11	3678	600	99.79	99.79	29.17	41.99	0.14	0.14	0.07	0.00
2015	641.36	1564	600	99.78	99.78	12.20	17.85	0.00	0.00	0.22	0.00
2016	0.00	0	600	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2017	0.00	0	600	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2018	0.00	0	600	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2019	3786.17	7051	608	71.76	71.76	71.09	80.49	3.80	2.83	25.41	0.00
2020	4910.14	8447	608	91.88	91.93	91.94	96.16	6.33	6.22	1.85	0.05

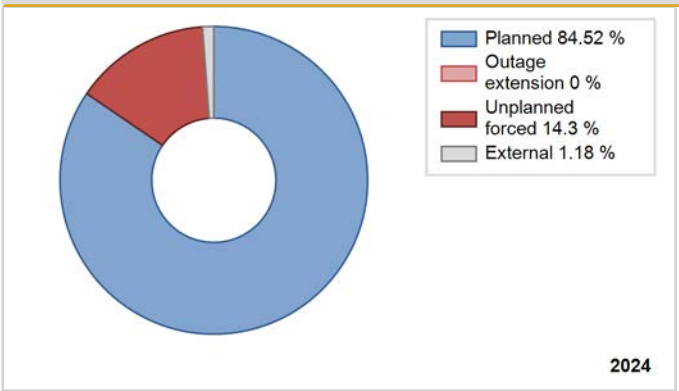
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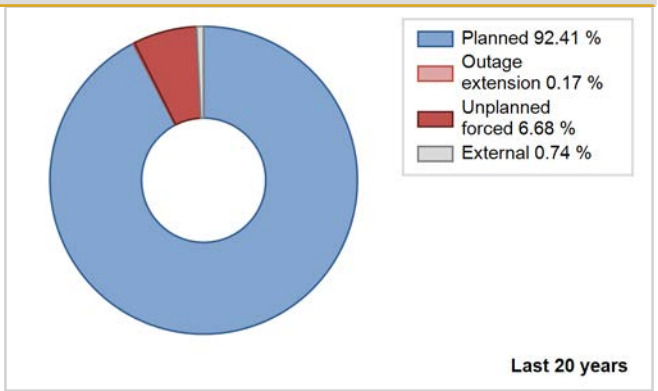
2021	4340.06	7227	608	81.49	81.70	81.49	82.50	3.56	3.01	15.29	0.21
2022	4176.48	6993	608	78.42	80.73	78.42	79.83	2.96	2.46	16.81	2.32
2023	5224.06	8660	608	98.05	99.04	98.08	98.86	0.95	0.95	0.01	0.98
2024	4281.61	7128	608	80.06	80.29	80.17	81.15	3.43	2.85	16.85	0.24

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		188			208	
C.	Inspection, maintenance or repair combined with refuelling				86		
D.	Inspection, maintenance or repair without refuelling	1467			702		
E.	Testing of plant systems or components				35	1	
G.	Major backfitting, refurbishment or upgrading activities without refuelling				669		
H.	Nuclear regulatory requirements					1	
J.	Grid limitation, failure or grid unavailability						15
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						15
L.	Human factor related					2	
M.	Governmental requirements or court decisions						300
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						4
Z.	Other					2	
Subtotal		1467	188		1492	214	335
Total		**1655**			**2041**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		29
14. Safety Systems		3
15. Reactor Cooling Systems		10
16. Steam generation systems	65	58
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		2
31. Turbine and auxiliaries		26
32. Feedwater and Main Steam System		20
33. Circulating Water System		1
34. Miscellaneous Systems	57	5
41. Main Generator Systems	5	36
42. Electrical Power Supply Systems	61	9
Total	**188**	**214**

Highlights (2024)

R1 1/1/2024 00:00 to 9/1/2024 09:40 - Environmental condition: seasonal variation in cooling water temperature.
R2 9/1/2024 09:40 to 20/1/2024 17:09 - 4313 P103B pump out of service due to mechanic seal failure.
R3 20/1/2024 17:09 to 30/1/2024 00:28 - Environmental condition: seasonal variation in cooling water temperature.
R4 30/1/2024 00:28 to 30/1/2024 14:02 - 4313 P103B pump out of service due to mechanic seal failure.
R5 30/1/2024 14:02 to 1/2/2024 00:14 - Environmental condition: seasonal variation in cooling water temperature.
R6 1/2/2024 00:14 to 1/2/2024 17:35 - 4313 P103C pump out of service due to mechanic seal failure.
R7 1/2/2024 17:35 to 8/2/2024 15:10 - Environmental condition: seasonal variation in cooling water temperature.
R8 8/2/2024 15:10 to 8/2/2024 16:14 - Failure 63611 FT3, Steam generator N° 3 flow transmitter.
R9 8/2/2024 16:14 to 17/3/2024 08:33 - Environmental condition: seasonal variation in cooling water temperature.
R10 17/3/2024 08:33 to 17/3/2024 08:52 - Turbine control valves test (PF-41100-08)
R11 17/3/2024 08:52 to 28/3/2024 15:45 - Environmental condition: seasonal variation in cooling water temperature.
R12 28/3/2024 15:45 to 28/3/2024 16:05 - Power ramp down.
S1 28/3/2024 16:05 to 31/3/2024 05:29 - Shutdown due to loss of power supply.
R13 31/3/2024 05:29 to 1/4/2024 00:29 - Power ramp up.
S2 1/4/2024 00:29 to 1/4/2024 05:13 - Disconnection from the grid. T/G block fue to low differential pressure oil seals.
R14 1/4/2024 05:13 to 4/4/2024 00:32 - Power ramp up.
R15 4/4/2024 00:32 to 4/4/2024 10:54 - Environmental condition: seasonal variation in cooling water temperature.
R16 4/4/2024 10:54 to 4/4/2024 11:15 - Failure in 64116-FCV-8#1, level control valve.
R17 4/4/2024 11:15 to 29/4/2024 16:48 - Environmental condition: seasonal variation in cooling water temperature.
R18 29/4/2024 16:48 to 30/4/2024 16:30 - Failure in 4313-V616, manual valve.
R19 18/5/2024 00:10 to 18/5/2024 00:18 - 4313 P532 out of service fue to failure in the panel.
R20 21/5/2024 03:27 to 21/5/2024 04:03 - Power ramp down.
S3 21/5/2024 04:03 to 23/5/2024 21:20 - Shutdown due to loss of D2O from the SPTC.
R21 23/5/2024 21:20 to 25/5/2024 23:49 - Power ramp up.
R22 2/8/2024 22:00 to 3/8/2024 00:55 - Power ramp down.
S4 3/8/2024 00:55 to 3/10/2024 04:20 - Planned outage.
R23 3/10/2024 04:20 to 3/10/2024 16:30 - Power ramp up.
R24 3/10/2024 16:30 to 6/10/2024 13:04 - Loss of water due to mecanic seal from pump 4323-P102B
R25 6/10/2024 13:04 to 6/10/2024 14:52 - Power ramp up.
R26 6/10/2024 14:52 to 6/10/2024 17:38 - Trip of channel F of the SPN°1.
R27 6/10/2024 17:38 to 7/10/2024 08:44 - Power ramp up.
R28 2/11/2024 23:20 to 3/11/2024 00:10 - Turbine control valves test (PF-14400-08)
R29 3/11/2024 00:38 to 3/11/2024 01:57 - Power ramp down.
S5 3/11/2024 01:57 to 5/11/2024 10:42 - Shutdown dunscheduled planned due to loss of process water in inaccessible area.
R30 5/11/2024 10:42 to 6/11/2024 03:20 - Power ramp up.
R31 7/11/2024 11:50 to 7/11/2024 18:18 - Failure in 4323-P1, pneumatic valve.
R32 13/11/2024 23:34 to 14/11/2024 01:01 - Failure in 5542-INV-C INVERSOR CC/CA.
R33 20/11/2024 16:50 to 20/11/2024 17:30 - Failure in pump seal 4323-P102C.
R34 21/11/2024 20:30 to 21/11/2024 20:55 - Failure in pump seal 4323-P102A.
R35 1/12/2024 00:00 to 1/1/2025 00:00 - Environmental condition: seasonal variation in cooling water temperature.

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2024 Operating Experience

AM-19 ARMENIAN-2 ARMENIA

Status at end of year	:	**Operational**
Operator	:	ANPPCJSC (Closed Joint Stock Company Armenian NPP)
Owner	:	M.E. (Ministry of Territorial Administration and Infrastructure)
Reactor Supplier	:	FAEA (Federal Atomic Energy Agency)
Turbine Supplier	:	EITM ("Electrotiazhmash" Kharkiv)



Reactor Unit Details

Reactor type and model	:	PWR / VVER V-270
Thermal power	:	1375 MWth
Gross electrical power	:	448 MWe
Reference unit power (net)	:	416 MWe

Key Dates

Construction Date	:	1975-07-01
Grid Date	:	1980-01-05
Commercial Date	:	1980-05-03
Age at end of year	:	44 years

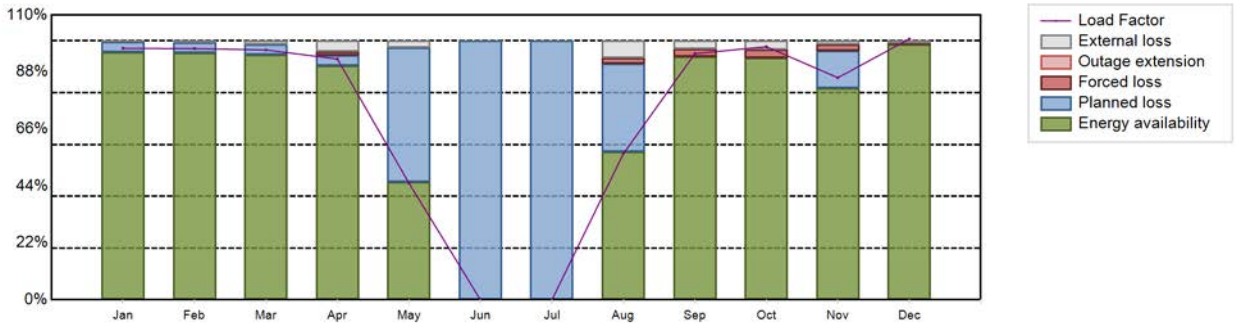
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	12.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	295.8
Fuel material	:	UO2	Number of SG	:	6
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	28600	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	2.88	HP cylinder inlet steam pressure [MPa]	:	4.4
Active core height/length [m]	:	2.5	Output voltage [kV]	:	15.75
Number of fissile fuel assemblies/bundles	:	349	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	13.1	Number of main condensate pumps	:	3
Number of control rod assemblies	:	37	Number of FW pumps for full power operation	:	4
Number of external reactor coolant loops	:	6	Number of on-site safety related diesel generators	:	4
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	2629.13 GW(e).h	Forced Loss Rate (FLR)	:	1.5 %
Energy Availability Factor (EAF)	:	70.44 %	Unplanned Capability Loss Factor (UCL)	:	1.11 %
Unit Capability Factor (UCF)	:	72.47 %	Planned Unavailability Factor (PUF)	:	26.42 %
Load Factor (LF)	:	71.95 %	Externally cause unavailability (XUF)	:	2.03 %
Operating Factor (OF)	:	75.89 %	Total off-line time	:	2118 hours

Annual Summary



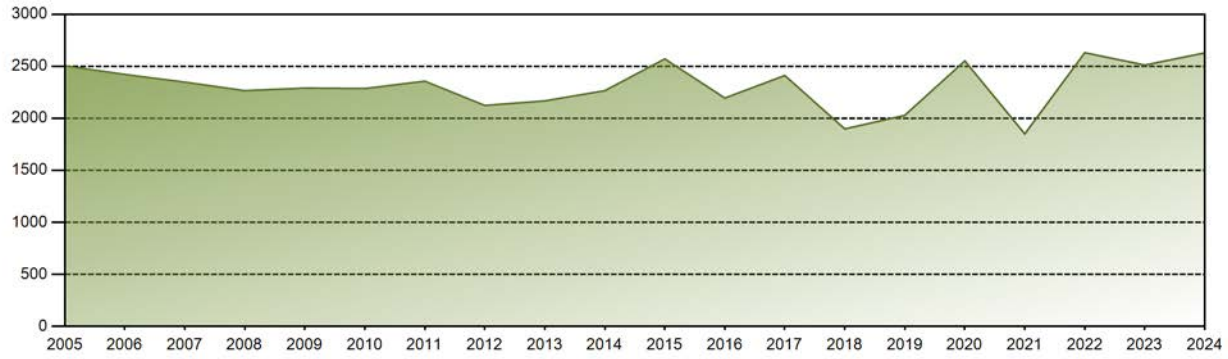
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	300.65	280.91	298.70	278.49	139.61	0.00	0.00	174.68	284.81	302.57	256.94	311.77	2629.13
EAF [%]	95.57	95.36	94.70	90.51	45.58	0.00	0.00	57.28	93.88	93.33	81.65	98.55	70.44
UCF [%]	96.02	96.03	96.03	94.50	48.25	0.00	0.00	63.84	97.02	96.59	82.95	99.45	72.47
LF [%]	97.14	97.02	96.51	92.98	45.11	0.00	0.00	56.44	95.09	97.76	85.78	100.73	71.95
OF [%]	100.00	100.00	100.00	100.00	48.25	0.00	0.00	63.84	100.00	100.00	100.00	100.00	75.89
FLR [%]	0.00	0.00	0.00	1.60	0.00	0.00	0.00	3.26	2.98	3.41	3.13	0.55	1.50
UCL [%]	0.00	0.00	0.00	1.53	0.00	0.00	0.00	2.15	2.98	3.41	2.68	0.55	1.11
PUF [%]	3.98	3.97	3.97	3.97	51.75	100.00	100.00	34.01	0.00	0.00	14.37	0.00	26.42
XUF [%]	0.45	0.67	1.34	3.99	2.68	0.00	0.00	6.57	3.14	3.25	1.30	0.91	2.03

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Historical Summary

Lifetime energy generation	:	85579.81 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.3 %
Cumulative Energy Availability Factor (EAF)	:	65.46 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.37 %
Cumulative Unit Capability Factor (UCF)	:	67.63 %	Cumulative Planned Unavailability Factor (PUF)	:	29 %
Cumulative Load Factor (LF)	:	65.38 %	Cumulative Externally cause unavailability (XUF)	:	2.17 %
Cumulative Operating Factor (OF)	:	78.52 %			

Electricity Production (net) [GWh]

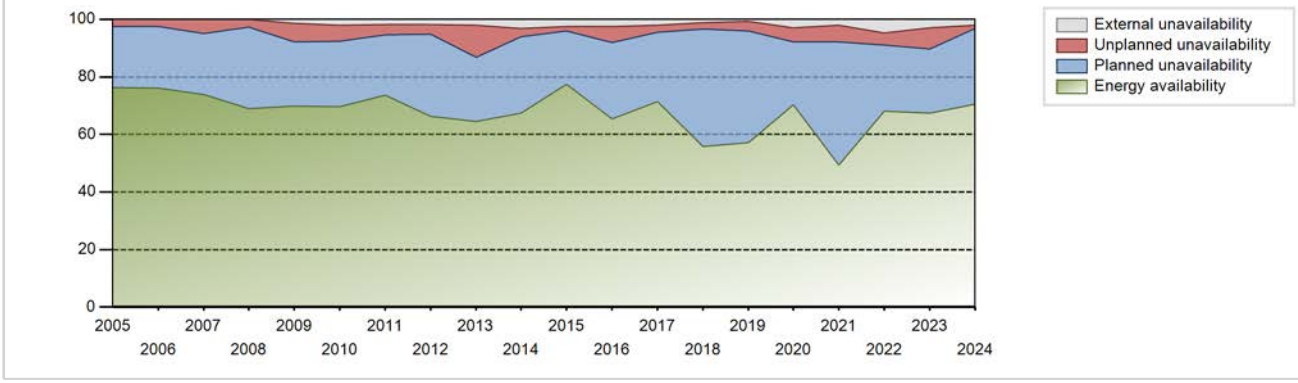


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	Data not provided										
1981	"										
1982	"										
1983	"										
1984	"										
1985	"										
1986	"										
1987	2629.08	7040	408	79.34	79.34	73.56	80.37	10.91	9.71	10.95	0.00
1988	2254.53	6741	376	73.40	73.40	68.26	76.74	7.07	5.58	21.02	0.00
1989	671.28	1838	376	99.58	99.58	82.69	85.13	0.42	0.42	0.00	0.00
1990	Data not available - Suspended Operation										
1991	"										
1992	"										
1993	"										
1994	"										
1995	Data not provided										
1996	2097.98	7561	376	63.60	86.25	63.52	86.08	0.42	0.37	13.39	22.64
1997	1429.96	5700	376	43.41	43.41	43.41	65.07	1.59	0.70	55.88	0.00
1998	1416.47	6408	376	44.62	44.62	43.00	73.15	0.11	0.05	55.33	0.00
1999	1890.37	6193	376	57.39	57.39	57.39	70.70	0.41	0.23	42.37	0.00
2000	1841.51	5699	376	55.77	55.78	55.76	64.88	2.17	1.24	42.99	0.01
2001	1815.41	5660	376	55.11	55.12	55.12	64.61	0.57	0.32	44.57	0.01
2002	2078.90	6961	376	63.20	63.31	63.12	79.46	0.87	0.56	36.13	0.11
2003	1997.55	6120	376	60.65	63.39	60.65	69.86	0.00	0.00	36.61	2.74
2004	2196.58	7135	376	64.18	70.29	66.51	81.23	0.75	0.89	28.82	6.11
2005	2504.49	7658	376	76.25	76.25	76.04	87.42	3.26	2.57	21.18	0.00
2006	2421.62	7632	376	76.13	76.13	73.52	87.12	3.15	2.48	21.39	0.00
2007	2347.83	7447	376	73.81	73.81	71.28	85.01	6.26	4.93	21.26	0.00
2008	2265.89	7013	376	69.01	69.01	68.61	79.84	3.79	2.72	28.27	0.00
2009	2290.42	7408	375	69.85	71.28	69.72	84.57	7.74	6.32	22.39	1.43
2010	2286.54	7535	375	69.70	71.78	69.61	86.02	7.26	5.62	22.61	2.08
2011	2356.84	7552	375	73.70	75.49	71.75	86.21	3.76	3.64	20.87	1.79
2012	2123.50	7052	375	66.39	68.31	64.47	80.28	4.50	3.22	28.47	1.92
2013	2167.63	7237	375	64.44	66.45	65.99	82.61	14.48	11.25	22.30	2.01
2014	2265.64	7542	375	67.32	70.51	68.97	86.10	3.94	2.89	26.60	3.19
2015	2571.10	7859	375	77.43	79.90	78.27	89.71	1.91	1.55	18.55	2.47
2016	2194.85	6756	375	65.45	67.82	66.63	76.91	1.76	5.72	26.45	2.37

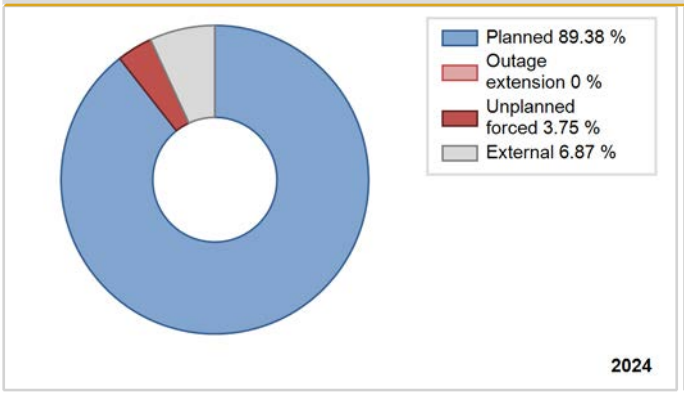
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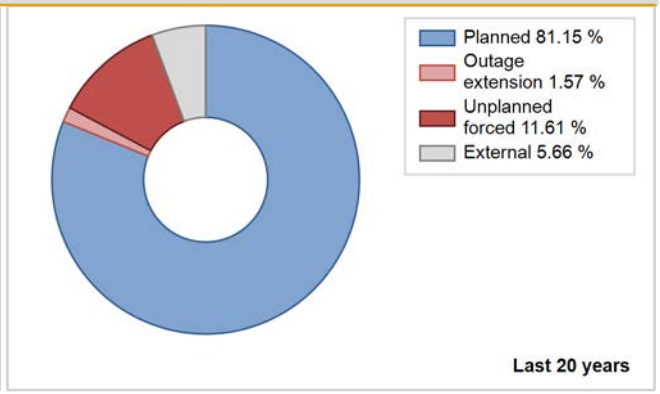
2017	2411.39	7341	375	71.41	73.43	73.41	83.80	3.19	2.42	24.15	2.02
2018	1898.08	7169	375	55.75	56.87	57.78	81.84	3.81	2.25	40.88	1.12
2019	2028.96	6252	375	57.15	57.76	61.76	71.37	5.62	3.44	38.80	0.60
2020	2551.80	7295	415	70.30	73.30	70.00	83.05	6.29	4.92	21.78	3.00
2021	1850.04	5028	448	49.46	51.55	50.22	57.40	2.74	5.78	42.67	2.09
2022	2630.85	7110	416	68.17	72.88	72.19	81.16	5.40	4.16	22.96	4.72
2023	2512.03	6490	416	67.31	70.21	68.93	74.09	9.58	7.44	22.35	2.90
2024	2629.13	6666	416	70.44	72.47	71.95	75.89	1.50	1.11	26.42	2.03

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1980 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		16			109	
C. Inspection, maintenance or repair combined with refuelling	2102			1534	13	
D. Inspection, maintenance or repair without refuelling				126		
E. Testing of plant systems or components					2	
F. Major backfitting, refurbishment or upgrading activities with refuelling				50		
J. Grid limitation, failure or grid unavailability						8
L. Human factor related					2	
Z. Other					13	
Subtotal	2102	16		1710	139	8
Total	**2118**			**1857**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		25
12. Reactor I&C Systems		11
13. Reactor Auxiliary Systems		8
15. Reactor Cooling Systems		32
16. Steam generation systems		7
17. Safety I&C Systems (excluding reactor I&C)	16	2
31. Turbine and auxiliaries		1
34. Miscellaneous Systems		22
35. All other I&C Systems		1
41. Main Generator Systems		1
42. Electrical Power Supply Systems		3
Total	**16**	**113**

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2024 Operating Experience

BY-1 BELARUSIAN-1 BELARUS

Status at end of year	:	**Operational**
Operator	:	BelNPP (Republican Unitary Enterprise "Belarusian Nuclear Power Plant")
Owner	:	BelNPP (Republican Unitary Enterprise "Belarusian Nuclear Power Plant")
Reactor Supplier	:	JSC ASE (JSC "Atomstroyexport")
Turbine Supplier	:	JSC ASE (JSC "Atomstroyexport")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-491
Thermal power	:	3200 MWth
Gross electrical power	:	1194 MWe
Reference unit power (net)	:	1110 MWe

Key Dates

Construction Date	:	2013-11-08
Grid Date	:	2020-11-03
Commercial Date	:	2021-06-10
Age at end of year	:	4 years

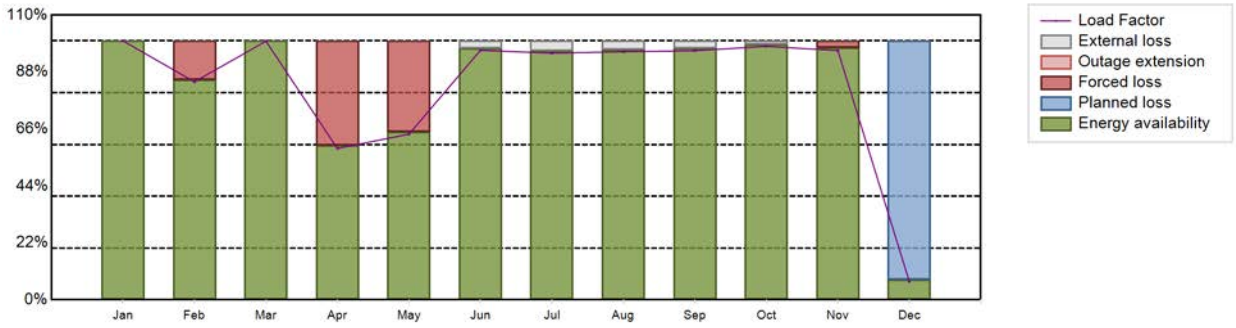
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	16.2
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.6
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.4
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	55500	Number of LP cylinders per turbine	:	4
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6.8
Active core height/length [m]	:	3.73	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	16.87	Number of main condensate pumps	:	6
Number of control rod assemblies	:	121	Number of FW pumps for full power operation	:	4
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	5
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8050.29 GW(e).h	Forced Loss Rate (FLR)	:	8.33 %
Energy Availability Factor (EAF)	:	83.33 %	Unplanned Capability Loss Factor (UCL)	:	7.67 %
Unit Capability Factor (UCF)	:	84.51 %	Planned Unavailability Factor (PUF)	:	7.82 %
Load Factor (LF)	:	82.57 %	Externally cause unavailability (XUF)	:	1.18 %
Operating Factor (OF)	:	87.9 %	Total off-line time	:	1063 hours

Annual Summary



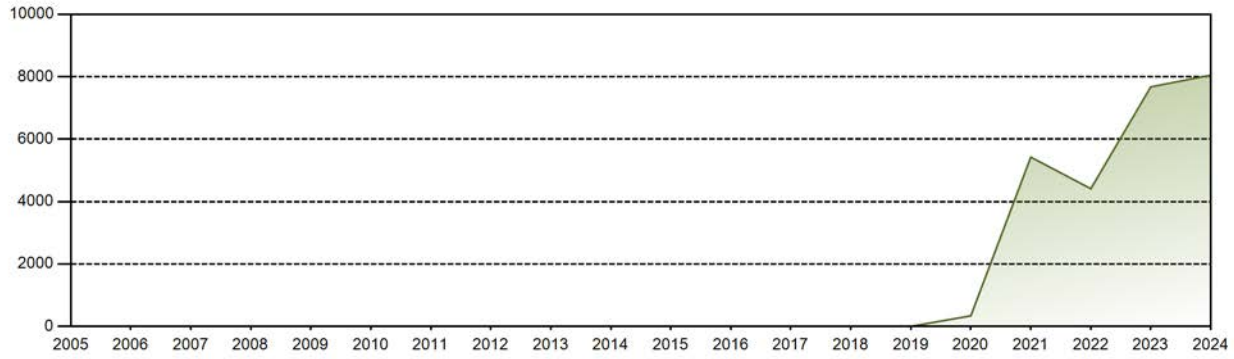
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	825.97	650.64	824.83	467.13	528.35	770.12	786.80	791.39	768.96	808.48	769.33	58.29	8050.29
EAF [%]	100.00	85.09	100.00	59.62	64.90	97.19	96.16	96.74	97.08	98.71	97.43	7.69	83.33
UCF [%]	100.00	85.09	100.00	59.62	64.90	100.00	100.00	100.00	100.00	100.00	97.43	7.69	84.51
LF [%]	100.02	84.22	99.88	58.45	63.98	96.36	95.27	95.83	96.22	97.90	96.26	7.06	82.57
OF [%]	100.00	85.06	100.00	77.22	85.48	100.00	100.00	100.00	100.00	100.00	100.00	7.66	87.90
FLR [%]	0.00	14.91	0.00	40.38	35.10	0.00	0.00	0.00	0.00	0.00	2.57	0.00	8.33
UCL [%]	0.00	14.91	0.00	40.38	35.10	0.00	0.00	0.00	0.00	0.00	2.57	0.00	7.67
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	92.31	7.82
XUF [%]	0.00	0.00	0.00	0.00	0.00	2.81	3.84	3.26	2.92	1.29	0.00	0.00	1.18

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Historical Summary

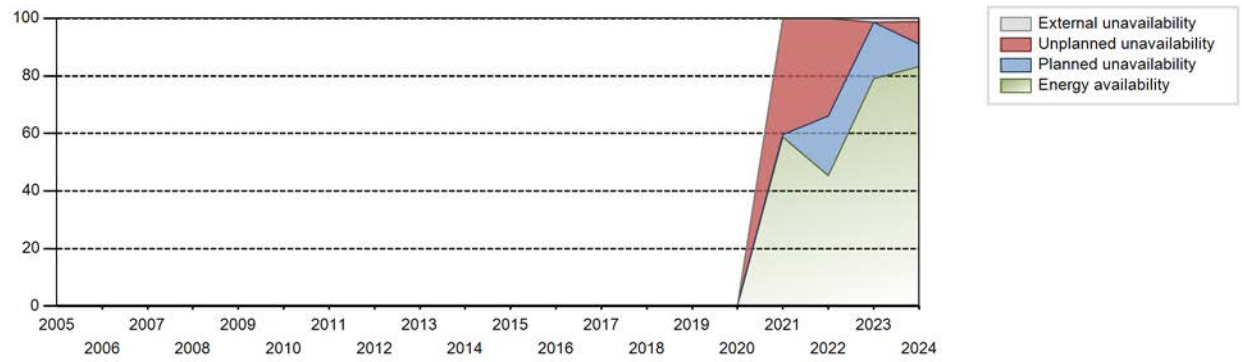
Lifetime energy generation	:	25897.58 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	11.46 %
Cumulative Energy Availability Factor (EAF)	:	67.54 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	18.19 %
Cumulative Unit Capability Factor (UCF)	:	68.24 %	Cumulative Planned Unavailability Factor (PUF)	:	13.57 %
Cumulative Load Factor (LF)	:	67.23 %	Cumulative Externally cause unavailability (XUF)	:	0.7 %
Cumulative Operating Factor (OF)	:	69.49 %			

Electricity Production (net) [GWh]

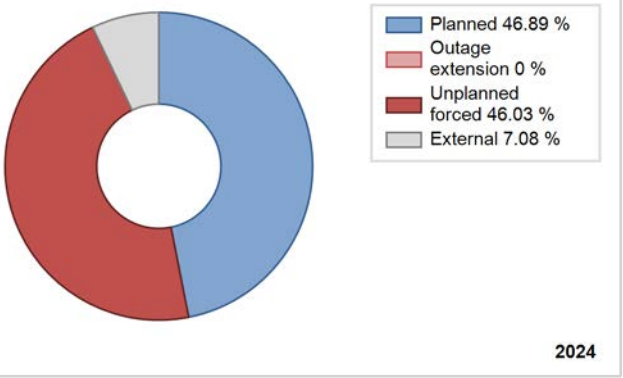


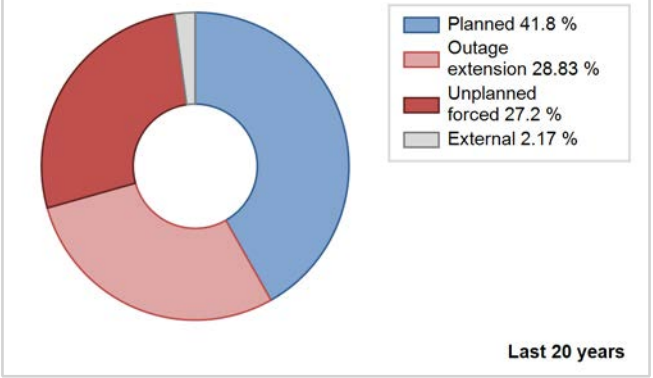
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2021	5422.11	5255	1110	58.75	58.75	58.32	59.66	40.71	40.34	0.91	0.00
2022	4411.35	4008	1110	45.38	45.38	45.37	45.75	0.74	33.93	20.69	0.00
2023	7675.40	7054	1110	79.03	80.37	78.94	80.53	0.00	0.00	19.63	1.35
2024	8050.29	7721	1110	83.33	84.51	82.57	87.90	8.33	7.67	7.82	1.18

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2021 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		375			686	
C. Inspection, maintenance or repair combined with refuelling	687			1170		
Z. Other					821	
Subtotal	687	375		1170	1507	
Total	**1062**			**2677**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2021 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		13
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System	375	94
41. Main Generator Systems		505
Total	**375**	**614**

Highlights (2024)

Scheduled repair of power unit No.1

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2024 Operating Experience

BY-2 BELARUSIAN-2 BELARUS

Status at end of year	:	**Operational**
Operator	:	BelNPP (Republican Unitary Enterprise "Belarusian Nuclear Power Plant")
Owner	:	BelNPP (Republican Unitary Enterprise "Belarusian Nuclear Power Plant")
Reactor Supplier	:	JSC ASE (JSC "Atomstroyexport")
Turbine Supplier	:	JSC ASE (JSC "Atomstroyexport")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-491
Thermal power	:	3200 MWth
Gross electrical power	:	1194 MWe
Reference unit power (net)	:	1110 MWe

Key Dates

Construction Date	:	2014-04-27
Grid Date	:	2023-05-13
Commercial Date	:	2023-11-01
Age at end of year	:	1 years

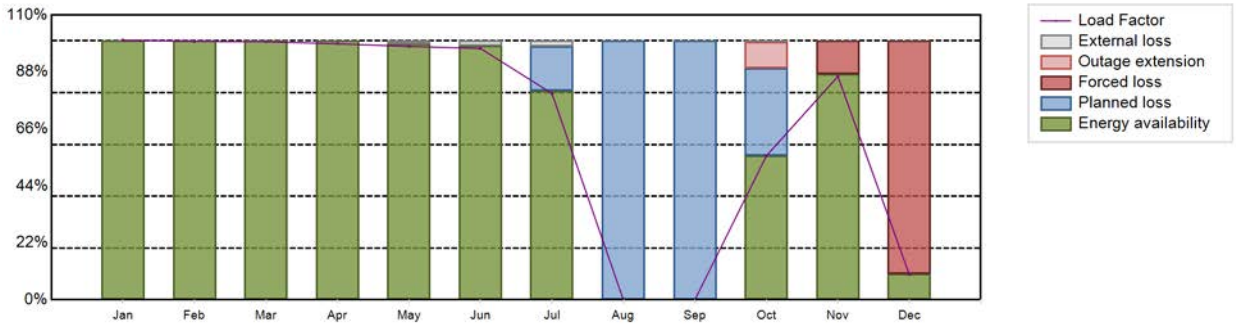
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	55500
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.73
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	16.87
Number of control rod assemblies	:	121
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	16.2
Reactor outlet temperature [°C]	:	328.6
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	0.2
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	4
HP cylinder inlet steam pressure [MPa]	:	6.8
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	6
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	5
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6684.62 GW(e).h
Energy Availability Factor (EAF)	:	69.03 %
Unit Capability Factor (UCF)	:	69.49 %
Load Factor (LF)	:	68.56 %
Operating Factor (OF)	:	69.73 %
Forced Loss Rate (FLR)	:	11.1 %
Unplanned Capability Loss Factor (UCL)	:	9.54 %
Planned Unavailability Factor (PUF)	:	20.97 %
Externally cause unavailability (XUF)	:	0.46 %
Total off-line time	:	2659 hours

Annual Summary



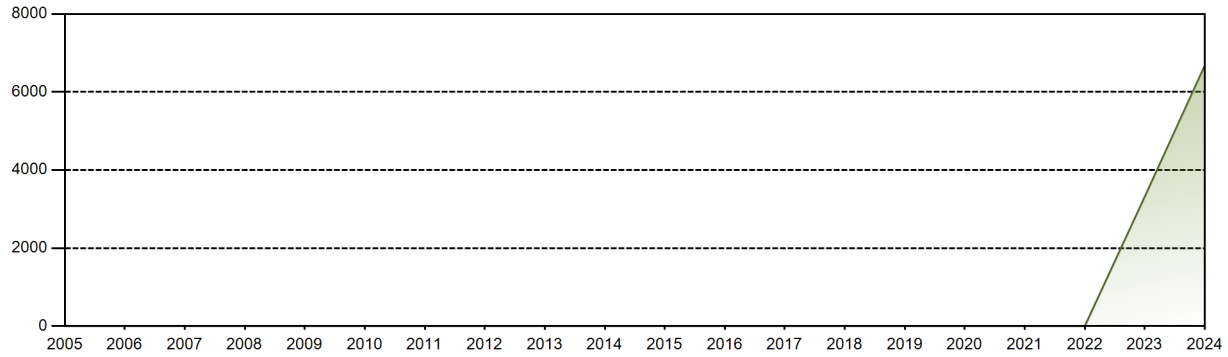
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	828.63	770.87	823.25	790.27	808.11	776.01	658.36	0.00	0.00	459.06	689.69	80.37	6684.62
EAF [%]	100.00	100.00	100.00	100.00	98.82	98.21	80.87	0.00	0.00	55.68	87.21	9.91	69.03
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	82.96	0.00	0.00	56.07	87.21	9.91	69.49
LF [%]	100.34	99.78	99.69	98.88	97.85	97.10	79.72	0.00	0.00	55.59	86.30	9.73	68.56
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	83.60	0.00	0.00	57.53	87.92	9.95	69.73
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.79	90.09	11.10
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.20	12.79	90.09	9.54
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	17.04	100.00	100.00	33.72	0.00	0.00	20.97
XUF [%]	0.00	0.00	0.00	0.00	1.18	1.79	2.09	0.00	0.00	0.39	0.00	0.00	0.46

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Historical Summary

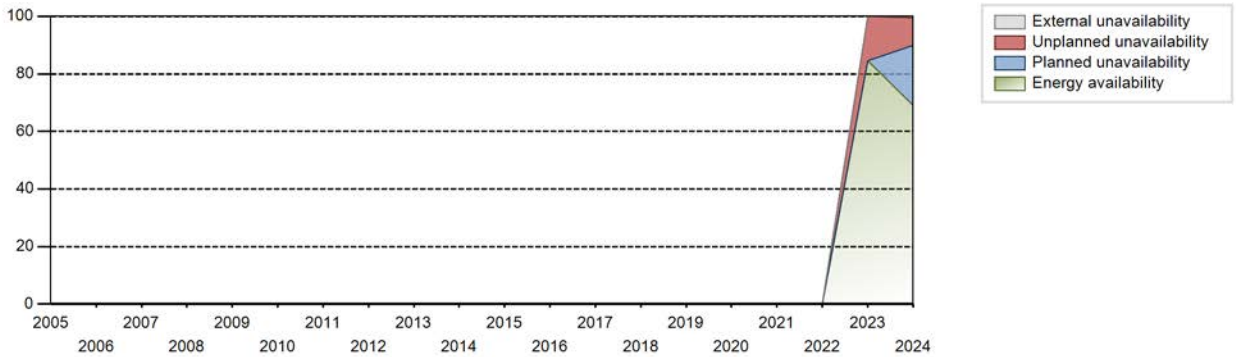
Lifetime energy generation	:	10005.74 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	11.86 %
Cumulative Energy Availability Factor (EAF)	:	71.25 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	10.38 %
Cumulative Unit Capability Factor (UCF)	:	71.65 %	Cumulative Planned Unavailability Factor (PUF)	:	17.97 %
Cumulative Load Factor (LF)	:	70.85 %	Cumulative Externally cause unavailability (XUF)	:	0.39 %
Cumulative Operating Factor (OF)	:	73.84 %			

Electricity Production (net) [GWh]

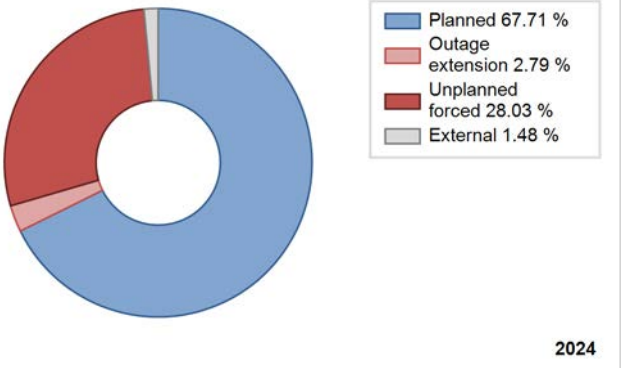


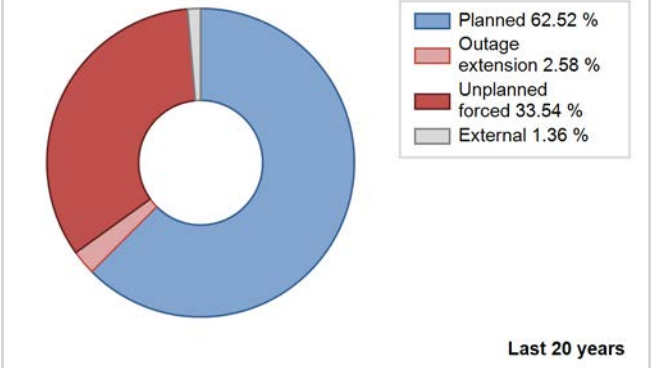
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2023	3321.12	3674	1110	84.58	84.58	84.58	98.50	15.42	15.42	0.00	0.00
2024	6684.62	6125	1110	69.03	69.49	68.56	69.73	11.10	9.54	20.97	0.46

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2023 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		99			103	
C. Inspection, maintenance or repair combined with refuelling	1826			1565		
E. Testing of plant systems or components		76			65	
Z. Other		670			575	
Subtotal	1826	845		1565	743	
Total		**2671**			**2308**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2023 to 2024
	Hours Lost	Average hours lost per reactor-year
14. Safety Systems	76	46
31. Turbine and auxiliaries		13
35. All other I&C Systems	670	402
41. Main Generator Systems	99	59
Total	**845**	**520**

Highlights (2024)

Scheduled repair of power unit No.2

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2024 Operating Experience

BE-2 DOEL-1 BELGIUM



Status at end of year	:	**Permanent Shutdown**
Operator	:	EBL+EDF (ENGIE ELECTRABEL + EDF BELGIUM + EDF LUMINUS)
Owner	:	IND.DOEL (INDIVISION DOEL (EBES , INTERCOM , UNERG))
Reactor Supplier	:	ACECOWEN (ACECOWEN (ACEC-COCKERILL-WESTINGHOUSE))
Turbine Supplier	:	COC/ACEC (TURBINE: COCKERILL-TOSI ; ALTERNATOR: ACEC)

Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP
Thermal power	:	1311 MWth
Gross electrical power	:	454 MWe
Reference unit power (net)	:	445 MWe

Key Dates

Construction Date	:	1969-07-01
Grid Date	:	1974-08-28
Commercial Date	:	1975-02-15
Age at end of year	:	50 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	2.46
Active core height/length [m]	:	2.44
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	22.22
Number of control rod assemblies	:	21
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

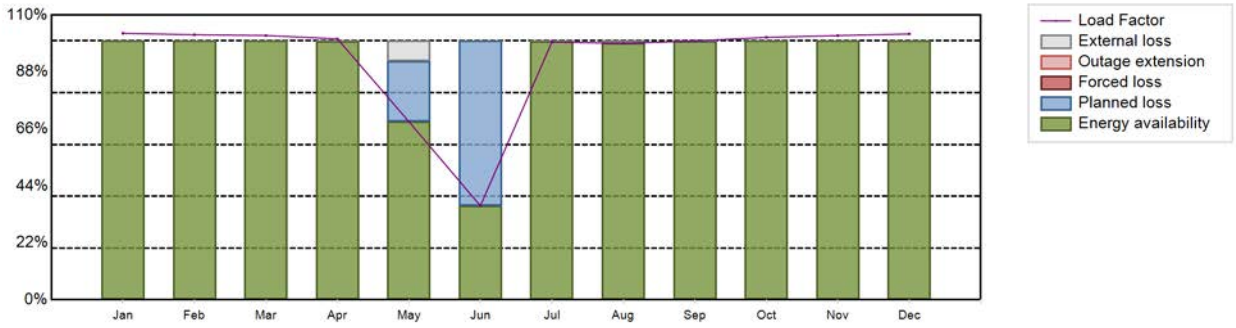
Operating coolant pressure [MPa]	:	15.73
Reactor outlet temperature [°C]	:	315.08
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	2.9
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.8
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3643.48 GW(e).h
Energy Availability Factor (EAF)	:	92 %
Unit Capability Factor (UCF)	:	92.79 %
Load Factor (LF)	:	93.21 %
Operating Factor (OF)	:	93 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	7.21 %
Externally cause unavailability (XUF)	:	0.79 %
Total off-line time	:	615 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	340.77	317.09	337.56	322.90	227.85	116.34	329.70	327.88	320.37	336.08	327.01	339.93	3643.48
EAF [%]	100.00	100.00	100.00	99.76	68.82	36.22	99.83	99.03	99.77	100.00	100.00	100.00	92.00
UCF [%]	100.00	100.00	100.00	100.00	76.59	36.22	100.00	100.00	99.98	100.00	100.00	100.00	92.79
LF [%]	102.93	102.38	102.09	100.78	68.82	36.31	99.58	99.03	99.99	101.37	102.06	102.67	93.21
OF [%]	100.00	100.00	100.00	100.00	76.75	38.61	100.00	100.00	100.00	100.00	100.00	100.00	93.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	23.41	63.78	0.00	0.00	0.02	0.00	0.00	0.00	7.21
XUF [%]	0.00	0.00	0.00	0.24	7.77	0.00	0.17	0.97	0.21	0.00	0.00	0.00	0.79

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Historical Summary

Lifetime energy generation	:	147555.38 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.97 %
Cumulative Energy Availability Factor (EAF)	:	84.05 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.94 %
Cumulative Unit Capability Factor (UCF)	:	84.87 %	Cumulative Planned Unavailability Factor (PUF)	:	12.19 %
Cumulative Load Factor (LF)	:	82.59 %	Cumulative Externally cause unavailability (XUF)	:	0.82 %
Cumulative Operating Factor (OF)	:	84.07 %			

Electricity Production (net) [GWh]

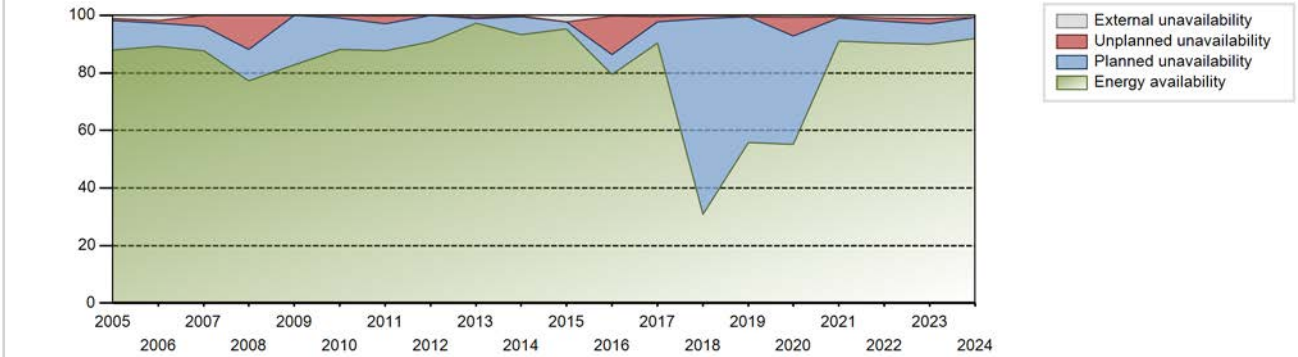


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	2557.60	7257	392	75.78	75.78	75.77	81.78	24.22	24.22	0.00	0.00
1976	2667.10	6928	395	75.48	75.48	76.87	78.87	12.67	10.95	13.57	0.00
1977	2830.00	7332	395	81.77	81.77	81.79	83.70	8.45	7.55	10.67	0.00
1978	2731.20	7071	395	78.89	78.89	78.93	80.72	0.99	0.78	20.33	0.00
1979	3037.00	7812	395	86.38	86.38	87.77	89.18	1.45	1.27	12.35	0.00
1980	2901.00	7596	395	84.36	84.36	83.61	86.48	2.96	2.57	13.07	0.00
1981	2946.00	7644	395	85.00	85.00	85.14	87.26	0.00	0.00	15.00	0.00
1982	3184.50	8103	395	91.24	91.24	92.03	92.50	1.45	1.34	7.42	0.00
1983	2823.00	7316	393	81.78	81.78	82.00	83.52	17.98	17.92	0.30	0.00
1984	3129.00	7988	393	90.22	90.22	90.64	90.94	1.88	1.73	8.06	0.00
1985	2896.32	7330	392	82.44	82.44	84.34	83.68	2.58	2.18	15.38	0.00
1986	2685.93	7040	392	78.85	79.15	78.22	80.37	3.69	3.03	17.82	0.30
1987	2928.35	7306	400	85.44	85.45	83.57	83.40	3.59	3.18	11.37	0.01
1988	2694.15	7686	400	81.28	86.59	76.68	87.50	1.53	1.35	12.06	5.31
1989	2513.10	6475	400	71.87	73.57	71.72	73.92	9.59	7.81	18.63	1.70
1990	2859.89	7380	400	83.54	85.62	81.62	84.25	0.84	0.73	13.65	2.07
1991	3061.38	7860	400	89.20	89.48	87.37	89.73	1.12	1.02	9.51	0.28
1992	2990.54	7741	400	86.52	87.69	85.11	88.13	1.18	1.05	11.26	1.17
1993	2908.89	7580	400	84.38	86.00	83.02	86.53	3.84	3.43	10.57	1.62
1994	2921.78	7635	400	84.32	88.72	83.38	87.16	0.38	0.34	10.94	4.40
1995	2791.52	7342	392	80.96	82.67	81.29	83.81	3.45	2.95	14.37	1.72
1996	3169.35	8141	392	91.25	91.48	92.04	92.68	0.48	0.44	8.08	0.23
1997	3113.83	7899	392	88.92	88.97	90.68	90.17	2.08	1.89	9.14	0.05
1998	3292.46	8277	392	93.74	94.05	95.88	94.49	0.17	0.16	5.78	0.31
1999	3196.84	8123	392	91.12	92.58	93.10	92.73	0.27	0.25	7.16	1.46
2000	3264.77	8317	392	92.34	94.25	94.81	94.68	0.39	0.37	5.39	1.91
2001	3157.62	8098	392	90.47	91.37	91.94	92.43	3.11	2.93	5.70	0.90
2002	3260.70	8308	392	93.33	93.44	94.96	94.84	0.39	0.37	6.19	0.11
2003	3024.60	7953	392	86.35	90.29	88.08	90.79	0.23	0.58	9.13	3.94
2004	2989.10	7742	392	85.54	87.55	86.81	88.14	1.66	1.72	10.72	2.02
2005	3062.65	7849	392	87.95	89.14	89.18	89.59	0.78	0.70	10.16	1.18
2006	3100.48	8030	392	89.19	91.10	90.29	91.67	0.89	0.82	8.08	1.91
2007	3028.97	7709	392	87.64	87.72	88.21	88.00	0.00	3.70	8.58	0.08
2008	2690.32	6847	392	77.29	77.29	78.13	77.95	12.89	11.96	10.75	0.00
2009	2874.05	7266	392	82.89	82.90	83.70	82.95	0.00	0.00	17.09	0.01
2010	3401.38	7801	433	88.25	88.25	89.67	89.05	1.09	0.97	10.78	0.01
2011	3328.53	7740	433	87.77	87.94	87.75	88.36	0.34	2.72	9.34	0.17

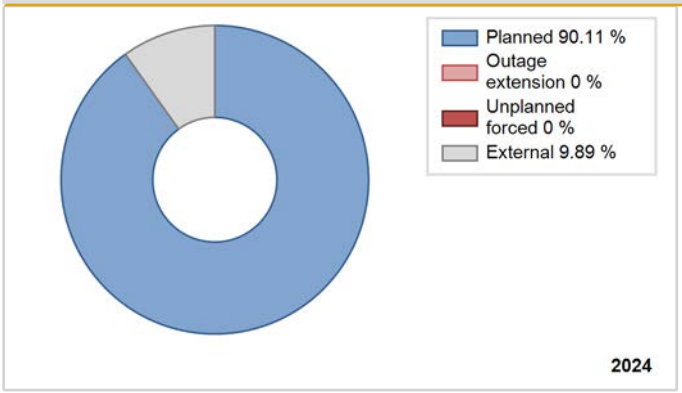
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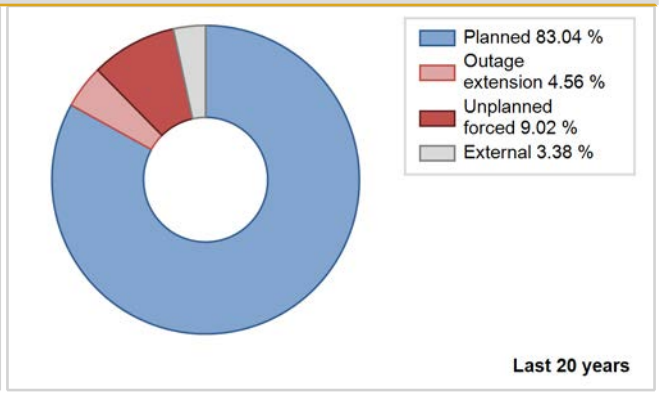
2012	3444.69	8019	433	90.91	90.91	90.57	91.29	0.08	0.07	9.02	0.00
2013	3707.93	8595	433	97.23	97.93	97.76	98.12	0.37	0.36	1.71	0.70
2014	3556.42	8230	433	93.35	93.62	93.76	93.95	0.32	0.30	6.08	0.27
2015	396.78	1143	433	95.33	97.63	10.46	13.05	0.00	0.00	2.37	2.30
2016	3014.51	7056	433	79.41	79.64	79.26	80.33	13.14	13.44	6.92	0.23
2017	3426.38	8019	433	90.28	90.68	90.33	91.54	0.61	1.85	7.46	0.40
2018	1172.49	2700	433	30.81	30.81	30.91	30.82	3.61	1.15	68.04	0.00
2019	2185.67	4968	445	55.84	56.39	56.31	56.71	0.05	0.03	43.58	0.55
2020	2172.18	4946	445	55.19	55.81	55.57	56.31	0.00	6.55	37.64	0.62
2021	3587.85	8045	445	91.05	91.44	92.04	91.84	0.51	0.47	8.10	0.39
2022	3551.15	8045	445	90.40	91.39	91.10	91.84	1.13	1.04	7.56	0.99
2023	3540.07	8075	445	89.90	91.08	90.81	92.18	1.98	1.84	7.09	1.17
2024	3643.49	8169	445	92.00	92.79	93.21	93.00	0.00	0.00	7.21	0.79

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1975 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					186	
C. Inspection, maintenance or repair combined with refuelling	615			715		
D. Inspection, maintenance or repair without refuelling				5		
E. Testing of plant systems or components				43	2	
F. Major backfitting, refurbishment or upgrading activities with refuelling				261		
H. Nuclear regulatory requirements					5	
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						5
L. Human factor related					24	
M. Governmental requirements or court decisions						149
P. Fire					1	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				17	31	
Z. Other					1	
Subtotal	615			1041	250	154
Total	**615**			**1445**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1975 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		8
12. Reactor I&C Systems		29
13. Reactor Auxiliary Systems		3
14. Safety Systems		11
15. Reactor Cooling Systems		32
16. Steam generation systems		30
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		56
32. Feedwater and Main Steam System		16
33. Circulating Water System		0
41. Main Generator Systems		6
42. Electrical Power Supply Systems		0
Total		**192**

Highlights (2024)

13-04 to 24-5 : Stretch-out
24-5 to 19-6 : Refuelling outage end cycle 48
19-6 to 21-6 : startup cycle 49

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2024 Operating Experience

BE-4 DOEL-2 BELGIUM



Status at end of year	:	**Operational**
Operator	:	EBL+EDF (ENGIE ELECTRABEL + EDF BELGIUM + EDF LUMINUS)
Owner	:	IND.DOEL (INDIVISION DOEL (EBES , INTERCOM , UNERG))
Reactor Supplier	:	ACECOWEN (ACECOWEN (ACEC-COCKERILL-WESTINGHOUSE))
Turbine Supplier	:	COC/ACEC (TURBINE: COCKERILL-TOSI ; ALTERNATOR: ACEC)

Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP
Thermal power	:	1311 MWth
Gross electrical power	:	454 MWe
Reference unit power (net)	:	445 MWe

Key Dates

Construction Date	:	1971-09-01
Grid Date	:	1975-08-21
Commercial Date	:	1975-12-01
Age at end of year	:	49 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	2.46
Active core height/length [m]	:	2.44
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	22.22
Number of control rod assemblies	:	21
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

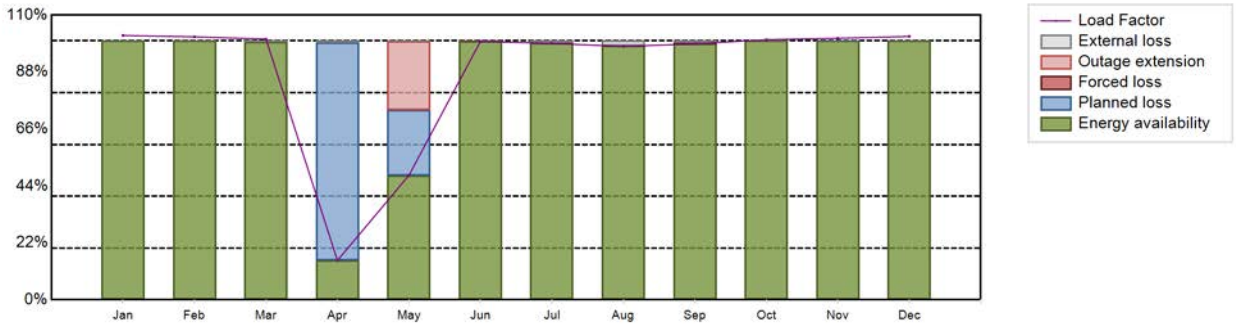
Operating coolant pressure [MPa]	:	15.73
Reactor outlet temperature [°C]	:	315.08
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	2.9
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.8
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3475.46 GW(e).h
Energy Availability Factor (EAF)	:	88.26 %
Unit Capability Factor (UCF)	:	88.59 %
Load Factor (LF)	:	88.91 %
Operating Factor (OF)	:	88.97 %

Forced Loss Rate (FLR)	:	0.13 %
Unplanned Capability Loss Factor (UCL)	:	2.36 %
Planned Unavailability Factor (PUF)	:	9.05 %
Externally cause unavailability (XUF)	:	0.33 %
Total off-line time	:	969 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	338.04	314.62	332.98	48.71	159.19	319.78	327.88	323.96	316.74	333.07	323.67	336.81	3475.46
EAF [%]	100.00	100.00	99.65	15.20	48.04	99.77	99.03	98.12	98.86	100.00	99.99	100.00	88.26
UCF [%]	100.00	100.00	100.00	15.85	48.07	99.77	99.56	99.89	99.41	100.00	99.99	100.00	88.59
LF [%]	102.10	101.58	100.71	15.20	48.08	99.81	99.03	97.85	98.86	100.47	101.02	101.73	88.91
OF [%]	100.00	100.00	100.00	16.11	50.94	100.00	100.00	100.00	100.00	100.00	100.00	100.00	88.97
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.23	0.44	0.11	0.59	0.00	0.00	0.00	0.13
UCL [%]	0.00	0.00	0.00	0.00	26.54	0.23	0.44	0.11	0.59	0.00	0.00	0.00	2.36
PUF [%]	0.00	0.00	0.00	84.15	25.39	0.00	0.00	0.00	0.00	0.00	0.01	0.00	9.05
XUF [%]	0.00	0.00	0.35	0.64	0.03	0.00	0.53	1.77	0.55	0.00	0.00	0.00	0.33

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Historical Summary

Lifetime energy generation	:	145723.1 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.29 %
Cumulative Energy Availability Factor (EAF)	:	81.71 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.23 %
Cumulative Unit Capability Factor (UCF)	:	82.47 %	Cumulative Planned Unavailability Factor (PUF)	:	14.3 %
Cumulative Load Factor (LF)	:	81.97 %	Cumulative Externally cause unavailability (XUF)	:	0.75 %
Cumulative Operating Factor (OF)	:	82.79 %			

Electricity Production (net) [GWh]

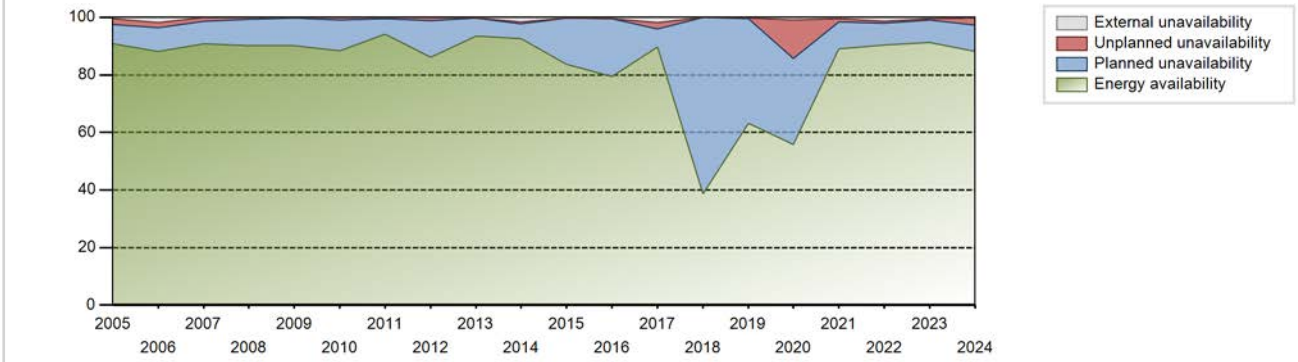


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	711.50	2305	392	91.30	91.30	91.34	93.28	8.70	8.70	0.00	0.00
1976	2462.80	6519	395	71.64	71.64	70.98	74.21	6.58	5.05	23.31	0.00
1977	2576.80	6649	395	74.30	74.30	74.47	75.90	15.58	13.71	11.99	0.00
1978	2750.60	7114	395	79.53	79.53	79.49	81.21	8.68	7.56	12.91	0.00
1979	2593.30	6639	395	74.56	74.56	74.95	75.79	2.02	1.54	23.90	0.00
1980	2782.00	7111	395	79.75	79.75	80.18	80.95	0.36	0.29	19.96	0.00
1981	2841.70	7226	395	81.36	81.36	82.13	82.49	2.77	2.32	16.33	0.00
1982	2582.00	6598	395	73.82	73.82	74.62	75.32	19.44	17.82	8.37	0.00
1983	2017.00	5190	393	58.02	58.02	58.59	59.25	0.06	0.03	41.95	0.00
1984	2916.00	7508	393	84.15	84.15	84.47	85.47	3.08	2.67	13.18	0.00
1985	2908.66	7341	392	83.04	83.04	84.70	83.80	7.64	6.86	10.10	0.00
1986	2282.63	5891	392	69.76	69.85	66.47	67.25	5.08	3.74	26.41	0.09
1987	2616.44	6612	400	76.77	77.75	74.67	75.48	8.61	7.32	14.92	0.99
1988	2906.68	7408	400	82.60	83.20	82.73	84.34	5.39	4.74	12.06	0.60
1989	2479.80	6436	400	70.79	71.79	70.77	73.47	11.54	9.36	18.85	1.00
1990	1982.58	5170	400	56.58	66.48	56.58	59.02	19.63	16.23	17.29	9.90
1991	2779.83	7136	400	81.02	81.17	79.33	81.46	2.08	1.72	17.10	0.15
1992	2971.94	7617	400	86.12	86.33	84.58	86.71	0.88	0.76	12.91	0.21
1993	2949.55	7551	400	85.68	85.94	84.18	86.20	2.40	2.12	11.94	0.27
1994	2982.45	7810	392	86.22	87.28	86.85	89.16	0.54	0.48	12.24	1.06
1995	2867.54	7342	392	82.70	82.92	83.51	83.81	5.02	4.38	12.70	0.23
1996	2888.76	7390	392	83.13	83.39	83.89	84.13	7.17	6.44	10.18	0.25
1997	2935.03	7749	392	84.50	87.71	85.47	88.46	2.97	2.68	9.61	3.21
1998	3145.01	7987	392	90.13	90.18	91.59	91.18	2.50	2.31	7.51	0.05
1999	3091.67	7875	392	88.88	89.57	90.03	89.90	3.65	3.39	7.04	0.70
2000	3135.59	8022	392	89.81	90.43	91.06	91.33	3.57	3.34	6.23	0.62
2001	3150.54	8060	392	90.30	90.89	91.75	92.01	2.41	2.25	6.87	0.58
2002	3104.45	8076	392	89.51	91.39	90.41	92.19	1.37	1.27	7.34	1.89
2003	3142.62	8184	392	90.13	93.09	91.52	93.42	0.47	0.59	6.32	2.96
2004	2951.91	7174	433	80.50	81.92	81.35	81.67	0.37	0.30	17.77	1.43
2005	3506.72	8036	433	90.79	91.26	92.44	91.72	2.11	1.97	6.77	0.47
2006	3399.32	7954	433	88.18	90.10	89.62	90.80	1.86	1.71	8.19	1.91
2007	3483.14	7985	433	90.76	90.77	91.83	91.15	0.09	1.43	7.80	0.01
2008	3478.91	8000	433	90.26	90.26	91.47	91.07	0.68	0.61	9.12	0.00
2009	3468.52	7941	433	90.11	90.11	91.44	90.65	0.39	0.36	9.54	0.00
2010	3411.40	7823	433	88.29	88.40	89.95	89.31	0.70	0.90	10.70	0.11
2011	3570.91	8292	433	94.12	94.12	94.14	94.66	0.49	0.47	5.41	0.00

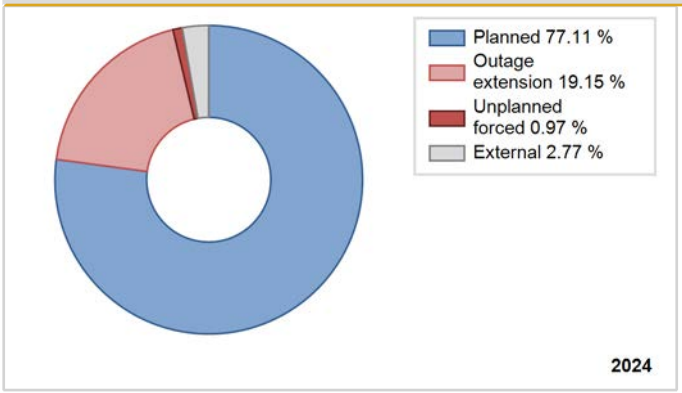
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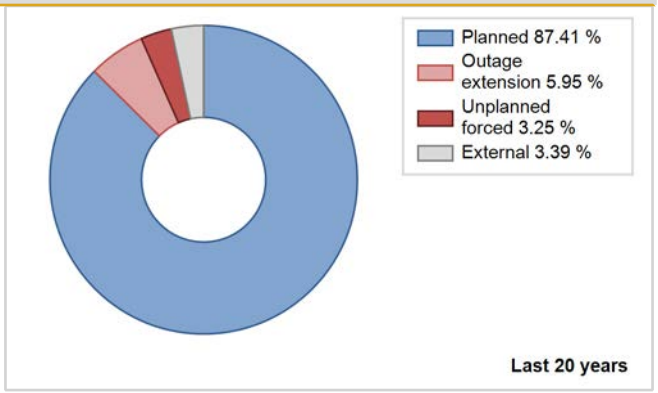
2012	3261.59	7605	433	86.06	86.14	85.75	86.58	1.34	1.17	12.68	0.09
2013	3566.80	8238	433	93.52	93.77	94.03	94.04	0.02	0.02	6.21	0.26
2014	3528.42	8291	433	92.67	94.33	93.02	94.65	0.59	0.56	5.10	1.66
2015	2971.43	6883	433	83.77	83.98	78.34	78.57	0.02	0.02	16.01	0.20
2016	3037.09	7056	433	79.47	79.90	79.85	80.33	0.07	0.05	20.05	0.43
2017	3413.43	8071	433	89.78	91.54	89.99	92.13	0.30	2.35	6.11	1.76
2018	1475.20	3400	433	38.68	38.70	38.89	38.81	0.24	0.09	61.21	0.02
2019	2405.33	5653	433	63.12	63.46	63.41	64.53	0.23	0.14	36.39	0.34
2020	2161.14	5003	445	55.74	56.73	55.91	56.96	0.26	13.38	29.89	0.99
2021	3490.70	7901	445	89.11	89.66	89.55	90.19	1.05	0.95	9.39	0.55
2022	3538.97	8105	445	90.46	91.80	90.78	92.52	0.88	0.81	7.39	1.34
2023	3570.58	8091	445	91.16	91.70	91.60	92.36	0.45	0.41	7.89	0.54
2024	3475.46	7815	445	88.26	88.59	88.91	88.97	0.13	2.36	9.05	0.33

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1975 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		197			226	
C. Inspection, maintenance or repair combined with refuelling	772			770		
D. Inspection, maintenance or repair without refuelling				134		
E. Testing of plant systems or components				61	9	
F. Major backfitting, refurbishment or upgrading activities with refuelling				222		
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						15
L. Human factor related					41	
M. Governmental requirements or court decisions						11
P. Fire					1	
Z. Other					7	
Subtotal	772	197		1187	284	26
Total	**969**			**1497**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		9
13. Reactor Auxiliary Systems		6
14. Safety Systems		9
15. Reactor Cooling Systems		18
16. Steam generation systems		61
21. Fuel Handling and Storage Facilities		19
31. Turbine and auxiliaries		62
32. Feedwater and Main Steam System	118	15
34. Miscellaneous Systems		17
41. Main Generator Systems	79	21
42. Electrical Power Supply Systems		6
Total	**197**	**246**

Highlights (2024)

10-03 to 05-04 : stretch-out
05-04 to 08-05 : Refuelling outage end cycle 48
08-05 to16-05 : Refuelling outage extention (malfunction generator)
16-05 to 18-05 : Start up cycle 49

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2024 Operating Experience

BE-7 DOEL-4 BELGIUM



Status at end of year	:	**Operational**
Operator	:	EBL+EDF (ENGIE ELECTRABEL + EDF BELGIUM + EDF LUMINUS)
Owner	:	EBES (SOCIETES REUNIES D'ENERGIE DU BASSIN DE L'ESCAUT SA)
Reactor Supplier	:	ACECOWEN (ACECOWEN (ACEC-COCKERILL-WESTINGHOUSE))
Turbine Supplier	:	AA/BB/AC ((ALSTHOM - BBC / ACEC))

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP
Thermal power	:	2988 MWth
Gross electrical power	:	1090 MWe
Reference unit power (net)	:	1026 MWe

Key Dates

Construction Date	:	1978-12-01
Grid Date	:	1985-04-08
Commercial Date	:	1985-07-01
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	4.27
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	16.47
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

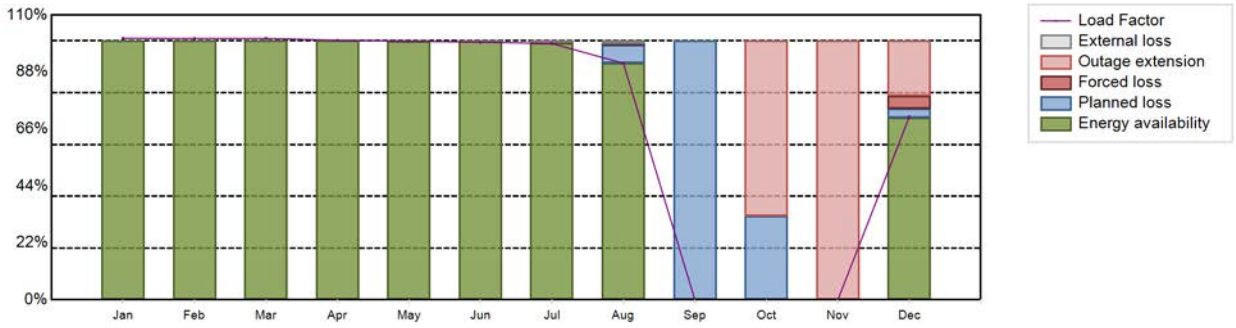
Operating coolant pressure [MPa]	:	15.73
Reactor outlet temperature [°C]	:	315.08
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	3.5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	7.28
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6492.93 GW(e).h
Energy Availability Factor (EAF)	:	71.77 %
Unit Capability Factor (UCF)	:	71.96 %
Load Factor (LF)	:	72.04 %
Operating Factor (OF)	:	72.44 %

Forced Loss Rate (FLR)	:	0.64 %
Unplanned Capability Loss Factor (UCL)	:	16.18 %
Planned Unavailability Factor (PUF)	:	11.86 %
Externally cause unavailability (XUF)	:	0.19 %
Total off-line time	:	2421 hours

Annual Summary



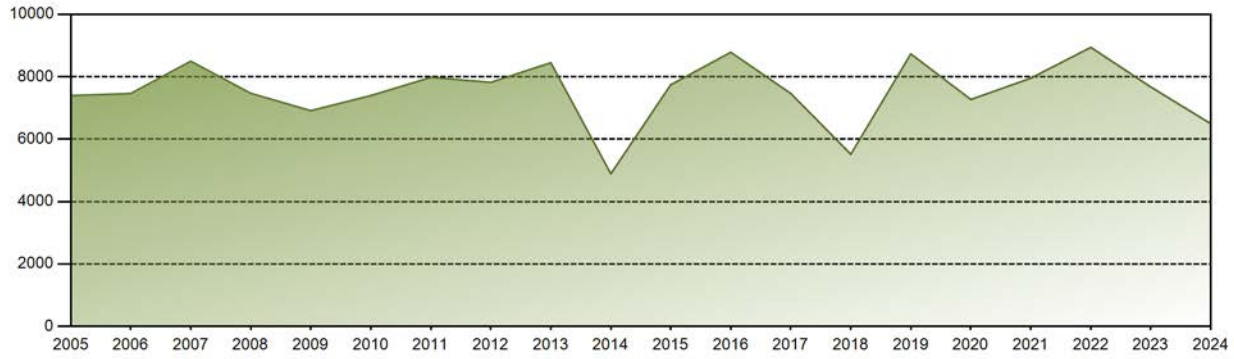
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	771.23	720.89	769.59	740.91	762.22	735.38	755.44	697.49	0.00	0.00	0.00	539.80	6492.93
EAF [%]	100.00	100.00	100.00	100.00	99.94	99.77	99.10	91.37	0.00	0.00	0.00	70.22	71.77
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	99.79	92.62	0.00	0.00	0.00	70.22	71.96
LF [%]	101.03	100.95	100.95	100.30	99.85	99.55	98.96	91.37	0.00	0.00	0.00	70.71	72.04
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	93.28	0.00	0.00	0.00	75.00	72.44
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.40	0.00	0.00	0.00	6.45	0.64
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.37	0.00	67.52	100.00	26.10	16.18
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.01	100.00	32.48	0.00	3.67	11.86
XUF [%]	0.00	0.00	0.00	0.00	0.06	0.23	0.68	1.25	0.00	0.00	0.00	0.00	0.19

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Historical Summary

Lifetime energy generation	:	293030.3 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.74 %
Cumulative Energy Availability Factor (EAF)	:	83.59 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.83 %
Cumulative Unit Capability Factor (UCF)	:	84.25 %	Cumulative Planned Unavailability Factor (PUF)	:	9.92 %
Cumulative Load Factor (LF)	:	83.31 %	Cumulative Externally cause unavailability (XUF)	:	0.66 %
Cumulative Operating Factor (OF)	:	85.54 %			

Electricity Production (net) [GWh]

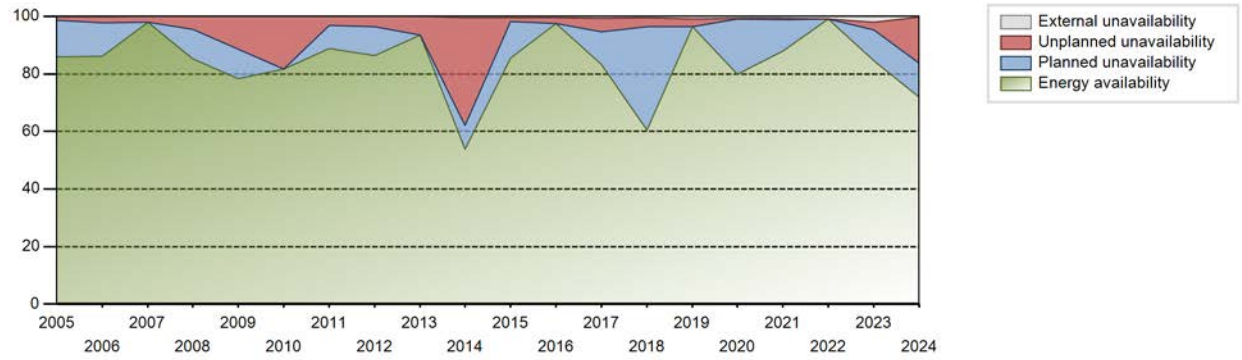


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	4282.13	5263	981	82.56	82.56	82.59	87.93	17.44	17.44	0.00	0.00
1986	7722.89	7973	1006	87.77	87.77	87.64	91.02	0.00	0.00	12.23	0.00
1987	6809.26	7448	1006	77.04	81.42	77.27	85.02	4.33	3.69	14.89	4.38
1988	7551.97	7784	1000	85.90	87.60	85.97	88.62	2.34	2.10	10.30	1.70
1989	7445.90	7737	1010	84.43	87.37	84.16	88.32	5.46	5.05	7.59	2.94
1990	7535.84	7790	1010	85.25	88.23	85.17	88.93	2.53	2.29	9.48	2.97
1991	7425.40	7673	1010	84.07	84.76	83.93	87.59	3.04	2.66	12.59	0.69
1992	7418.56	7481	1010	85.93	86.73	83.62	85.17	5.16	4.72	8.55	0.80
1993	6980.93	7112	1010	78.90	79.63	78.90	81.19	12.71	11.59	8.78	0.74
1994	3462.74	3637	1001	39.18	39.18	39.49	41.52	52.92	44.04	16.78	0.00
1995	6769.69	7381	1001	76.83	76.93	77.20	84.26	5.55	4.52	18.55	0.10
1996	6186.80	6565	1001	69.86	70.57	70.36	74.74	1.92	1.38	28.05	0.72
1997	7548.66	7653	1001	86.99	87.10	86.09	87.36	6.16	5.72	7.19	0.11
1998	7844.02	7998	985	89.99	89.99	90.91	91.30	1.51	1.38	8.63	0.00
1999	8008.40	8150	985	92.41	92.51	92.81	93.04	0.08	0.08	7.42	0.10
2000	7992.87	8323	985	91.98	92.01	92.38	94.75	2.75	2.60	5.40	0.03
2001	8098.91	8264	985	93.25	93.30	93.86	94.34	0.81	0.77	5.93	0.05
2002	7831.93	8017	985	90.45	90.61	90.77	91.52	1.97	1.82	7.57	0.16
2003	7781.23	8015	985	90.55	91.06	90.18	91.50	0.52	0.47	8.47	0.51
2004	7519.82	7843	985	86.98	88.35	86.90	89.28	0.81	2.24	9.40	1.37
2005	7394.83	7647	985	85.86	86.08	85.69	87.28	1.24	1.08	12.83	0.22
2006	7461.97	7633	1008	86.21	86.53	84.51	87.13	2.14	1.89	11.58	0.32
2007	8496.87	8608	1008	98.06	98.09	96.22	98.25	1.91	1.91	0.00	0.04
2008	7466.73	7534	1008	85.22	85.22	84.33	85.77	0.10	4.40	10.38	0.00
2009	6910.95	6946	1047	78.29	78.32	77.76	79.29	8.59	11.42	10.26	0.03
2010	7395.39	7192	1038	81.59	81.59	81.27	82.10	18.41	18.41	0.00	0.00
2011	7978.47	7832	1039	88.78	88.78	87.66	89.41	3.38	3.11	8.11	0.00
2012	7818.70	7659	1039	86.44	86.52	85.67	87.19	3.89	3.62	9.86	0.08
2013	8447.48	8192	1039	93.48	93.48	92.81	93.52	6.51	6.51	0.00	0.00
2014	4886.99	4796	1039	53.72	54.19	53.69	54.75	40.90	37.50	8.30	0.48
2015	7743.88	7568	1033	85.53	85.91	85.58	86.39	0.20	1.43	12.66	0.38
2016	8782.01	8630	1033	97.49	98.03	96.78	98.25	1.97	1.97	0.00	0.54
2017	7461.43	7326	1038	83.17	83.82	82.19	83.63	5.25	4.65	11.54	0.65
2018	5514.68	5479	1038	60.56	60.98	60.65	62.55	4.86	3.12	35.90	0.42
2019	8730.31	8760	1038	96.30	97.16	96.01	100.00	2.84	2.84	0.00	0.87
2020	7270.15	7147	1038	79.80	80.60	79.74	81.36	0.28	0.23	19.17	0.81
2021	7952.78	7802	1038	87.82	88.54	87.46	89.06	0.14	0.33	11.12	0.73

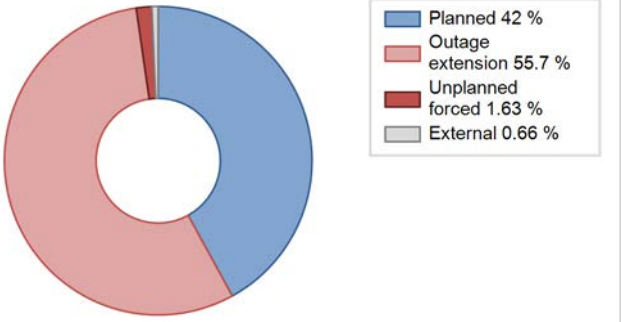
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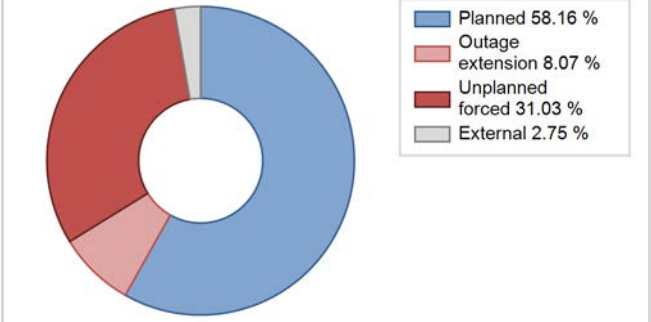
2022	8940.45	8760	1038	99.03	99.98	98.32	100.00	0.02	0.02	0.00	0.95
2023	7670.06	7635	1026	84.58	86.55	84.60	87.16	3.13	2.80	10.65	1.97
2024	6492.93	6363	1026	71.77	71.96	72.04	72.44	0.64	16.18	11.86	0.19

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		28			336	
C. Inspection, maintenance or repair combined with refuelling	1012			716		
D. Inspection, maintenance or repair without refuelling				42		
E. Testing of plant systems or components				1	1	
F. Major backfitting, refurbishment or upgrading activities with refuelling				82		
H. Nuclear regulatory requirements		1380			37	
J. Grid limitation, failure or grid unavailability						4
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L. Human factor related					23	
P. Fire					22	
Z. Other					29	
Subtotal	1012	1408		841	448	4
Total	**2420**			**1293**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		0
12. Reactor I&C Systems		4
13. Reactor Auxiliary Systems		4
14. Safety Systems		9
15. Reactor Cooling Systems		14
16. Steam generation systems		128
31. Turbine and auxiliaries	28	149
32. Feedwater and Main Steam System		12
33. Circulating Water System		5
41. Main Generator Systems		49
42. Electrical Power Supply Systems		4
Total	**28**	**378**

Highlights (2024)

29-8 to 11-10 : Refuelling outage (end cycle 33)
11-10 to 07-12 : Refuelling outage extention
07-12 to 12-12 : start up cycle 34 (and limitations due toprotections power measurement capacity)

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2024 Operating Experience

BE-3 TIHANGE-1 BELGIUM



Status at end of year	:	**Operational**
Operator	:	EBL (ENGIE ELECTRABEL
Owner	:	EBL (ENGIE ELECTRABEL
Reactor Supplier	:	ACLF ((ACECOWEN - CREUSOT LOIRE - FRAMATOME))
Turbine Supplier	:	AAJSCH ((ALSTOM - ACEC - JEUMONT - SCHNEIDER))

Reactor Unit Details

Reactor type and model	:	PWR / Framatome 3 loops reactor
Thermal power	:	2873 MWth
Gross electrical power	:	1009 MWe
Reference unit power (net)	:	962 MWe

Key Dates

Construction Date	:	1970-06-01
Grid Date	:	1975-03-07
Commercial Date	:	1975-10-01
Age at end of year	:	49 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.6
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	23.8
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

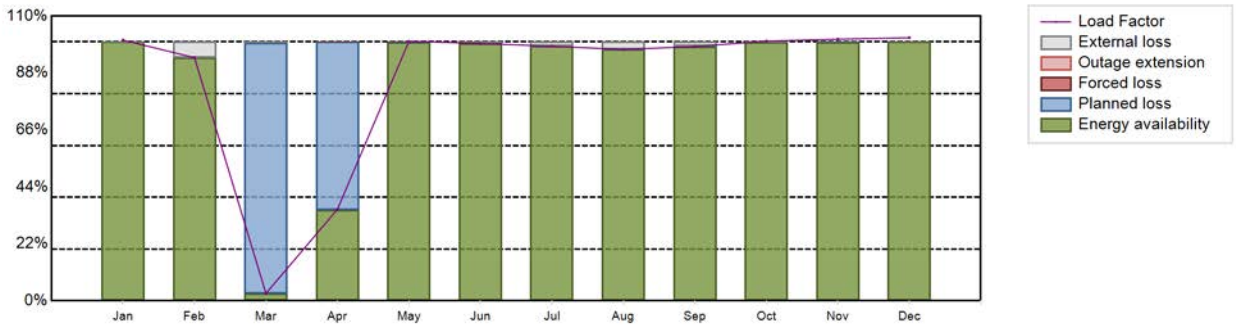
Operating coolant pressure [MPa]	:	15.41
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Double
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	5.65
Output voltage [kV]	:	18
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	6
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7245.99 GW(e).h
Energy Availability Factor (EAF)	:	85.39 %
Unit Capability Factor (UCF)	:	86.45 %
Load Factor (LF)	:	85.75 %
Operating Factor (OF)	:	86.85 %

Forced Loss Rate (FLR)	:	0.01 %
Unplanned Capability Loss Factor (UCL)	:	0.01 %
Planned Unavailability Factor (PUF)	:	13.54 %
Externally cause unavailability (XUF)	:	1.06 %
Total off-line time	:	1155 hours

Annual Summary



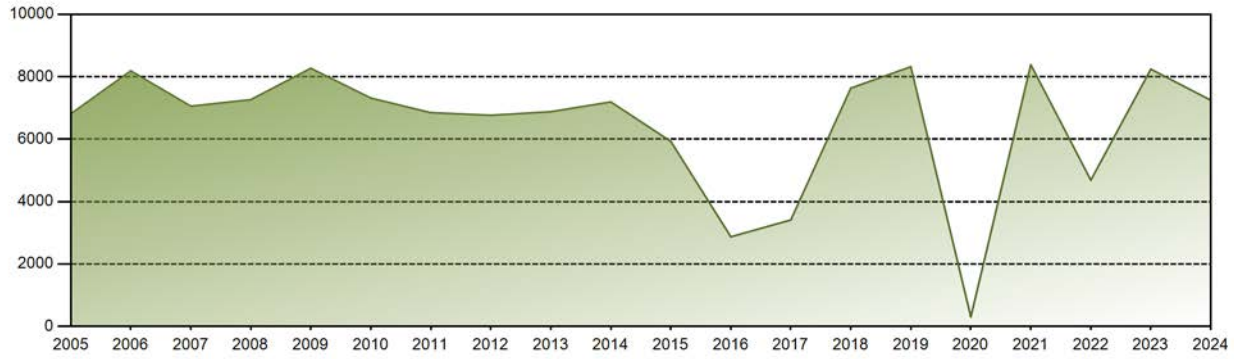
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	720.61	628.91	20.49	244.95	717.35	688.64	703.71	694.96	680.33	718.83	699.89	727.31	7245.99
EAF [%]	100.00	93.93	2.87	35.04	99.95	99.45	98.32	97.10	98.22	99.96	99.97	100.00	85.39
UCF [%]	100.00	100.00	3.22	35.04	99.95	99.90	99.89	99.95	99.93	99.97	99.97	100.00	86.45
LF [%]	100.68	93.93	2.87	35.37	100.23	99.42	98.32	97.10	98.22	100.30	101.05	101.62	85.75
OF [%]	100.00	100.00	3.77	38.89	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	86.85
FLR [%]	0.00	0.00	0.00	0.02	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.01
UCL [%]	0.00	0.00	0.00	0.01	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.01
PUF [%]	0.00	0.00	96.78	64.95	0.03	0.05	0.11	0.05	0.07	0.03	0.03	0.00	13.54
XUF [%]	0.00	6.07	0.35	0.00	0.00	0.45	1.57	2.85	1.71	0.00	0.00	0.00	1.06

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Historical Summary

Lifetime energy generation	:	321809.67 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.04 %
Cumulative Energy Availability Factor (EAF)	:	80.23 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.17 %
Cumulative Unit Capability Factor (UCF)	:	82.19 %	Cumulative Planned Unavailability Factor (PUF)	:	11.63 %
Cumulative Load Factor (LF)	:	80.15 %	Cumulative Externally cause unavailability (XUF)	:	1.97 %
Cumulative Operating Factor (OF)	:	83.71 %			

Electricity Production (net) [GWh]

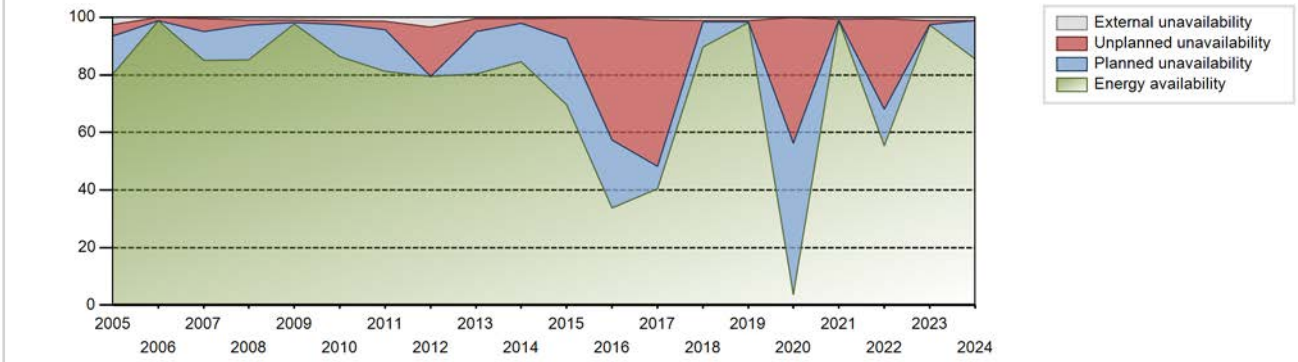


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	3096.30	5360	885	76.15	76.15	76.16	94.52	23.85	23.85	0.00	0.00
1976	4409.50	6354	870	57.54	89.78	57.70	72.34	3.70	3.45	6.76	32.24
1977	5842.30	7234	870	76.67	76.67	76.66	82.58	1.49	1.16	22.17	0.00
1978	6371.00	7582	870	84.31	84.31	83.60	86.55	0.51	0.43	15.26	0.00
1979	5159.00	6121	870	67.58	67.58	67.69	69.87	0.00	0.00	32.42	0.00
1980	6173.00	7337	870	80.70	80.71	80.78	83.53	8.46	7.46	11.83	0.01
1981	6414.20	7762	870	83.80	83.80	84.16	88.61	0.54	0.45	15.75	0.00
1982	6164.80	7269	870	80.80	80.80	80.89	82.98	2.21	1.82	17.38	0.00
1983	5843.00	7135	870	76.50	76.50	76.67	81.45	14.43	12.90	10.60	0.00
1984	6374.00	7774	870	83.44	83.44	83.41	88.50	4.99	4.38	12.18	0.00
1985	5979.00	8077	870	81.07	90.80	78.45	92.20	1.13	1.04	8.16	9.72
1986	4005.00	5429	870	54.78	59.15	52.55	61.97	5.05	3.15	37.70	4.37
1987	7337.00	8733	870	97.57	98.50	96.27	99.69	1.50	1.50	0.00	0.93
1988	6310.00	7520	870	83.89	84.93	82.57	85.61	8.66	8.05	7.01	1.05
1989	6508.00	7854	870	87.85	88.40	85.39	89.66	1.29	1.16	10.44	0.54
1990	6683.00	8082	870	88.40	90.85	87.69	92.26	1.09	1.00	8.15	2.45
1991	6163.00	7714	870	80.98	86.71	80.87	88.06	2.10	1.86	11.43	5.73
1992	6059.00	7807	870	79.10	80.45	79.28	88.88	5.88	5.02	14.52	1.35
1993	7317.00	8459	870	96.37	99.80	96.01	96.56	0.20	0.20	0.00	3.44
1994	6737.00	8018	863	89.97	90.66	89.12	91.53	0.66	0.60	8.74	0.69
1995	5442.00	6488	882	69.96	72.88	70.36	74.06	2.38	1.77	25.35	2.92
1996	7210.66	7823	931	88.22	88.40	88.18	89.07	1.71	1.54	10.06	0.18
1997	7942.57	8385	962	94.30	95.50	94.25	95.72	1.16	1.12	3.38	1.20
1998	7264.00	7777	962	86.32	87.44	86.20	88.78	2.68	2.41	10.15	1.12
1999	7272.00	7905	962	85.53	86.91	86.29	90.24	3.34	3.00	10.09	1.38
2000	8457.00	8782	962	99.28	99.28	100.08	99.98	0.02	0.02	0.70	0.00
2001	6969.00	7481	962	82.52	91.20	82.70	85.40	0.24	0.22	8.58	8.69
2002	7047.15	7631	962	83.92	85.98	83.62	87.11	0.96	0.83	13.19	2.06
2003	7990.42	8552	962	95.11	95.54	94.81	97.61	4.46	4.46	0.00	0.44
2004	7106.47	7456	962	84.50	84.50	84.10	84.88	2.05	2.41	13.09	0.00
2005	6810.95	7403	962	80.24	82.67	80.82	84.51	2.72	4.08	13.25	2.43
2006	8186.91	8693	962	98.79	98.79	97.15	99.24	1.21	1.21	0.00	0.00
2007	7055.90	7627	962	85.07	85.58	83.73	87.07	4.93	4.44	9.98	0.50
2008	7264.54	7650	962	85.25	86.24	85.97	87.09	1.60	1.68	12.09	0.98
2009	8269.54	8679	962	97.83	98.68	98.13	99.08	1.04	1.03	0.29	0.85
2010	7316.10	7752	962	86.35	87.47	86.82	88.49	1.64	1.46	11.07	1.12
2011	6848.28	7333	962	81.20	82.59	81.26	83.71	1.97	2.96	14.45	1.40

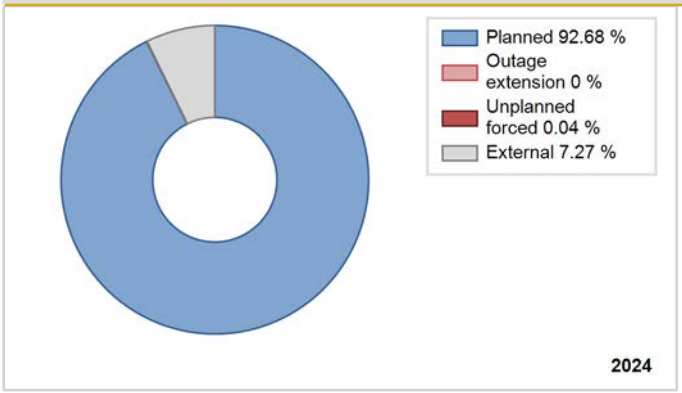
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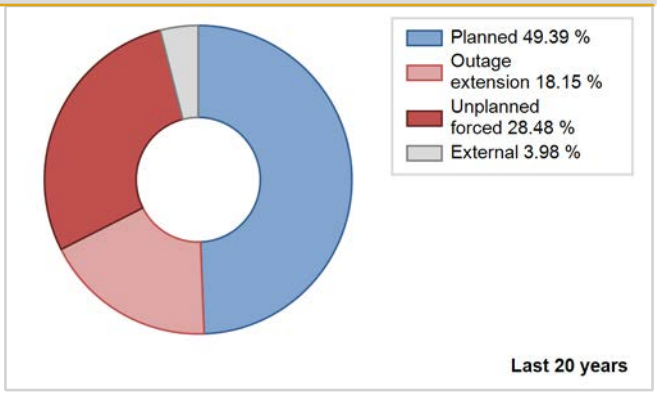
2012	6763.30	8784	962	79.44	82.88	80.04	100.00	17.12	17.12	0.00	3.44
2013	6878.12	7203	962	80.40	80.90	81.62	82.23	1.20	4.40	14.70	0.49
2014	7192.76	7503	962	84.51	85.06	85.35	85.65	0.32	1.57	13.37	0.55
2015	5927.29	6211	962	69.69	69.84	70.34	70.90	7.56	7.34	22.82	0.15
2016	2871.03	3026	962	33.69	33.85	33.98	34.45	52.16	42.50	23.65	0.16
2017	3409.97	3675	962	40.36	41.23	40.46	41.95	55.23	50.86	7.90	0.87
2018	7633.87	8024	962	89.79	91.05	90.59	91.60	0.40	0.36	8.59	1.26
2019	8319.24	8714	962	98.19	99.28	98.72	99.47	0.43	0.43	0.29	1.10
2020	303.85	434	962	3.57	3.57	3.60	4.94	30.28	43.82	52.61	0.00
2021	8384.09	8760	962	98.96	99.75	99.49	100.00	0.23	0.23	0.02	0.79
2022	4685.63	4940	962	55.27	55.67	55.60	56.39	6.80	31.55	12.78	0.40
2023	8242.06	8760	962	97.40	98.50	97.80	100.00	1.47	1.47	0.03	1.10
2024	7245.99	7629	962	85.39	86.45	85.75	86.85	0.01	0.01	13.54	1.06

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1975 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					326	
C.	Inspection, maintenance or repair combined with refuelling	1156			880		
D.	Inspection, maintenance or repair without refuelling				22		
G.	Major backfitting, refurbishment or upgrading activities without refuelling				40		
L.	Human factor related					81	
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						58
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						6
Z.	Other					6	
Subtotal		1156			942	413	64
Total		**1156**			**1419**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		86
13. Reactor Auxiliary Systems		5
14. Safety Systems		21
15. Reactor Cooling Systems		56
16. Steam generation systems		12
31. Turbine and auxiliaries		9
32. Feedwater and Main Steam System		184
33. Circulating Water System		2
34. Miscellaneous Systems		1
35. All other I&C Systems		0
41. Main Generator Systems		12
42. Electrical Power Supply Systems		13
Total		**401**

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2024 Operating Experience

BE-8 TIHANGE-3 BELGIUM



Status at end of year	:	**Operational**
Operator	:	EBL (ENGIE ELECTRABEL
Owner	:	EBL (ENGIE ELECTRABEL
Reactor Supplier	:	ACECOWEN (ACECOWEN (ACEC-COCKERILL-WESTINGHOUSE))
Turbine Supplier	:	BBC/ACEC (BBC - CEM / ACEC)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP
Thermal power	:	3000 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1030 MWe

Key Dates

Construction Date	:	1978-11-01
Grid Date	:	1985-06-15
Commercial Date	:	1985-09-01
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.35
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	16.47
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

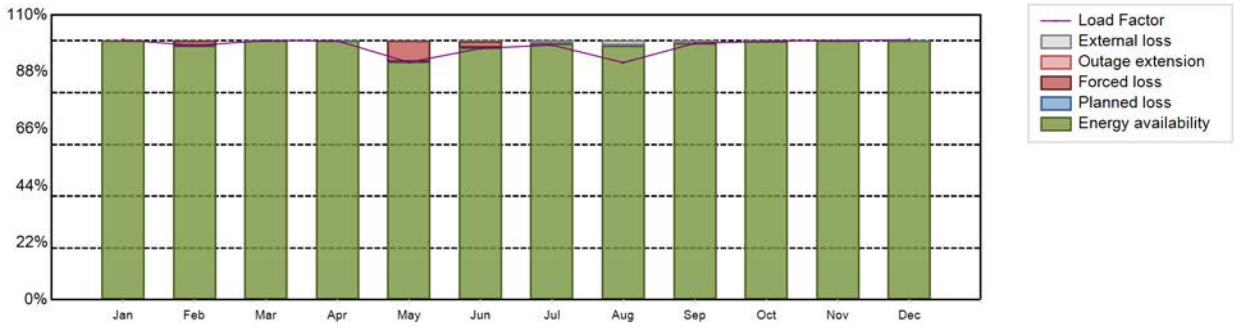
Operating coolant pressure [MPa]	:	15.52
Reactor outlet temperature [°C]	:	330.3
Number of SG	:	3
Containment type	:	Double
Containment design pressure [MPa]	:	0.35
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	7.28
Output voltage [kV]	:	24
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	6
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8874.52 GW(e).h
Energy Availability Factor (EAF)	:	98.63 %
Unit Capability Factor (UCF)	:	98.94 %
Load Factor (LF)	:	98.09 %
Operating Factor (OF)	:	98.9 %

Forced Loss Rate (FLR)	:	1.02 %
Unplanned Capability Loss Factor (UCL)	:	1.02 %
Planned Unavailability Factor (PUF)	:	0.04 %
Externally cause unavailability (XUF)	:	0.31 %
Total off-line time	:	97 hours

Annual Summary



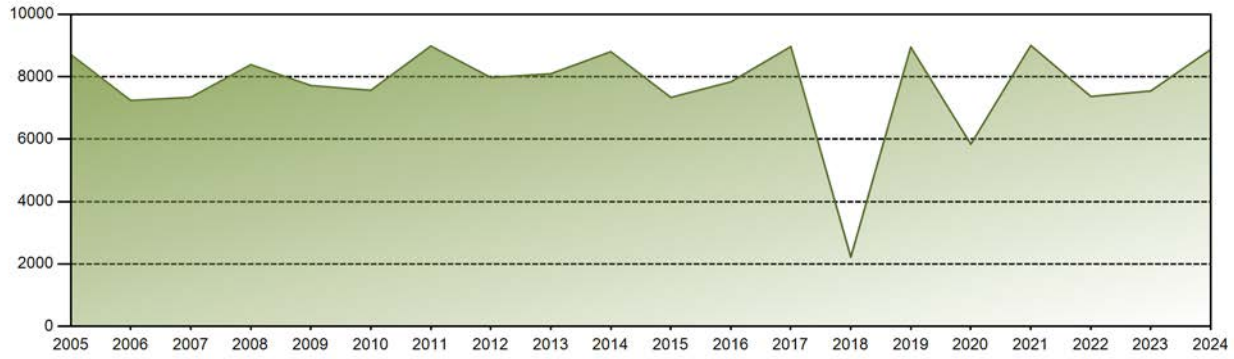
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	769.21	704.50	766.12	741.69	703.03	720.00	754.13	702.19	734.78	766.52	742.82	769.55	8874.52
EAF [%]	99.99	98.22	99.99	100.00	91.95	97.32	98.90	98.25	99.08	99.89	99.99	99.99	98.63
UCF [%]	99.99	98.22	99.99	100.00	91.95	97.49	99.90	99.91	99.91	99.92	99.99	99.99	98.94
LF [%]	100.38	98.27	100.11	100.01	91.74	97.09	98.41	91.63	99.08	99.89	100.16	100.42	98.09
OF [%]	100.00	99.14	100.00	100.00	92.74	100.00	100.00	95.03	100.00	100.00	100.00	100.00	98.90
FLR [%]	0.00	1.78	0.00	0.00	8.02	2.41	0.02	0.00	0.02	0.02	0.00	0.00	1.02
UCL [%]	0.00	1.78	0.00	0.00	8.02	2.41	0.02	0.00	0.02	0.02	0.00	0.00	1.02
PUF [%]	0.01	0.00	0.01	0.00	0.02	0.10	0.08	0.09	0.06	0.07	0.01	0.01	0.04
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.17	1.00	1.66	0.83	0.02	0.00	0.00	0.31

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Historical Summary

Lifetime energy generation	:	305979.48 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.71 %
Cumulative Energy Availability Factor (EAF)	:	86.41 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.45 %
Cumulative Unit Capability Factor (UCF)	:	87.73 %	Cumulative Planned Unavailability Factor (PUF)	:	8.82 %
Cumulative Load Factor (LF)	:	86.16 %	Cumulative Externally cause unavailability (XUF)	:	1.32 %
Cumulative Operating Factor (OF)	:	88.21 %			

Electricity Production (net) [GWh]

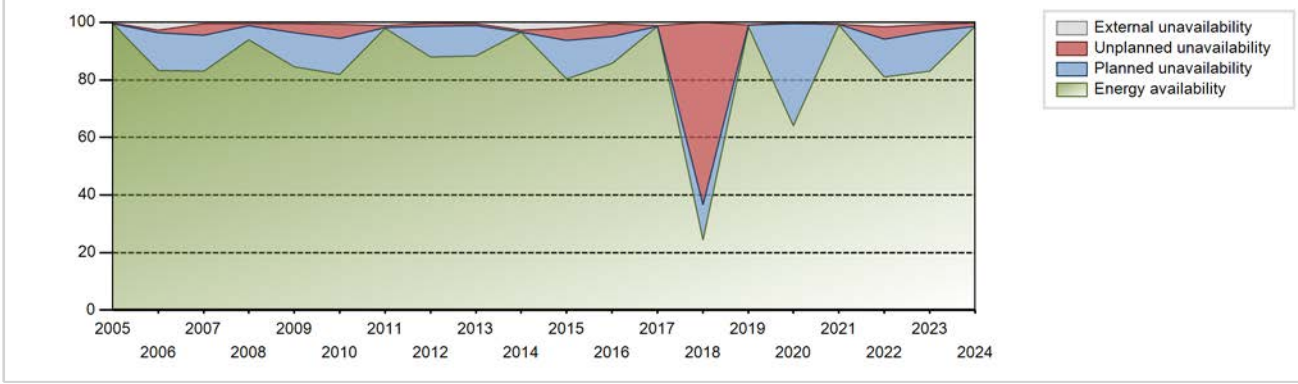


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	Data not provided										
1986	7558.00	7733	1020	85.57	86.51	84.59	88.28	4.86	4.42	9.07	0.94
1987	7829.00	7872	1020	87.31	89.01	87.62	89.86	0.98	0.88	10.12	1.70
1988	7623.00	7773	1020	85.05	87.38	85.08	88.49	3.04	2.74	9.88	2.33
1989	7749.00	7790	1020	86.99	87.45	86.72	88.93	0.89	0.79	11.76	0.46
1990	7794.00	7924	1020	87.11	90.01	87.23	90.46	0.30	0.27	9.73	2.90
1991	7649.00	7903	1020	86.15	88.35	85.61	90.22	2.95	2.69	8.96	2.20
1992	8335.00	8246	1020	93.30	93.36	93.03	93.88	0.55	0.51	6.13	0.06
1993	7748.00	7874	1020	88.06	89.50	86.71	89.89	0.01	0.01	10.49	1.43
1994	7480.00	7666	1015	84.68	86.84	84.13	87.51	3.22	2.89	10.27	2.16
1995	7559.00	7632	1015	84.70	86.70	85.01	87.12	1.06	0.93	12.37	2.00
1996	7189.00	7142	1015	81.08	81.08	80.63	81.31	11.24	10.26	8.66	0.00
1997	8357.00	8342	1015	94.40	99.15	93.99	95.23	0.49	0.49	0.36	4.76
1998	6738.00	6903	1015	75.93	77.89	75.78	78.80	0.46	0.36	21.75	1.96
1999	8799.00	8686	1015	98.92	99.13	98.96	99.16	0.87	0.87	0.00	0.21
2000	7597.00	7656	1015	84.93	86.40	85.21	87.16	5.04	4.59	9.01	1.47
2001	7729.00	7929	1015	86.49	89.90	86.92	90.50	2.47	2.28	7.82	3.41
2002	8340.47	8368	1015	93.71	95.68	93.80	95.53	1.23	1.19	3.13	1.97
2003	7661.54	7846	1015	86.51	89.43	86.16	89.56	0.14	0.13	10.45	2.91
2004	7936.43	7969	1015	89.18	90.40	89.02	90.72	0.12	0.11	9.50	1.22
2005	8707.53	8753	1015	99.58	99.77	97.93	99.92	0.23	0.23	0.00	0.18
2006	7237.59	7592	1015	83.33	86.09	81.40	86.67	1.08	0.94	12.97	2.76
2007	7339.40	7406	1015	82.97	83.40	82.54	84.54	4.73	4.14	12.47	0.43
2008	8385.26	8365	1015	93.88	94.26	94.05	95.23	0.75	0.71	5.03	0.38
2009	7717.15	7480	1054	84.64	85.23	84.61	85.39	0.23	3.02	11.75	0.59
2010	7563.23	7489	1046	81.88	82.49	82.02	85.49	3.79	4.91	12.60	0.61
2011	8981.89	8701	1046	98.01	99.11	98.02	99.33	0.73	0.73	0.15	1.10
2012	7974.73	7800	1046	87.85	88.17	86.79	88.80	0.53	1.10	10.72	0.33
2013	8094.07	7839	1046	88.34	88.89	88.33	89.49	0.63	0.56	10.54	0.55
2014	8800.74	8550	1046	96.61	99.30	96.05	97.60	0.68	0.68	0.02	2.69
2015	7336.42	7264	1038	80.45	82.40	80.48	82.92	4.90	4.25	13.35	1.95
2016	7835.57	7623	1038	85.78	86.19	85.94	86.78	0.30	4.46	9.36	0.40
2017	8963.79	8737	1038	98.52	99.59	98.58	99.74	0.41	0.41	0.00	1.07
2018	2221.56	2138	1038	24.37	24.37	24.43	24.41	0.00	63.44	12.19	0.00
2019	8945.12	8758	1038	98.45	99.43	98.37	99.98	0.03	0.05	0.52	0.98
2020	5838.22	5686	1038	63.97	64.08	64.03	64.73	0.59	0.38	35.54	0.11
2021	9001.86	8760	1038	99.16	99.96	99.00	100.00	0.01	0.01	0.04	0.80

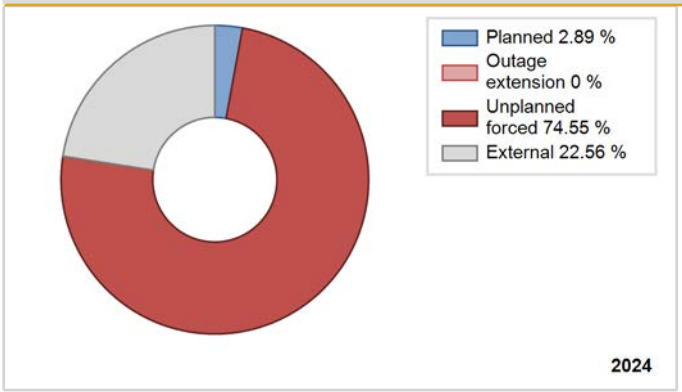
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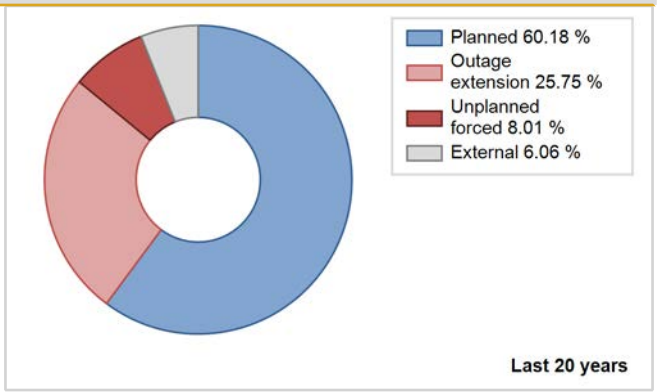
2022	7366.37	7297	1038	81.11	82.64	81.01	83.30	5.00	4.35	13.01	1.53
2023	7544.13	7389	1030	83.03	83.82	83.13	84.35	0.74	2.27	13.90	0.79
2024	8874.52	8687	1030	98.63	98.94	98.09	98.90	1.02	1.02	0.04	0.31

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		6			265	
C. Inspection, maintenance or repair combined with refuelling				701	7	
D. Inspection, maintenance or repair without refuelling				21		
E. Testing of plant systems or components				1		
H. Nuclear regulatory requirements					1	
J. Grid limitation, failure or grid unavailability			37			2
L. Human factor related					3	
P. Fire		54			1	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				14		15
Z. Other				4		
Subtotal		60	37	741	277	17
Total		**97**			**1035**	

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Equipment Related Unplanned Full Outages, Analysis by System

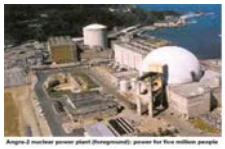
System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		6
15. Reactor Cooling Systems		28
16. Steam generation systems		29
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		27
32. Feedwater and Main Steam System		165
33. Circulating Water System		5
34. Miscellaneous Systems		1
41. Main Generator Systems	6	2
42. Electrical Power Supply Systems	91	6
Total	**97**	**270**

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2024 Operating Experience

BR-1 ANGRA-1 BRAZIL

Status at end of year	:	**Operational**
Operator	:	ELETRONUCLEAR S (ELETRONUCLEAR S.A.)
Owner	:	ELETRONUCLEAR S (ELETRONUCLEAR S.A.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)



Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP
Thermal power	:	1882 MWth
Gross electrical power	:	640 MWe
Reference unit power (net)	:	609 MWe

Key Dates

Construction Date	:	1971-05-01
Grid Date	:	1982-04-01
Commercial Date	:	1985-01-01
Age at end of year	:	42 years

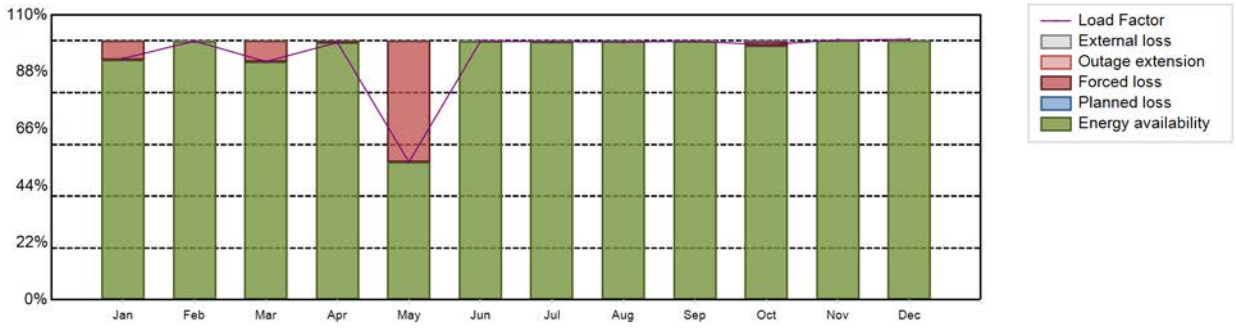
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.71
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	323
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.32
Average fuel enrichment [% of U235]	:	4.0	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	35.1	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	2.47	HP cylinder inlet steam pressure [MPa]	:	6.05
Active core height/length [m]	:	3.66	Output voltage [kV]	:	19
Number of fissile fuel assemblies/bundles	:	121	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	21	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	4
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5060.82 GW(e).h	Forced Loss Rate (FLR)	:	5.47 %
Energy Availability Factor (EAF)	:	94.45 %	Unplanned Capability Loss Factor (UCL)	:	5.47 %
Unit Capability Factor (UCF)	:	94.51 %	Planned Unavailability Factor (PUF)	:	0.02 %
Load Factor (LF)	:	94.6 %	Externally cause unavailability (XUF)	:	0.06 %
Operating Factor (OF)	:	95.42 %	Total off-line time	:	402 hours

Annual Summary



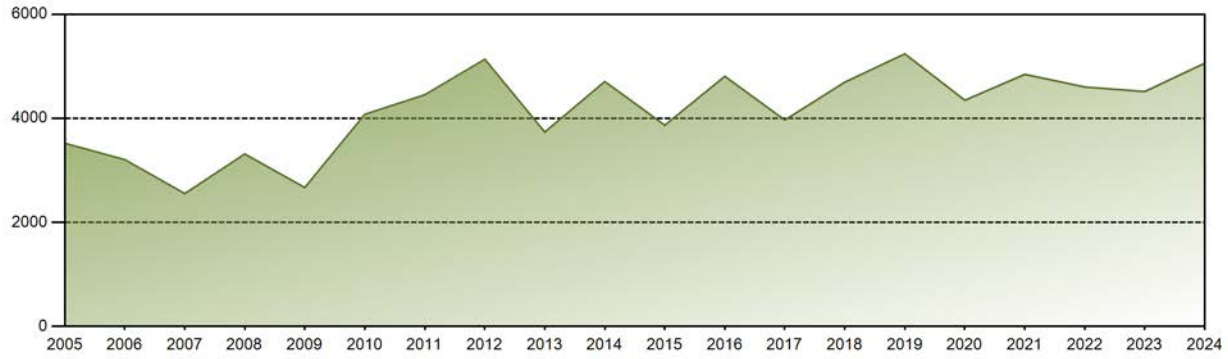
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	422.21	423.61	416.97	435.78	241.10	437.73	451.89	451.22	437.84	446.62	440.07	455.79	5060.82
EAF [%]	92.66	99.94	91.96	99.33	53.18	99.83	99.73	99.77	99.85	98.14	100.00	100.00	94.45
UCF [%]	92.66	100.00	91.96	99.33	53.18	100.00	100.00	99.77	100.00	98.26	100.00	100.00	94.51
LF [%]	93.18	99.94	92.03	99.38	53.21	99.83	99.73	99.59	99.85	98.57	100.36	100.59	94.60
OF [%]	95.97	100.00	95.16	100.00	54.97	100.00	100.00	100.00	100.00	99.87	100.00	100.00	95.42
FLR [%]	7.34	0.00	8.04	0.67	46.82	0.00	0.00	0.00	0.00	1.74	0.00	0.00	5.47
UCL [%]	7.34	0.00	8.04	0.67	46.82	0.00	0.00	0.00	0.00	1.74	0.00	0.00	5.47
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.02
XUF [%]	0.00	0.06	0.00	0.00	0.00	0.17	0.27	0.00	0.15	0.12	0.00	0.00	0.06

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Historical Summary

Lifetime energy generation	:	128854.35 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	14.56 %
Cumulative Energy Availability Factor (EAF)	:	65.43 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.28 %
Cumulative Unit Capability Factor (UCF)	:	69.88 %	Cumulative Planned Unavailability Factor (PUF)	:	17.83 %
Cumulative Load Factor (LF)	:	59.1 %	Cumulative Externally cause unavailability (XUF)	:	4.46 %
Cumulative Operating Factor (OF)	:	71.82 %			

Electricity Production (net) [GWh]

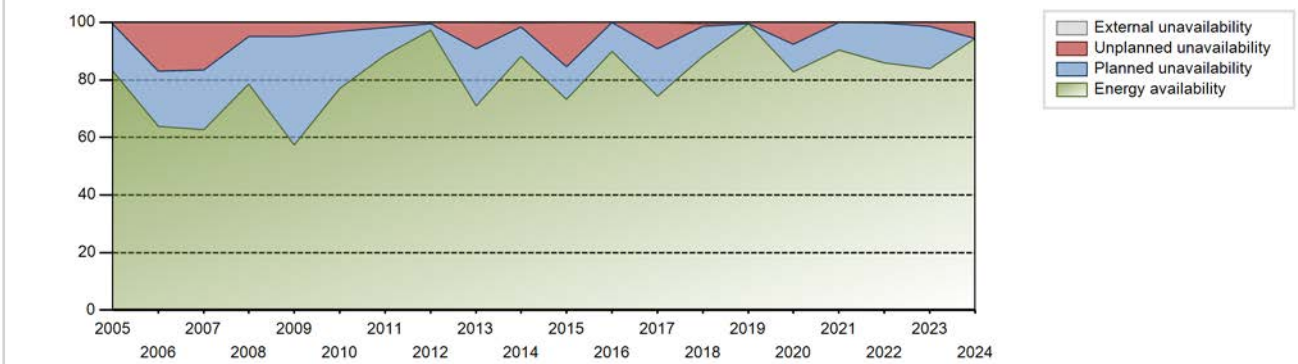


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	3169.38	6847	626	57.80	57.80	57.80	78.16	37.49	34.66	7.55	0.00
1986	132.36	512	626	3.70	3.70	2.41	5.84	89.62	31.97	64.33	0.00
1987	910.56	1958	626	19.72	19.72	16.60	22.35	80.28	80.28	0.00	0.00
1988	566.64	1488	626	18.52	18.52	10.30	16.94	81.48	81.48	0.00	0.00
1989	1695.10	5362	626	61.30	61.78	30.91	61.21	6.96	4.62	33.60	0.47
1990	2055.34	7400	626	82.54	86.08	37.48	84.47	10.13	9.71	4.21	3.54
1991	1306.35	5046	626	57.18	57.18	23.82	57.60	1.56	0.91	41.92	0.00
1992	1506.37	4275	626	47.93	47.93	27.39	48.67	16.27	9.31	42.76	0.00
1993	402.70	1524	626	17.17	17.17	7.34	17.40	82.83	82.83	0.00	0.00
1994	41.45	305	626	3.48	83.84	0.76	3.48	16.16	16.16	0.00	80.35
1995	2333.64	8127	626	42.56	92.77	42.56	92.77	3.09	2.96	4.27	50.22
1996	2288.84	5063	626	55.23	66.99	41.62	57.64	0.00	0.00	33.01	11.76
1997	2989.97	6219	626	53.17	60.65	54.52	70.99	0.75	0.46	38.89	7.49
1998	3093.82	6976	626	56.42	56.42	56.42	79.63	6.39	3.85	39.73	0.00
1999	3631.68	8429	626	64.79	65.19	66.23	96.22	4.69	3.21	31.60	0.40
2000	3164.93	6514	626	58.73	58.73	57.56	74.16	15.27	10.59	30.69	0.00
2001	3614.43	7295	626	82.88	82.88	65.91	83.28	4.94	4.31	12.82	0.00
2002	3775.19	7595	626	85.93	87.66	68.84	86.70	0.64	0.56	11.78	1.73
2003	3137.06	6551	626	57.20	74.53	57.21	74.78	9.74	8.04	17.43	17.33
2004	3890.16	7968	626	70.75	70.75	70.75	90.71	0.35	0.25	29.00	0.00
2005	3520.38	7275	626	83.05	83.05	64.20	83.05	0.85	0.71	16.24	0.00
2006	3205.23	6743	626	63.96	63.96	58.45	76.97	20.91	16.91	19.12	0.00
2007	2553.47	5481	520	62.79	62.79	56.06	62.57	8.97	16.59	20.61	0.00
2008	3314.53	6967	491	78.60	78.60	76.85	79.31	5.95	4.98	16.43	0.00
2009	2668.92	5256	609	57.41	57.41	50.87	60.00	7.83	4.88	37.71	0.00
2010	4076.72	7055	609	77.02	77.02	76.42	80.54	3.94	3.16	19.81	0.00
2011	4452.48	7789	609	88.65	88.76	83.46	88.92	1.93	1.75	9.49	0.11
2012	5134.91	8734	609	97.39	97.39	95.99	99.43	0.58	0.57	2.04	0.00
2013	3734.79	6765	609	70.91	70.91	70.01	77.23	11.56	9.27	19.82	0.00
2014	4706.85	7857	609	88.17	88.54	88.23	89.69	1.43	1.28	10.18	0.37
2015	3867.66	6619	609	73.21	73.29	72.50	75.56	11.77	15.33	11.38	0.08
2016	4807.12	7951	609	89.98	90.08	89.86	90.52	0.04	0.03	9.89	0.10
2017	3966.79	6633	609	74.22	74.34	74.36	75.72	10.96	9.15	16.51	0.12
2018	4695.30	7793	609	88.12	88.61	88.01	88.96	0.06	0.87	10.52	0.49
2019	5239.68	8668	609	99.46	99.54	98.21	98.94	0.36	0.36	0.10	0.08
2020	4347.14	7299	609	82.69	82.69	81.26	83.09	8.37	7.56	9.75	0.00
2021	4845.93	8014	609	90.41	90.43	90.84	91.48	0.05	0.04	9.53	0.02

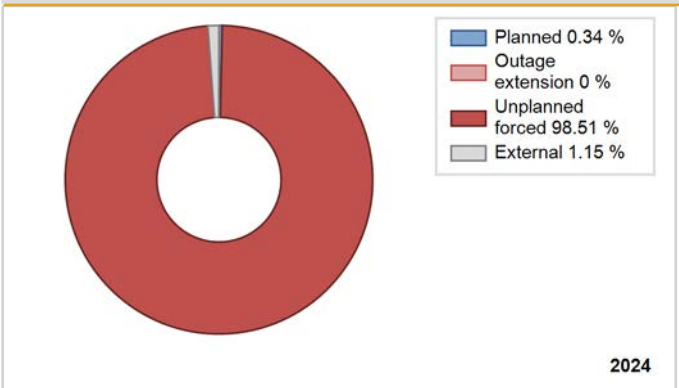
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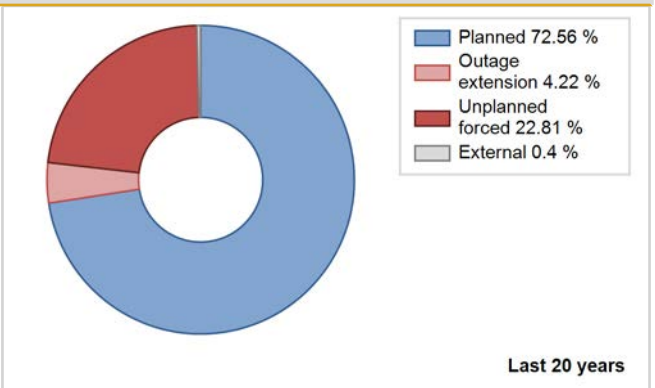
2022	4602.31	7603	609	85.82	85.82	86.27	86.79	0.23	0.20	13.98	0.00
2023	4515.48	7508	609	83.91	83.91	84.63	85.70	1.69	1.44	14.65	0.00
2024	5060.82	8382	609	94.45	94.51	94.60	95.42	5.47	5.47	0.02	0.06

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		401			1121	
B. Refuelling without maintenance				26		
C. Inspection, maintenance or repair combined with refuelling				1002		
D. Inspection, maintenance or repair without refuelling				225		
E. Testing of plant systems or components				47	1	
F. Major backfitting, refurbishment or upgrading activities with refuelling				79		
H. Nuclear regulatory requirements					1	
J. Grid limitation, failure or grid unavailability			1			11
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						6
L. Human factor related					16	
M. Governmental requirements or court decisions						206
P. Fire					0	
Z. Other					16	2
Subtotal		401	1	1379	1155	225
Total		**402**			**2759**	

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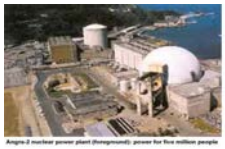
Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		249
12. Reactor I&C Systems		43
13. Reactor Auxiliary Systems		74
14. Safety Systems		1
15. Reactor Cooling Systems	36	11
16. Steam generation systems		27
31. Turbine and auxiliaries	30	107
32. Feedwater and Main Steam System	335	48
33. Circulating Water System		6
34. Miscellaneous Systems		0
41. Main Generator Systems		340
42. Electrical Power Supply Systems	1	168
Total	**402**	**1074**

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2024 Operating Experience

BR-2 ANGRA-2 BRAZIL



Status at end of year	:	**Operational**
Operator	:	ELETRONUCLEAR S (ELETRONUCLEAR S.A.)
Owner	:	ELETRONUCLEAR S (ELETRONUCLEAR S.A.)
Reactor Supplier	:	KWU (KRAFTWERK UNION, AG)
Turbine Supplier	:	KWU (KRAFTWERK UNION, AG)

Reactor Unit Details

Reactor type and model	:	PWR / PRE KONVOI
Thermal power	:	3764 MWth
Gross electrical power	:	1350 MWe
Reference unit power (net)	:	1275 MWe

Key Dates

Construction Date	:	1976-01-01
Grid Date	:	2000-07-21
Commercial Date	:	2001-02-01
Age at end of year	:	24 years

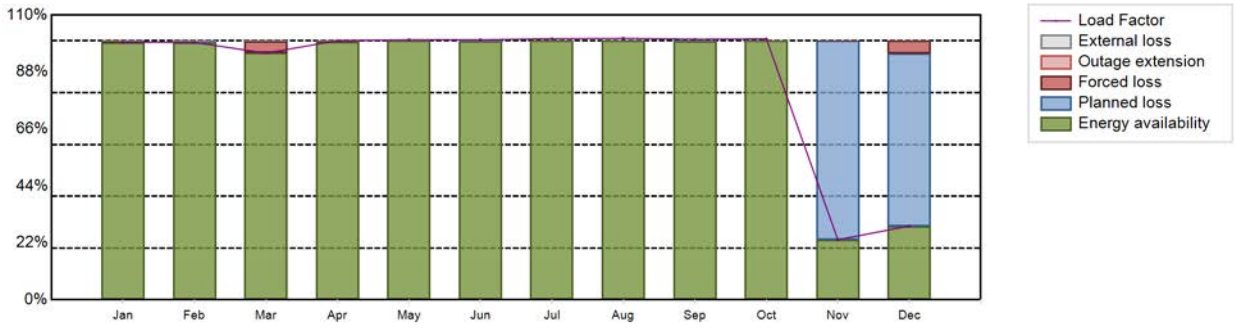
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.5
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	35000
Active core diameter [m]	:	3.61
Active core height/length [m]	:	3.9
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	20.79
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.9
Reactor outlet temperature [°C]	:	326
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	0.53
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.295
Output voltage [kV]	:	25
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	8
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9802.14 GW(e).h
Energy Availability Factor (EAF)	:	87.12 %
Unit Capability Factor (UCF)	:	87.19 %
Load Factor (LF)	:	87.52 %
Operating Factor (OF)	:	87.53 %
Forced Loss Rate (FLR)	:	0.95 %
Unplanned Capability Loss Factor (UCL)	:	0.84 %
Planned Unavailability Factor (PUF)	:	11.97 %
Externally cause unavailability (XUF)	:	0.07 %
Total off-line time	:	1095 hours

Annual Summary



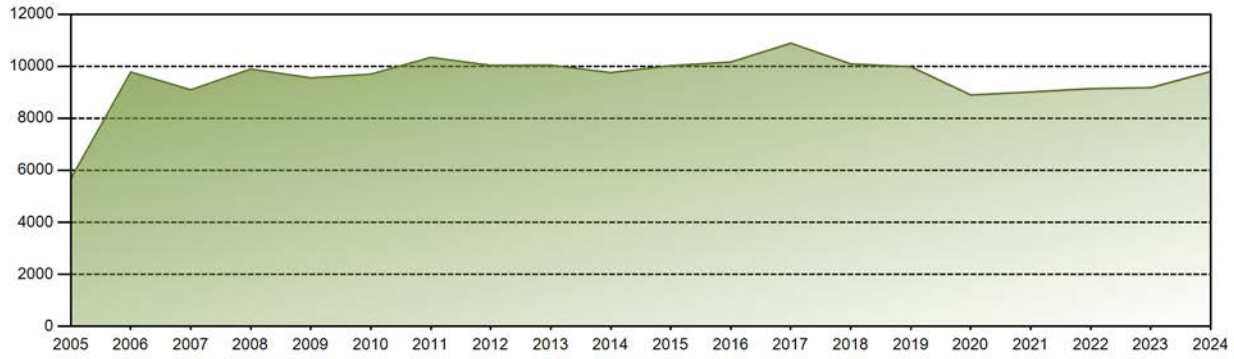
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	943.63	882.11	904.00	918.72	953.12	922.10	956.60	958.11	924.08	955.96	213.30	270.43	9802.14
EAF [%]	99.48	99.40	95.30	99.71	100.00	99.86	100.00	100.00	99.86	100.00	23.23	28.51	87.12
UCF [%]	99.69	99.83	95.56	99.72	100.00	99.86	100.00	100.00	99.86	100.00	23.23	28.51	87.19
LF [%]	99.48	99.40	95.30	100.08	100.48	100.45	100.84	101.00	100.66	100.78	23.23	28.51	87.52
OF [%]	100.00	100.00	96.24	100.00	100.00	100.00	100.00	100.00	100.00	100.00	23.47	30.65	87.53
FLR [%]	0.31	0.00	4.44	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.02	14.63	0.95
UCL [%]	0.31	0.00	4.44	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.01	4.89	0.84
PUF [%]	0.00	0.17	0.00	0.00	0.00	0.14	0.00	0.00	0.14	0.00	76.76	66.60	11.97
XUF [%]	0.21	0.43	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07

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Historical Summary

Lifetime energy generation	:	228965.95 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.62 %
Cumulative Energy Availability Factor (EAF)	:	86.27 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.61 %
Cumulative Unit Capability Factor (UCF)	:	87.31 %	Cumulative Planned Unavailability Factor (PUF)	:	9.09 %
Cumulative Load Factor (LF)	:	84.33 %	Cumulative Externally cause unavailability (XUF)	:	1.04 %
Cumulative Operating Factor (OF)	:	88.3 %			

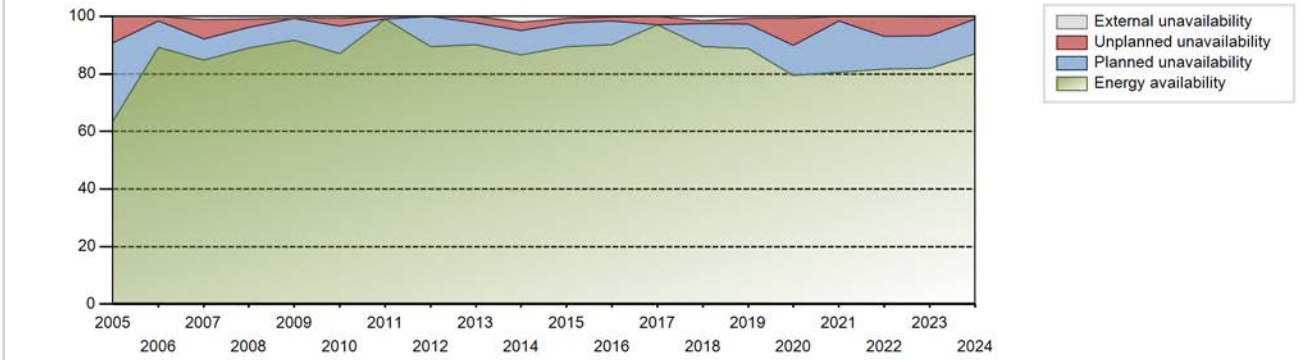
Electricity Production (net) [GWh]



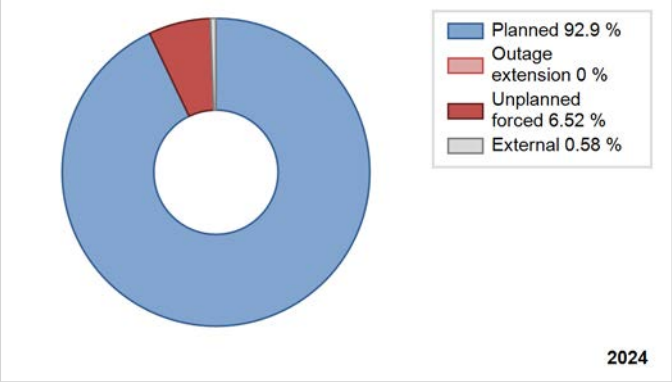
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2001	9904.99	8315	1350	94.21	94.34	85.69	97.27	3.11	3.02	2.64	0.13
2002	9238.24	8060	1275	83.33	91.26	82.71	92.01	0.43	0.39	8.35	7.93
2003	9418.97	8019	1275	84.29	90.97	84.33	91.54	1.91	1.77	7.26	6.68
2004	6919.82	6497	1275	72.76	72.76	61.79	73.96	20.26	18.49	8.74	0.00
2005	5676.66	5581	1275	63.71	63.71	50.83	63.71	4.70	9.17	27.12	0.00
2006	9778.32	8014	1275	89.34	89.34	87.55	91.48	1.64	1.49	9.17	0.00
2007	9096.95	7606	1275	84.70	85.92	81.45	86.83	4.68	6.68	7.39	1.22
2008	9894.03	7924	1275	89.12	90.06	88.34	90.21	0.41	2.83	7.10	0.94
2009	9554.65	8068	1275	91.66	92.40	85.55	92.10	0.00	0.00	7.60	0.73
2010	9697.44	7727	1275	87.10	87.92	86.82	88.21	2.89	2.62	9.47	0.82
2011	10342.26	8682	1275	99.04	99.11	92.60	99.11	0.89	0.89	0.00	0.07
2012	10035.50	8064	1275	89.50	89.50	89.61	91.80	0.00	0.00	10.50	0.00
2013	10045.27	7961	1275	90.06	90.06	89.94	90.88	1.74	2.19	7.75	0.00
2014	9756.54	7754	1275	86.57	88.61	87.35	88.52	0.77	2.82	8.57	2.04
2015	10023.96	7990	1275	89.41	90.22	89.75	91.21	1.18	1.56	8.22	0.81
2016	10163.34	7939	1275	90.05	90.20	90.75	90.38	0.03	1.45	8.35	0.16
2017	10887.54	8521	1275	96.97	97.02	97.48	97.27	2.95	2.95	0.03	0.05
2018	10091.65	8011	1275	89.53	91.22	90.35	91.45	0.19	0.81	7.97	1.69
2019	9984.43	7895	1275	88.83	89.57	89.38	90.12	1.76	1.93	8.50	0.74
2020	8897.22	7423	1275	79.38	79.99	79.44	84.51	0.03	9.50	10.51	0.61
2021	9012.51	7497	1275	80.52	80.52	80.69	85.58	2.04	1.67	17.81	0.00
2022	9142.51	7171	1275	81.58	81.59	81.86	81.86	6.81	6.90	11.51	0.02
2023	9179.95	7228	1275	81.91	82.09	82.19	82.51	3.95	6.52	11.38	0.19
2024	9802.14	7689	1275	87.12	87.19	87.52	87.53	0.95	0.84	11.97	0.07

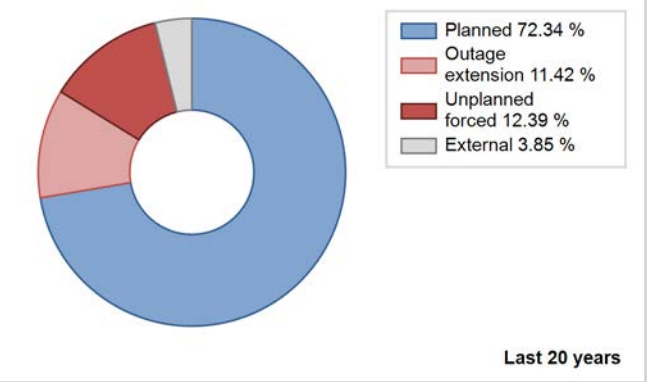
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2001 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		41			253	
C. Inspection, maintenance or repair combined with refuelling	1037			643	22	
D. Inspection, maintenance or repair without refuelling				137		
E. Testing of plant systems or components				2	1	
J. Grid limitation, failure or grid unavailability						3
P. Fire		30			1	
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					8	
Subtotal	1037	71		782	285	3
Total	**1108**			**1070**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2001 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		47
12. Reactor I&C Systems	1	0
13. Reactor Auxiliary Systems		25
14. Safety Systems		1
15. Reactor Cooling Systems	4	20
16. Steam generation systems		0
31. Turbine and auxiliaries	30	9
32. Feedwater and Main Steam System		8
33. Circulating Water System		2
41. Main Generator Systems		86
42. Electrical Power Supply Systems	35	72
Total	**70**	**270**

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Highlights (2024)

Angra 2 remained connected to the National Electrical Grid for 322,4 days in 2024 and performed its refueling outage (20th) in 43,19 days, for refueling, maintenance and routine testing.

Angra 2 operated cycle 20 and cycle 21, until the end of December, without fuel failure.

In cycle 20, the main period of scheduled unavailability during 2024 at Angra 2 was due to the Fuel Refueling Shutdown (2P20).

In 2024, Angra 2 presented the following highlights:

• There was no reactor shutdown at Angra 2 in 2024. This is the fifth consecutive operation cycle without any reactor shutdown;

On November 07th, power reduction began to shut down the plant for the beginning of the 20th Refueling Outage.

On November 08th, at 01:00, the unit was turned off, starting its 20th refueling outage (2P20).

On December 21th, at 05:39, the 20th Recharging Stop (2P20) was closed, with the plant synchronizing with to grid, and to start Angra 2 21th Cycle.

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2024 Operating Experience

BG-5 KOZLODUY-5 BULGARIA

Status at end of year	:	**Operational**
Operator	:	KNPP (Kozloduy Npp ,lc)
Owner	:	BEH (Bulgarian Energy Holding)
Reactor Supplier	:	AEE (ATOMENERGOEXPORT)
Turbine Supplier	:	AEE (ATOMENERGOEXPORT)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3120 MWth
Gross electrical power	:	1040 MWe
Reference unit power (net)	:	1003 MWe

Key Dates

Construction Date	:	1980-07-09
Grid Date	:	1987-11-29
Commercial Date	:	1988-12-23
Age at end of year	:	37 years

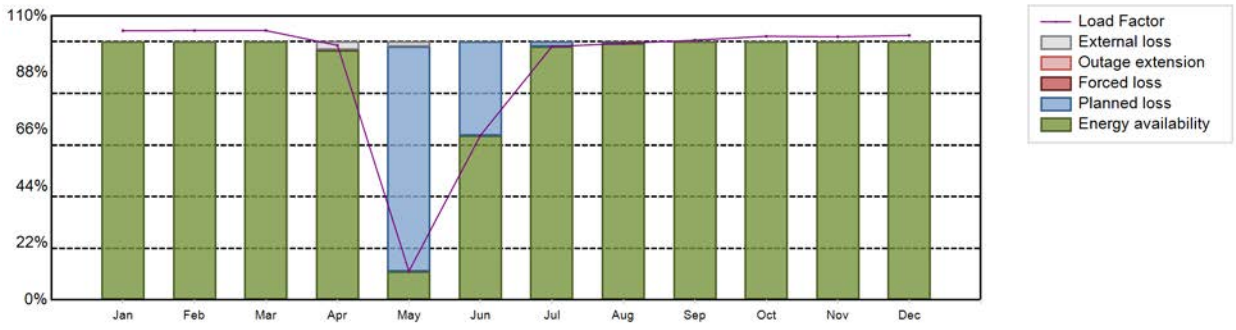
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.23
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	30
Average discharge burnup [MWd/t]	:	48870
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.55
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.3
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	320
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	24
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	6
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	8003.77 GW(e).h
Energy Availability Factor (EAF)	:	89.02 %
Unit Capability Factor (UCF)	:	89.44 %
Load Factor (LF)	:	90.85 %
Operating Factor (OF)	:	90.07 %
Equivalent non-electrical energy generated (NEG)	:	34.84 GW(e).h
Forced Loss Rate (FLR)	:	0.02 %
Unplanned Capability Loss Factor (UCL)	:	0.02 %
Planned Unavailability Factor (PUF)	:	10.55 %
Externally cause unavailability (XUF)	:	0.42 %
Total off-line time	:	872 hours

Annual Summary



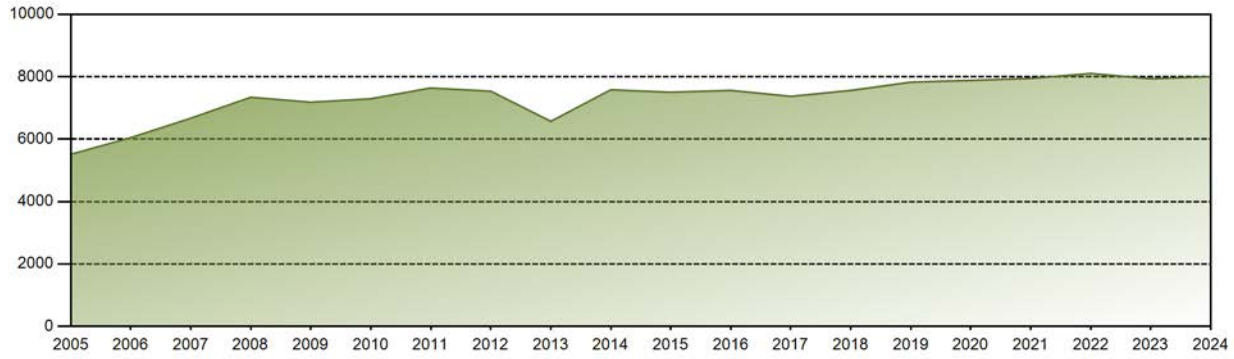
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	778.14	728.58	778.58	712.10	83.14	460.21	732.46	741.34	726.68	762.15	736.05	764.33	8003.77
EAF [%]	100.00	100.00	100.00	96.74	11.14	63.73	98.15	99.34	100.00	100.00	100.00	100.00	89.02
UCF [%]	100.00	100.00	100.00	99.97	12.92	63.73	98.15	99.34	100.00	100.00	100.00	100.00	89.44
LF [%]	104.28	104.37	104.33	98.61	11.14	63.73	98.15	99.34	100.63	102.13	101.92	102.43	90.85
OF [%]	100.00	100.00	100.00	100.00	13.17	68.61	100.00	100.00	100.00	100.00	100.00	100.00	90.07
FLR [%]	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.02
UCL [%]	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.02
PUF [%]	0.00	0.00	0.00	0.00	87.08	36.27	1.85	0.50	0.00	0.00	0.00	0.00	10.55
XUF [%]	0.00	0.00	0.00	3.23	1.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42

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Historical Summary

Lifetime energy generation	:	211970.78 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.1 %
Cumulative Energy Availability Factor (EAF)	:	74.67 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.64 %
Cumulative Unit Capability Factor (UCF)	:	76.59 %	Cumulative Planned Unavailability Factor (PUF)	:	21.76 %
Cumulative Load Factor (LF)	:	69.54 %	Cumulative Externally cause unavailability (XUF)	:	1.92 %
Cumulative Operating Factor (OF)	:	76.89 %			

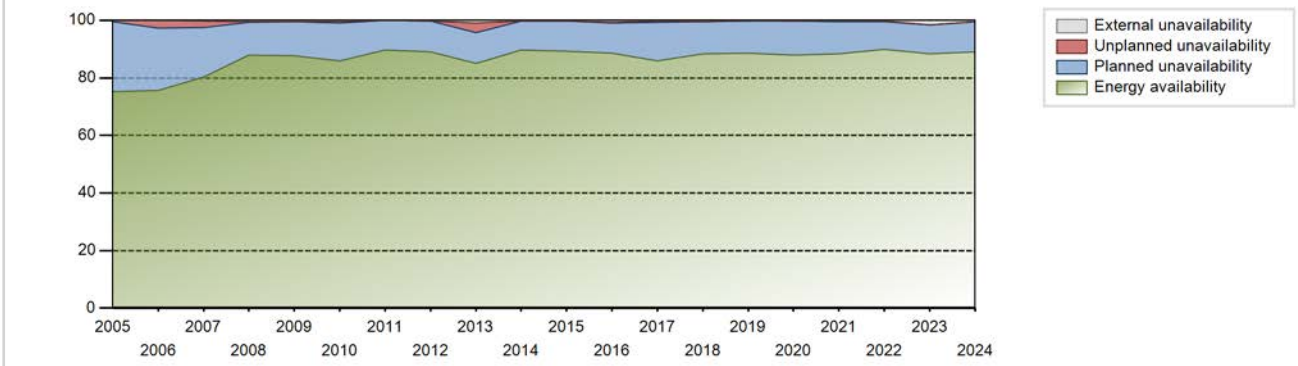
Electricity Production (net) [GWh]



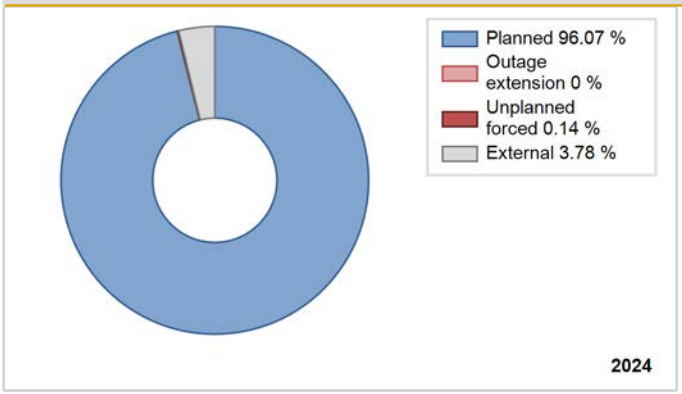
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	3933.16	7027	887	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1989	3355.08	4663	953	51.52	51.52	40.19	53.23	5.32	2.90	45.58	0.00
1990	3380.91	5592	953	41.77	58.12	40.50	63.84	36.14	32.89	9.00	16.35
1991	1950.37	2777	953	31.73	31.73	23.36	31.70	1.27	0.41	67.86	0.00
1992	3540.69	4982	953	47.04	56.65	42.30	56.72	9.57	5.99	37.35	9.61
1993	3278.01	4675	953	47.53	50.50	39.27	53.37	0.74	0.38	49.12	2.97
1994	2880.40	4350	953	48.05	52.58	34.50	49.66	1.91	1.03	46.39	4.53
1995	4699.34	5988	953	59.36	68.12	56.29	68.36	2.13	1.48	30.40	8.76
1996	4720.27	6468	953	73.84	73.84	56.39	73.63	0.00	0.00	26.16	0.00
1997	4410.25	6034	953	68.67	68.67	52.83	68.88	0.31	0.21	31.12	0.00
1998	3741.00	6467	953	73.34	73.34	44.81	73.82	0.31	0.23	26.43	0.00
1999	3423.21	4838	953	50.36	54.80	41.00	55.23	1.82	1.01	44.19	4.43
2000	4340.81	5406	1000	54.42	63.52	49.42	61.54	2.23	1.45	35.03	9.10
2001	5049.55	5940	953	61.48	66.56	60.49	67.81	0.98	0.66	32.78	5.08
2002	5095.85	7003	953	79.39	79.77	61.04	79.94	0.18	0.14	20.08	0.38
2003	5596.69	8579	953	98.60	98.60	67.04	97.93	0.00	0.00	1.40	0.00
2004	4842.04	5906	953	67.18	67.19	57.84	67.24	0.10	0.07	32.75	0.00
2005	5513.48	6641	953	75.23	75.23	66.04	75.81	0.51	0.38	24.38	0.01
2006	6047.02	6691	953	75.73	75.82	72.43	76.38	3.28	2.57	21.61	0.09
2007	6669.92	7090	953	80.25	80.42	79.90	80.94	2.83	2.35	17.23	0.18
2008	7341.29	7796	953	87.85	88.44	87.70	88.75	0.00	0.12	11.44	0.59
2009	7181.55	7759	953	87.72	88.30	86.02	88.57	0.01	0.01	11.70	0.58
2010	7293.30	7620	953	85.87	86.41	87.37	87.00	0.48	0.42	13.17	0.54
2011	7639.25	7878	953	89.71	89.75	91.51	89.93	0.00	0.00	10.25	0.04
2012	7534.46	7876	953	89.12	89.38	90.01	89.66	0.00	0.00	10.62	0.26
2013	6569.82	7551	953	85.11	85.97	78.70	86.20	3.77	3.37	10.66	0.86
2014	7580.91	7912	963	89.66	89.93	89.87	90.32	0.05	0.04	10.02	0.27
2015	7502.66	7856	963	89.34	89.52	88.94	89.68	0.13	0.11	10.37	0.18
2016	7562.34	7875	963	88.62	89.39	89.40	89.65	0.27	0.24	10.37	0.77
2017	7369.19	7580	963	85.90	86.27	87.36	86.53	0.33	0.29	13.44	0.37
2018	7561.29	7788	963	88.28	88.77	89.63	88.90	0.00	0.00	11.23	0.49
2019	7825.41	7808	1003	88.51	88.57	92.12	89.13	0.30	0.27	11.16	0.06
2020	7881.46	7768	1003	87.85	88.20	89.46	88.43	0.00	0.00	11.80	0.34
2021	7946.42	7771	1003	88.27	88.38	90.44	88.71	0.49	0.43	11.19	0.11
2022	8104.37	7923	1003	89.98	90.20	92.24	90.45	0.28	0.25	9.55	0.22
2023	7932.76	7888	1003	88.29	89.86	90.29	90.05	0.01	0.01	10.14	1.57
2024	8003.77	7912	1003	89.02	89.44	90.85	90.07	0.02	0.02	10.55	0.42

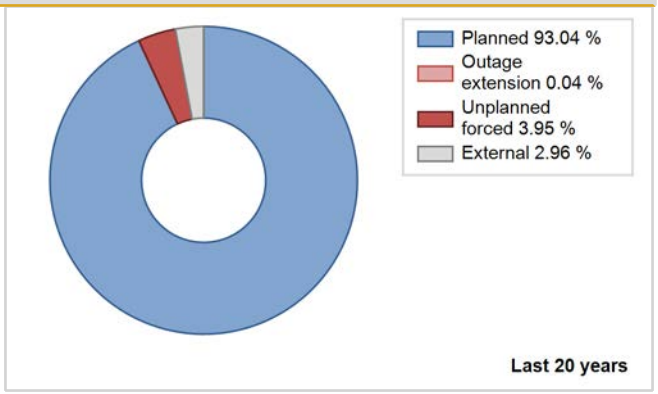
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					111	
C. Inspection, maintenance or repair combined with refuelling				1376		
D. Inspection, maintenance or repair without refuelling				142		
E. Testing of plant systems or components				0		
F. Major backfitting, refurbishment or upgrading activities with refuelling	872			92		
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L. Human factor related					6	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
Subtotal	872			1610	117	1
Total	**872**			**1728**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1988 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		6
13. Reactor Auxiliary Systems		1
15. Reactor Cooling Systems		5
16. Steam generation systems		7
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		10
35. All other I&C Systems		1
41. Main Generator Systems		66
42. Electrical Power Supply Systems		2
Total		**110**

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Highlights (2024)

During the year the unit is operated in base load mode, incl. fuel coastdown mode in April. In the first quarter Unit 5 hit record values of the nominal performance indicators since its start-up. The planned outage for annual maintenance, refueling and modernization was completed in period 05 May - 10 June, and lasted 36,33 days. The first batch of Westinghouse RWFA fuel assemblies was loaded into the reactor core during the outage to diversify the fuel supply and the core is currently mixed. Following the start-up, the unit was scheduled to operate at 3000MW and after a gradual power increase, Unit 5 was operated at 3060 thermal power.
There were no reactor scrams during the year.

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2024 Operating Experience

BG-6 KOZLODUY-6 BULGARIA

Status at end of year	:	**Operational**
Operator	:	KNPP (Kozloduy Npp ,lc)
Owner	:	B EH (Bulgarian Energy Holding)
Reactor Supplier	:	AEE (ATOMENERGOEXPORT)
Turbine Supplier	:	AEE (ATOMENERGOEXPORT)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3120 MWth
Gross electrical power	:	1040 MWe
Reference unit power (net)	:	1003 MWe

Key Dates

Construction Date	:	1982-04-01
Grid Date	:	1991-08-02
Commercial Date	:	1993-12-30
Age at end of year	:	33 years

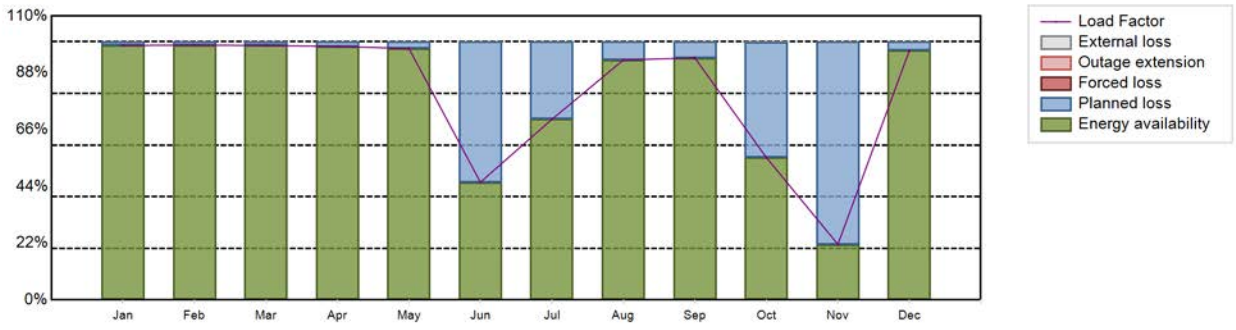
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	16
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	320
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.5
Average fuel enrichment [% of U235]	:	4.25	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	30	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	49450	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6
Active core height/length [m]	:	3.55	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	17.3	Number of main condensate pumps	:	6
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH

Annual Production Results (2024)

Net Energy Production	:	7105.78 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	80.66 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	80.68 %	Planned Unavailability Factor (PUF)	:	19.32 %
Load Factor (LF)	:	80.65 %	Externally cause unavailability (XUF)	:	0.01 %
Operating Factor (OF)	:	84.08 %	Total off-line time	:	1398 hours
Equivalent non-electrical energy generated (NEG)	:	2.42 GW(e).h			

Annual Summary



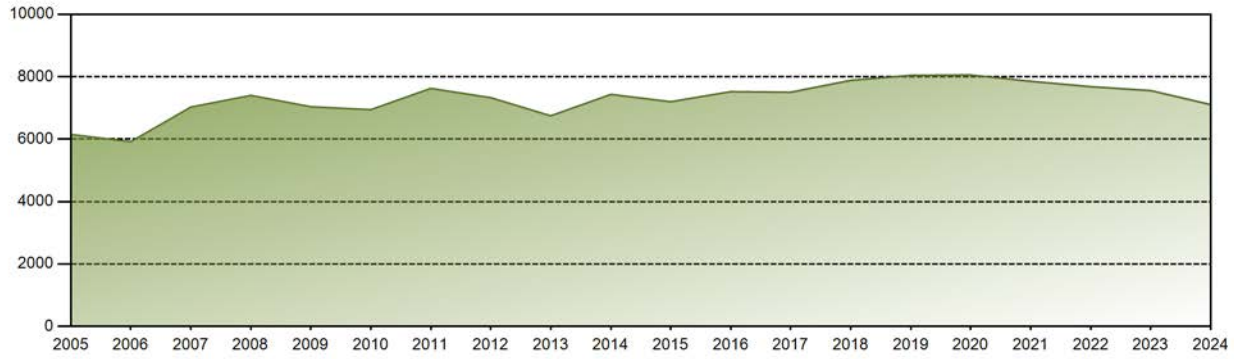
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	735.66	689.02	735.52	709.04	726.82	329.27	522.11	693.63	676.98	411.57	155.66	720.50	7105.78
EAF [%]	98.58	98.70	98.70	98.18	97.40	45.60	69.97	92.95	93.74	55.15	21.55	96.55	80.66
UCF [%]	98.58	98.70	98.70	98.18	97.40	45.60	69.97	92.95	93.74	55.29	21.55	96.55	80.68
LF [%]	98.58	98.70	98.56	98.18	97.40	45.60	69.97	92.95	93.74	55.15	21.55	96.55	80.65
OF [%]	100.00	100.00	100.00	100.00	100.00	48.19	76.21	100.00	100.00	58.33	25.28	100.00	84.08
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	1.42	1.30	1.30	1.82	2.60	54.40	30.03	7.05	6.26	44.71	78.45	3.45	19.32
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.01

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Historical Summary

Lifetime energy generation	:	197790.38 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.68 %
Cumulative Energy Availability Factor (EAF)	:	79.51 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.66 %
Cumulative Unit Capability Factor (UCF)	:	81.13 %	Cumulative Planned Unavailability Factor (PUF)	:	18.21 %
Cumulative Load Factor (LF)	:	75.26 %	Cumulative Externally cause unavailability (XUF)	:	1.62 %
Cumulative Operating Factor (OF)	:	81.74 %			

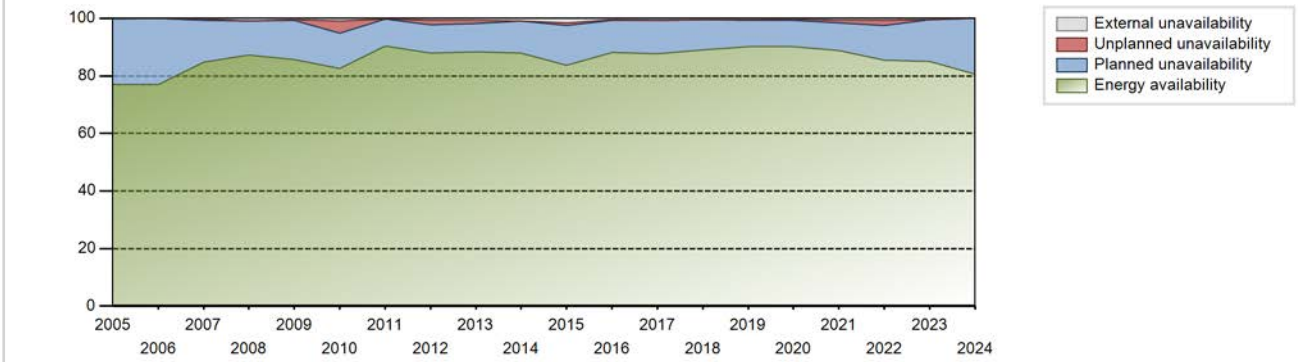
Electricity Production (net) [GWh]



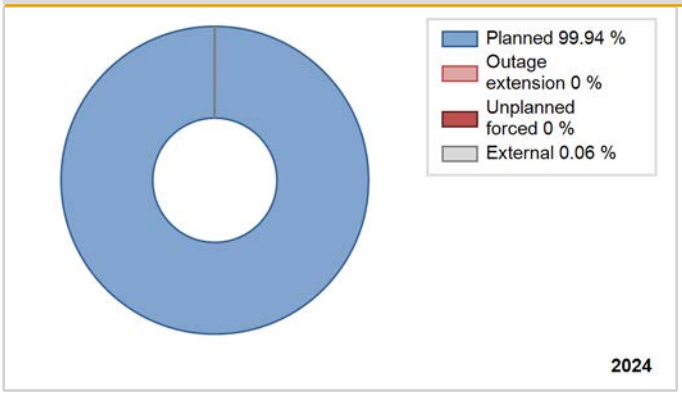
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1993	2799.64	4032	953	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1994	4862.58	7817	953	87.61	88.72	58.25	89.24	0.50	0.45	10.83	1.12
1995	3831.85	5568	953	63.56	63.56	45.90	63.56	0.09	0.06	36.38	0.00
1996	5495.89	6698	953	76.25	76.25	65.65	76.25	0.67	0.52	23.24	0.00
1997	4825.42	6380	953	72.83	72.83	57.80	72.83	0.00	0.00	27.17	0.00
1998	3970.04	6079	953	63.70	63.70	47.56	69.39	7.10	4.87	31.44	0.00
1999	4407.84	6194	953	60.71	69.56	52.80	70.71	1.16	0.82	29.62	8.86
2000	4064.35	5772	1000	51.23	66.78	46.27	65.71	0.60	0.41	32.82	15.55
2001	4189.45	5441	953	50.42	63.42	50.18	62.11	0.01	0.00	36.58	13.00
2002	5324.95	6256	953	71.52	71.52	63.78	71.42	0.03	1.10	27.38	0.00
2003	5480.56	6474	953	72.89	72.89	65.65	73.90	0.16	0.11	27.00	0.00
2004	5298.10	6614	953	75.25	75.25	63.29	75.30	0.00	0.00	24.75	0.00
2005	6149.97	6772	953	76.94	76.96	73.67	77.31	0.17	0.13	22.91	0.01
2006	5917.29	6821	953	76.96	77.05	70.88	77.87	0.06	0.04	22.90	0.10
2007	7024.83	7493	953	84.72	85.02	84.15	85.54	0.54	0.46	14.52	0.31
2008	7400.25	7753	953	87.23	88.14	88.40	88.26	0.00	0.00	11.86	0.91
2009	7037.38	7562	953	85.61	86.19	84.30	86.32	0.08	0.07	13.75	0.58
2010	6943.07	7387	953	82.68	83.70	83.17	84.33	2.98	4.11	12.19	1.02
2011	7624.89	7962	953	90.28	90.43	91.32	90.88	0.17	0.15	9.42	0.15
2012	7326.44	7842	953	87.90	88.54	87.52	89.28	1.74	1.57	9.89	0.64
2013	6746.29	7848	953	88.32	89.10	80.81	89.59	1.10	0.99	9.91	0.77
2014	7433.08	7863	963	88.02	88.95	88.11	89.76	0.00	0.00	11.05	0.93
2015	7198.32	7489	963	83.65	85.24	85.33	85.49	0.20	0.96	13.80	1.58
2016	7521.11	7807	963	88.06	88.64	88.91	88.88	0.21	0.18	11.18	0.58
2017	7503.07	7784	963	87.62	88.35	88.94	88.86	0.07	0.07	11.58	0.73
2018	7883.42	7864	1003	88.93	89.51	90.31	89.77	0.00	0.00	10.49	0.58
2019	8043.47	7973	1003	90.19	90.57	91.55	91.02	0.39	0.36	9.07	0.38
2020	8056.13	8007	1003	90.20	90.54	91.44	91.15	0.42	0.39	9.08	0.33
2021	7852.47	7970	1003	88.80	89.54	89.37	90.98	1.00	0.91	9.55	0.75
2022	7679.72	7576	1003	85.47	86.15	87.41	86.48	2.15	1.89	11.95	0.68
2023	7555.28	7666	1003	85.03	85.46	85.99	87.51	0.00	0.00	14.54	0.43
2024	7105.78	7386	1003	80.66	80.68	80.65	84.08	0.00	0.00	19.32	0.01

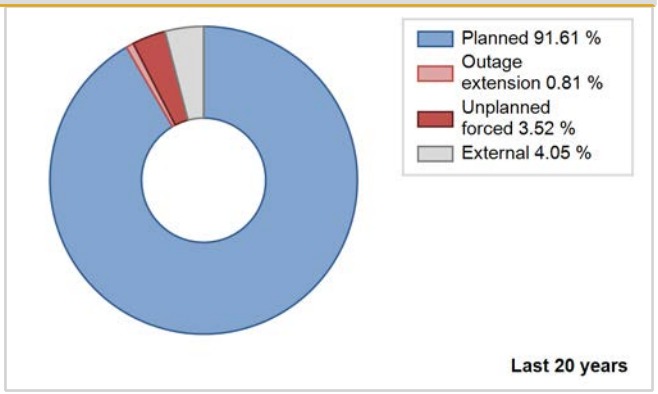
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1993 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					132	
C. Inspection, maintenance or repair combined with refuelling				1306		
D. Inspection, maintenance or repair without refuelling	550			102		
E. Testing of plant systems or components				6	0	
F. Major backfitting, refurbishment or upgrading activities with refuelling	848			97		
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					0	
Subtotal	1398			1511	132	3
Total	**1398**			**1646**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1993 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		8
14. Safety Systems		16
31. Turbine and auxiliaries		9
32. Feedwater and Main Steam System		1
35. All other I&C Systems		0
41. Main Generator Systems		14
42. Electrical Power Supply Systems		77
Total		**125**

Highlights (2024)

Unit 6 is operated in base load mode. From the beginning to the middle of the year, the unit is scheduled to operate at 3000MW reactor thermal power. As a preventive measure, Unit 6 was shut down in mid-June for corrective maintenance due to indications of primary to secondary leak in Steam Generator 3 (no operational limit reached) and the need to deal with malfunctions found in the oil system of the 24/400 kV main transformer during operation. The unit was connected to the national grid on 8 July and is operating according to the schedule at 3000/2940 MW reactor thermal power.
The planned outage for annual maintenance, refueling and modernization was completed in the period 19 October to 23 November 2024 and lasted 35.36 days. Following the outage with refuelling, Unit 6 is operating as scheduled at 2940 MW thermal power.
There were no reactor scrams during the year.

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2024 Operating Experience

CA-8 BRUCE-1 CANADA



Status at end of year	:	**Operational**
Operator	:	BRUCEPOW (Bruce Power)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 791
Thermal power	:	2620 MWth
Gross electrical power	:	868 MWe
Reference unit power (net)	:	816 MWe

Key Dates

Construction Date	:	1971-06-01
Grid Date	:	1977-01-14
Commercial Date	:	1977-09-01
Age at end of year	:	47 years

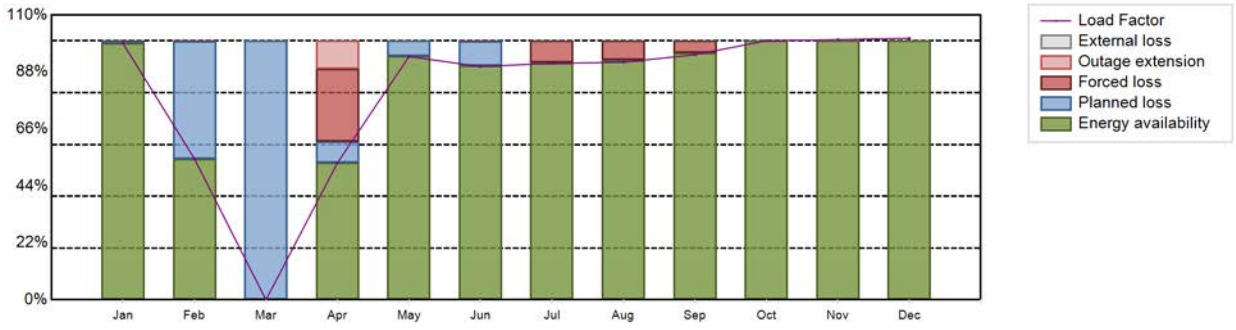
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9.36
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	300
Fuel material	:	UO2	Number of SG	:	8
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.74
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8750	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.67	HP cylinder inlet steam pressure [MPa]	:	4.37
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	4	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	1	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5800 GW(e).h	Forced Loss Rate (FLR)	:	4.79 %
Energy Availability Factor (EAF)	:	80.96 %	Unplanned Capability Loss Factor (UCL)	:	4.95 %
Unit Capability Factor (UCF)	:	80.96 %	Planned Unavailability Factor (PUF)	:	14.09 %
Load Factor (LF)	:	80.92 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	83.14 %	Total off-line time	:	1481 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	601.15	309.34	0.00	310.87	570.25	529.43	554.52	557.06	556.13	607.51	590.39	613.36	5800.00
EAF [%]	99.04	54.34	0.02	53.01	94.14	90.46	91.51	92.45	95.32	100.00	100.00	100.00	80.96
UCF [%]	99.04	54.34	0.02	53.01	94.14	90.46	91.51	92.45	95.32	100.00	100.00	100.00	80.96
LF [%]	99.02	54.47	0.00	52.91	93.93	90.11	91.34	91.76	94.66	100.07	100.49	101.03	80.92
OF [%]	100.00	54.89	0.00	62.50	100.00	93.06	92.20	97.31	96.53	100.00	100.00	100.00	83.14
FLR [%]	0.18	0.31	0.00	34.68	0.00	0.23	8.40	7.38	4.68	0.00	0.00	0.00	4.79
UCL [%]	0.18	0.17	0.00	38.89	0.00	0.21	8.39	7.37	4.68	0.00	0.00	0.00	4.95
PUF [%]	0.79	45.49	99.98	8.10	5.86	9.33	0.10	0.19	0.00	0.00	0.00	0.00	14.09
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	165503.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	17.13 %
Cumulative Energy Availability Factor (EAF)	:	74.02 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	15.54 %
Cumulative Unit Capability Factor (UCF)	:	74.44 %	Cumulative Planned Unavailability Factor (PUF)	:	10.02 %
Cumulative Load Factor (LF)	:	73.77 %	Cumulative Externally cause unavailability (XUF)	:	0.42 %
Cumulative Operating Factor (OF)	:	81.67 %			

Electricity Production (net) [GWh]

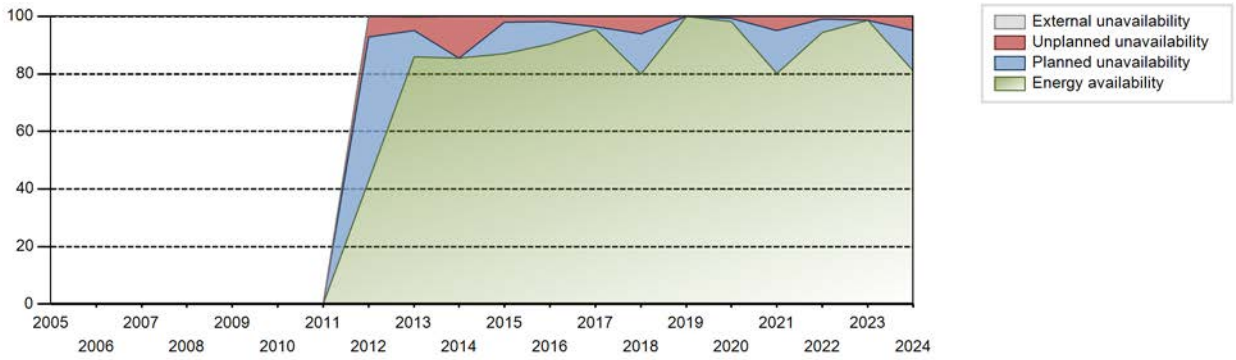


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1977	1860.70	2698	740	88.40	88.40	88.04	94.47	11.60	11.60	0.00	0.00
1978	4152.60	6649	740	72.65	72.65	64.24	76.11	15.38	13.20	14.15	0.00
1979	5018.80	7334	740	81.48	81.48	76.58	82.81	18.52	18.52	0.00	0.00
1980	5597.50	7902	740	86.18	86.18	86.11	89.96	7.87	7.36	6.46	0.00
1981	6253.30	8486	740	96.66	96.66	96.47	96.87	3.34	3.34	0.00	0.00
1982	5914.90	7884	740	88.80	88.80	91.25	90.00	11.20	11.20	0.00	0.00
1983	5802.80	7590	740	84.81	84.81	89.52	86.64	15.04	15.01	0.18	0.00
1984	6457.62	8546	740	94.76	94.76	99.35	97.29	5.10	5.09	0.15	0.00
1985	6417.45	8349	772	94.89	99.99	94.78	95.31	0.01	0.01	0.00	5.10
1986	4398.02	5783	770	65.33	65.97	65.20	66.02	0.07	0.05	33.98	0.64
1987	4087.07	5462	848	60.73	63.26	55.02	62.35	19.62	15.44	21.29	2.54
1988	4642.66	6066	848	65.95	66.85	62.33	69.06	15.12	11.91	21.24	0.89
1989	5094.78	7543	848	68.74	69.91	68.58	86.11	25.23	23.59	6.50	1.16
1990	2451.13	4629	848	32.98	33.58	33.00	52.84	39.00	21.46	44.96	0.60
1991	2394.45	3467	848	32.22	34.08	32.23	39.58	65.87	65.78	0.14	1.87
1992	4546.54	7484	848	61.04	61.04	61.04	85.20	38.96	38.96	0.00	0.00
1993	3389.20	6869	848	45.67	45.67	45.62	78.41	45.60	38.28	16.06	0.00
1994	3849.03	7094	848	51.81	51.81	51.81	80.98	48.19	48.19	0.00	0.00
1995	3531.45	5827	848	47.54	47.54	47.54	66.52	34.50	25.04	27.42	0.00
1996	4326.40	7306	848	58.09	58.09	58.08	83.17	39.23	37.49	4.42	0.00
1997	1383.58	2254	848	23.52	23.52	23.52	32.50	63.04	40.12	36.35	0.00
1998	Data not available - Suspended Operation										
1999	"										
2000	"										
2001	"										
2002	"										
2003	"										
2004	"										
2005	"										
2006	"										
2007	"										
2008	"										
2009	"										
2010	"										
2011	"										
2012	743.65	1365	772	42.86	42.86	42.87	57.11	14.46	7.25	49.90	0.00
2013	5257.07	7883	772	85.98	86.14	77.74	89.99	5.31	4.83	9.03	0.16

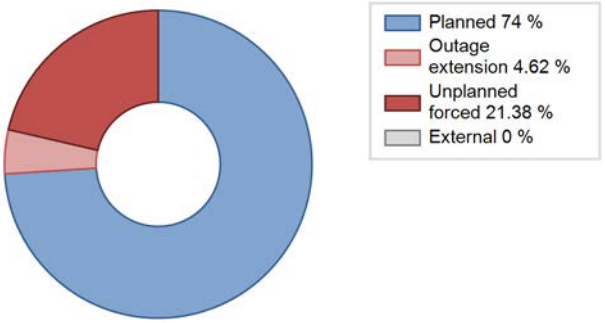
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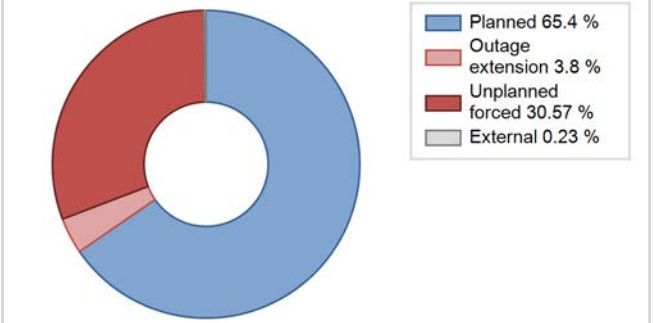
2014	5630.95	7540	772	85.52	85.52	83.26	86.07	14.48	14.48	0.00	0.00
2015	5816.97	7711	760	86.96	86.96	87.37	88.03	2.37	2.11	10.94	0.00
2016	6122.17	8004	760	90.36	90.42	91.71	91.12	1.55	1.69	7.89	0.06
2017	6434.23	8412	760	95.42	95.42	96.64	96.03	3.40	3.59	0.99	0.01
2018	5424.38	7046	760	79.92	79.93	81.48	80.43	7.03	6.04	14.03	0.01
2019	6720.15	8760	760	99.95	99.95	100.94	100.00	0.00	0.00	0.05	0.00
2020	6658.49	8630	774	98.13	98.15	97.94	98.25	0.76	0.75	1.10	0.02
2021	5613.00	7075	774	80.11	80.17	82.78	80.76	1.24	4.84	14.99	0.06
2022	6691.27	8298	774	94.38	94.38	98.69	94.73	1.07	1.02	4.60	0.00
2023	7022.43	8649	811	98.59	98.59	101.13	98.73	1.38	1.38	0.03	0.00
2024	5800.00	7303	816	80.96	80.96	80.92	83.14	4.79	4.95	14.09	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1977 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		46			730	
D. Inspection, maintenance or repair without refuelling	1130			745		
E. Testing of plant systems or components		225		70	9	
H. Nuclear regulatory requirements					16	
J. Grid limitation, failure or grid unavailability						5
L. Human factor related		79			8	
P. Fire					4	
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						13
Z. Other				10	2	
Subtotal	1130	350		825	769	18
Total	**1480**			**1612**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1977 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		46
12. Reactor I&C Systems		68
13. Reactor Auxiliary Systems		75
14. Safety Systems	58	55
15. Reactor Cooling Systems		77
16. Steam generation systems		199
21. Fuel Handling and Storage Facilities		25
31. Turbine and auxiliaries	125	42
32. Feedwater and Main Steam System	168	27
34. Miscellaneous Systems		18
41. Main Generator Systems		63
42. Electrical Power Supply Systems		40
Total	**351**	**735**

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2024 Operating Experience

CA-9 BRUCE-2 CANADA



Status at end of year	:	**Operational**
Operator	:	BRUCEPOW (Bruce Power)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 791
Thermal power	:	2620 MWth
Gross electrical power	:	836 MWe
Reference unit power (net)	:	817 MWe

Key Dates

Construction Date	:	1970-12-01
Grid Date	:	1976-09-04
Commercial Date	:	1977-09-01
Age at end of year	:	48 years

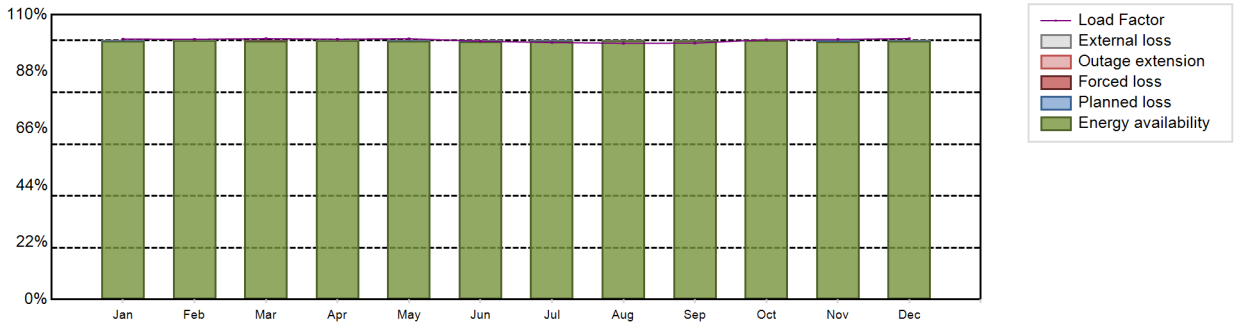
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9.36
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	300
Fuel material	:	UO2	Number of SG	:	8
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.74
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8750	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.67	HP cylinder inlet steam pressure [MPa]	:	4.37
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	4	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	1	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7186.42 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	99.91 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	99.91 %	Planned Unavailability Factor (PUF)	:	0.09 %
Load Factor (LF)	:	100.14 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	611.41	571.50	612.44	591.36	612.28	586.87	603.27	601.62	582.41	610.00	590.73	612.53	7186.43
EAF [%]	99.92	100.00	99.98	100.00	99.90	99.71	99.90	100.00	100.00	100.00	99.56	99.96	99.91
UCF [%]	99.92	100.00	99.98	100.00	99.90	99.71	99.90	100.00	100.00	100.00	99.56	99.96	99.91
LF [%]	100.59	100.50	100.76	100.53	100.73	99.77	99.25	98.98	99.01	100.35	100.42	100.77	100.14
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.08	0.00	0.00	0.00	0.10	0.29	0.10	0.00	0.00	0.00	0.44	0.04	0.09
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	150299.04 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	18.25 %
Cumulative Energy Availability Factor (EAF)	:	72.33 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	16.4 %
Cumulative Unit Capability Factor (UCF)	:	72.75 %	Cumulative Planned Unavailability Factor (PUF)	:	10.85 %
Cumulative Load Factor (LF)	:	72.09 %	Cumulative Externally cause unavailability (XUF)	:	0.42 %
Cumulative Operating Factor (OF)	:	78.2 %			

Electricity Production (net) [GWh]

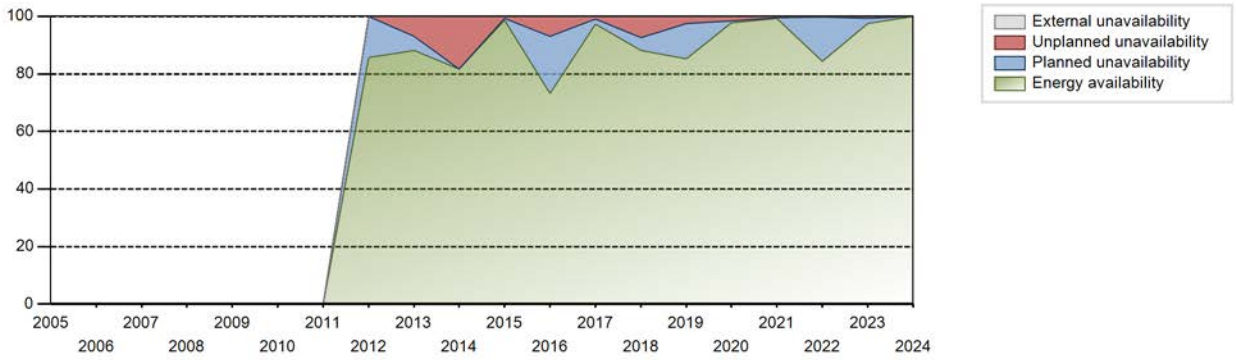


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1977	1696.80	2481	740	87.01	87.01	80.29	86.87	12.99	12.99	0.00	0.00
1978	3603.80	5946	740	65.23	65.45	55.75	68.06	22.17	18.65	15.91	0.22
1979	4408.80	6534	740	73.76	73.76	67.27	73.78	19.40	17.75	8.49	0.00
1980	6074.90	8463	740	93.52	93.52	93.46	96.35	6.48	6.48	0.00	0.00
1981	5795.10	7904	740	89.57	89.57	89.40	90.23	4.02	3.75	6.67	0.00
1982	4432.40	6163	740	68.00	68.00	68.38	70.35	32.00	32.00	0.00	0.00
1983	6112.80	7941	740	89.51	89.51	94.30	90.65	10.35	10.34	0.15	0.00
1984	6223.90	8649	740	91.03	91.03	95.75	98.46	8.84	8.83	0.15	0.00
1985	4979.30	6525	781	73.54	77.95	72.76	74.49	11.25	9.88	12.17	4.41
1986	4257.63	5308	848	56.97	59.21	57.31	60.59	40.79	40.79	0.00	2.24
1987	3781.40	4636	848	50.56	52.18	50.90	52.92	6.98	3.91	43.91	1.62
1988	4971.25	7741	848	71.70	71.70	66.74	88.13	25.15	24.08	4.22	0.00
1989	1316.31	2149	848	17.72	17.82	17.72	24.53	26.85	6.54	75.64	0.10
1990	2578.32	3460	848	35.22	35.48	34.71	39.50	41.05	24.71	39.81	0.26
1991	4483.48	5915	848	60.25	63.20	60.36	67.52	36.71	36.66	0.15	2.95
1992	353.88	625	848	4.73	4.73	4.75	7.12	95.27	95.27	0.00	0.00
1993	3016.81	6041	848	40.75	40.75	40.61	68.96	45.16	33.56	25.69	0.00
1994	3882.47	7046	848	52.26	52.26	52.26	80.43	40.39	35.41	12.32	0.00
1995	3791.00	6225	848	66.34	66.34	66.34	92.22	27.76	25.50	8.16	0.00
1996	Data not available - Suspended Operation										
1997	"										
1998	"										
1999	"										
2000	"										
2001	"										
2002	"										
2003	"										
2004	"										
2005	"										
2006	"										
2007	"										
2008	"										
2009	"										
2010	"										
2011	"										
2012	1039.20	1826	734	85.69	85.71	85.41	100.00	0.00	0.00	14.29	0.02
2013	5607.65	8190	734	88.10	88.23	87.21	93.49	7.18	6.82	4.94	0.13

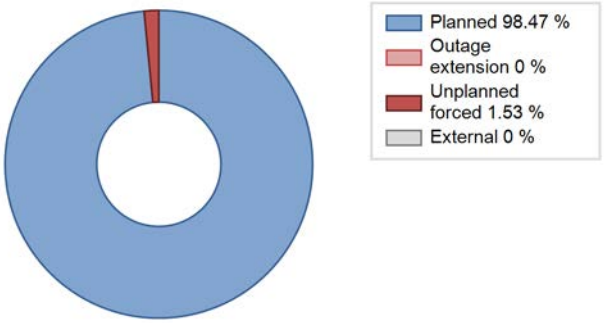
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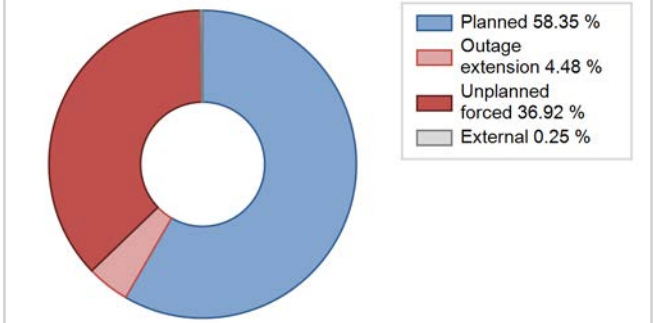
2014	4910.32	6984	734	81.74	81.74	76.37	79.73	18.26	18.26	0.00	0.00
2015	6365.71	8660	730	98.65	98.65	99.55	98.86	0.68	0.68	0.68	0.00
2016	4804.60	6408	760	73.21	73.23	73.17	72.95	2.57	6.93	19.84	0.02
2017	6482.56	8560	760	97.35	97.35	97.37	97.72	0.88	0.87	1.78	0.00
2018	5989.70	7828	760	88.11	88.12	89.97	89.36	7.67	7.32	4.55	0.01
2019	5766.96	7526	760	85.27	85.27	86.62	85.91	2.92	2.57	12.16	0.00
2020	6717.44	8584	777	97.69	97.69	98.42	97.72	1.69	1.68	0.63	0.00
2021	6797.00	8760	777	99.29	99.40	99.86	100.00	0.47	0.47	0.13	0.11
2022	5878.11	7481	777	84.33	84.33	86.36	85.40	0.28	0.23	15.44	0.00
2023	6992.40	8564	777	97.54	97.54	102.73	97.76	0.68	0.67	1.79	0.00
2024	7186.43	8784	817	99.91	99.91	100.14	100.00	0.00	0.00	0.09	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1977 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					912	
D.	Inspection, maintenance or repair without refuelling				872		
E.	Testing of plant systems or components					3	
H.	Nuclear regulatory requirements					9	
J.	Grid limitation, failure or grid unavailability						23
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						2
L.	Human factor related					35	
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						14
Z.	Other					29	
Subtotal					872	988	39
Total			**0**			**1899**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1977 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		115
12. Reactor I&C Systems		45
13. Reactor Auxiliary Systems		6
14. Safety Systems		12
15. Reactor Cooling Systems		124
16. Steam generation systems		412
21. Fuel Handling and Storage Facilities		25
31. Turbine and auxiliaries		19
32. Feedwater and Main Steam System		11
34. Miscellaneous Systems		13
35. All other I&C Systems		2
41. Main Generator Systems		121
42. Electrical Power Supply Systems		26
Total		**931**

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2024 Operating Experience

CA-10 BRUCE-3 CANADA



Status at end of year	:	**Operational**
Operator	:	BRUCEPOW (Bruce Power)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 750A
Thermal power	:	2550 MWth
Gross electrical power	:	865 MWe
Reference unit power (net)	:	770 MWe

Key Dates

Construction Date	:	1972-07-01
Grid Date	:	1977-12-12
Commercial Date	:	1978-02-01
Age at end of year	:	47 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	NA
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	8750
Active core diameter [m]	:	5.67
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	6240
Fuel linear heat generation rate [kW/m]	:	24.5
Number of control rod assemblies	:	4
Number of external reactor coolant loops	:	1
Coolant type	:	D2O

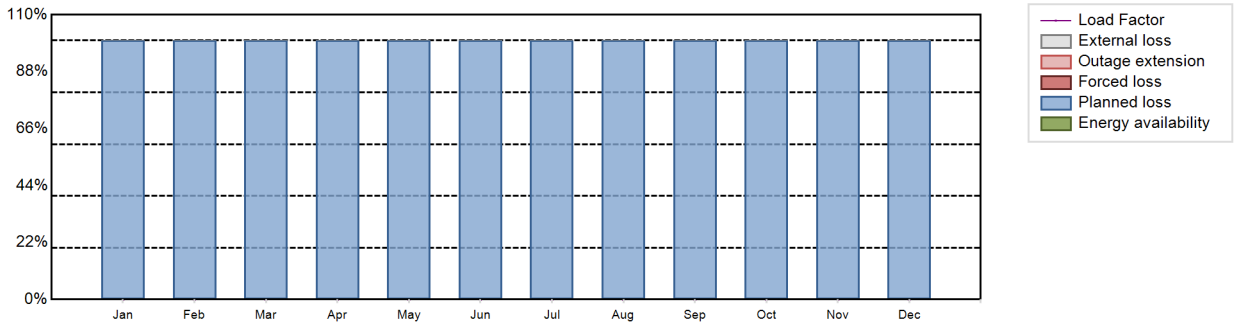
Operating coolant pressure [MPa]	:	9.36
Reactor outlet temperature [°C]	:	300
Number of SG	:	8
Containment type	:	Single
Containment design pressure [MPa]	:	1.74
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	4.37
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	NA
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	100 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	8784 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EAF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	187117.98 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	13.66 %
Cumulative Energy Availability Factor (EAF)	:	71.03 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.55 %
Cumulative Unit Capability Factor (UCF)	:	71.56 %	Cumulative Planned Unavailability Factor (PUF)	:	15.89 %
Cumulative Load Factor (LF)	:	71.15 %	Cumulative Externally cause unavailability (XUF)	:	0.53 %
Cumulative Operating Factor (OF)	:	76.12 %			

Electricity Production (net) [GWh]

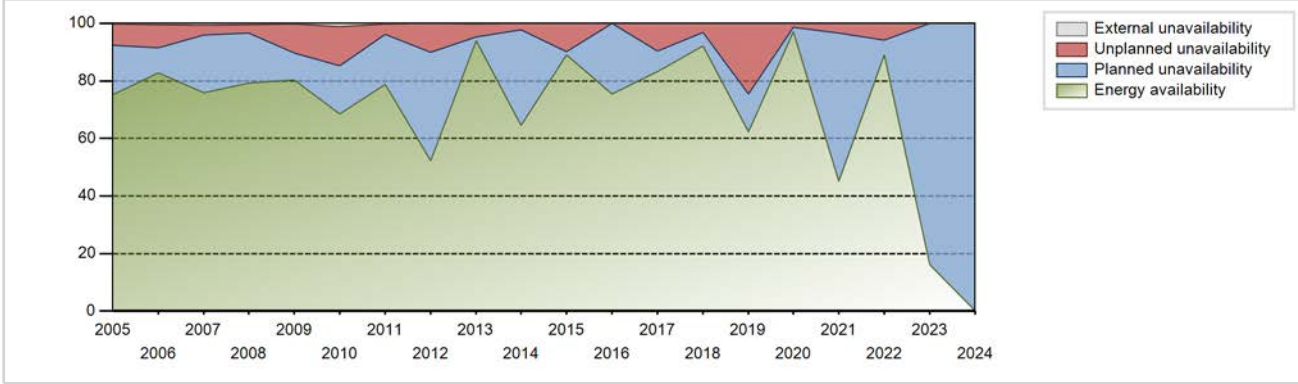


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1978	4793.00	7361	740	87.56	87.56	82.03	93.22	12.44	12.44	0.00	0.00
1979	4797.90	6885	740	77.78	77.78	73.21	77.74	11.80	10.41	11.82	0.00
1980	5939.80	8276	740	91.44	91.44	91.38	94.22	8.56	8.56	0.00	0.00
1981	5795.00	7873	740	89.48	89.48	89.40	89.87	4.74	4.45	6.07	0.00
1982	6381.90	8497	740	96.72	96.72	98.45	97.00	3.28	3.28	0.00	0.00
1983	6091.10	7905	740	89.23	89.23	93.96	90.24	10.64	10.62	0.15	0.00
1984	6148.73	8077	740	91.19	91.19	94.59	91.95	8.56	8.54	0.27	0.00
1985	6015.13	8118	775	88.59	93.91	88.60	92.67	6.09	6.09	0.00	5.32
1986	5891.24	7600	796	84.18	86.94	84.48	86.76	13.01	13.00	0.06	2.76
1987	6073.27	7724	848	81.91	85.78	81.76	88.17	7.86	7.32	6.90	3.87
1988	3310.57	4044	848	45.61	45.61	44.44	46.04	4.02	1.91	52.48	0.00
1989	4031.74	5364	848	54.79	57.43	54.27	61.23	31.42	26.31	16.26	2.64
1990	5652.68	7472	848	76.30	76.77	76.09	85.30	23.03	22.97	0.26	0.48
1991	6126.29	7950	848	82.38	84.29	82.47	90.75	15.71	15.71	0.00	1.90
1992	5800.97	7438	848	77.89	77.89	77.88	84.68	18.25	17.39	4.72	0.00
1993	3158.23	6557	848	42.99	42.99	42.52	74.85	54.42	51.32	5.69	0.00
1994	2737.62	5006	848	36.85	36.85	36.85	57.15	37.07	21.71	41.44	0.00
1995	4225.82	7000	848	56.89	56.89	56.89	79.91	43.11	43.11	0.00	0.00
1996	3321.48	5684	848	44.59	44.59	44.59	64.71	32.38	21.35	34.06	0.00
1997	4214.82	6325	848	56.76	56.76	56.74	72.20	43.24	43.24	0.00	0.00
1998	1642.52	2328	848	81.45	81.45	81.45	97.87	18.55	18.55	0.00	0.00
1999	Data not available - Suspended Operation										
2000	"										
2001	"										
2002	"										
2003	"										
2004	4971.58	7154	750	76.09	76.45	75.30	81.44	22.51	22.21	1.34	0.36
2005	4938.11	6782	750	75.24	75.52	75.16	77.42	8.92	7.40	17.08	0.28
2006	5440.25	7435	750	82.86	83.27	82.80	84.87	8.75	8.05	8.68	0.41
2007	4966.67	6911	750	75.95	76.68	75.60	78.89	3.18	3.34	19.97	0.73
2008	5148.88	7125	734	79.32	79.77	79.86	81.11	3.51	2.90	17.33	0.45
2009	5162.09	7148	730	80.39	80.59	80.72	81.60	2.07	10.14	9.27	0.20
2010	4375.77	6198	730	68.44	69.58	68.43	70.75	16.32	13.57	16.85	1.15
2011	5084.86	6959	730	78.89	79.13	79.52	79.44	4.24	3.50	17.37	0.25
2012	3352.06	4617	730	52.21	52.26	52.28	52.56	5.80	9.96	37.78	0.06
2013	5518.71	7914	730	94.01	94.16	86.30	90.34	4.71	4.66	1.18	0.14
2014	4125.00	5718	730	64.55	64.55	64.51	65.27	3.30	2.20	33.25	0.00

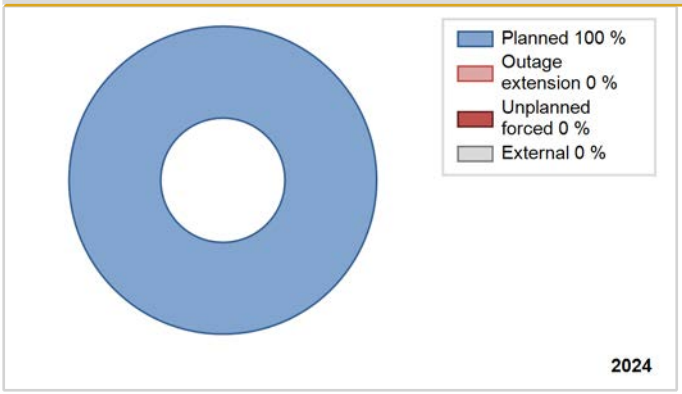
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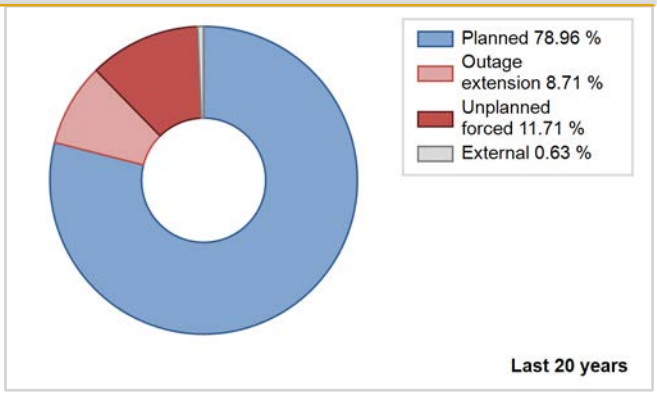
2015	5827.57	7831	750	89.01	89.01	88.90	89.39	10.00	9.89	1.09	0.00
2016	4995.72	6579	750	75.54	75.60	75.83	74.90	0.00	0.00	24.40	0.06
2017	5502.68	7344	750	83.22	83.22	83.75	83.84	0.08	9.65	7.13	0.00
2018	6268.88	8079	750	92.18	92.21	95.42	92.23	3.26	3.11	4.68	0.03
2019	4213.89	5592	750	62.40	62.40	64.14	63.84	1.68	24.63	12.98	0.00
2020	6776.48	8574	770	97.08	97.12	100.19	97.61	1.35	1.33	1.54	0.04
2021	3164.00	4022	770	45.09	45.09	46.91	45.91	0.00	3.40	51.51	0.00
2022	6220.67	7953	770	89.12	89.15	92.22	90.79	6.16	5.85	5.00	0.03
2023	1145.06	1438	770	16.24	16.24	16.98	16.42	0.00	0.00	83.76	0.00
2024	0.00	0	770	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1978 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					667	
C.	Inspection, maintenance or repair combined with refuelling				36	0	
D.	Inspection, maintenance or repair without refuelling				863		
E.	Testing of plant systems or components				13	1	
G.	Major backfitting, refurbishment or upgrading activities without refuelling	8784			462		
J.	Grid limitation, failure or grid unavailability						3
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						16
L.	Human factor related					10	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						12
Z.	Other					8	
Subtotal		8784			1374	686	32
Total		**8784**			**2092**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1978 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		125
12. Reactor I&C Systems		41
13. Reactor Auxiliary Systems		22
14. Safety Systems		59
15. Reactor Cooling Systems		81
16. Steam generation systems		94
17. Safety I&C Systems (excluding reactor I&C)		3
21. Fuel Handling and Storage Facilities		28
31. Turbine and auxiliaries		93
32. Feedwater and Main Steam System		32
33. Circulating Water System		5
34. Miscellaneous Systems		7
35. All other I&C Systems		5
41. Main Generator Systems		74
42. Electrical Power Supply Systems		17
Total		**686**

Highlights (2024)

Refurbishment continues (2023 - 2026)

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2024 Operating Experience

CA-11 BRUCE-4 CANADA



Status at end of year	:	**Operational**
Operator	:	BRUCEPOW (Bruce Power)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 750A
Thermal power	:	2550 MWth
Gross electrical power	:	868 MWe
Reference unit power (net)	:	807 MWe

Key Dates

Construction Date	:	1972-09-01
Grid Date	:	1978-12-21
Commercial Date	:	1979-01-18
Age at end of year	:	46 years

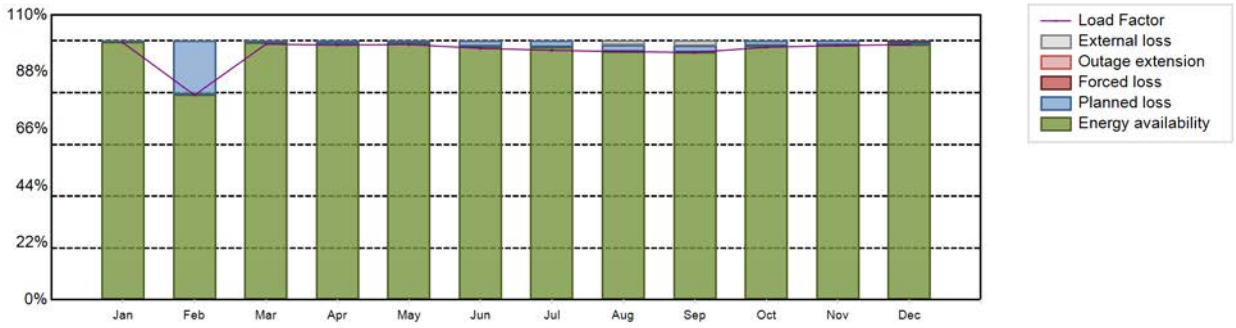
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9.36
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	300
Fuel material	:	UO2	Number of SG	:	8
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.74
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8750	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.67	HP cylinder inlet steam pressure [MPa]	:	4.37
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	4	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	1	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6818.83 GW(e).h	Forced Loss Rate (FLR)	:	0.03 %
Energy Availability Factor (EAF)	:	96.61 %	Unplanned Capability Loss Factor (UCL)	:	0.03 %
Unit Capability Factor (UCF)	:	96.9 %	Planned Unavailability Factor (PUF)	:	3.06 %
Load Factor (LF)	:	96.19 %	Externally cause unavailability (XUF)	:	0.29 %
Operating Factor (OF)	:	98.54 %	Total off-line time	:	128 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	596.34	444.10	592.95	571.67	591.98	564.46	578.48	575.62	555.02	585.66	570.72	591.83	6818.83
EAF [%]	99.56	79.33	99.34	98.94	99.06	97.97	97.69	95.80	95.57	98.13	98.36	98.62	96.61
UCF [%]	99.56	79.33	99.34	98.94	99.06	97.97	97.69	97.53	97.34	98.13	98.36	98.62	96.90
LF [%]	99.32	79.07	98.76	98.39	98.60	97.15	96.35	95.87	95.52	97.54	98.22	98.57	96.19
OF [%]	100.00	81.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.54
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.03
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.03
PUF [%]	0.44	20.67	0.66	1.06	0.94	2.03	2.31	2.47	2.66	1.87	1.64	0.98	3.06
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.73	1.77	0.00	0.00	0.00	0.29

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Historical Summary

Lifetime energy generation	:	196944.22 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	13.41 %
Cumulative Energy Availability Factor (EAF)	:	75.26 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.7 %
Cumulative Unit Capability Factor (UCF)	:	75.89 %	Cumulative Planned Unavailability Factor (PUF)	:	11.41 %
Cumulative Load Factor (LF)	:	75.11 %	Cumulative Externally cause unavailability (XUF)	:	0.63 %
Cumulative Operating Factor (OF)	:	79.92 %			

Electricity Production (net) [GWh]

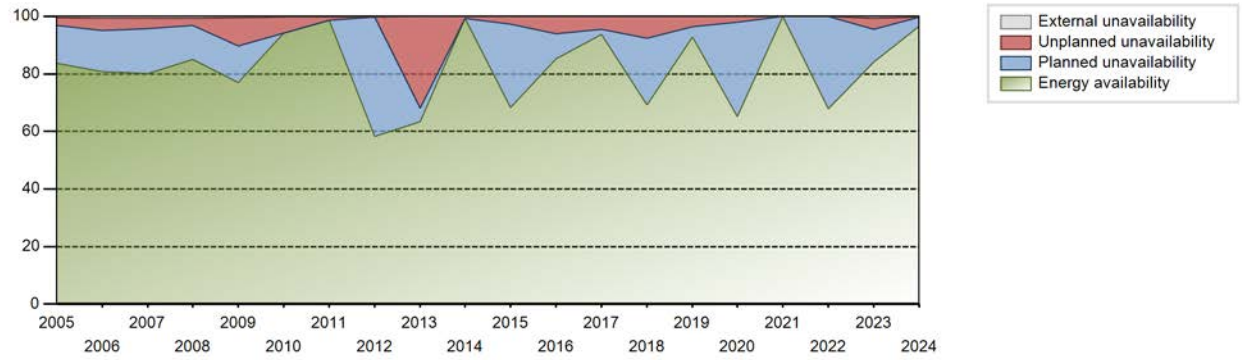


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1979	4966.40	7084	740	84.17	84.17	79.65	84.18	15.83	15.83	0.00	0.00
1980	4945.10	6962	740	76.12	76.12	76.08	79.26	14.06	12.46	11.42	0.00
1981	5753.50	7874	740	89.10	89.10	88.76	89.89	10.90	10.90	0.00	0.00
1982	6050.20	8150	740	92.18	92.18	93.33	93.04	2.13	2.01	5.81	0.00
1983	6407.40	8345	740	94.25	94.25	98.84	95.26	5.68	5.67	0.07	0.00
1984	6664.64	8625	740	97.85	97.85	102.53	98.19	2.08	2.07	0.08	0.00
1985	4995.16	6518	788	73.24	78.99	72.29	74.41	7.88	6.76	14.26	5.75
1986	6891.57	8644	848	92.85	95.51	92.77	98.68	4.49	4.49	0.00	2.67
1987	5044.99	6366	848	67.90	71.54	67.91	72.67	5.78	4.39	24.07	3.64
1988	4663.68	5997	848	65.71	66.92	62.61	68.27	18.05	14.74	18.34	1.21
1989	5584.21	7290	848	75.29	77.00	75.17	83.22	17.87	16.75	6.25	1.71
1990	3533.03	4611	848	47.54	48.29	47.56	52.64	51.71	51.71	0.00	0.75
1991	5940.70	7955	848	79.91	81.65	79.97	90.81	17.92	17.83	0.52	1.74
1992	5843.37	8070	848	78.37	80.08	78.45	91.87	19.92	19.92	0.00	1.71
1993	350.09	527	848	4.71	4.71	4.71	6.02	79.26	18.01	77.27	0.00
1994	3655.98	7206	848	49.30	49.30	49.22	82.26	50.38	50.06	0.64	0.00
1995	3034.92	5024	848	40.87	40.87	40.86	57.35	42.28	29.94	29.19	0.00
1996	5296.28	8686	848	71.17	71.17	71.10	98.88	28.83	28.83	0.00	0.00
1997	2923.05	4968	848	39.36	39.36	39.35	56.71	60.64	60.64	0.00	0.00
1998	12.34	45	848	0.81	0.81	0.81	2.50	99.19	99.19	0.00	0.00
1999	Data not available - Suspended Operation										
2000	"										
2001	"										
2002	"										
2003	934.47	802	769	100.00	100.00	55.01	36.31	0.00	0.00	0.00	0.00
2004	5418.78	7469	769	83.42	83.42	82.08	85.03	6.58	6.45	10.13	0.00
2005	5499.12	7469	750	83.67	84.10	83.70	85.26	3.21	2.79	13.11	0.43
2006	5308.22	7261	750	80.78	81.59	80.79	82.89	2.28	4.12	14.29	0.81
2007	5250.98	7298	750	80.15	80.78	79.92	83.31	4.27	3.60	15.62	0.63
2008	5504.43	7603	734	84.92	85.62	85.37	86.56	2.17	2.35	12.03	0.70
2009	4907.55	7014	730	76.92	77.37	76.74	80.07	5.42	9.91	12.72	0.44
2010	5976.18	8360	730	94.11	94.49	93.45	95.43	5.50	5.50	0.02	0.37
2011	6259.24	8670	730	98.71	98.97	97.88	98.97	1.03	1.03	0.00	0.26
2012	3700.41	5137	730	58.31	58.46	57.71	58.48	0.00	0.00	41.54	0.15
2013	4131.32	5778	730	63.44	63.55	64.60	65.96	10.79	31.78	4.67	0.11
2014	6027.76	8243	730	99.39	99.39	94.26	94.10	0.61	0.61	0.00	0.00
2015	4503.60	6069	750	68.26	68.26	68.55	69.28	0.00	2.74	29.00	0.00

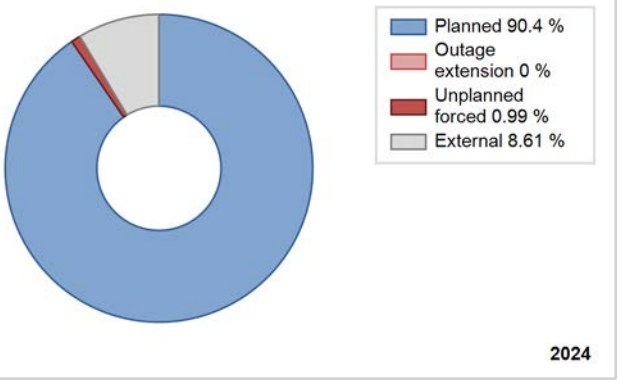
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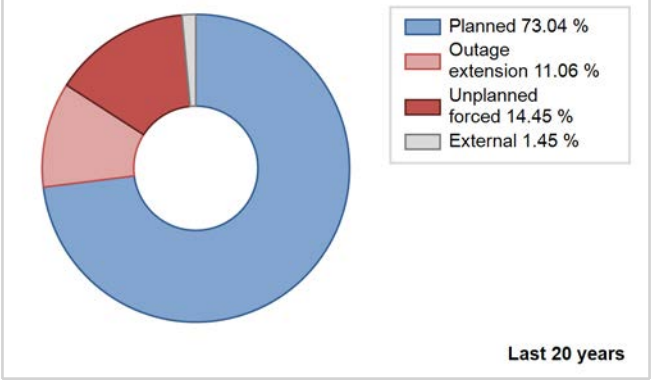
2016	5731.38	7511	750	85.23	85.25	87.00	85.51	6.54	5.96	8.78	0.02
2017	6188.10	8262	750	93.76	93.77	94.19	94.32	4.65	4.58	1.65	0.02
2018	4638.81	6146	750	69.12	69.13	70.61	70.16	4.78	7.58	23.30	0.00
2019	6115.21	8168	750	92.93	92.93	93.08	93.24	3.71	3.58	3.49	0.00
2020	4506.10	5775	769	65.21	65.35	66.71	65.74	2.84	1.91	32.74	0.14
2021	6922.00	8760	769	99.98	100.00	102.75	100.00	0.00	0.00	0.00	0.02
2022	4701.86	6006	769	67.91	68.04	69.80	68.56	0.00	0.00	31.96	0.13
2023	5895.12	7775	807	84.15	84.77	85.38	88.76	3.23	3.91	11.32	0.62
2024	6818.83	8656	807	96.61	96.90	96.19	98.54	0.03	0.03	3.06	0.29

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1979 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					712	
C.	Inspection, maintenance or repair combined with refuelling				56		
D.	Inspection, maintenance or repair without refuelling	128			867		
E.	Testing of plant systems or components				38		
H.	Nuclear regulatory requirements					5	
J.	Grid limitation, failure or grid unavailability						15
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						2
L.	Human factor related					7	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						12
Z.	Other					10	2
Subtotal		128			961	734	33
Total		**128**			**1728**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1979 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		95
12. Reactor I&C Systems		40
14. Safety Systems		40
15. Reactor Cooling Systems		63
16. Steam generation systems		158
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		17
31. Turbine and auxiliaries		61
32. Feedwater and Main Steam System		32
33. Circulating Water System		6
34. Miscellaneous Systems		30
35. All other I&C Systems		86
41. Main Generator Systems		72
42. Electrical Power Supply Systems		32
Total		**733**

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2024 Operating Experience

CA-18 BRUCE-5 CANADA



Status at end of year	:	**Operational**
Operator	:	BRUCEPOW (Bruce Power)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	CGE (CANADIAN GENERAL ELECTRIC)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 750B
Thermal power	:	2832 MWth
Gross electrical power	:	872 MWe
Reference unit power (net)	:	817 MWe

Key Dates

Construction Date	:	1978-05-31
Grid Date	:	1984-12-01
Commercial Date	:	1985-02-28
Age at end of year	:	40 years

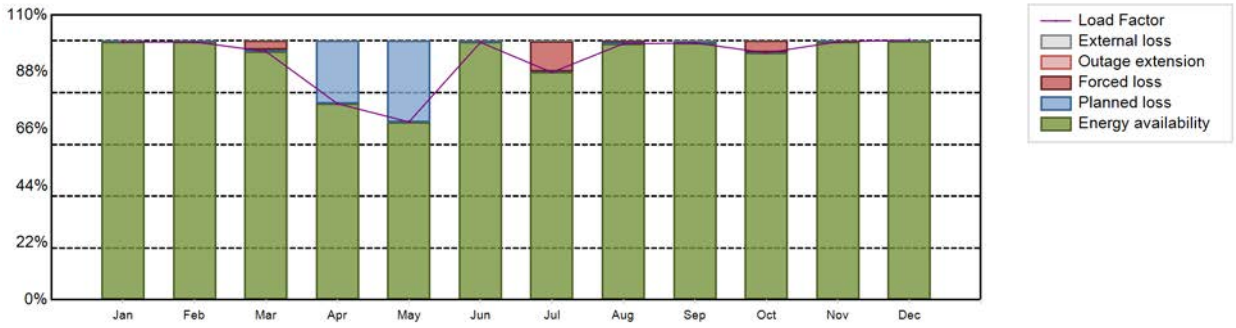
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9.49
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	305
Fuel material	:	UO2	Number of SG	:	8
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.88
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	7710	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.67	HP cylinder inlet steam pressure [MPa]	:	4.78
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	1	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6697.25 GW(e).h	Forced Loss Rate (FLR)	:	1.73 %
Energy Availability Factor (EAF)	:	93.3 %	Unplanned Capability Loss Factor (UCL)	:	1.64 %
Unit Capability Factor (UCF)	:	93.32 %	Planned Unavailability Factor (PUF)	:	5.03 %
Load Factor (LF)	:	93.32 %	Externally cause unavailability (XUF)	:	0.03 %
Operating Factor (OF)	:	94.06 %	Total off-line time	:	522 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	605.28	566.46	583.00	445.60	417.61	584.77	534.07	601.24	583.52	579.85	586.17	609.67	6697.25
EAF [%]	99.59	99.62	95.91	75.75	68.70	99.49	87.85	98.89	99.20	95.38	99.64	99.98	93.30
UCF [%]	99.59	99.62	95.91	75.75	68.70	99.49	88.06	98.89	99.32	95.38	99.64	99.98	93.32
LF [%]	99.58	99.62	95.91	75.75	68.70	99.41	87.86	98.91	99.20	95.39	99.65	100.30	93.32
OF [%]	100.00	100.00	97.31	76.39	70.16	100.00	88.98	100.00	100.00	96.24	100.00	100.00	94.06
FLR [%]	0.00	0.00	3.33	0.00	0.00	0.00	11.56	0.30	0.00	4.29	0.00	0.00	1.73
UCL [%]	0.00	0.00	3.31	0.00	0.00	0.00	11.51	0.29	0.00	4.28	0.00	0.00	1.64
PUF [%]	0.41	0.38	0.78	24.25	31.30	0.51	0.43	0.82	0.68	0.34	0.36	0.02	5.03
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.12	0.00	0.00	0.00	0.03

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Historical Summary

Lifetime energy generation	:	244410.92 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.48 %
Cumulative Energy Availability Factor (EAF)	:	85.93 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.4 %
Cumulative Unit Capability Factor (UCF)	:	86.37 %	Cumulative Planned Unavailability Factor (PUF)	:	9.22 %
Cumulative Load Factor (LF)	:	85.26 %	Cumulative Externally cause unavailability (XUF)	:	0.45 %
Cumulative Operating Factor (OF)	:	88.25 %			

Electricity Production (net) [GWh]

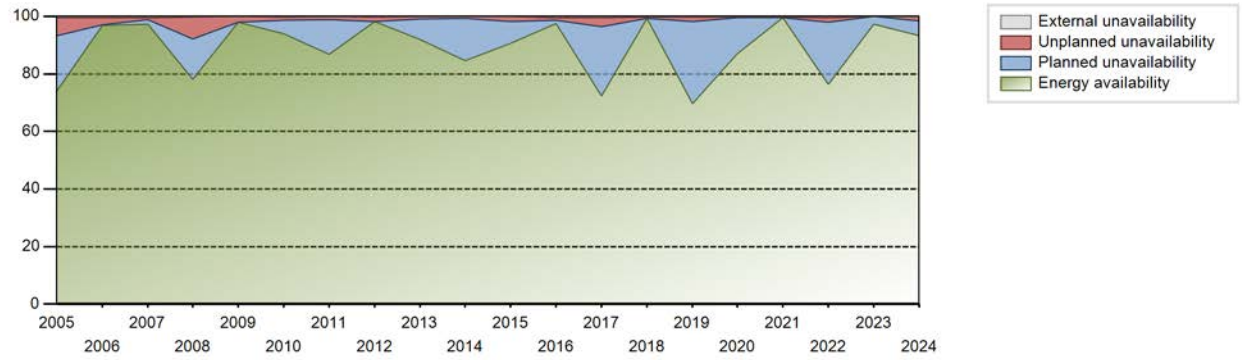


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	5464.16	7163	805	85.86	91.57	84.23	86.11	8.43	8.43	0.00	5.71
1986	7078.03	8675	835	96.67	98.43	96.77	99.03	1.57	1.57	0.00	1.76
1987	5730.15	7197	835	78.18	80.17	78.34	82.16	8.82	7.76	12.08	1.99
1988	6673.56	7824	860	88.49	88.52	88.34	89.07	6.14	5.79	5.69	0.02
1989	7130.76	8589	860	94.14	97.10	94.65	98.05	2.28	2.26	0.64	2.96
1990	5534.66	6656	860	73.53	74.60	73.47	75.98	10.83	9.06	16.34	1.06
1991	6769.63	8130	860	90.30	90.74	89.86	92.81	2.14	1.98	7.27	0.44
1992	6452.05	7636	860	85.79	85.79	85.41	86.93	4.20	3.76	10.45	0.00
1993	5118.34	7457	860	68.08	68.08	67.94	85.13	21.44	18.58	13.34	0.00
1994	5629.34	7671	860	75.02	75.02	74.72	87.57	15.74	14.02	10.97	0.00
1995	6125.27	7859	860	81.41	81.41	81.31	89.71	18.59	18.59	0.00	0.00
1996	5767.61	7153	860	76.40	76.40	76.35	81.43	8.58	7.17	16.42	0.00
1997	6388.27	8148	860	84.80	84.80	84.80	93.01	13.20	12.89	2.31	0.00
1998	5623.11	7305	785	81.68	81.69	81.77	83.39	10.74	9.83	8.48	0.01
1999	5281.90	6719	785	76.57	76.58	76.81	76.70	4.27	3.42	20.01	0.01
2000	6908.74	8719	785	99.08	99.08	100.19	99.26	0.92	0.92	0.00	0.00
2001	4902.08	6220	790	70.91	70.91	70.84	71.00	2.07	1.50	27.59	0.00
2002	5993.14	7630	790	86.28	86.28	86.60	87.10	3.85	3.86	9.86	0.00
2003	5302.51	6783	790	77.26	77.26	76.62	77.43	0.00	0.00	22.74	0.00
2004	5889.11	7543	790	85.13	85.13	84.87	85.87	2.05	7.33	7.54	0.00
2005	5109.63	6678	790	74.14	74.64	73.83	76.23	4.77	6.14	19.22	0.50
2006	6723.49	8694	806	96.79	97.18	95.89	99.25	2.60	2.60	0.22	0.38
2007	6710.89	8760	795	97.23	97.69	96.36	100.00	0.74	0.73	1.58	0.46
2008	5596.97	6943	817	78.05	78.30	77.99	79.04	6.40	7.64	14.05	0.25
2009	6826.70	8597	817	97.91	98.00	95.39	98.14	1.98	1.98	0.01	0.10
2010	6699.69	8368	817	93.97	94.15	93.61	95.53	1.20	1.14	4.71	0.18
2011	6149.76	7666	817	86.78	86.86	85.93	87.51	1.23	1.08	12.06	0.08
2012	6927.64	8690	817	98.24	98.38	96.53	98.93	1.58	1.58	0.03	0.14
2013	6421.79	8141	817	92.04	92.11	89.73	92.93	0.62	0.85	7.04	0.07
2014	5859.11	7487	817	84.64	84.76	81.87	85.47	0.00	0.51	14.73	0.11
2015	6180.84	7978	817	90.60	90.70	86.36	91.07	1.65	1.63	7.66	0.10
2016	6742.40	8613	817	97.45	97.86	93.95	98.05	0.87	0.86	1.28	0.41
2017	5034.08	6394	817	72.35	72.75	70.34	72.99	0.52	3.12	24.13	0.40
2018	7076.65	8760	817	99.38	99.64	98.88	100.00	0.36	0.36	0.00	0.26
2019	4865.80	6173	817	69.74	69.96	67.99	70.47	2.10	1.50	28.54	0.22
2020	6227.87	7682	817	87.06	87.37	86.78	87.45	0.08	0.07	12.56	0.31
2021	7138.88	8760	817	99.56	99.78	99.75	100.00	0.20	0.20	0.03	0.22

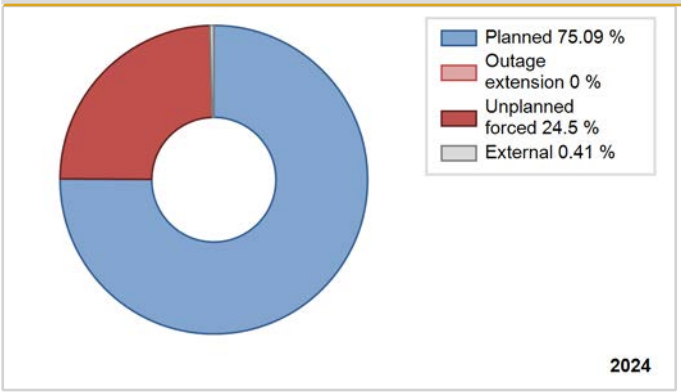
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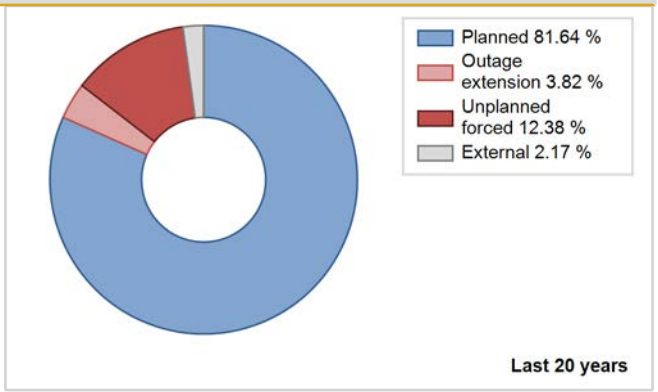
2022	5465.11	6776	817	76.36	76.78	76.36	77.35	2.08	1.63	21.58	0.43
2023	6928.72	8527	817	97.18	97.25	96.81	97.34	0.00	0.00	2.75	0.07
2024	6697.25	8262	817	93.30	93.32	93.32	94.06	1.73	1.64	5.03	0.03

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		132			210	
C.	Inspection, maintenance or repair combined with refuelling				16		
D.	Inspection, maintenance or repair without refuelling	392			766	6	
E.	Testing of plant systems or components				5	0	
J.	Grid limitation, failure or grid unavailability						0
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						2
L.	Human factor related					4	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						12
Z.	Other					1	
Subtotal		392	132		787	221	15
Total			**524**			**1023**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		22
13. Reactor Auxiliary Systems		8
14. Safety Systems		16
15. Reactor Cooling Systems		68
16. Steam generation systems		19
21. Fuel Handling and Storage Facilities		22
31. Turbine and auxiliaries	22	16
32. Feedwater and Main Steam System		18
33. Circulating Water System		2
34. Miscellaneous Systems		2
41. Main Generator Systems	111	16
42. Electrical Power Supply Systems		10
Total	**133**	**221**

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2024 Operating Experience

CA-19 BRUCE-6 CANADA



Status at end of year	:	**Operational**
Operator	:	BRUCEPOW (Bruce Power)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	CGE (CANADIAN GENERAL ELECTRIC)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 750B
Thermal power	:	2690 MWth
Gross electrical power	:	891 MWe
Reference unit power (net)	:	817 MWe

Key Dates

Construction Date	:	1978-01-01
Grid Date	:	1984-06-26
Commercial Date	:	1984-09-14
Age at end of year	:	40 years

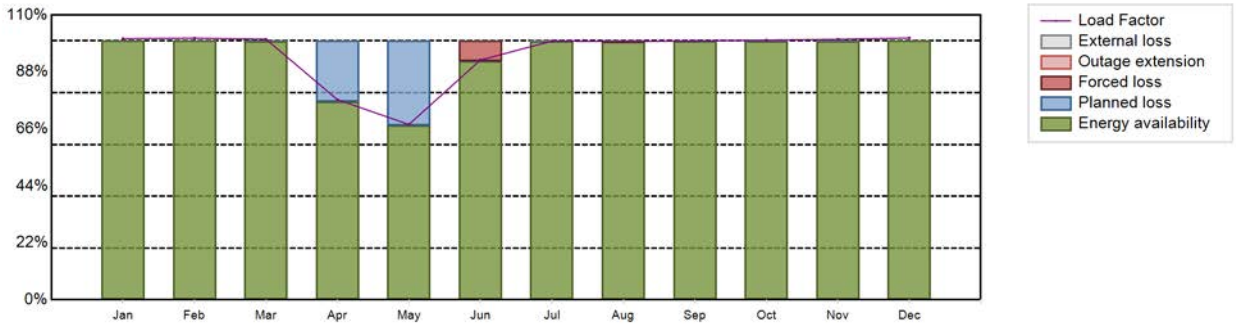
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9.49
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	305
Fuel material	:	UO2	Number of SG	:	8
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.88
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	7710	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.67	HP cylinder inlet steam pressure [MPa]	:	4.78
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	1	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6829.4 GW(e).h	Forced Loss Rate (FLR)	:	0.68 %
Energy Availability Factor (EAF)	:	94.56 %	Unplanned Capability Loss Factor (UCL)	:	0.64 %
Unit Capability Factor (UCF)	:	94.61 %	Planned Unavailability Factor (PUF)	:	4.74 %
Load Factor (LF)	:	95.16 %	Externally cause unavailability (XUF)	:	0.06 %
Operating Factor (OF)	:	94.95 %	Total off-line time	:	444 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	613.29	574.79	611.85	454.73	411.68	544.81	607.37	606.46	587.98	609.92	591.86	614.67	6829.40
EAF [%]	100.00	100.00	99.79	76.63	67.24	92.16	99.75	99.60	99.84	99.89	99.83	100.00	94.56
UCF [%]	100.00	100.00	99.79	76.63	67.24	92.16	99.98	99.95	99.95	99.89	99.83	100.00	94.61
LF [%]	100.90	101.08	100.66	77.30	67.73	92.62	99.92	99.77	99.96	100.34	100.61	101.12	95.16
OF [%]	100.00	100.00	100.00	76.81	69.09	93.47	100.00	100.00	100.00	100.00	100.00	100.00	94.95
FLR [%]	0.00	0.00	0.00	0.00	0.00	7.83	0.00	0.02	0.00	0.00	0.00	0.00	0.68
UCL [%]	0.00	0.00	0.00	0.00	0.00	7.83	0.00	0.02	0.00	0.00	0.00	0.00	0.64
PUF [%]	0.00	0.00	0.21	23.37	32.76	0.01	0.02	0.03	0.05	0.11	0.17	0.00	4.74
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.34	0.11	0.00	0.00	0.00	0.06

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Historical Summary

Lifetime energy generation	:	213604.01 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.79 %
Cumulative Energy Availability Factor (EAF)	:	76.29 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.2 %
Cumulative Unit Capability Factor (UCF)	:	76.83 %	Cumulative Planned Unavailability Factor (PUF)	:	16.98 %
Cumulative Load Factor (LF)	:	75.68 %	Cumulative Externally cause unavailability (XUF)	:	0.53 %
Cumulative Operating Factor (OF)	:	78.59 %			

Electricity Production (net) [GWh]

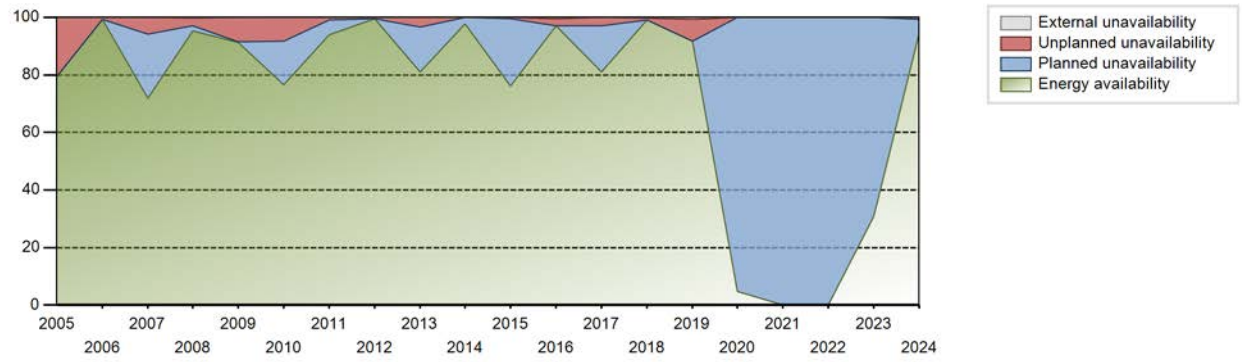


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	3068.32	4230	822	98.80	99.38	98.85	99.93	0.46	0.46	0.17	0.58
1985	5900.13	7369	805	84.04	88.69	83.66	84.12	10.23	10.10	1.20	4.65
1986	5716.03	7213	835	77.78	81.71	78.13	82.34	6.94	6.09	12.20	3.93
1987	7017.10	8610	837	95.33	97.85	95.70	98.29	1.92	1.92	0.23	2.52
1988	6139.49	7880	837	89.10	89.22	83.51	89.71	4.88	4.58	6.20	0.12
1989	5386.17	7069	837	73.43	78.94	73.46	80.70	8.94	7.75	13.32	5.50
1990	6213.64	7429	852	82.31	83.85	83.21	84.81	5.69	5.06	11.09	1.54
1991	7013.36	8194	860	93.03	93.31	93.09	93.54	0.94	0.89	5.81	0.27
1992	5328.20	6393	860	70.51	70.55	70.53	72.78	7.40	5.64	23.82	0.04
1993	4351.00	6950	860	58.03	58.03	57.75	79.34	38.84	36.85	5.12	0.00
1994	6451.71	8760	860	85.75	85.75	85.64	100.00	14.25	14.25	0.00	0.00
1995	4671.57	6049	860	62.10	62.10	62.01	69.05	11.48	8.05	29.85	0.00
1996	6822.75	8682	860	90.38	90.39	90.32	98.84	9.61	9.61	0.00	0.01
1997	4796.41	6201	860	63.70	63.70	63.67	70.79	26.88	23.42	12.88	0.00
1998	4678.62	6137	785	68.04	68.11	68.04	70.06	21.80	18.98	12.91	0.07
1999	6860.15	8760	785	99.32	99.44	99.76	100.00	0.56	0.56	0.00	0.12
2000	4668.21	5912	785	66.81	66.81	67.70	67.30	11.72	8.87	24.32	0.00
2001	6840.06	8624	790	98.32	98.32	98.84	98.45	1.68	1.68	0.00	0.00
2002	3522.45	4539	790	50.64	50.64	50.90	51.82	0.42	14.91	34.45	0.00
2003	6750.85	8559	790	98.18	98.18	97.55	97.71	1.81	1.81	0.01	0.00
2004	5379.09	6698	790	76.65	76.65	75.43	76.25	1.06	0.98	22.37	0.00
2005	5721.10	7151	841	79.56	79.56	78.90	81.63	20.44	20.44	0.00	0.00
2006	7104.45	8760	822	99.32	99.45	98.66	100.00	0.50	0.50	0.06	0.12
2007	5145.02	6363	822	71.77	71.77	71.45	72.64	7.49	5.81	22.42	0.00
2008	6857.25	8452	817	95.35	95.52	95.55	96.22	2.77	2.72	1.77	0.17
2009	6063.07	7732	817	91.32	91.36	84.72	88.26	8.43	8.41	0.23	0.04
2010	5471.91	6815	817	76.54	76.67	76.46	77.80	4.31	8.21	15.12	0.13
2011	6552.52	8277	817	94.00	94.07	91.55	94.49	0.84	0.80	5.13	0.07
2012	7125.32	8784	817	99.58	99.72	99.29	100.00	0.28	0.28	0.00	0.14
2013	5684.00	7174	817	81.00	81.07	79.42	81.89	0.67	3.27	15.66	0.07
2014	6768.62	8488	817	97.74	97.85	94.57	96.89	0.00	0.00	2.15	0.11
2015	5344.31	6694	817	76.15	76.15	74.67	76.42	0.74	0.57	23.28	0.00
2016	6875.21	8613	817	97.09	97.61	95.80	98.05	2.39	2.39	0.00	0.52
2017	5741.56	7164	817	80.96	81.10	80.22	81.78	0.19	2.89	16.01	0.14
2018	7059.65	8718	817	99.03	99.18	98.64	99.52	0.80	0.80	0.02	0.15
2019	6498.25	8224	817	91.71	92.35	90.80	93.88	7.63	7.63	0.02	0.64
2020	313.80	408	817	4.74	4.74	4.37	4.64	0.74	0.04	95.22	0.00

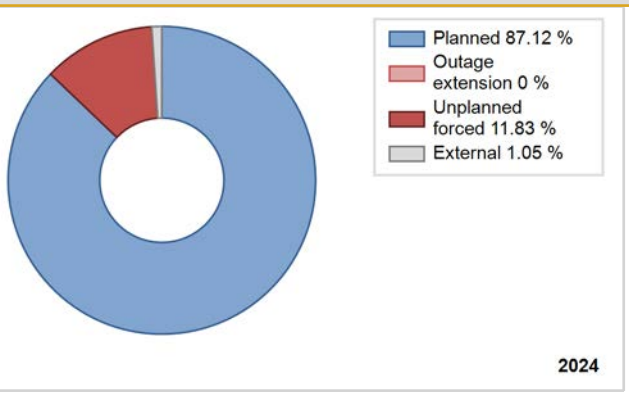
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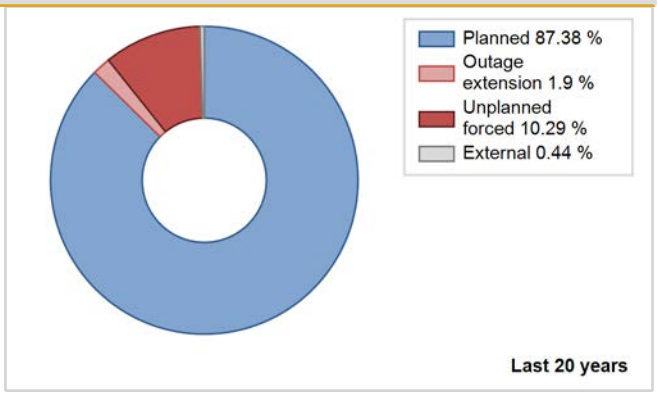
2021	0.00	0	817	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2022	0.00	0	817	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2023	2197.13	2759	817	30.80	30.80	30.70	31.50	0.00	0.00	69.20	0.00
2024	6829.40	8340	817	94.56	94.61	95.16	94.95	0.68	0.64	4.74	0.06

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		47			321	
C.	Inspection, maintenance or repair combined with refuelling				282		
D.	Inspection, maintenance or repair without refuelling	397			604	4	
E.	Testing of plant systems or components				0	15	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				443		
G.	Major backfitting, refurbishment or upgrading activities without refuelling				149		
J.	Grid limitation, failure or grid unavailability						2
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						14
L.	Human factor related					15	
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						11
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					10	
Z.	Other					12	
Subtotal		397	47		1478	377	27
Total		**444**			**1882**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		79
12. Reactor I&C Systems		49
13. Reactor Auxiliary Systems		1
14. Safety Systems		22
15. Reactor Cooling Systems		88
16. Steam generation systems		50
21. Fuel Handling and Storage Facilities		9
31. Turbine and auxiliaries		12
32. Feedwater and Main Steam System		14
33. Circulating Water System		7
34. Miscellaneous Systems		2
35. All other I&C Systems		6
41. Main Generator Systems		3
42. Electrical Power Supply Systems	47	19
Total	**47**	**361**

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2024 Operating Experience

CA-20 BRUCE-7 CANADA



Status at end of year	:	**Operational**
Operator	:	BRUCEPOW (Bruce Power)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	CGE (CANADIAN GENERAL ELECTRIC)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 750B
Thermal power	:	2832 MWth
Gross electrical power	:	872 MWe
Reference unit power (net)	:	817 MWe

Key Dates

Construction Date	:	1979-05-01
Grid Date	:	1986-02-22
Commercial Date	:	1986-04-10
Age at end of year	:	38 years

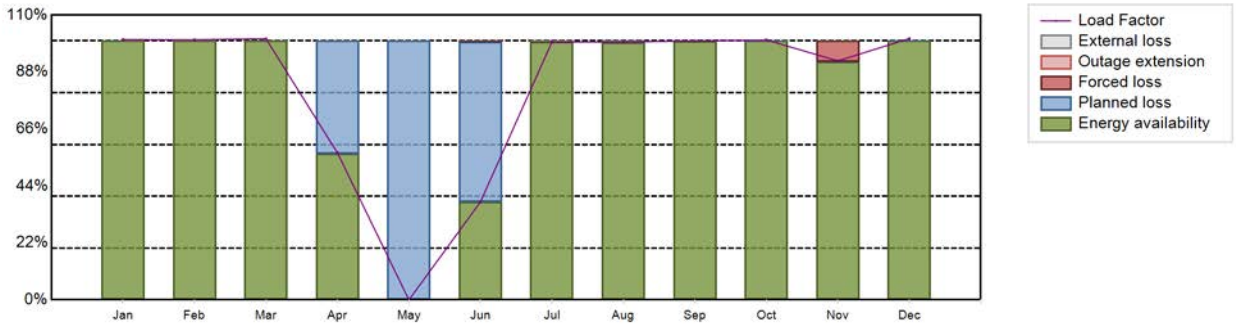
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9.49
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	305
Fuel material	:	UO2	Number of SG	:	8
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.88
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	7710	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.67	HP cylinder inlet steam pressure [MPa]	:	4.78
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	1	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5916.23 GW(e).h	Forced Loss Rate (FLR)	:	0.84 %
Energy Availability Factor (EAF)	:	82.08 %	Unplanned Capability Loss Factor (UCL)	:	0.7 %
Unit Capability Factor (UCF)	:	82.11 %	Planned Unavailability Factor (PUF)	:	17.19 %
Load Factor (LF)	:	82.44 %	Externally cause unavailability (XUF)	:	0.03 %
Operating Factor (OF)	:	82.59 %	Total off-line time	:	1529 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	610.91	571.25	612.98	334.01	0.00	222.30	605.17	605.53	587.82	610.15	542.78	613.32	5916.23
EAF [%]	100.00	100.00	100.00	56.34	0.00	37.79	99.49	99.48	99.85	99.99	91.82	100.00	82.08
UCF [%]	100.00	100.00	100.00	56.34	0.00	37.79	99.63	99.68	99.85	99.99	91.82	100.00	82.11
LF [%]	100.50	100.46	100.84	56.78	0.00	37.79	99.56	99.62	99.93	100.38	92.27	100.90	82.44
OF [%]	100.00	100.00	100.00	56.67	0.00	41.39	100.00	100.00	100.00	100.00	92.92	100.00	82.59
FLR [%]	0.00	0.00	0.00	0.00	0.00	1.08	0.11	0.00	0.00	0.00	8.02	0.00	0.84
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.41	0.11	0.00	0.00	0.00	8.01	0.00	0.70
PUF [%]	0.00	0.00	0.00	43.66	100.00	61.80	0.26	0.32	0.15	0.01	0.18	0.00	17.19
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.21	0.00	0.00	0.00	0.00	0.03

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Historical Summary

Lifetime energy generation	:	238140.76 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.66 %
Cumulative Energy Availability Factor (EAF)	:	86.17 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.89 %
Cumulative Unit Capability Factor (UCF)	:	86.8 %	Cumulative Planned Unavailability Factor (PUF)	:	8.31 %
Cumulative Load Factor (LF)	:	85.34 %	Cumulative Externally cause unavailability (XUF)	:	0.62 %
Cumulative Operating Factor (OF)	:	88.83 %			

Electricity Production (net) [GWh]

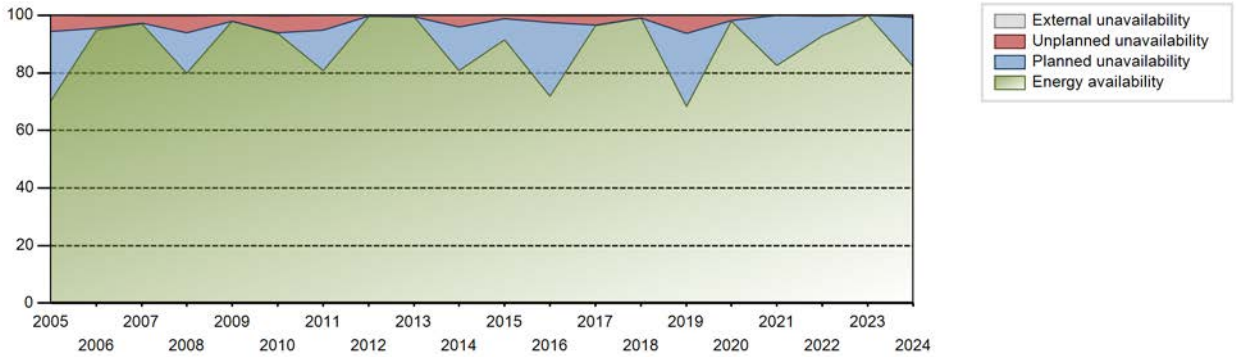


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	5256.62	6957	838	89.83	96.68	89.66	97.55	3.31	3.30	0.02	6.85
1987	6288.05	8489	837	85.91	96.87	85.76	96.91	2.80	2.79	0.34	10.96
1988	4866.19	6636	846	74.75	74.75	65.44	75.55	9.46	7.81	17.44	0.00
1989	7280.79	8632	860	96.44	97.83	96.64	98.54	1.83	1.82	0.35	1.39
1990	6659.40	8065	860	88.53	90.69	88.40	92.07	4.64	4.41	4.89	2.17
1991	5733.63	6835	860	76.27	76.39	76.11	78.03	8.22	6.84	16.77	0.12
1992	6413.41	7589	860	85.11	85.16	84.90	86.40	1.64	1.42	13.42	0.05
1993	5802.33	8760	860	78.12	78.12	77.02	100.00	21.87	21.87	0.00	0.00
1994	5496.71	7577	860	73.20	73.20	72.96	86.50	17.13	15.13	11.67	0.00
1995	6285.10	8092	860	83.47	83.47	83.43	92.37	16.53	16.53	0.00	0.00
1996	5475.68	7000	860	72.55	72.58	72.48	79.69	16.16	13.98	13.44	0.03
1997	6154.48	7874	860	81.69	81.69	81.69	89.89	18.31	18.31	0.00	0.00
1998	4990.76	6474	785	72.42	72.42	72.58	73.90	6.83	5.31	22.27	0.00
1999	6315.74	8208	785	91.84	92.29	91.84	93.70	7.71	7.71	0.00	0.44
2000	5322.68	6790	785	76.91	78.20	77.19	77.30	1.57	1.25	20.55	1.29
2001	7026.30	8760	790	100.00	100.00	101.53	100.00	0.00	0.00	0.00	0.00
2002	4819.35	6121	790	69.49	69.49	69.64	69.87	1.46	3.67	26.84	0.00
2003	6730.24	8592	790	97.66	97.66	97.25	98.08	2.20	2.20	0.14	0.00
2004	6428.77	8188	790	92.77	92.77	92.64	93.21	0.00	0.03	7.20	0.00
2005	4890.45	6310	790	70.21	70.23	70.07	72.03	3.28	5.70	24.07	0.02
2006	6740.47	8486	806	94.79	95.06	94.37	96.87	4.30	4.27	0.67	0.28
2007	6969.91	8570	822	97.07	97.33	96.79	97.83	2.49	2.48	0.18	0.26
2008	5763.74	7101	817	79.92	80.08	80.31	80.84	3.49	5.99	13.93	0.16
2009	6475.33	8144	817	97.93	97.93	90.48	92.97	1.99	1.98	0.08	0.01
2010	6726.64	8610	817	93.68	93.84	93.99	98.29	5.98	5.97	0.19	0.16
2011	5761.53	7137	817	80.73	80.82	80.50	81.47	0.17	4.98	14.20	0.09
2012	7055.97	8731	817	99.55	99.68	98.32	99.40	0.24	0.24	0.08	0.14
2013	7003.57	8758	817	99.42	99.49	97.86	99.98	0.51	0.51	0.00	0.07
2014	5479.21	7113	817	80.72	80.72	76.56	81.20	1.04	4.01	15.27	0.00
2015	6324.10	8029	817	91.46	91.46	88.36	91.66	1.35	1.26	7.29	0.00
2016	4983.38	6332	817	71.92	72.20	69.44	72.09	0.00	2.23	25.57	0.27
2017	6643.16	8431	817	96.33	96.53	92.82	96.24	3.28	3.27	0.20	0.20
2018	7116.79	8715	817	99.01	99.07	99.44	99.49	0.91	0.91	0.02	0.06
2019	4849.09	6036	817	68.32	68.46	67.75	68.90	0.19	6.15	25.39	0.14
2020	7036.81	8664	817	97.96	98.04	98.05	98.63	1.71	1.71	0.25	0.08
2021	5948.94	7264	817	82.66	82.76	83.12	82.92	0.00	0.00	17.24	0.09
2022	6676.03	8208	817	92.94	93.10	93.28	93.70	0.07	0.06	6.84	0.16

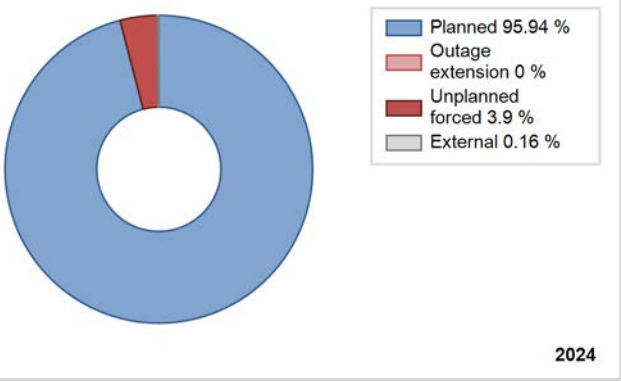
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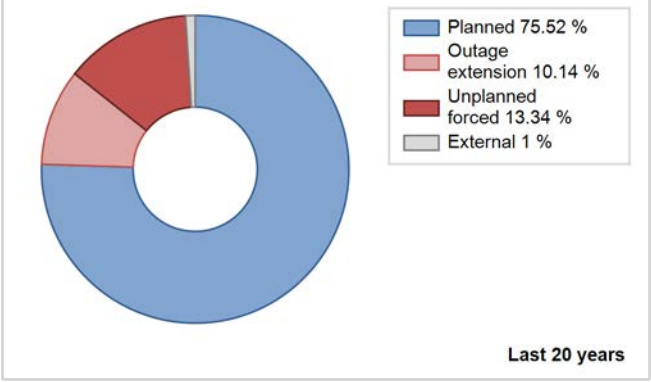
2023	7176.72	8760	817	100.00	100.00	100.28	100.00	0.00	0.00	0.00	0.00
2024	5916.23	7255	817	82.08	82.11	82.44	82.59	0.84	0.70	17.19	0.03

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		51			223	
C. Inspection, maintenance or repair combined with refuelling				16		
D. Inspection, maintenance or repair without refuelling	1473			633	7	
E. Testing of plant systems or components				7		
G. Major backfitting, refurbishment or upgrading activities without refuelling				58		
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						17
L. Human factor related					3	
Z. Other					9	3
Subtotal	1473	51		714	242	20
Total	**1524**			**976**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		12
12. Reactor I&C Systems		29
13. Reactor Auxiliary Systems		2
14. Safety Systems		5
15. Reactor Cooling Systems		36
16. Steam generation systems		22
21. Fuel Handling and Storage Facilities		24
31. Turbine and auxiliaries	51	30
32. Feedwater and Main Steam System		27
33. Circulating Water System		4
34. Miscellaneous Systems		27
41. Main Generator Systems		9
42. Electrical Power Supply Systems		15
Total	**51**	**242**

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2024 Operating Experience

CA-21 BRUCE-8 CANADA



Status at end of year	:	**Operational**
Operator	:	BRUCEPOW (Bruce Power)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	CGE (CANADIAN GENERAL ELECTRIC)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 750B
Thermal power	:	2690 MWth
Gross electrical power	:	872 MWe
Reference unit power (net)	:	817 MWe

Key Dates

Construction Date	:	1979-07-30
Grid Date	:	1987-03-07
Commercial Date	:	1987-05-20
Age at end of year	:	37 years

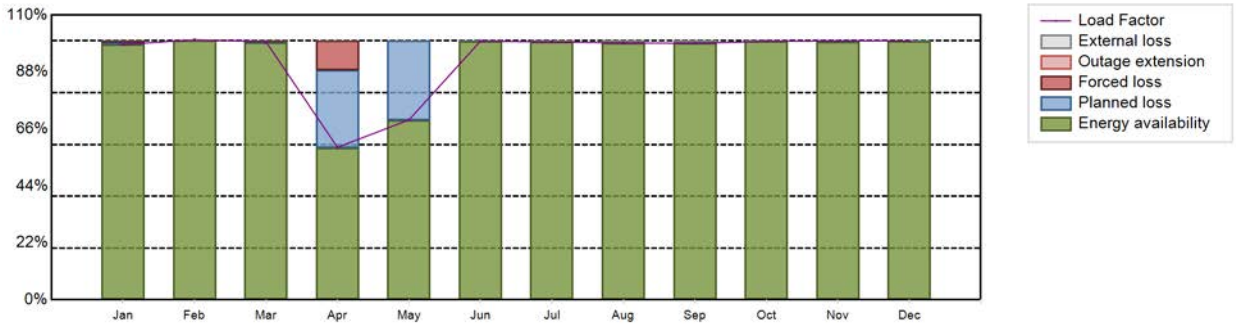
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9.49
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	305
Fuel material	:	UO2	Number of SG	:	8
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.88
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	7710	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.67	HP cylinder inlet steam pressure [MPa]	:	4.78
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	1	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6726.84 GW(e).h	Forced Loss Rate (FLR)	:	1.07 %
Energy Availability Factor (EAF)	:	93.62 %	Unplanned Capability Loss Factor (UCL)	:	1.01 %
Unit Capability Factor (UCF)	:	93.69 %	Planned Unavailability Factor (PUF)	:	5.3 %
Load Factor (LF)	:	93.73 %	Externally cause unavailability (XUF)	:	0.07 %
Operating Factor (OF)	:	94.14 %	Total off-line time	:	515 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	599.13	571.18	605.79	346.56	422.35	587.60	605.56	603.15	582.74	606.75	588.22	607.81	6726.84
EAF [%]	98.54	100.00	99.46	58.74	69.43	99.82	99.57	99.15	99.20	99.77	99.73	99.88	93.62
UCF [%]	98.54	100.00	99.46	58.74	69.43	99.82	99.62	99.49	99.55	99.86	99.73	99.88	93.69
LF [%]	98.57	100.45	99.66	58.91	69.48	99.89	99.62	99.23	99.06	99.82	100.00	99.99	93.73
OF [%]	100.00	100.00	100.00	58.75	70.70	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.14
FLR [%]	0.63	0.00	0.46	16.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07
UCL [%]	0.63	0.00	0.46	11.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01
PUF [%]	0.83	0.00	0.08	30.01	30.57	0.18	0.38	0.51	0.45	0.14	0.27	0.12	5.30
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.34	0.34	0.09	0.00	0.00	0.07

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Historical Summary

Lifetime energy generation	:	224562.02 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.49 %
Cumulative Energy Availability Factor (EAF)	:	84.23 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.66 %
Cumulative Unit Capability Factor (UCF)	:	85.03 %	Cumulative Planned Unavailability Factor (PUF)	:	9.31 %
Cumulative Load Factor (LF)	:	83.45 %	Cumulative Externally cause unavailability (XUF)	:	0.8 %
Cumulative Operating Factor (OF)	:	87.12 %			

Electricity Production (net) [GWh]

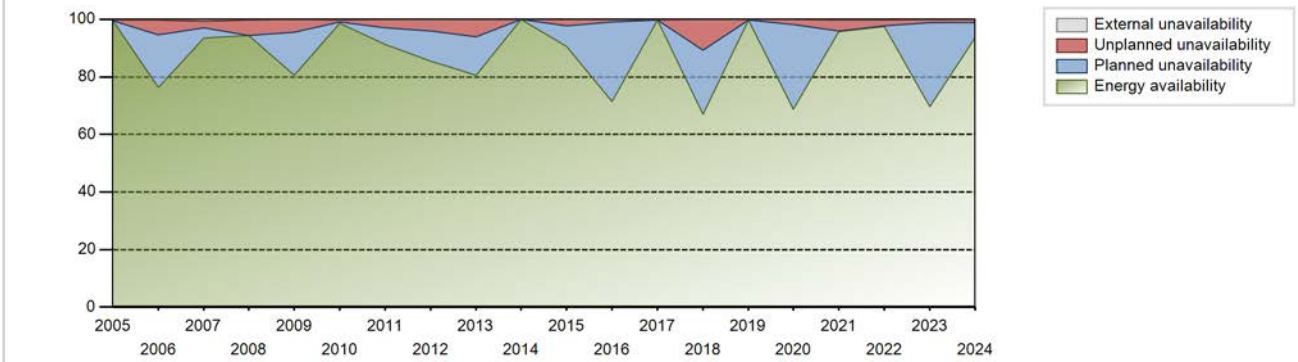


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	3673.23	5849	844	76.58	99.06	76.45	99.90	0.69	0.69	0.25	22.48
1988	5958.52	7659	837	86.53	86.85	81.04	87.19	8.74	8.32	4.83	0.32
1989	6523.47	8661	837	89.21	98.45	88.97	98.87	1.29	1.29	0.26	9.24
1990	5758.67	7186	842	78.09	80.67	78.00	82.03	7.58	6.62	12.71	2.58
1991	6932.70	8213	860	92.47	92.96	92.02	93.76	1.65	1.56	5.48	0.48
1992	5451.09	6587	860	72.41	72.43	72.16	74.99	11.73	9.63	17.94	0.02
1993	4675.90	7064	860	62.27	62.27	62.07	80.64	28.79	25.18	12.55	0.00
1994	6443.16	8760	860	86.00	86.00	85.53	100.00	13.88	13.86	0.15	0.00
1995	6113.35	7876	860	81.34	81.34	81.15	89.91	9.36	8.40	10.26	0.00
1996	6957.82	8783	860	92.14	92.14	92.10	99.99	7.86	7.86	0.00	0.00
1997	6346.54	8003	860	84.24	84.24	84.24	91.36	15.73	15.72	0.03	0.00
1998	4122.43	5368	785	59.76	59.86	59.95	61.28	18.78	13.84	26.30	0.10
1999	4114.43	5414	785	59.77	59.98	59.83	61.80	15.23	10.77	29.25	0.21
2000	6530.94	8293	785	93.67	93.67	94.71	94.41	4.25	4.16	2.17	0.00
2001	5424.77	6852	790	78.03	78.03	78.39	78.22	4.50	3.67	18.30	0.00
2002	6685.96	8543	790	97.01	97.01	96.61	97.52	2.99	2.99	0.00	0.00
2003	4959.99	6301	790	71.89	71.89	71.67	71.93	0.08	11.29	16.81	0.00
2004	5695.77	7374	790	82.80	83.01	82.08	83.95	11.13	10.39	6.60	0.21
2005	6889.22	8745	790	99.44	99.65	99.55	99.83	0.34	0.34	0.01	0.22
2006	5283.88	6791	790	76.37	76.58	76.31	77.52	4.47	5.14	18.28	0.20
2007	6485.25	8341	795	93.39	94.04	93.12	95.22	2.41	2.32	3.64	0.65
2008	6514.39	8699	782	94.30	94.52	94.84	99.03	5.43	5.42	0.06	0.22
2009	5266.44	6906	782	80.58	80.58	76.88	78.84	1.79	4.43	14.99	0.00
2010	6930.19	8760	817	98.61	98.78	98.93	100.00	0.75	0.74	0.48	0.16
2011	6453.40	8015	817	91.37	91.44	90.17	91.50	1.81	2.81	5.75	0.07
2012	5682.67	7161	817	85.48	85.62	79.18	81.52	1.87	3.88	10.51	0.14
2013	5656.62	7141	817	80.58	80.64	79.04	81.52	7.01	6.08	13.28	0.07
2014	6873.54	8760	817	99.87	99.87	96.04	100.00	0.13	0.13	0.00	0.00
2015	6288.54	8001	817	90.66	90.66	87.87	91.34	2.36	2.19	7.15	0.00
2016	5038.39	6291	817	71.41	71.41	70.21	71.62	1.17	0.84	27.74	0.00
2017	6992.50	8760	817	99.70	99.98	97.70	100.00	0.00	0.00	0.02	0.28
2018	4816.88	6123	817	67.07	67.14	67.30	69.90	2.68	10.62	22.25	0.07
2019	7082.00	8760	817	99.75	99.82	98.95	100.00	0.18	0.18	0.01	0.07
2020	4936.59	6141	817	68.69	68.82	68.79	69.91	2.40	1.69	29.49	0.13
2021	6880.50	8472	817	95.80	96.12	96.14	96.71	3.81	3.81	0.07	0.32
2022	6985.60	8616	817	97.52	97.85	97.61	98.36	2.01	2.01	0.14	0.33
2023	4955.12	6248	817	69.63	69.63	69.24	71.32	1.77	1.26	29.12	0.00

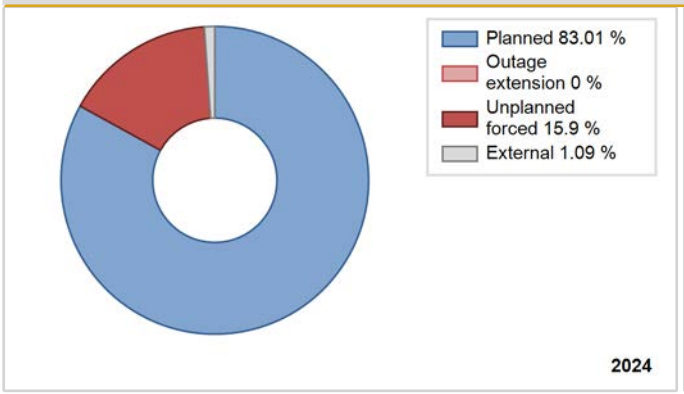
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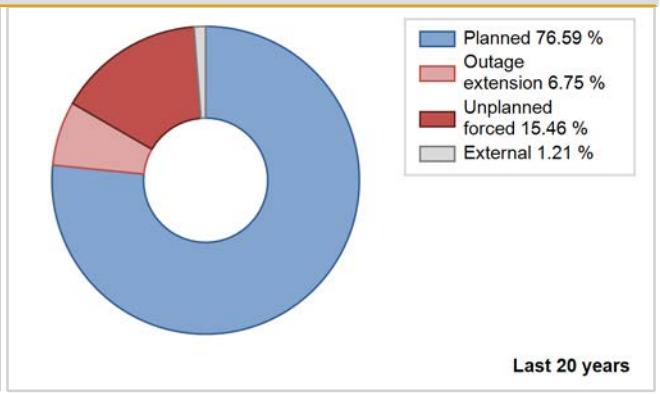
2024	6726.84	8269	817	93.62	93.69	93.73	94.14	1.07	1.01	5.30	0.07

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		94			282	
C.	Inspection, maintenance or repair combined with refuelling				100		
D.	Inspection, maintenance or repair without refuelling	421			698	26	
E.	Testing of plant systems or components				0	1	
J.	Grid limitation, failure or grid unavailability						0
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						20
L.	Human factor related					5	
Z.	Other					1	
Subtotal		421	94		798	315	20
Total		**515**			**1133**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		30
12. Reactor I&C Systems		8
13. Reactor Auxiliary Systems		1
14. Safety Systems		16
15. Reactor Cooling Systems		49
16. Steam generation systems		133
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		12
31. Turbine and auxiliaries	94	19
32. Feedwater and Main Steam System		11
33. Circulating Water System		6
34. Miscellaneous Systems		5
35. All other I&C Systems		4
41. Main Generator Systems		1
42. Electrical Power Supply Systems		17
Total	**94**	**312**

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2024 Operating Experience

CA-22 DARLINGTON-1 CANADA



Status at end of year	:	**Operational**
Operator	:	OPG (Ontario Power Generation)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	BBC (BROWN BOVERI ET CIE)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 850
Thermal power	:	2776 MWth
Gross electrical power	:	934 MWe
Reference unit power (net)	:	878 MWe

Key Dates

Construction Date	:	1982-04-01
Grid Date	:	1990-12-19
Commercial Date	:	1992-11-14
Age at end of year	:	34 years

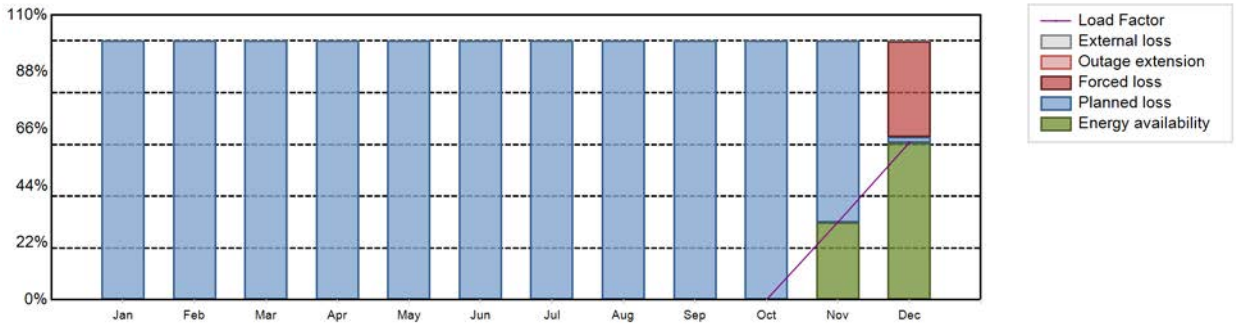
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	10
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	310
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	0.0965
Average fuel enrichment [% of U235]	:	0.72	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	NA	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8625	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	7.068	HP cylinder inlet steam pressure [MPa]	:	4.93
Active core height/length [m]	:	6.06	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24	Number of main condensate pumps	:	3
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	586.14 GW(e).h	Forced Loss Rate (FLR)	:	29.15 %
Energy Availability Factor (EAF)	:	7.59 %	Unplanned Capability Loss Factor (UCL)	:	3.13 %
Unit Capability Factor (UCF)	:	7.6 %	Planned Unavailability Factor (PUF)	:	89.27 %
Load Factor (LF)	:	7.6 %	Externally cause unavailability (XUF)	:	0.01 %
Operating Factor (OF)	:	9.85 %	Total off-line time	:	7919 hours

Annual Summary



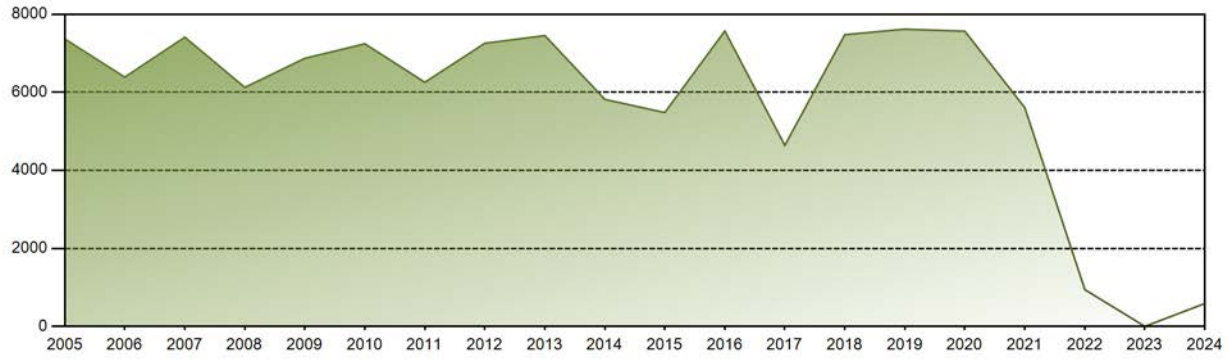
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	189.49	396.66	586.14
EAF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.88	60.72	7.59
UCF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.88	60.82	7.60
LF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.97	60.72	7.60
OF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.61	64.38	9.85
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.77	29.15
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.92	3.13
PUF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	70.12	2.26	89.27
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.01

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Historical Summary

Lifetime energy generation	:	196634.83 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.62 %
Cumulative Energy Availability Factor (EAF)	:	77.79 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.75 %
Cumulative Unit Capability Factor (UCF)	:	78.68 %	Cumulative Planned Unavailability Factor (PUF)	:	16.57 %
Cumulative Load Factor (LF)	:	77.42 %	Cumulative Externally cause unavailability (XUF)	:	0.89 %
Cumulative Operating Factor (OF)	:	81.14 %			

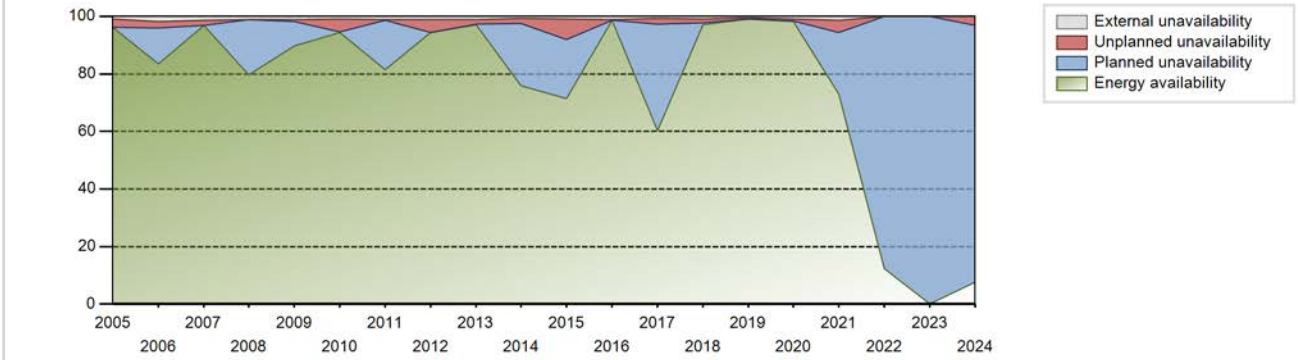
Electricity Production (net) [GWh]



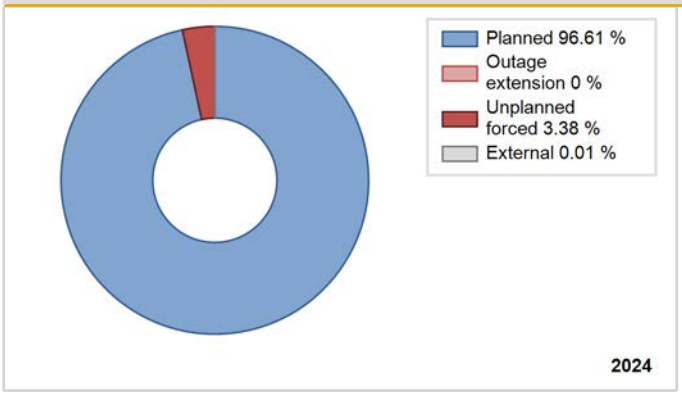
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1992	973.98	1152	881	96.83	96.83	75.51	78.69	3.17	3.17	0.00	0.00
1993	6016.23	7213	881	78.72	79.18	77.96	82.34	9.34	8.16	12.66	0.45
1994	6326.65	7446	881	83.13	83.46	81.98	85.00	10.94	10.25	6.29	0.33
1995	6853.27	8046	881	89.72	90.65	88.80	91.85	4.41	4.19	5.16	0.94
1996	5745.25	6827	881	75.03	75.68	74.24	77.72	20.47	19.48	4.84	0.65
1997	4765.08	7236	881	62.33	63.04	61.74	82.60	31.33	28.76	8.20	0.71
1998	6427.46	7717	881	83.28	84.27	83.28	88.09	6.58	5.94	9.79	0.99
1999	7175.13	8705	881	92.97	94.35	92.97	99.37	5.65	5.65	0.00	1.38
2000	6280.57	7615	881	81.18	81.97	81.16	86.69	5.20	4.49	13.54	0.79
2001	6980.80	8502	881	90.45	91.17	90.45	97.05	5.81	5.62	3.21	0.71
2002	6532.91	7887	881	84.65	85.51	84.65	90.03	7.89	7.32	7.16	0.86
2003	6562.38	7846	881	85.10	87.47	85.03	89.57	5.14	4.74	7.79	2.38
2004	5612.12	6540	881	72.82	73.58	72.52	74.45	9.72	7.92	18.50	0.76
2005	7366.26	8553	881	96.20	97.04	95.69	97.64	2.96	2.96	0.00	0.84
2006	6388.89	7520	878	83.43	85.16	83.07	85.84	1.85	2.36	12.47	1.73
2007	7412.62	8647	878	96.81	98.15	96.38	98.71	1.74	1.74	0.11	1.35
2008	6125.27	7125	878	79.73	80.79	79.42	81.11	0.08	0.06	19.15	1.06
2009	6870.24	8038	878	89.79	90.98	89.33	91.76	0.66	0.60	8.42	1.19
2010	7244.93	8660	878	94.48	95.47	94.20	98.86	4.48	4.48	0.04	1.00
2011	6256.80	7313	878	81.55	82.66	81.35	83.48	0.44	0.36	16.98	1.11
2012	7256.40	8468	878	94.31	95.50	94.09	96.40	4.44	4.44	0.06	1.19
2013	7454.01	8760	878	97.12	98.37	96.92	100.00	1.37	1.37	0.26	1.25
2014	5818.57	6848	878	75.86	76.51	75.65	78.17	2.22	1.74	21.75	0.65
2015	5480.95	6449	878	71.43	72.33	71.26	73.62	8.35	7.09	20.58	0.90
2016	7570.79	8784	878	98.62	99.69	98.16	100.00	0.25	0.25	0.07	1.07
2017	4638.42	6181	878	60.26	60.87	60.31	70.56	3.49	2.20	36.93	0.61
2018	7477.90	8606	878	97.02	97.92	97.23	98.24	0.69	1.43	0.64	0.90
2019	7619.17	8760	878	99.13	99.70	99.06	100.00	0.29	0.29	0.01	0.57
2020	7565.81	8784	878	98.22	99.08	98.10	100.00	0.81	0.81	0.11	0.85
2021	5603.75	6621	878	72.88	74.29	72.86	75.58	5.32	4.17	21.54	1.41
2022	943.49	1080	878	12.26	12.26	12.27	12.33	0.40	0.05	87.69	0.00
2023	0.00	0	878	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2024	586.14	865	878	7.59	7.60	7.60	9.85	29.15	3.13	89.27	0.01

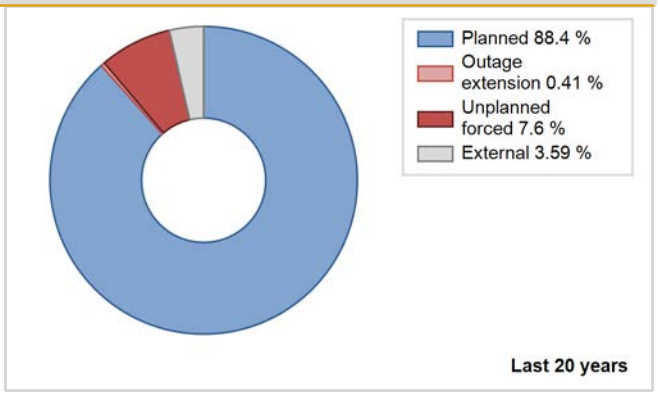
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1992 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		265			369	
C. Inspection, maintenance or repair combined with refuelling				58		
D. Inspection, maintenance or repair without refuelling				617		
F. Major backfitting, refurbishment or upgrading activities with refuelling	7654			782		
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					0	
Z. Other					1	
Subtotal	7654	265		1457	370	3
Total		**7919**			**1830**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1992 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		27
12. Reactor I&C Systems		31
13. Reactor Auxiliary Systems		3
14. Safety Systems		11
15. Reactor Cooling Systems		157
21. Fuel Handling and Storage Facilities		21
31. Turbine and auxiliaries		15
32. Feedwater and Main Steam System	265	9
34. Miscellaneous Systems		7
35. All other I&C Systems		19
41. Main Generator Systems		42
42. Electrical Power Supply Systems		10
Total	**265**	**352**

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Highlights (2024)

Darlington unit 1 was returned to service in November following Refurbishment. It experienced a forced brief outage in December.

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2024 Operating Experience

CA-23 DARLINGTON-2 CANADA



Status at end of year	:	**Operational**
Operator	:	OPG (Ontario Power Generation)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	BBC (BROWN BOVERI ET CIE)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 850
Thermal power	:	2776 MWth
Gross electrical power	:	934 MWe
Reference unit power (net)	:	878 MWe

Key Dates

Construction Date	:	1981-09-01
Grid Date	:	1990-01-15
Commercial Date	:	1990-10-09
Age at end of year	:	34 years

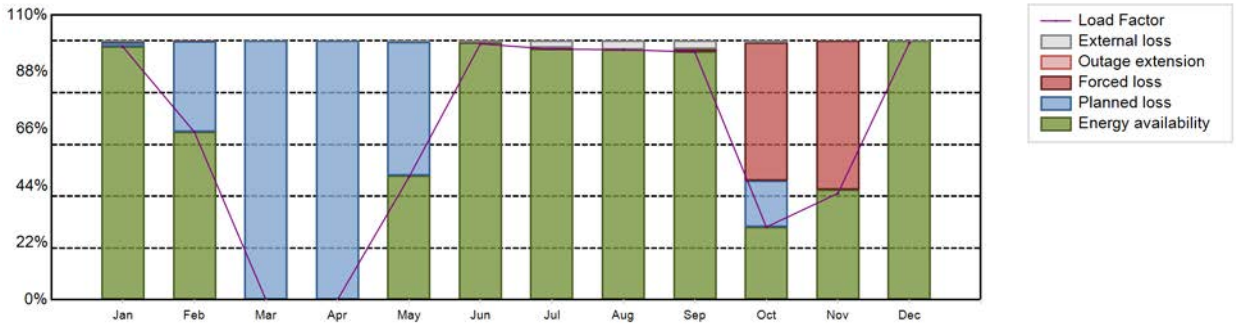
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	10
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	310
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	0.0965
Average fuel enrichment [% of U235]	:	0.72	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	NA	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8625	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	7.068	HP cylinder inlet steam pressure [MPa]	:	4.93
Active core height/length [m]	:	6.06	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24	Number of main condensate pumps	:	3
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4928.43 GW(e).h	Forced Loss Rate (FLR)	:	12.59 %
Energy Availability Factor (EAF)	:	64.23 %	Unplanned Capability Loss Factor (UCL)	:	9.39 %
Unit Capability Factor (UCF)	:	65.15 %	Planned Unavailability Factor (PUF)	:	25.47 %
Load Factor (LF)	:	63.9 %	Externally cause unavailability (XUF)	:	0.92 %
Operating Factor (OF)	:	65.9 %	Total off-line time	:	2995 hours

Annual Summary



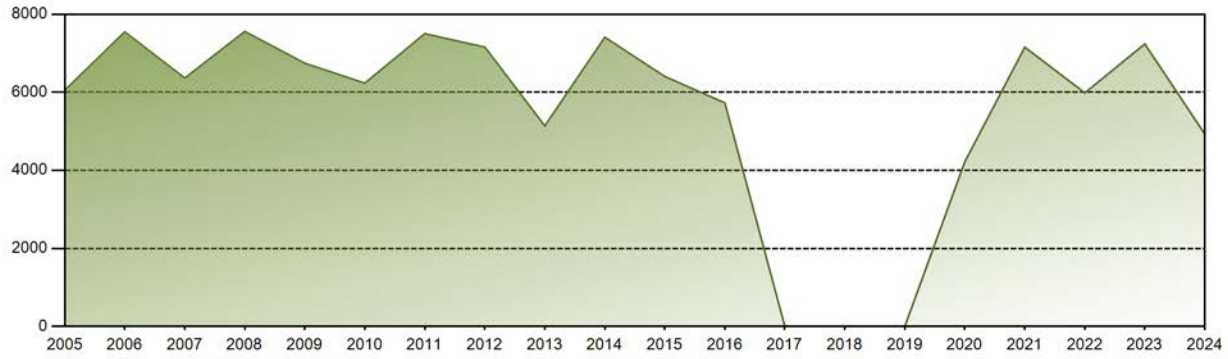
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	638.11	395.70	0.00	0.00	309.43	625.06	632.36	631.23	605.08	183.62	259.83	648.01	4928.43
EAF [%]	97.86	64.80	0.00	0.00	48.04	99.37	96.91	96.73	95.87	28.11	42.47	99.99	64.23
UCF [%]	98.28	64.80	0.00	0.00	48.49	99.94	99.47	100.00	98.89	28.77	42.47	99.99	65.15
LF [%]	97.68	64.75	0.00	0.00	47.37	98.88	96.81	96.63	95.72	28.11	41.10	99.20	63.90
OF [%]	100.00	65.37	0.00	0.00	50.00	100.00	100.00	100.00	100.00	29.03	45.83	100.00	65.90
FLR [%]	0.10	0.07	0.00	0.00	0.00	0.00	0.53	0.00	1.11	64.98	57.53	0.01	12.59
UCL [%]	0.10	0.04	0.00	0.00	0.00	0.00	0.53	0.00	1.11	53.39	57.53	0.01	9.39
PUF [%]	1.63	35.16	100.00	100.00	51.51	0.06	0.00	0.00	0.00	17.84	0.00	0.00	25.47
XUF [%]	0.42	0.00	0.00	0.00	0.45	0.56	2.56	3.27	3.02	0.67	0.00	0.00	0.92

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Historical Summary

Lifetime energy generation	:	190861.87 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	12 %
Cumulative Energy Availability Factor (EAF)	:	71.9 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	10.23 %
Cumulative Unit Capability Factor (UCF)	:	72.84 %	Cumulative Planned Unavailability Factor (PUF)	:	16.93 %
Cumulative Load Factor (LF)	:	71.7 %	Cumulative Externally cause unavailability (XUF)	:	0.94 %
Cumulative Operating Factor (OF)	:	75.29 %			

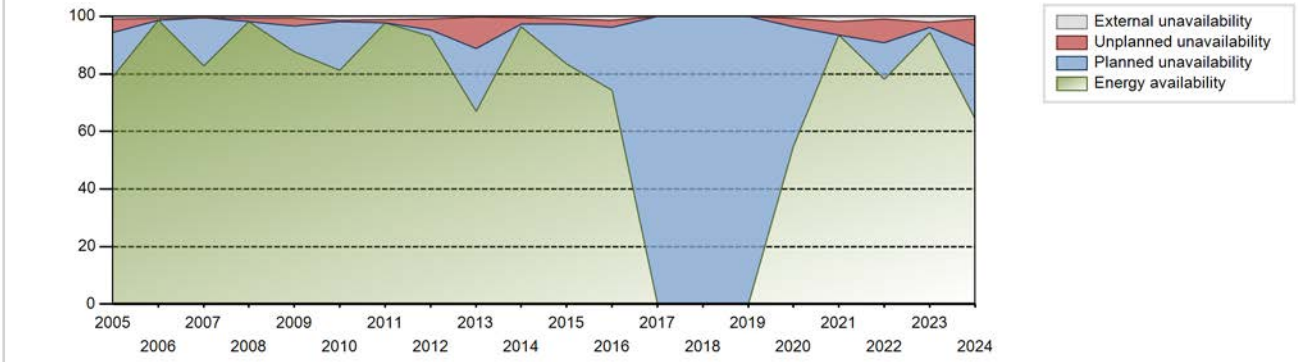
Electricity Production (net) [GWh]



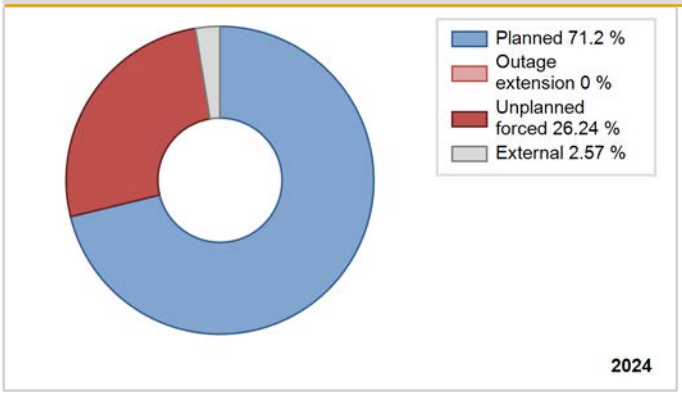
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1990	1153.47	1608	881	64.94	64.94	65.73	80.72	35.03	35.02	0.04	0.00
1991	51.48	102	881	0.67	0.67	0.67	1.16	99.33	99.33	0.00	0.00
1992	1290.16	2418	881	16.68	16.68	16.67	27.53	83.32	83.32	0.00	0.00
1993	6370.16	7594	881	82.74	83.28	82.54	86.69	8.13	7.37	9.34	0.54
1994	6750.76	8069	881	88.52	88.90	87.47	92.11	5.87	5.54	5.56	0.38
1995	6952.96	8104	881	90.65	91.30	90.09	92.51	5.07	4.88	3.82	0.65
1996	6705.75	7752	881	87.22	87.76	86.65	88.25	5.55	5.15	7.09	0.53
1997	4710.39	7069	881	61.53	61.73	61.03	80.70	29.89	26.32	11.95	0.20
1998	6227.93	7492	881	80.70	81.91	80.70	85.53	18.09	18.09	0.00	1.21
1999	6469.08	7824	881	83.82	85.13	83.82	89.32	5.12	4.60	10.27	1.31
2000	6885.42	8221	881	88.97	90.14	88.97	93.59	9.86	9.86	0.00	1.17
2001	5826.45	7030	881	75.50	76.30	75.50	80.25	6.64	5.43	18.27	0.81
2002	7268.93	8627	881	94.19	95.43	94.19	98.48	4.57	4.57	0.00	1.25
2003	6084.10	7245	881	79.29	81.59	78.83	82.71	5.71	4.94	13.47	2.30
2004	7038.38	8737	881	91.42	96.71	90.95	99.46	3.29	3.29	0.00	5.29
2005	6056.21	7031	878	78.93	79.75	78.67	80.26	0.98	4.72	15.53	0.82
2006	7548.39	8745	878	98.59	99.38	98.14	99.83	0.62	0.62	0.00	0.79
2007	6364.83	7327	878	82.85	83.37	82.75	83.64	0.01	0.01	16.62	0.52
2008	7560.94	8696	878	98.15	98.82	98.04	99.00	1.18	1.18	0.00	0.67
2009	6745.27	7769	878	87.67	88.37	87.70	88.69	2.03	2.71	8.91	0.70
2010	6234.30	7248	878	81.14	82.48	81.06	82.74	0.67	0.56	16.96	1.34
2011	7503.51	8719	878	97.74	98.90	97.56	99.53	1.06	1.06	0.04	1.16
2012	7157.95	8467	878	92.97	93.92	92.81	96.39	3.86	3.77	2.30	0.96
2013	5138.76	6131	878	66.97	67.33	66.81	69.99	7.39	10.77	21.91	0.36
2014	7412.53	8522	878	96.38	96.90	96.38	97.28	2.22	2.21	0.89	0.52
2015	6405.95	7428	878	83.41	84.28	83.29	84.79	2.05	1.77	13.95	0.87
2016	5728.84	6793	878	74.41	75.73	74.28	77.33	3.13	2.45	21.82	1.32
2017	0.00	0	878	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2018	0.00	0	878	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2019	0.00	0	878	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2020	4218.91	5144	878	54.74	55.41	54.70	58.56	5.06	2.95	41.64	0.67
2021	7158.02	8568	878	93.52	95.29	93.07	97.81	4.67	4.66	0.04	1.77
2022	5985.00	7018	878	78.08	79.06	77.82	80.11	9.49	8.29	12.65	0.98
2023	7240.39	8621	878	94.40	96.40	94.14	98.41	1.94	1.91	1.69	2.00
2024	4928.43	5789	878	64.23	65.15	63.90	65.90	12.59	9.39	25.47	0.92

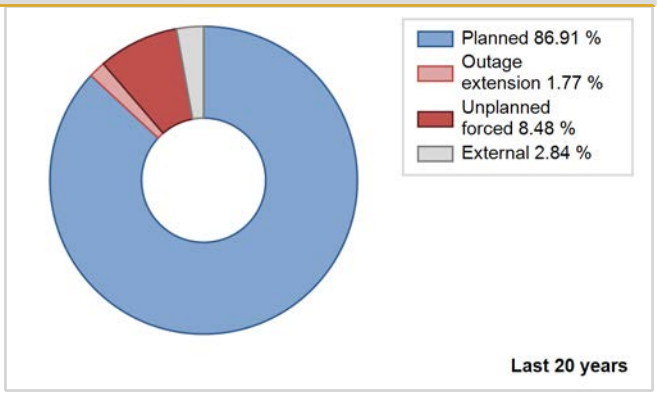
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1990 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		786			495	
D. Inspection, maintenance or repair without refuelling	2209			538	10	
E. Testing of plant systems or components				11		
G. Major backfitting, refurbishment or upgrading activities without refuelling				915		
J. Grid limitation, failure or grid unavailability						2
Z. Other					191	
Subtotal	2209	786		1464	696	2
Total	**2995**			**2162**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1990 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		32
12. Reactor I&C Systems		24
13. Reactor Auxiliary Systems		1
14. Safety Systems		7
15. Reactor Cooling Systems		280
16. Steam generation systems		36
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		20
31. Turbine and auxiliaries	786	45
32. Feedwater and Main Steam System		8
34. Miscellaneous Systems		5
35. All other I&C Systems		9
41. Main Generator Systems		6
42. Electrical Power Supply Systems		24
Total	**786**	**498**

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Highlights (2024)

Darlington Unit 2 experienced 1 unbudgeted and 2 forced outages in 2024.

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2024 Operating Experience

CA-24 DARLINGTON-3 CANADA

Status at end of year	:	**Operational**
Operator	:	OPG (Ontario Power Generation)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	BBC (BROWN BOVERI ET CIE)



Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 850
Thermal power	:	2776 MWth
Gross electrical power	:	934 MWe
Reference unit power (net)	:	878 MWe

Key Dates

Construction Date	:	1984-09-01
Grid Date	:	1992-12-07
Commercial Date	:	1993-02-14
Age at end of year	:	32 years

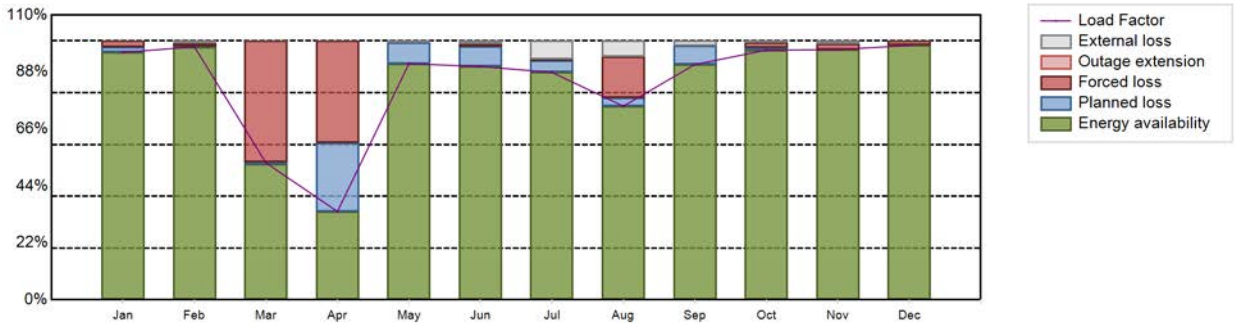
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	10
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	310
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	0.0965
Average fuel enrichment [% of U235]	:	0.72	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	NA	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8625	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	7.068	HP cylinder inlet steam pressure [MPa]	:	4.93
Active core height/length [m]	:	6.06	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24	Number of main condensate pumps	:	3
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6467.75 GW(e).h	Forced Loss Rate (FLR)	:	9.96 %
Energy Availability Factor (EAF)	:	83.84 %	Unplanned Capability Loss Factor (UCL)	:	9.46 %
Unit Capability Factor (UCF)	:	85.48 %	Planned Unavailability Factor (PUF)	:	5.06 %
Load Factor (LF)	:	83.86 %	Externally cause unavailability (XUF)	:	1.64 %
Operating Factor (OF)	:	89.69 %	Total off-line time	:	906 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	624.13	597.10	345.61	215.68	595.79	569.69	573.85	488.65	574.59	629.91	610.86	641.89	6467.75
EAF [%]	95.75	97.71	52.49	33.99	91.21	90.12	87.85	74.80	90.89	96.43	96.64	98.30	83.84
UCF [%]	95.75	98.61	52.49	33.99	91.91	91.25	94.86	81.01	92.74	96.96	97.84	98.30	85.48
LF [%]	95.55	97.71	52.91	34.12	91.21	90.12	87.85	74.80	90.89	96.43	96.63	98.26	83.86
OF [%]	100.00	100.00	53.09	37.36	100.00	100.00	100.00	85.75	100.00	100.00	100.00	100.00	89.69
FLR [%]	2.46	1.15	47.19	53.61	0.00	1.11	0.50	16.36	0.00	2.19	2.16	1.70	9.96
UCL [%]	2.41	1.15	46.91	39.28	0.00	1.03	0.47	15.84	0.00	2.18	2.16	1.70	9.46
PUF [%]	1.83	0.24	0.60	26.73	8.09	7.72	4.67	3.15	7.26	0.87	0.00	0.00	5.06
XUF [%]	0.00	0.90	0.00	0.00	0.71	1.13	7.01	6.20	1.85	0.53	1.20	0.00	1.64

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Historical Summary

Lifetime energy generation	:	193166.78 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.07 %
Cumulative Energy Availability Factor (EAF)	:	78.66 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.59 %
Cumulative Unit Capability Factor (UCF)	:	79.45 %	Cumulative Planned Unavailability Factor (PUF)	:	15.96 %
Cumulative Load Factor (LF)	:	78.4 %	Cumulative Externally cause unavailability (XUF)	:	0.8 %
Cumulative Operating Factor (OF)	:	81.26 %			

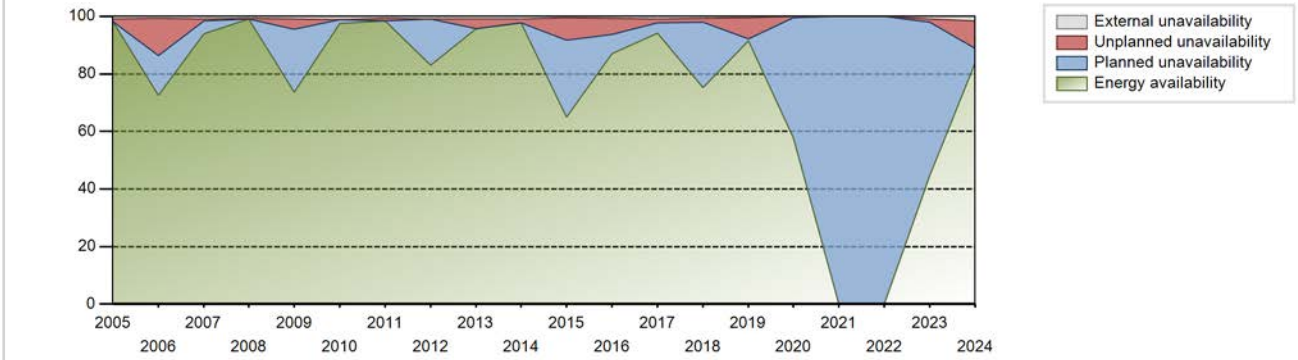
Electricity Production (net) [GWh]



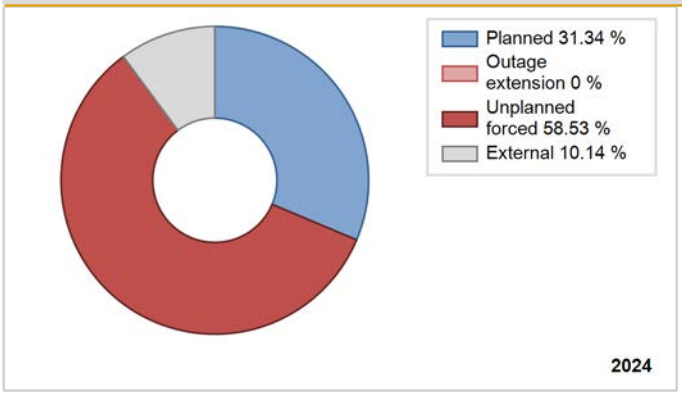
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1993	6003.39	7141	881	89.24	89.81	85.01	89.08	10.05	10.04	0.15	0.57
1994	6528.54	7642	881	85.26	85.64	84.59	87.24	2.11	1.85	12.51	0.38
1995	7061.53	8219	881	92.22	92.93	91.50	93.82	3.05	2.92	4.15	0.71
1996	7391.57	8574	881	96.66	97.34	95.51	97.61	2.65	2.65	0.01	0.68
1997	4010.78	6314	881	52.10	52.35	51.97	72.08	40.36	35.42	12.22	0.25
1998	7244.91	8593	881	93.88	94.68	93.88	98.09	4.05	4.00	1.32	0.80
1999	5629.08	6929	881	72.94	75.09	72.94	79.10	6.57	5.28	19.63	2.15
2000	6517.02	7822	881	84.22	85.10	84.21	89.05	8.27	7.67	7.23	0.88
2001	6577.97	7901	881	85.23	86.30	85.23	90.19	8.87	8.40	5.30	1.07
2002	6371.77	7595	881	82.58	83.68	82.56	86.70	4.81	4.23	12.09	1.10
2003	6827.19	8004	881	88.62	89.45	88.46	91.37	2.21	2.02	8.53	0.83
2004	6601.58	7649	881	85.59	86.88	85.31	87.08	5.14	4.71	8.41	1.29
2005	7562.05	8760	878	98.26	99.08	98.24	100.00	0.89	0.89	0.02	0.83
2006	5573.10	6452	878	72.50	73.12	72.46	73.65	8.54	13.05	13.84	0.62
2007	7221.13	8311	878	93.90	94.75	93.89	94.87	0.02	0.75	4.49	0.85
2008	7654.59	8784	878	99.15	99.93	99.25	100.00	0.04	0.04	0.03	0.78
2009	5657.16	6590	878	73.60	74.47	73.55	75.23	2.00	3.62	21.91	0.87
2010	7500.90	8643	878	97.47	98.51	97.52	98.66	0.06	0.06	1.43	1.04
2011	7558.56	8707	878	98.37	99.17	98.27	99.39	0.78	0.78	0.04	0.81
2012	6377.61	7419	878	83.03	83.97	82.69	84.46	0.06	0.05	15.98	0.94
2013	7334.60	8470	878	95.63	96.61	95.36	96.69	3.35	3.35	0.04	0.98
2014	7501.60	8708	878	97.75	98.75	97.53	99.41	1.23	1.23	0.02	1.00
2015	4992.10	5787	878	65.00	65.52	64.91	66.06	8.58	7.75	26.73	0.52
2016	6716.91	7832	878	86.99	87.63	87.09	89.16	5.93	5.53	6.84	0.64
2017	7219.88	8442	878	94.27	95.20	93.87	96.37	1.42	1.37	3.43	0.93
2018	5781.75	6718	878	75.15	75.94	75.17	76.69	1.62	1.25	22.81	0.79
2019	7026.63	8178	878	91.58	91.98	91.36	93.36	7.52	7.48	0.54	0.40
2020	4483.41	5087	878	57.75	57.88	58.13	57.91	0.04	0.37	41.75	0.13
2021	0.00	0	878	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2022	0.00	0	878	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2023	3440.41	4177	878	44.74	45.74	44.73	47.68	2.01	0.94	53.32	1.00
2024	6467.75	7878	878	83.84	85.48	83.86	89.69	9.96	9.46	5.06	1.64

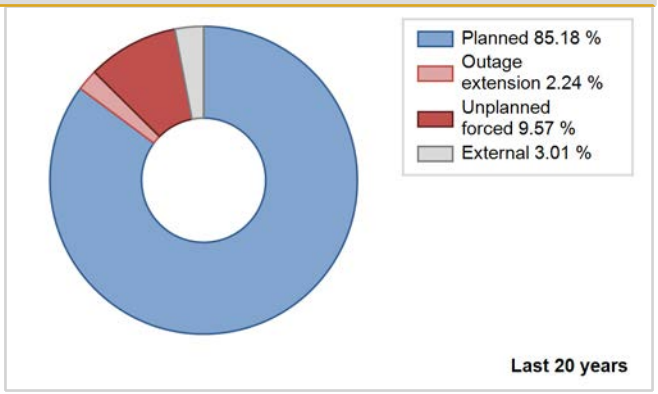
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1993 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		736			254	
C. Inspection, maintenance or repair combined with refuelling				62		
D. Inspection, maintenance or repair without refuelling	170			528		
E. Testing of plant systems or components					5	
F. Major backfitting, refurbishment or upgrading activities with refuelling				690		
G. Major backfitting, refurbishment or upgrading activities without refuelling				90		
L. Human factor related					3	
Subtotal	170	736		1370	262	
Total	**906**			**1632**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1993 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		20
12. Reactor I&C Systems		24
13. Reactor Auxiliary Systems		30
14. Safety Systems		2
15. Reactor Cooling Systems		38
16. Steam generation systems	630	32
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		17
31. Turbine and auxiliaries		50
32. Feedwater and Main Steam System		13
33. Circulating Water System	106	3
34. Miscellaneous Systems		8
35. All other I&C Systems		17
42. Electrical Power Supply Systems		7
Total	**736**	**262**

Highlights (2024)

Darlington unit 3 experienced a forced outage in 2024.

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2024 Operating Experience

CA-25 DARLINGTON-4 CANADA



Status at end of year	:	**Operational**
Operator	:	OPG (Ontario Power Generation)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	BBC (BROWN BOVERI ET CIE)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 850
Thermal power	:	2776 MWth
Gross electrical power	:	934 MWe
Reference unit power (net)	:	878 MWe

Key Dates

Construction Date	:	1985-07-01
Grid Date	:	1993-04-17
Commercial Date	:	1993-06-14
Age at end of year	:	31 years

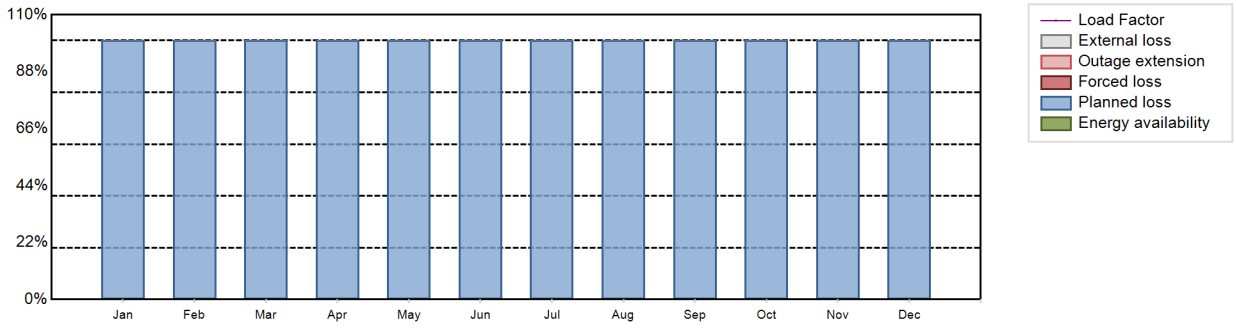
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	10
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	310
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	0.0965
Average fuel enrichment [% of U235]	:	0.72	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	NA	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8625	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	7.068	HP cylinder inlet steam pressure [MPa]	:	4.93
Active core height/length [m]	:	6.06	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	6240	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	24	Number of main condensate pumps	:	3
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	NA
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0 %	Planned Unavailability Factor (PUF)	:	100 %
Load Factor (LF)	:	0 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0 %	Total off-line time	:	8784 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EAF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	200285.66 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.8 %
Cumulative Energy Availability Factor (EAF)	:	82.07 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.54 %
Cumulative Unit Capability Factor (UCF)	:	82.73 %	Cumulative Planned Unavailability Factor (PUF)	:	12.72 %
Cumulative Load Factor (LF)	:	82 %	Cumulative Externally cause unavailability (XUF)	:	0.66 %
Cumulative Operating Factor (OF)	:	84.26 %			

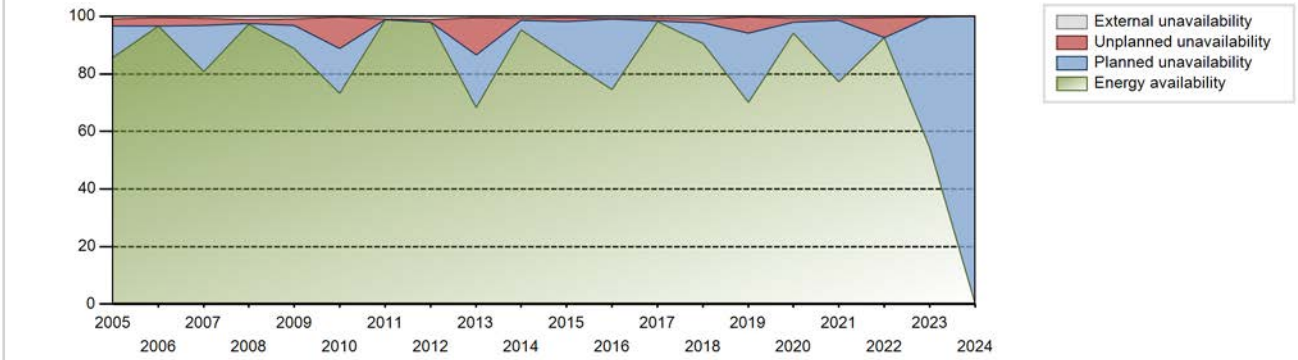
Electricity Production (net) [GWh]



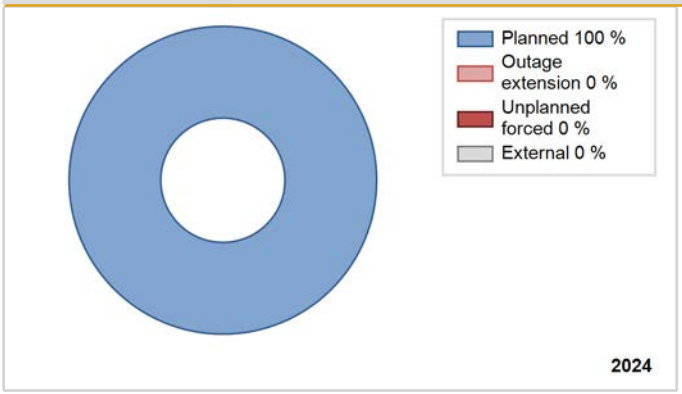
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1993	3528.78	4447	881	73.87	74.02	67.58	70.40	10.42	8.61	17.37	0.15
1994	7038.67	8143	881	91.85	92.19	91.20	92.96	3.36	3.21	4.60	0.35
1995	6750.56	7751	881	87.72	88.14	87.47	88.48	2.41	2.18	9.68	0.43
1996	6105.35	7023	881	79.14	79.37	78.89	79.95	12.79	11.65	8.98	0.23
1997	5069.64	7428	881	65.71	65.97	65.69	84.79	28.56	26.37	7.65	0.27
1998	6520.88	7699	881	84.49	85.32	84.49	87.89	11.60	11.20	3.48	0.83
1999	6216.13	7431	881	80.55	81.60	80.55	84.83	5.28	4.55	13.85	1.05
2000	6975.02	8219	881	90.13	90.78	90.13	93.57	9.22	9.22	0.00	0.65
2001	6836.35	8037	881	88.58	89.62	88.58	91.75	3.01	2.78	7.59	1.04
2002	7449.79	8760	881	96.53	97.33	96.53	100.00	2.67	2.67	0.00	0.80
2003	5428.86	6320	881	70.64	72.28	70.34	72.15	5.81	4.46	23.26	1.64
2004	7321.13	8451	881	94.60	95.25	94.60	96.21	4.75	4.75	0.00	0.65
2005	6569.70	7617	878	85.63	86.47	85.35	86.95	0.36	2.49	11.04	0.84
2006	7449.44	8541	878	96.54	97.08	96.86	97.50	2.92	2.92	0.00	0.54
2007	6210.23	7170	878	80.77	81.44	80.74	81.85	2.90	2.43	16.13	0.67
2008	7525.46	8652	878	97.35	98.39	97.58	98.50	1.48	1.48	0.13	1.05
2009	6836.15	7892	878	88.71	89.71	88.88	90.09	2.12	2.23	8.06	1.00
2010	5633.65	6612	878	73.26	73.62	73.25	75.48	8.67	10.81	15.57	0.36
2011	7617.80	8760	878	98.89	99.73	99.04	100.00	0.23	0.23	0.04	0.85
2012	7557.72	8725	878	97.88	98.99	97.99	99.33	0.87	0.87	0.14	1.11
2013	5237.45	6132	878	68.25	68.83	68.10	70.00	9.51	12.75	18.42	0.58
2014	7302.71	8476	878	95.24	95.97	94.95	96.76	0.65	0.63	3.40	0.73
2015	6532.11	7490	878	84.72	85.13	84.93	85.50	1.53	1.32	13.55	0.40
2016	5774.65	6678	878	74.66	75.46	74.88	76.02	0.23	0.18	24.36	0.80
2017	7593.09	8684	878	98.10	98.77	98.72	99.13	1.03	1.03	0.20	0.67
2018	6993.41	8105	878	90.71	91.56	90.93	92.52	1.42	1.32	7.12	0.85
2019	5423.69	6248	878	70.07	70.44	70.52	71.32	7.34	5.58	23.99	0.37
2020	7294.39	8784	878	94.26	94.87	94.58	100.00	1.46	1.41	3.72	0.61
2021	5970.37	6865	878	77.24	78.00	77.63	78.37	0.74	0.58	21.42	0.76
2022	7159.58	8207	878	92.53	93.02	93.09	93.69	6.98	6.98	0.00	0.49
2023	4163.79	4778	878	54.25	54.41	54.14	54.54	0.24	0.13	45.46	0.16
2024	0.00	0	878	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00

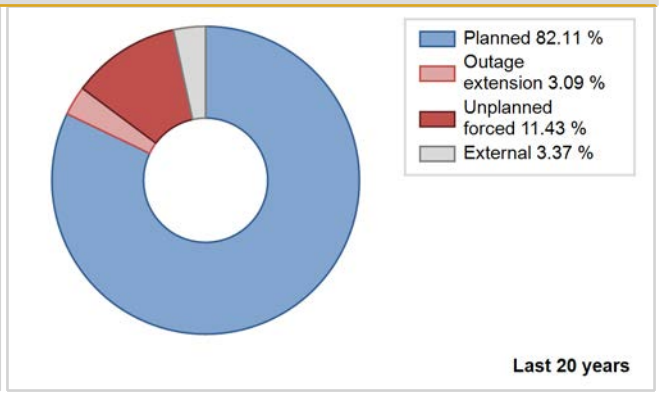
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1993 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					265	
C. Inspection, maintenance or repair combined with refuelling				83		
D. Inspection, maintenance or repair without refuelling				596		
E. Testing of plant systems or components				11	2	
F. Major backfitting, refurbishment or upgrading activities with refuelling	8784			404		
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z. Other					9	
Subtotal	8784			1094	277	4
Total	**8784**			**1375**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1993 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		36
13. Reactor Auxiliary Systems		6
14. Safety Systems		11
15. Reactor Cooling Systems		88
16. Steam generation systems		3
21. Fuel Handling and Storage Facilities		14
31. Turbine and auxiliaries		40
32. Feedwater and Main Steam System		7
33. Circulating Water System		5
34. Miscellaneous Systems		18
35. All other I&C Systems		2
41. Main Generator Systems		17
42. Electrical Power Supply Systems		28
Total		**279**

Highlights (2024)

Darlington unit 4 continued its Refurbishment in 2024.

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2024 Operating Experience

CA-4 PICKERING-1 CANADA



Status at end of year	:	**Permanent Shutdown**
Operator	:	OPG (Ontario Power Generation)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 500A
Thermal power	:	1744 MWth
Gross electrical power	:	542 MWe
Reference unit power (net)	:	515 MWe

Key Dates

Construction Date	:	1966-06-01
Grid Date	:	1971-04-04
Commercial Date	:	1971-07-29
Age at end of year	:	53 years

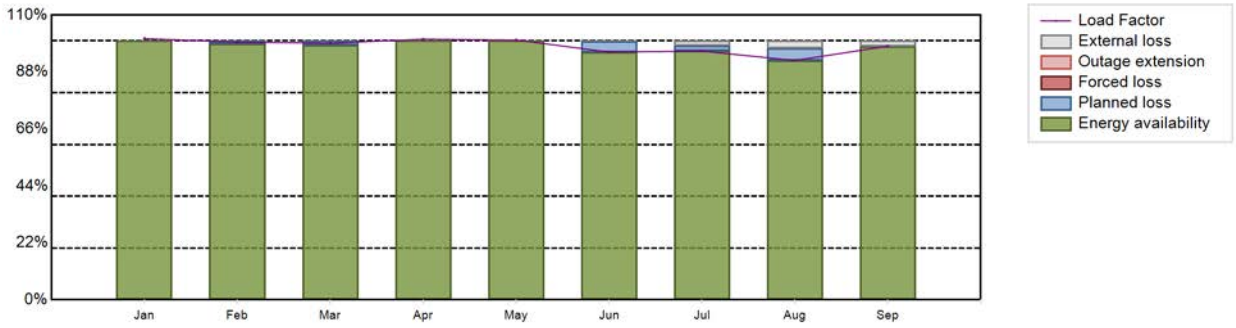
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	293
Fuel material	:	UO2	Number of SG	:	12
Refuelling type	:	ON-line	Containment type	:	-
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.46
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	9080	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.94	HP cylinder inlet steam pressure [MPa]	:	3.8
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	4680	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	26.6	Number of main condensate pumps	:	-
Number of control rod assemblies	:	6	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	3333.23 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	97.73 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	98.51 %	Planned Unavailability Factor (PUF)	:	1.49 %
Load Factor (LF)	:	98.07 %	Externally cause unavailability (XUF)	:	0.78 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



	Dec	Oct	Nov	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
GW(e)-h				386.51	356.72	379.84	373.26	384.41	354.92	367.99	354.24	363.22	3321.12
EAF [%]				100.00	98.93	98.45	100.00	100.00	95.70	96.20	92.46	97.94	97.73
UCF [%]				100.00	98.93	98.45	100.00	100.00	95.84	98.18	95.24	100.00	98.51
LF [%]				100.87	99.52	99.13	100.66	100.33	95.72	96.04	92.45	97.96	98.07
OF [%]				100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]				0.00	1.07	1.55	0.00	0.00	4.16	1.82	4.76	0.00	1.49
XUF [%]				0.00	0.00	0.00	0.00	0.00	0.15	1.98	2.78	2.06	0.78

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Historical Summary

Lifetime energy generation	:	138240.57 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	22.27 %
Cumulative Energy Availability Factor (EAF)	:	68.98 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	20.82 %
Cumulative Unit Capability Factor (UCF)	:	69.24 %	Cumulative Planned Unavailability Factor (PUF)	:	9.94 %
Cumulative Load Factor (LF)	:	67.1 %	Cumulative Externally cause unavailability (XUF)	:	0.26 %
Cumulative Operating Factor (OF)	:	70.44 %			

Electricity Production (net) [GWh]

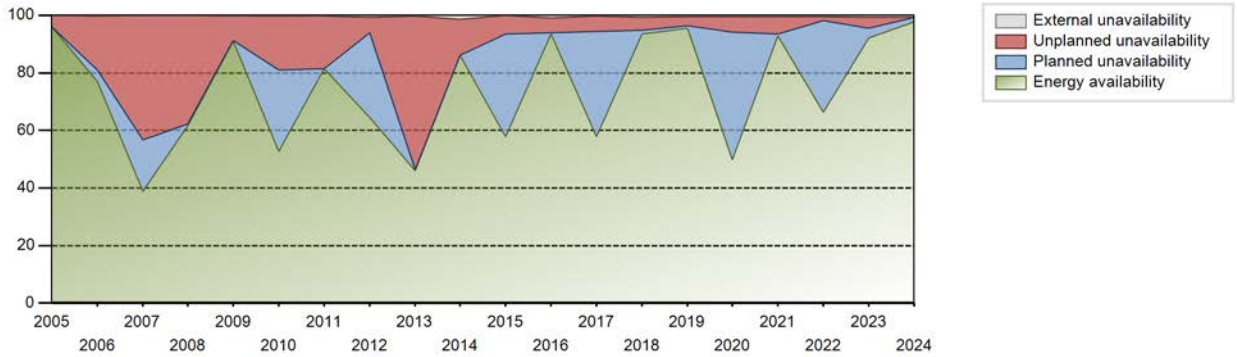


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1971	2302.30	4829	514	100.00	100.00	80.43	78.16	0.00	0.00	0.00	0.00
1972	2207.90	4117	514	100.00	100.00	48.90	46.87	0.00	0.00	0.00	0.00
1973	4222.40	8523	514	93.98	93.98	92.26	95.72	5.19	5.15	0.88	0.00
1974	3232.00	6979	514	71.92	71.92	71.98	79.89	20.17	18.17	9.91	0.00
1975	3592.80	7234	512	80.17	80.17	80.32	82.81	11.74	10.66	9.17	0.00
1976	4169.70	8136	514	92.73	92.73	92.61	92.88	2.07	1.96	5.31	0.00
1977	3852.80	7545	514	85.79	85.79	85.80	86.37	6.14	5.61	8.59	0.00
1978	4273.70	8359	515	95.09	95.09	94.99	95.68	4.91	4.91	0.00	0.00
1979	3781.40	7554	515	85.29	85.29	82.91	85.30	14.71	14.71	0.00	0.00
1980	3356.90	6640	515	73.68	73.68	74.21	75.59	14.10	12.09	14.23	0.00
1981	3947.70	7795	515	88.05	88.05	87.50	88.98	5.07	4.70	7.25	0.00
1982	3499.30	6915	515	77.80	77.80	77.57	78.94	10.00	8.65	13.55	0.00
1983	3070.80	6101	515	68.11	68.11	68.07	69.65	27.81	26.23	5.66	0.00
1984	0.00	0	515	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1985	0.00	0	515	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1986	0.00	0	515	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1987	832.79	1981	515	17.35	19.69	18.46	22.61	78.69	72.71	7.60	2.33
1988	3986.48	8224	515	89.12	89.16	88.12	93.62	10.81	10.81	0.04	0.03
1989	3222.13	6943	515	72.62	72.72	71.42	79.26	20.54	18.80	8.48	0.11
1990	3041.75	7435	515	70.56	70.86	67.42	84.87	22.19	20.21	8.93	0.30
1991	3051.08	6525	515	67.83	67.84	67.63	74.49	18.36	15.26	16.90	0.01
1992	2919.96	5798	515	65.43	65.43	64.55	66.01	22.58	19.09	15.48	0.00
1993	3451.16	6908	515	78.39	78.43	76.50	78.86	8.82	7.59	13.98	0.04
1994	897.64	1835	515	20.12	20.12	19.90	20.95	54.24	23.84	56.04	0.00
1995	2013.23	4234	515	44.85	45.71	44.63	48.33	49.07	44.04	10.25	0.86
1996	3011.76	6202	515	66.83	66.83	66.58	70.61	31.66	30.96	2.22	0.00
1997	3950.80	8205	515	89.68	89.68	88.54	94.70	10.32	10.32	0.00	0.00
1998	Data not available - Suspended Operation										
1999	"										
2000	"										
2001	"										
2002	"										
2003	"										
2004	"										
2005	584.96	1230	515	95.88	95.88	51.42	55.68	4.12	4.12	0.00	0.00
2006	3470.49	7260	515	77.02	77.22	76.93	82.88	19.42	18.85	3.92	0.21
2007	1750.26	3447	515	38.91	38.94	38.80	39.35	50.80	43.22	17.84	0.04

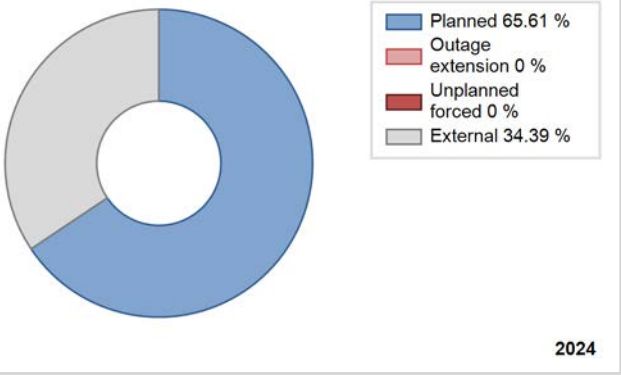
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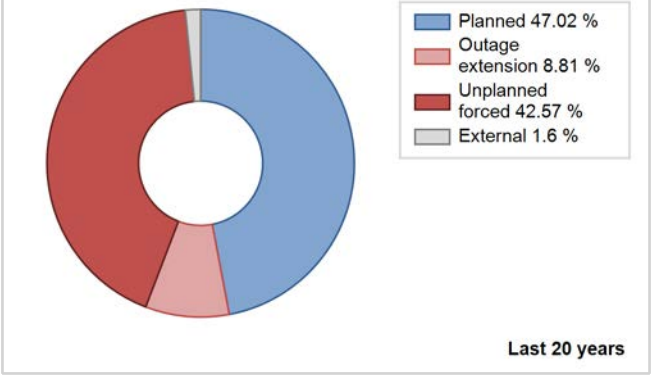
2008	2792.10	6221	515	61.72	61.78	61.72	70.82	37.71	37.70	0.52	0.06
2009	4108.77	8436	515	91.15	91.45	91.08	96.30	8.50	8.50	0.05	0.30
2010	2376.13	4983	515	52.73	52.90	52.67	56.88	22.60	18.82	28.28	0.17
2011	3669.17	7382	515	81.49	81.79	81.33	84.27	18.21	18.21	0.00	0.30
2012	2912.37	5799	515	64.48	65.11	64.38	66.02	4.03	5.44	29.45	0.64
2013	2074.98	4344	515	45.99	46.20	45.99	49.59	33.45	53.27	0.53	0.21
2014	3871.29	7855	515	86.08	87.40	85.81	89.67	12.55	12.55	0.05	1.32
2015	2599.85	5263	515	57.80	57.92	57.63	60.08	2.63	6.31	35.77	0.12
2016	4212.67	8784	515	93.41	94.28	93.12	100.00	5.25	5.22	0.50	0.87
2017	2608.49	5323	515	57.91	58.07	57.82	60.76	8.48	5.38	36.56	0.16
2018	4206.18	8503	515	93.41	94.09	93.23	97.07	4.63	4.57	1.34	0.68
2019	4299.59	8583	515	95.53	95.91	95.30	97.98	3.30	3.27	0.82	0.38
2020	2244.06	4660	515	49.73	50.11	49.61	53.05	9.73	5.40	44.49	0.38
2021	4183.00	8407	515	92.81	93.35	92.72	95.97	6.01	5.97	0.68	0.54
2022	2986.96	6046	515	66.29	66.78	66.21	69.02	2.09	1.42	31.79	0.50
2023	4165.01	8338	515	92.26	92.87	92.32	95.18	4.04	3.91	3.23	0.61
2024	3333.23	6599	515	97.73	98.51	98.07	100.00	0.00	0.00	1.49	0.78

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1971 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					1532	
D. Inspection, maintenance or repair without refuelling				870		
E. Testing of plant systems or components				5	5	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					51	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
P. Fire					31	
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						66
Z. Other					10	
Subtotal				875	1629	69
Total		**0**			**2573**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1971 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		793
12. Reactor I&C Systems		72
13. Reactor Auxiliary Systems		56
14. Safety Systems		54
15. Reactor Cooling Systems		128
16. Steam generation systems		55
21. Fuel Handling and Storage Facilities		70
31. Turbine and auxiliaries		116
32. Feedwater and Main Steam System		46
33. Circulating Water System		2
34. Miscellaneous Systems		10
35. All other I&C Systems		6
41. Main Generator Systems		46
42. Electrical Power Supply Systems		106
Total		**1560**

Highlights (2024)

Pickering unit 1 reached its' end of commercial operation in October 1, 2024.

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2024 Operating Experience

CA-7 PICKERING-4 CANADA



Status at end of year	:	**Permanent Shutdown**
Operator	:	OPG (Ontario Power Generation)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 500A
Thermal power	:	1744 MWth
Gross electrical power	:	542 MWe
Reference unit power (net)	:	515 MWe

Key Dates

Construction Date	:	1968-05-01
Grid Date	:	1973-05-21
Commercial Date	:	1973-06-17
Age at end of year	:	51 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	9080
Active core diameter [m]	:	5.94
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	4560
Fuel linear heat generation rate [kW/m]	:	26.6
Number of control rod assemblies	:	6
Number of external reactor coolant loops	:	2
Coolant type	:	D2O

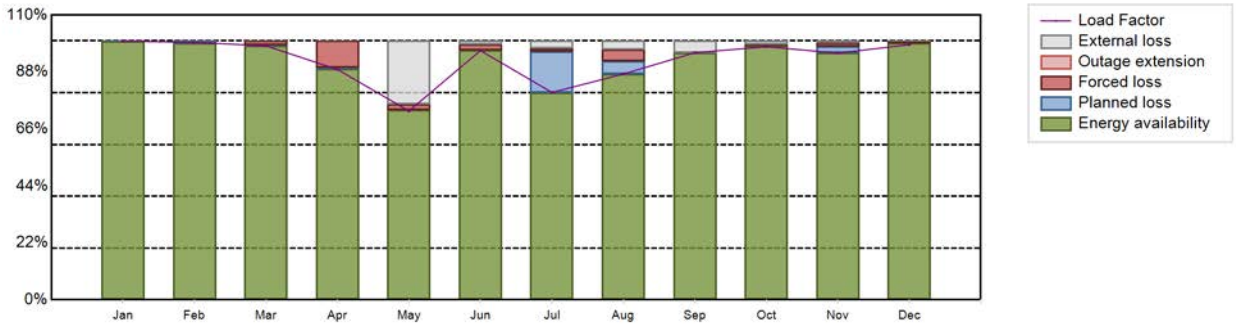
Operating coolant pressure [MPa]	:	9
Reactor outlet temperature [°C]	:	293
Number of SG	:	12
Containment type	:	-
Containment design pressure [MPa]	:	1.46
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	3.8
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4175.79 GW(e).h
Energy Availability Factor (EAF)	:	92.55 %
Unit Capability Factor (UCF)	:	95.79 %
Load Factor (LF)	:	92.43 %
Operating Factor (OF)	:	98.29 %

Forced Loss Rate (FLR)	:	2.16 %
Unplanned Capability Loss Factor (UCL)	:	2.11 %
Planned Unavailability Factor (PUF)	:	2.1 %
Externally cause unavailability (XUF)	:	3.24 %
Total off-line time	:	150 hours

Annual Summary



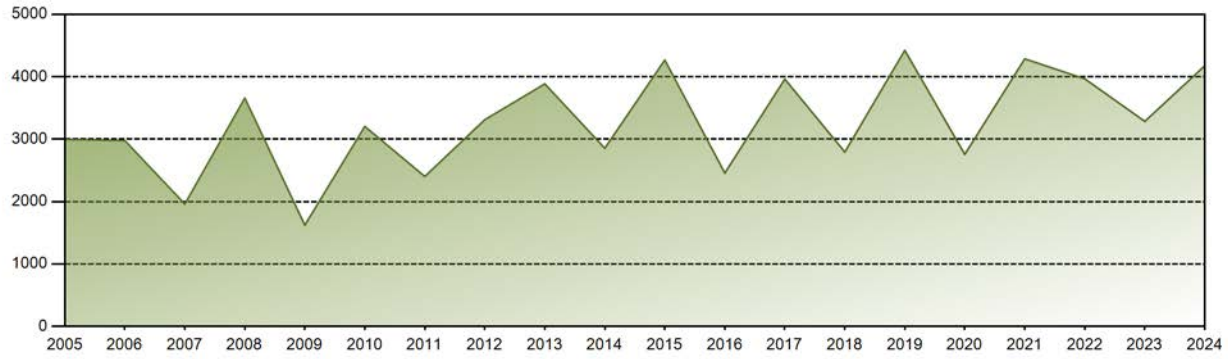
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	382.79	356.48	375.85	329.94	279.51	356.99	306.94	334.15	353.91	374.53	353.28	371.43	4175.79
EAF [%]	99.83	99.23	98.17	89.17	73.26	96.44	80.11	87.21	95.44	98.14	95.27	99.01	92.55
UCF [%]	99.83	99.23	98.17	89.17	97.78	97.70	82.89	90.55	100.00	99.51	95.86	99.04	95.79
LF [%]	99.90	99.45	98.09	88.98	72.95	96.27	80.11	87.21	95.44	97.75	95.27	98.53	92.43
OF [%]	100.00	100.00	100.00	100.00	79.84	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.29
FLR [%]	0.00	0.00	1.55	10.35	2.22	2.30	1.69	4.85	0.00	0.49	1.56	0.96	2.16
UCL [%]	0.00	0.00	1.55	10.30	2.22	2.30	1.42	4.61	0.00	0.49	1.52	0.96	2.11
PUF [%]	0.17	0.77	0.29	0.53	0.00	0.00	15.69	4.84	0.00	0.00	2.62	0.00	2.10
XUF [%]	0.00	0.00	0.00	0.00	24.51	1.26	2.78	3.34	4.56	1.37	0.58	0.04	3.24

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Historical Summary

Lifetime energy generation	:	143259.56 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	16.3 %
Cumulative Energy Availability Factor (EAF)	:	69.23 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	14.78 %
Cumulative Unit Capability Factor (UCF)	:	69.71 %	Cumulative Planned Unavailability Factor (PUF)	:	15.5 %
Cumulative Load Factor (LF)	:	69.1 %	Cumulative Externally cause unavailability (XUF)	:	0.48 %
Cumulative Operating Factor (OF)	:	72.28 %			

Electricity Production (net) [GWh]

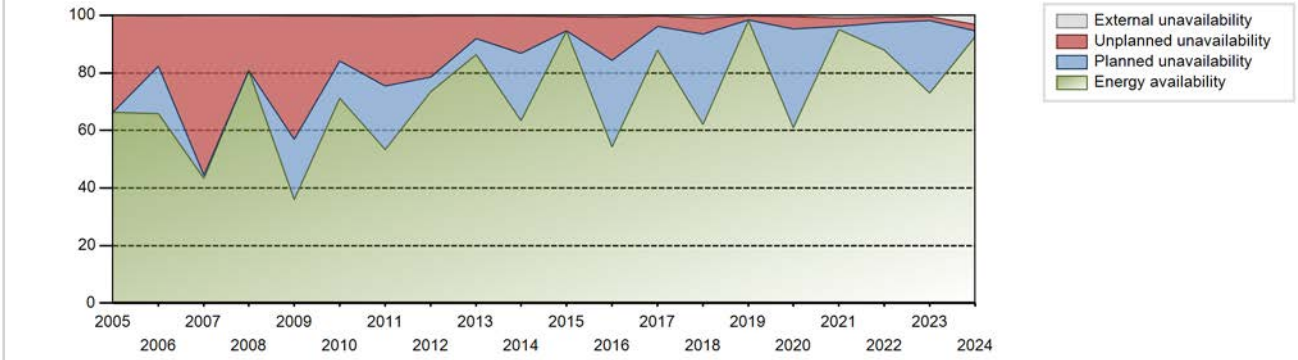


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1973	2226.60	4402	514	90.59	90.59	90.40	91.75	6.12	5.91	3.50	0.00
1974	4221.00	8356	514	94.00	94.00	94.00	95.65	5.22	5.18	0.82	0.00
1975	1094.20	2201	513	24.24	24.24	24.42	25.19	73.53	67.34	8.42	0.00
1976	3089.00	6063	514	68.23	68.23	68.60	69.21	31.44	31.29	0.49	0.00
1977	4107.20	7975	514	90.30	90.30	91.47	91.29	4.38	4.13	5.57	0.00
1978	4033.90	7876	515	89.70	89.70	89.66	90.16	3.07	2.84	7.46	0.00
1979	4102.20	8059	515	91.00	91.00	89.94	91.00	4.67	4.45	4.55	0.00
1980	3700.50	7321	515	81.76	81.76	81.80	83.34	8.38	7.48	10.77	0.00
1981	4142.00	8078	515	91.65	91.65	91.81	92.21	3.83	3.65	4.70	0.00
1982	4137.90	8087	515	91.76	91.76	91.72	92.32	2.61	2.46	5.78	0.00
1983	4170.20	8183	515	92.32	92.32	92.44	93.41	5.55	5.43	2.25	0.00
1984	3733.30	7425	515	82.75	82.75	82.53	84.53	4.49	3.89	13.36	0.00
1985	3438.86	6824	515	77.47	83.50	76.23	77.90	16.50	16.50	0.00	6.03
1986	3687.37	7410	515	83.16	83.16	81.73	84.59	7.06	6.32	10.52	0.00
1987	3770.41	7495	515	83.96	84.33	83.58	85.56	2.74	2.37	13.29	0.37
1988	3166.17	6525	515	70.11	70.11	69.99	74.28	17.91	15.29	14.60	0.00
1989	2255.49	5468	515	50.00	50.00	50.00	62.42	34.52	26.35	23.65	0.00
1990	1070.83	2851	515	23.74	23.74	23.74	32.55	43.49	18.27	58.00	0.00
1991	2130.76	5185	515	47.34	47.34	47.23	59.19	21.40	12.89	39.77	0.00
1992	0.00	0	515	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1993	3309.63	6711	515	73.76	74.21	73.36	76.61	7.77	6.25	19.55	0.45
1994	4009.64	7915	515	89.51	89.71	88.88	90.35	10.20	10.19	0.09	0.21
1995	2806.96	5684	515	63.33	63.84	62.22	64.89	36.16	36.16	0.00	0.50
1996	1134.91	2230	515	25.13	25.13	25.09	25.39	72.71	66.95	7.92	0.00
1997	0.00	0	515	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1998	Data not provided										
1999	Data not available - Suspended Operation										
2000	"										
2001	"										
2002	"										
2003	844.81	1880	515	72.27	72.27	72.27	82.70	27.73	27.73	0.00	0.00
2004	3266.76	6739	515	72.10	75.58	72.21	76.72	19.76	18.61	5.81	3.48
2005	2996.45	5900	515	66.40	66.52	66.42	67.35	33.48	33.48	0.00	0.13
2006	2976.54	6149	515	65.96	66.30	65.98	70.19	15.05	17.26	16.44	0.34
2007	1959.14	4086	515	43.44	43.44	43.43	46.64	49.23	55.59	0.96	0.00
2008	3656.45	7765	515	80.83	80.91	80.83	88.40	19.04	19.03	0.07	0.08
2009	1620.17	3845	515	35.91	36.15	35.91	43.89	48.47	42.90	20.95	0.24

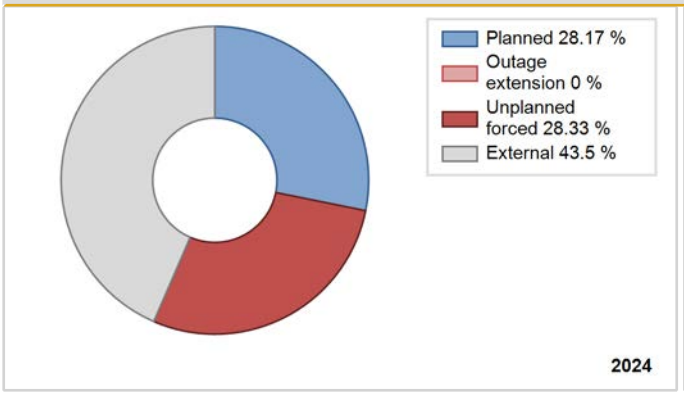
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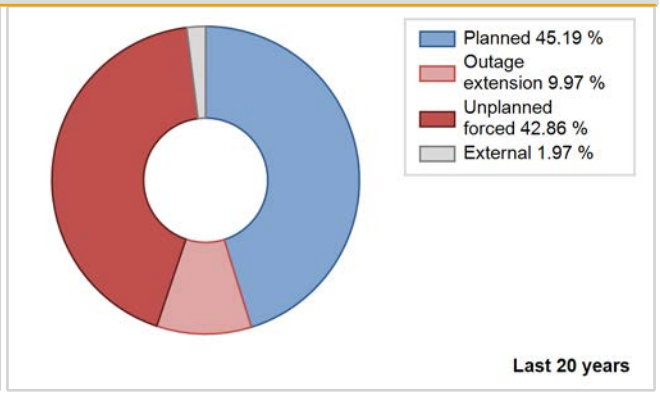
2010	3203.51	6583	515	71.13	71.37	71.01	75.15	17.89	15.55	13.08	0.24
2011	2401.12	4919	515	53.28	53.66	53.22	56.15	29.34	24.15	22.18	0.38
2012	3310.83	6592	515	73.42	73.73	73.19	75.05	20.62	21.17	5.10	0.31
2013	3884.54	7798	515	86.29	86.60	86.10	89.02	7.00	7.76	5.64	0.31
2014	2853.53	5772	515	63.30	63.49	63.25	65.89	5.37	13.00	23.51	0.19
2015	4266.31	8604	515	94.66	95.12	94.57	98.22	4.87	4.87	0.01	0.47
2016	2455.22	5169	515	54.32	54.91	54.27	58.85	10.39	15.07	30.01	0.60
2017	3961.10	7978	515	87.94	88.20	87.80	91.07	3.91	3.59	8.20	0.27
2018	2792.32	5901	515	62.06	62.92	61.89	67.36	8.24	5.65	31.43	0.87
2019	4421.44	8760	515	98.17	98.52	98.01	100.00	1.21	1.20	0.27	0.36
2020	2755.54	5555	515	60.92	61.42	60.91	63.24	1.20	4.29	34.29	0.50
2021	4286.99	8684	515	95.08	96.11	95.03	99.13	2.91	2.88	1.01	1.03
2022	3965.81	8020	515	87.88	88.68	87.91	91.55	1.90	1.71	9.61	0.80
2023	3284.29	6644	515	72.89	73.46	72.80	75.84	0.93	1.24	25.30	0.57
2024	4175.79	8622	515	92.55	95.79	92.43	98.29	2.16	2.11	2.10	3.24

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1973 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					1055	
C. Inspection, maintenance or repair combined with refuelling				58		
D. Inspection, maintenance or repair without refuelling				1239		
E. Testing of plant systems or components				49		
J. Grid limitation, failure or grid unavailability						4
L. Human factor related					3	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			150			3
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						11
Z. Other					6	
Subtotal			150	1346	1064	18
Total		**150**			**2428**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1973 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		52
12. Reactor I&C Systems		123
13. Reactor Auxiliary Systems		138
14. Safety Systems		15
15. Reactor Cooling Systems		393
16. Steam generation systems		36
21. Fuel Handling and Storage Facilities		10
31. Turbine and auxiliaries		101
32. Feedwater and Main Steam System		25
34. Miscellaneous Systems		15
35. All other I&C Systems		4
41. Main Generator Systems		41
42. Electrical Power Supply Systems	150	100
Total	**150**	**1053**

Highlights (2024)

Pickering Unit 4 experienced an unbudgeted planned outage and a forced outage in 2024. Unit has reached its's end of commercial operation on December 31, 2024.

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2024 Operating Experience

CA-13 PICKERING-5 CANADA



Status at end of year	:	**Operational**
Operator	:	OPG (Ontario Power Generation)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 500B
Thermal power	:	1744 MWth
Gross electrical power	:	540 MWe
Reference unit power (net)	:	516 MWe

Key Dates

Construction Date	:	1974-11-01
Grid Date	:	1982-12-19
Commercial Date	:	1983-05-10
Age at end of year	:	42 years

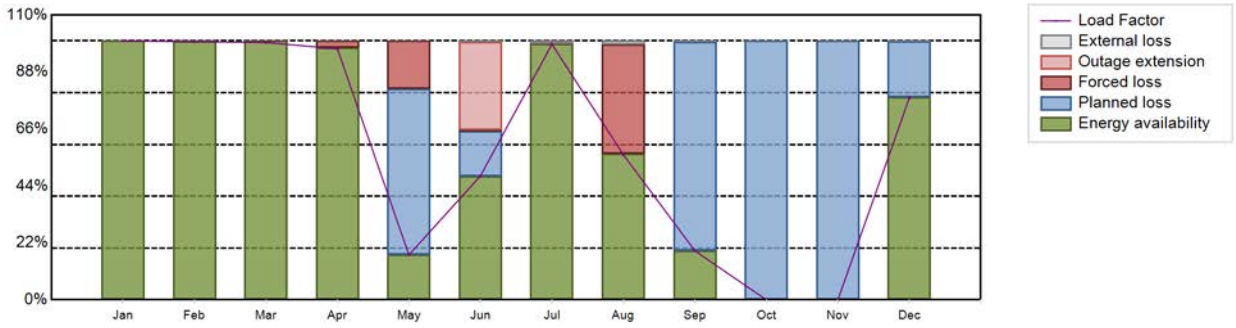
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	293.4
Fuel material	:	UO2	Number of SG	:	12
Refuelling type	:	ON-line	Containment type	:	-
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.46
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8330	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.94	HP cylinder inlet steam pressure [MPa]	:	3.8
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	4560	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	27.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	21	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	2691.94 GW(e).h	Forced Loss Rate (FLR)	:	8.28 %
Energy Availability Factor (EAF)	:	59.56 %	Unplanned Capability Loss Factor (UCL)	:	8.18 %
Unit Capability Factor (UCF)	:	59.84 %	Planned Unavailability Factor (PUF)	:	31.98 %
Load Factor (LF)	:	59.39 %	Externally cause unavailability (XUF)	:	0.28 %
Operating Factor (OF)	:	63.22 %	Total off-line time	:	3231 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	383.90	358.02	381.61	360.01	66.69	177.77	379.00	215.17	70.38	0.00	0.00	299.40	2691.94
EAF [%]	100.00	99.74	99.99	97.47	17.37	47.85	98.88	56.40	18.94	0.00	0.00	78.21	59.56
UCF [%]	100.00	99.74	99.99	97.47	17.37	48.34	99.90	57.75	19.27	0.00	0.00	78.38	59.84
LF [%]	100.00	99.69	99.40	96.90	17.37	47.85	98.72	56.05	18.94	0.00	0.00	77.99	59.39
OF [%]	100.00	100.00	100.00	100.00	35.89	59.44	100.00	59.81	20.42	0.00	0.00	83.06	63.22
FLR [%]	0.00	0.01	0.01	2.53	51.55	1.03	0.10	42.25	0.00	0.00	0.00	0.00	8.28
UCL [%]	0.00	0.01	0.01	2.53	18.48	34.44	0.10	42.25	0.00	0.00	0.00	0.00	8.18
PUF [%]	0.00	0.25	0.00	0.00	64.15	17.22	0.00	0.00	80.73	100.00	100.00	21.62	31.98
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.49	1.02	1.35	0.33	0.00	0.00	0.17	0.28

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Historical Summary

Lifetime energy generation	:	139714.63 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	11.82 %
Cumulative Energy Availability Factor (EAF)	:	74.15 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	11.41 %
Cumulative Unit Capability Factor (UCF)	:	74.87 %	Cumulative Planned Unavailability Factor (PUF)	:	13.72 %
Cumulative Load Factor (LF)	:	73.9 %	Cumulative Externally cause unavailability (XUF)	:	0.72 %
Cumulative Operating Factor (OF)	:	77.7 %			

Electricity Production (net) [GWh]

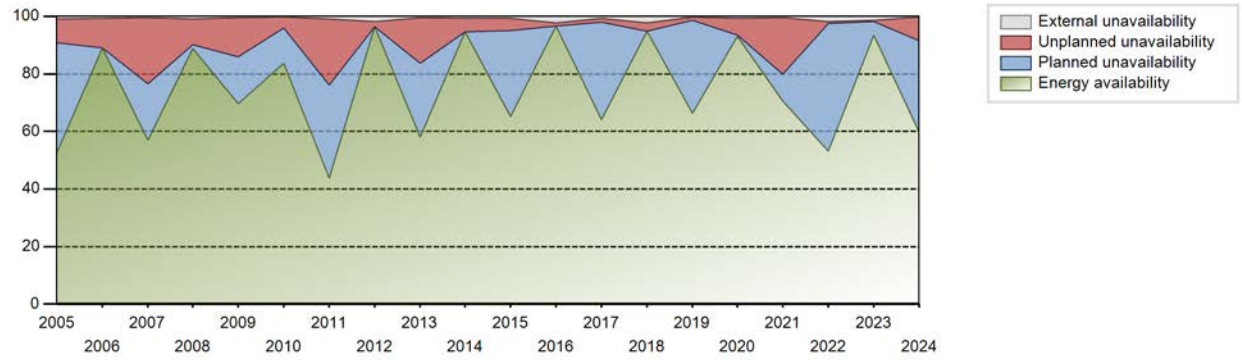


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	3202.40	6968	516	90.29	90.29	89.64	92.62	9.69	9.69	0.02	0.00
1984	3517.52	7035	516	77.75	77.75	77.61	80.09	11.82	10.42	11.83	0.00
1985	3366.50	6989	516	77.74	83.10	74.48	79.78	8.79	8.01	8.89	5.36
1986	4068.64	8057	516	90.70	91.16	90.01	91.97	2.33	2.18	6.66	0.46
1987	3600.10	7148	516	79.56	80.33	79.65	81.60	7.82	6.82	12.85	0.77
1988	4397.16	8683	516	97.52	97.55	97.01	98.85	2.09	2.09	0.37	0.03
1989	3400.76	6862	516	75.42	75.67	75.24	78.33	9.36	7.81	16.52	0.25
1990	3885.00	7821	516	86.36	86.44	85.95	89.28	4.06	3.65	9.90	0.08
1991	2887.06	5724	516	64.36	64.56	63.87	65.34	28.95	26.30	9.14	0.20
1992	1345.25	2621	516	29.76	29.76	29.68	29.84	70.24	70.24	0.00	0.00
1993	3841.81	8307	516	85.40	85.57	84.99	94.83	14.25	14.22	0.22	0.16
1994	3074.41	6196	516	68.53	68.53	68.02	70.73	9.15	6.90	24.57	0.00
1995	3372.87	7008	516	74.76	75.01	74.62	80.00	13.00	11.21	13.77	0.25
1996	3042.63	6429	516	67.13	67.13	67.13	73.19	32.87	32.87	0.00	0.00
1997	3924.89	7908	516	86.83	86.83	86.83	90.27	13.17	13.17	0.00	0.00
1998	3490.58	7296	516	77.22	77.22	77.22	83.29	8.70	7.36	15.42	0.00
1999	2511.57	5302	516	55.56	55.63	55.56	60.53	20.16	14.04	30.33	0.06
2000	2631.49	5457	516	58.03	58.12	58.06	62.12	32.58	28.09	13.79	0.09
2001	2980.21	5986	516	65.87	66.57	65.93	68.33	6.95	4.97	28.46	0.71
2002	2655.74	5565	516	58.75	59.17	58.75	63.53	11.96	8.03	32.80	0.41
2003	3294.96	6566	516	69.14	71.14	72.89	74.95	28.29	28.07	0.79	2.00
2004	4159.81	8264	516	92.16	92.60	91.78	94.08	4.45	4.31	3.09	0.44
2005	2352.79	4818	516	52.63	53.56	52.05	55.00	9.80	8.30	38.14	0.93
2006	4010.87	8113	516	88.95	89.66	88.73	92.61	10.34	10.34	0.00	0.71
2007	2567.59	5637	516	56.96	57.51	56.80	64.35	21.85	22.84	19.66	0.55
2008	4026.82	8357	516	88.86	89.80	88.84	95.14	7.64	8.89	1.31	0.94
2009	3140.88	6631	516	69.60	70.12	69.49	75.70	7.81	13.53	16.35	0.51
2010	3769.85	7645	516	83.73	84.08	83.40	87.27	4.21	3.69	12.23	0.36
2011	1973.46	4258	516	43.87	44.83	43.66	48.61	10.88	22.97	32.20	0.96
2012	4347.31	8725	516	96.34	98.24	95.91	99.33	1.69	1.69	0.07	1.89
2013	2603.23	5371	516	58.06	58.57	57.59	61.31	1.98	15.82	25.61	0.51
2014	4255.09	8760	516	94.57	95.35	94.14	100.00	4.50	4.49	0.15	0.78
2015	2932.28	5865	516	65.29	65.91	64.87	66.95	0.62	4.44	29.66	0.62
2016	4352.12	8784	516	96.56	98.79	96.02	100.00	1.11	1.10	0.10	2.23
2017	2883.68	5841	516	64.14	64.82	63.80	66.68	1.92	1.27	33.91	0.69
2018	4255.38	8615	516	94.81	97.08	94.14	98.34	2.88	2.87	0.04	2.28
2019	2978.82	5934	516	66.30	66.58	65.90	67.74	1.67	1.13	32.28	0.28

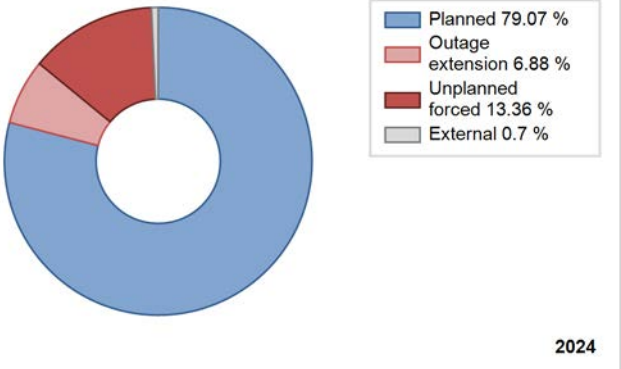
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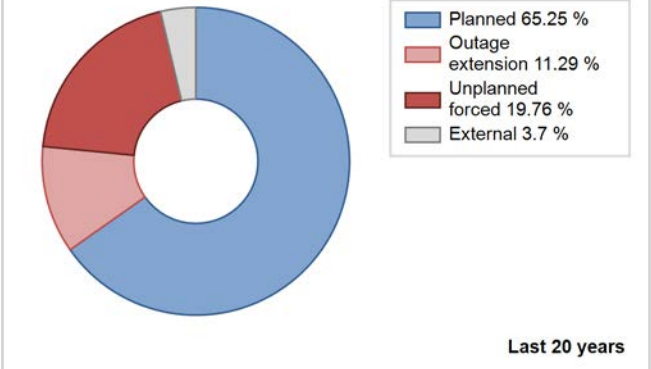
2020	4215.36	8520	516	93.12	93.85	93.00	96.99	5.72	5.70	0.45	0.73
2021	3187.45	6438	516	70.59	71.14	70.52	73.49	21.62	19.62	9.24	0.55
2022	2386.74	4852	516	53.15	54.86	52.80	55.39	0.88	0.78	44.36	1.71
2023	4208.07	8437	516	93.47	94.82	93.10	96.31	0.53	0.50	4.68	1.35
2024	2691.94	5553	516	59.56	59.84	59.39	63.22	8.28	8.18	31.98	0.28

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1983 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		544			753	
D. Inspection, maintenance or repair without refuelling	2688			1116		
E. Testing of plant systems or components				0	1	
L. Human factor related					46	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						7
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						14
Z. Other				23	18	
Subtotal	2688	544		1139	818	21
Total	**3232**			**1978**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		50
12. Reactor I&C Systems		58
13. Reactor Auxiliary Systems		47
14. Safety Systems		15
15. Reactor Cooling Systems		102
16. Steam generation systems		235
21. Fuel Handling and Storage Facilities	244	20
31. Turbine and auxiliaries		40
32. Feedwater and Main Steam System		7
33. Circulating Water System		9
35. All other I&C Systems		7
41. Main Generator Systems	299	106
42. Electrical Power Supply Systems		75
Total	**543**	**771**

Highlights (2024)

Pickering unit 5 experienced one planned, one unbudgeted and one forced outage in 2024.

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2024 Operating Experience

CA-14 PICKERING-6 CANADA



Status at end of year	:	**Operational**
Operator	:	OPG (Ontario Power Generation)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 500B
Thermal power	:	1744 MWth
Gross electrical power	:	540 MWe
Reference unit power (net)	:	516 MWe

Key Dates

Construction Date	:	1975-10-01
Grid Date	:	1983-11-08
Commercial Date	:	1984-02-01
Age at end of year	:	41 years

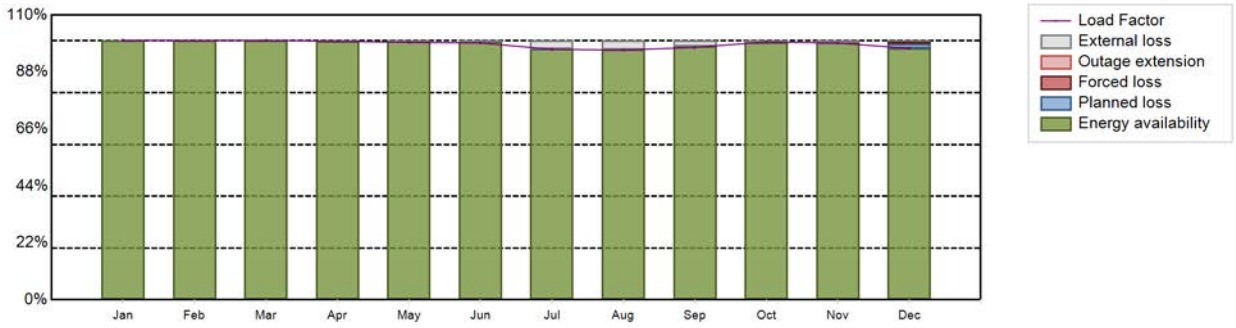
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	293.4
Fuel material	:	UO2	Number of SG	:	12
Refuelling type	:	ON-line	Containment type	:	-
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.46
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8330	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.94	HP cylinder inlet steam pressure [MPa]	:	3.8
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	4560	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	27.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	21	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4478.04 GW(e).h	Forced Loss Rate (FLR)	:	0.09 %
Energy Availability Factor (EAF)	:	98.9 %	Unplanned Capability Loss Factor (UCL)	:	0.09 %
Unit Capability Factor (UCF)	:	99.75 %	Planned Unavailability Factor (PUF)	:	0.16 %
Load Factor (LF)	:	98.8 %	Externally cause unavailability (XUF)	:	0.85 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	384.86	359.66	384.71	370.90	381.72	368.50	371.45	370.37	362.17	382.41	368.37	372.93	4478.05
EAF [%]	100.00	100.00	100.00	99.94	99.94	99.70	96.92	96.61	97.86	99.48	99.35	97.06	98.90
UCF [%]	100.00	100.00	100.00	99.94	99.96	100.00	100.00	100.00	100.00	100.00	99.98	97.13	99.75
LF [%]	100.25	100.15	100.21	99.83	99.43	99.19	96.75	96.47	97.48	99.61	99.15	97.14	98.80
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.02	1.01	0.09
UCL [%]	0.00	0.00	0.00	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.02	0.99	0.09
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.88	0.16
XUF [%]	0.00	0.00	0.00	0.00	0.02	0.30	3.08	3.39	2.14	0.52	0.64	0.07	0.85

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Historical Summary

Lifetime energy generation	:	146650.45 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.22 %
Cumulative Energy Availability Factor (EAF)	:	79.01 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.65 %
Cumulative Unit Capability Factor (UCF)	:	79.75 %	Cumulative Planned Unavailability Factor (PUF)	:	12.6 %
Cumulative Load Factor (LF)	:	78.96 %	Cumulative Externally cause unavailability (XUF)	:	0.74 %
Cumulative Operating Factor (OF)	:	81.65 %			

Electricity Production (net) [GWh]

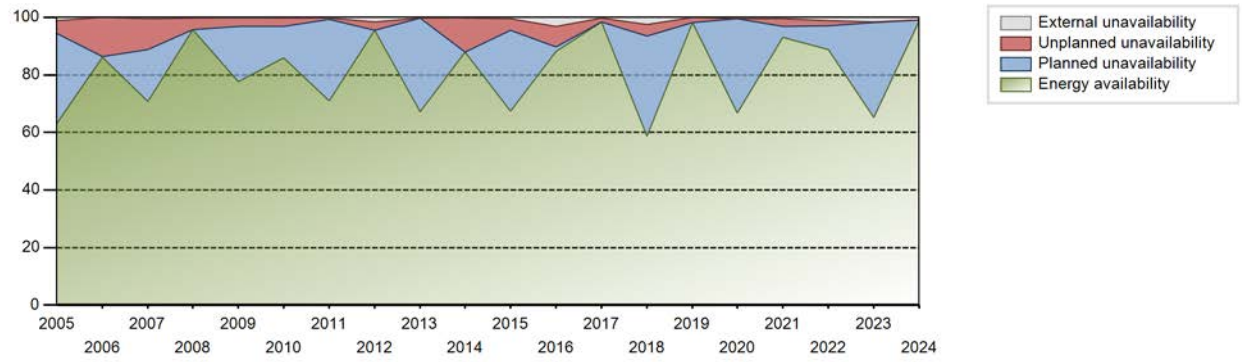


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	3816.08	7636	516	86.09	86.09	85.88	87.66	13.78	13.76	0.16	0.00
1985	3289.09	6540	516	73.11	79.48	72.76	74.66	6.72	5.73	14.80	6.37
1986	3395.22	6763	516	75.84	76.11	75.11	77.20	18.81	17.63	6.25	0.28
1987	3949.93	7791	516	86.60	88.53	87.38	88.94	3.42	3.13	8.33	1.94
1988	4496.76	8775	516	98.42	98.49	99.21	99.90	1.51	1.51	0.00	0.07
1989	3950.21	7794	516	87.57	87.89	87.39	88.97	5.86	5.47	6.64	0.31
1990	3473.45	7017	516	76.92	77.74	76.84	80.10	7.76	6.54	15.72	0.82
1991	4469.68	8721	516	98.97	99.21	98.88	99.55	0.79	0.79	0.00	0.24
1992	4050.47	7936	516	89.29	89.32	89.36	90.35	10.54	10.53	0.15	0.03
1993	2689.19	5506	516	59.88	60.38	59.49	62.85	11.28	7.68	31.94	0.50
1994	4043.00	8036	516	90.14	90.15	89.44	91.74	9.71	9.70	0.15	0.01
1995	3493.34	6962	516	77.19	77.51	77.28	79.47	5.67	4.66	17.83	0.32
1996	2591.65	5707	516	57.18	57.18	57.18	64.97	31.11	25.82	17.00	0.00
1997	3386.16	6841	516	74.91	74.91	74.91	78.09	16.79	15.11	9.98	0.00
1998	3130.15	6384	516	69.25	69.73	69.25	72.88	14.14	11.48	18.78	0.49
1999	3353.71	6863	516	74.18	74.42	74.19	78.34	25.38	25.31	0.27	0.24
2000	2738.74	6449	516	60.46	60.60	60.42	73.42	19.46	14.64	24.76	0.14
2001	2618.08	5286	516	57.68	57.68	57.92	60.34	21.61	15.90	26.42	0.00
2002	3982.31	7985	516	88.29	88.90	88.10	91.15	7.01	6.71	4.39	0.61
2003	3267.37	6566	516	72.46	74.27	72.28	74.95	12.71	10.81	14.92	1.81
2004	2780.80	5597	516	61.51	61.68	61.35	63.72	28.61	24.72	13.60	0.17
2005	2850.13	5596	516	63.14	64.25	63.05	63.88	3.16	4.41	31.34	1.12
2006	3899.46	7635	516	86.05	86.14	86.27	87.16	4.26	13.54	0.32	0.10
2007	3216.52	6588	516	70.75	71.26	71.16	75.21	8.36	10.77	17.97	0.51
2008	4323.78	8521	516	95.64	95.79	95.39	97.01	4.21	4.21	0.00	0.15
2009	3493.23	7051	516	77.60	77.97	77.28	80.49	3.36	2.71	19.32	0.36
2010	3865.26	7659	516	85.83	86.01	85.51	87.43	3.22	2.86	11.12	0.19
2011	3195.82	6334	516	70.96	71.33	70.70	72.31	0.60	0.43	28.24	0.38
2012	4333.57	8550	516	95.50	97.08	95.61	97.34	2.92	2.92	0.00	1.58
2013	3027.43	6047	516	67.19	67.42	66.98	69.03	0.14	0.10	32.49	0.23
2014	3979.30	8397	516	87.91	88.18	88.03	95.86	11.82	11.82	0.00	0.27
2015	3037.96	6064	516	67.32	67.86	67.21	69.22	5.43	3.89	28.25	0.54
2016	3995.28	8259	516	88.20	91.33	88.15	94.02	2.89	7.15	1.52	3.13
2017	4434.18	8686	516	98.31	98.57	98.10	99.16	1.43	1.43	0.00	0.27
2018	2652.58	5392	516	58.68	61.18	58.68	61.55	6.08	3.96	34.87	2.49
2019	4461.28	8681	516	98.28	98.40	98.70	99.10	1.59	1.59	0.01	0.12
2020	3027.01	5918	516	66.72	67.10	66.78	67.37	0.07	0.05	32.85	0.39

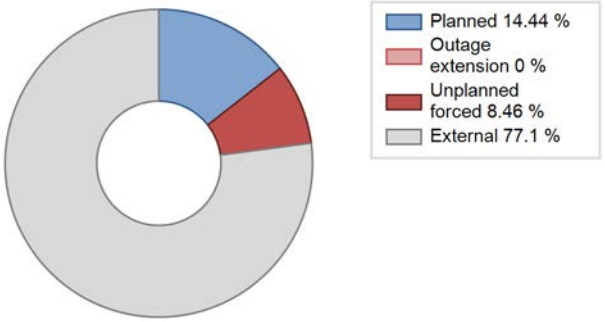
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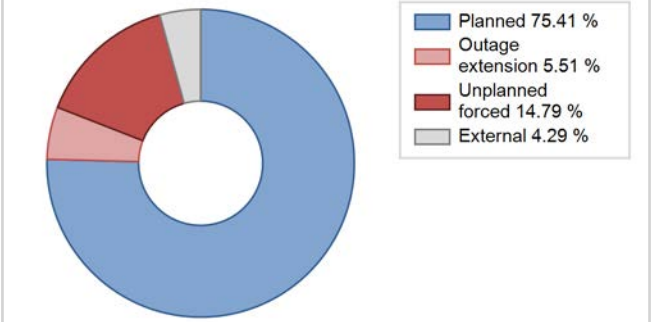
2021	4206.84	8455	516	92.99	93.52	93.07	96.52	2.70	2.60	3.88	0.53
2022	4022.03	7845	516	88.91	90.17	88.98	89.55	1.91	1.76	8.07	1.26
2023	2930.52	5826	516	65.12	66.79	64.83	66.51	0.07	0.05	33.16	1.67
2024	4478.05	8784	516	98.90	99.75	98.80	100.00	0.09	0.09	0.16	0.85

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					471	
C. Inspection, maintenance or repair combined with refuelling				73		
D. Inspection, maintenance or repair without refuelling				999		
E. Testing of plant systems or components				0	3	
J. Grid limitation, failure or grid unavailability						16
L. Human factor related					32	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						12
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						15
Z. Other					2	
Subtotal				1072	508	43
Total		**0**			**1623**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		51
12. Reactor I&C Systems		42
13. Reactor Auxiliary Systems		26
14. Safety Systems		34
15. Reactor Cooling Systems		45
16. Steam generation systems		89
21. Fuel Handling and Storage Facilities		12
31. Turbine and auxiliaries		48
32. Feedwater and Main Steam System		31
33. Circulating Water System		13
34. Miscellaneous Systems		18
35. All other I&C Systems		4
41. Main Generator Systems		58
42. Electrical Power Supply Systems		23
Total		**494**

Highlights (2024)

Pickering unit 6 has not experienced any planned of forced shutdowns in 2024.

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2024 Operating Experience

CA-15 PICKERING-7 CANADA



Status at end of year	:	**Operational**
Operator	:	OPG (Ontario Power Generation)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 500B
Thermal power	:	1744 MWth
Gross electrical power	:	540 MWe
Reference unit power (net)	:	516 MWe

Key Dates

Construction Date	:	1976-03-01
Grid Date	:	1984-11-17
Commercial Date	:	1985-01-01
Age at end of year	:	40 years

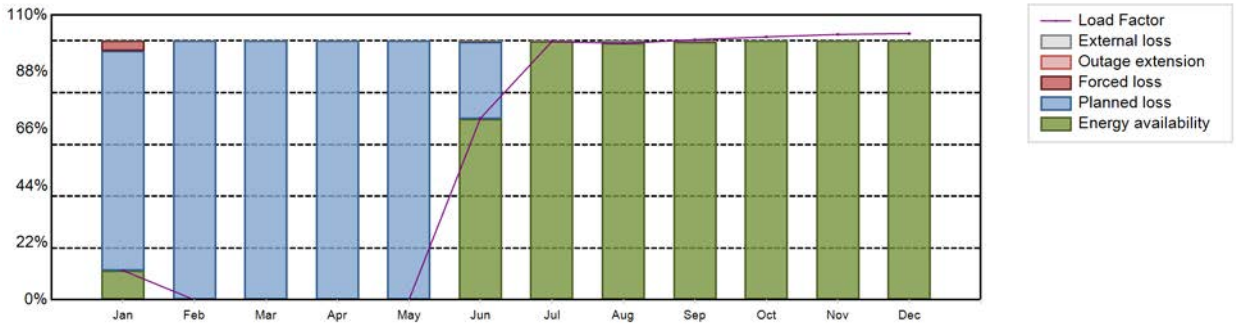
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	293.4
Fuel material	:	UO2/PuO2	Number of SG	:	12
Refuelling type	:	ON-line	Containment type	:	-
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.46
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8330	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.94	HP cylinder inlet steam pressure [MPa]	:	3.8
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	4560	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	27.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	21	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	2605.99 GW(e).h	Forced Loss Rate (FLR)	:	0.62 %
Energy Availability Factor (EAF)	:	56.86 %	Unplanned Capability Loss Factor (UCL)	:	0.36 %
Unit Capability Factor (UCF)	:	56.97 %	Planned Unavailability Factor (PUF)	:	42.68 %
Load Factor (LF)	:	57.5 %	Externally cause unavailability (XUF)	:	0.1 %
Operating Factor (OF)	:	57.87 %	Total off-line time	:	3701 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	43.53	0.00	0.00	0.00	0.00	260.52	382.97	380.29	373.24	389.90	380.75	394.79	2605.99
EAF [%]	11.35	0.00	0.00	0.00	0.00	69.92	99.88	99.18	99.71	100.00	100.00	100.00	56.86
UCF [%]	11.35	0.00	0.00	0.00	0.00	69.96	99.99	100.00	99.98	100.00	100.00	100.00	56.97
LF [%]	11.34	0.00	0.00	0.00	0.00	70.12	99.76	99.06	100.46	101.56	102.48	102.84	57.50
OF [%]	14.52	0.00	0.00	0.00	0.00	77.64	100.00	100.00	100.00	100.00	100.00	100.00	57.87
FLR [%]	25.75	0.00	0.00	0.00	0.00	0.34	0.01	0.00	0.02	0.00	0.00	0.00	0.62
UCL [%]	3.94	0.00	0.00	0.00	0.00	0.24	0.01	0.00	0.02	0.00	0.00	0.00	0.36
PUF [%]	84.71	100.00	100.00	100.00	100.00	29.79	0.00	0.00	0.00	0.00	0.00	0.00	42.68
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.04	0.11	0.82	0.26	0.00	0.00	0.00	0.10

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Historical Summary

Lifetime energy generation	:	141561.42 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	9.63 %
Cumulative Energy Availability Factor (EAF)	:	78.12 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	9.17 %
Cumulative Unit Capability Factor (UCF)	:	78.72 %	Cumulative Planned Unavailability Factor (PUF)	:	12.11 %
Cumulative Load Factor (LF)	:	78.03 %	Cumulative Externally cause unavailability (XUF)	:	0.6 %
Cumulative Operating Factor (OF)	:	80.7 %			

Electricity Production (net) [GWh]

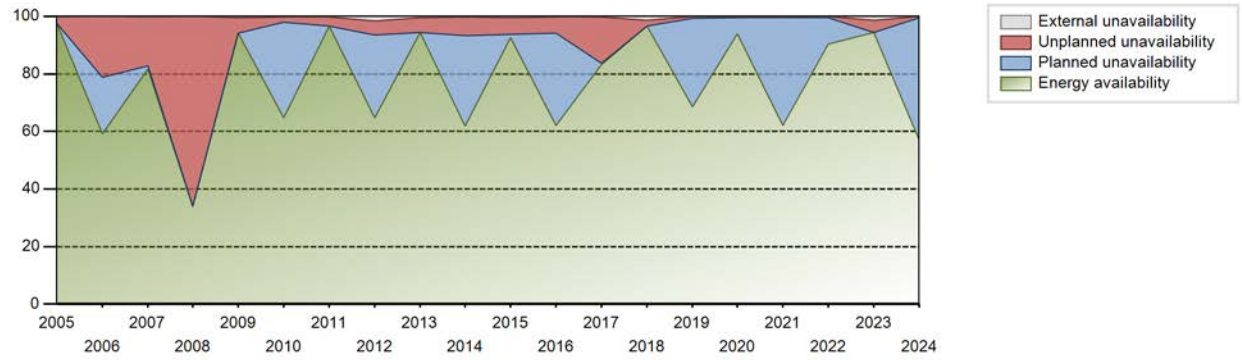


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	4093.95	8277	516	92.65	99.03	90.57	94.49	0.86	0.86	0.11	6.39
1986	3373.30	7002	516	75.20	75.45	74.63	79.93	8.27	6.80	17.75	0.25
1987	4339.89	8642	516	95.99	97.44	96.01	98.65	2.50	2.50	0.05	1.45
1988	4340.42	8519	516	95.39	95.94	95.76	96.98	4.06	4.06	0.00	0.55
1989	3408.69	6939	516	75.37	77.13	75.41	79.21	10.45	9.00	13.87	1.76
1990	3500.80	7420	516	77.73	78.35	77.45	84.70	13.66	12.39	9.25	0.62
1991	4258.77	8436	516	94.52	94.93	94.22	96.30	4.76	4.74	0.33	0.42
1992	3727.45	7349	516	82.40	82.41	82.24	83.66	2.52	2.13	15.46	0.01
1993	4415.95	8760	516	99.01	99.88	97.69	100.00	0.12	0.12	0.00	0.87
1994	3709.91	7386	516	83.40	83.40	82.07	84.32	1.67	1.41	15.18	0.00
1995	4056.79	8140	516	90.05	90.43	89.75	92.92	9.57	9.57	0.00	0.38
1996	2050.69	4416	516	45.37	45.37	45.24	50.27	54.63	54.63	0.00	0.00
1997	2936.16	6208	516	64.96	64.96	64.96	70.87	20.17	16.41	18.63	0.00
1998	3084.73	6495	516	68.24	68.87	68.24	74.14	20.36	17.61	13.52	0.63
1999	4433.82	8751	516	98.04	98.82	98.09	99.90	1.18	1.18	0.00	0.78
2000	2099.00	4445	516	46.29	46.37	46.31	50.60	14.46	7.84	45.79	0.08
2001	4020.78	7968	516	88.71	89.03	88.95	90.96	10.97	10.97	0.00	0.32
2002	4246.89	8538	516	93.85	94.45	93.95	97.47	5.55	5.55	0.00	0.59
2003	1790.66	3811	516	39.66	39.81	39.62	43.50	40.88	27.53	32.67	0.15
2004	3116.06	6127	516	68.86	68.93	68.75	69.75	4.64	3.36	27.72	0.07
2005	4390.76	8658	516	97.44	97.79	97.14	98.84	2.21	2.21	0.00	0.34
2006	2652.57	5311	516	59.06	59.11	58.68	60.63	10.24	21.12	19.77	0.05
2007	3667.91	7540	516	81.69	82.04	81.15	86.07	9.97	16.75	1.21	0.35
2008	1530.27	3084	516	33.98	33.99	33.76	35.11	66.01	66.01	0.00	0.00
2009	4229.46	8492	516	94.10	94.53	93.57	96.94	5.47	5.47	0.00	0.43
2010	2920.66	5895	516	64.78	65.13	64.61	67.29	1.64	1.69	33.18	0.35
2011	4337.70	8673	516	96.58	96.83	95.96	99.01	3.17	3.17	0.00	0.25
2012	2920.02	5965	516	64.76	66.28	64.42	67.91	6.84	4.87	28.85	1.52
2013	4264.55	8760	516	94.44	94.92	94.35	100.00	5.04	5.04	0.04	0.48
2014	2783.08	5489	516	61.95	62.18	61.57	62.66	6.72	6.53	31.30	0.23
2015	4171.04	8336	516	92.57	93.11	92.28	95.16	3.43	5.65	1.25	0.54
2016	2803.59	5574	516	61.97	62.32	61.85	63.46	6.62	5.50	32.18	0.35
2017	3751.37	7512	516	83.14	83.35	82.99	85.75	13.44	16.11	0.55	0.20
2018	4377.16	8687	516	96.67	98.11	96.84	99.17	1.89	1.89	0.00	1.45
2019	3132.65	6131	516	68.52	68.53	69.30	69.99	1.03	0.71	30.76	0.01
2020	4316.41	8321	516	94.04	94.20	95.23	94.73	0.35	0.33	5.47	0.15
2021	2840.99	5532	516	62.13	62.44	62.85	63.15	0.14	0.09	37.48	0.31

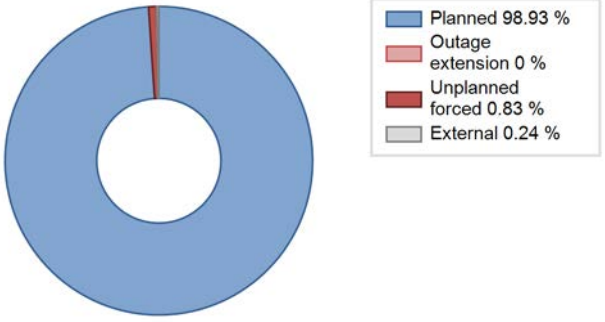
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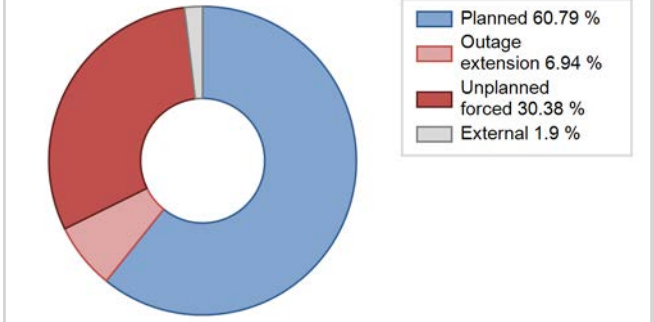
2022	4161.58	7970	516	90.47	90.60	92.07	90.98	0.30	0.27	9.13	0.13
2023	4324.26	8340	516	94.40	95.70	95.67	95.21	4.30	4.30	0.00	1.30
2024	2605.99	5083	516	56.86	56.97	57.50	57.87	0.62	0.36	42.68	0.10

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		13			507	
D.	Inspection, maintenance or repair without refuelling	3689			1025		
E.	Testing of plant systems or components				1	8	
J.	Grid limitation, failure or grid unavailability						2
L.	Human factor related					106	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						5
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						12
Z.	Other					30	
Subtotal		3689	13		1026	651	19
Total			**3702**			**1696**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		88
12. Reactor I&C Systems		50
13. Reactor Auxiliary Systems		13
14. Safety Systems		29
15. Reactor Cooling Systems	13	80
16. Steam generation systems		51
21. Fuel Handling and Storage Facilities		20
31. Turbine and auxiliaries		30
32. Feedwater and Main Steam System		17
33. Circulating Water System		12
34. Miscellaneous Systems		41
41. Main Generator Systems		61
42. Electrical Power Supply Systems		50
Total	**13**	**542**

Highlights (2024)

Pickering unit 7 had a planned outage and experienced a forced outage in 2024.

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2024 Operating Experience

CA-16 PICKERING-8 CANADA



Status at end of year	:	**Operational**
Operator	:	OPG (Ontario Power Generation)
Owner	:	OPG (Ontario Power Generation)
Reactor Supplier	:	OH/AECL (ONTARIO HYDRO / ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 500B
Thermal power	:	1744 MWth
Gross electrical power	:	540 MWe
Reference unit power (net)	:	516 MWe

Key Dates

Construction Date	:	1976-09-01
Grid Date	:	1986-01-21
Commercial Date	:	1986-02-28
Age at end of year	:	38 years

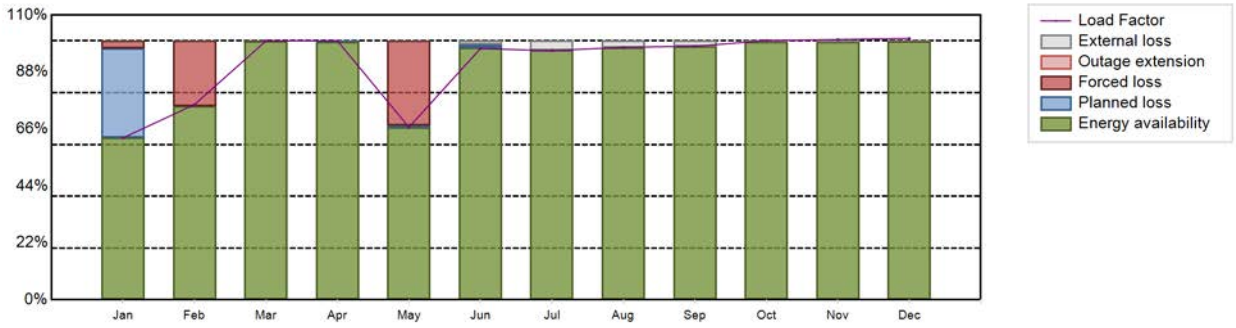
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	293.4
Fuel material	:	UO2	Number of SG	:	12
Refuelling type	:	ON-line	Containment type	:	-
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.46
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8330	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	5.94	HP cylinder inlet steam pressure [MPa]	:	3.8
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	4560	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	27.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	21	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4135.95 GW(e).h	Forced Loss Rate (FLR)	:	5.18 %
Energy Availability Factor (EAF)	:	91.02 %	Unplanned Capability Loss Factor (UCL)	:	5.02 %
Unit Capability Factor (UCF)	:	91.9 %	Planned Unavailability Factor (PUF)	:	3.09 %
Load Factor (LF)	:	91.25 %	Externally cause unavailability (XUF)	:	0.88 %
Operating Factor (OF)	:	96.29 %	Total off-line time	:	326 hours

Annual Summary



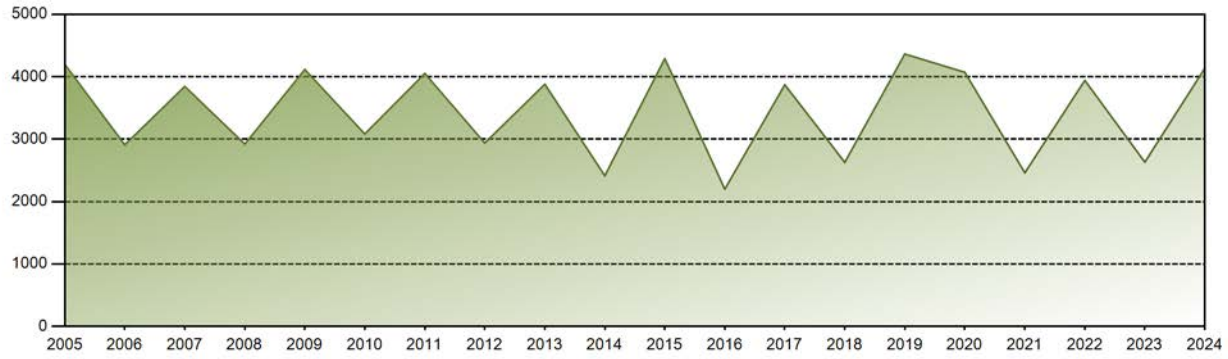
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	240.13	270.80	383.90	371.52	255.98	360.47	369.40	374.53	363.76	384.33	373.50	387.62	4135.95
EAF [%]	62.73	74.85	99.98	99.63	66.68	97.40	96.40	97.40	97.97	99.54	99.67	99.92	91.02
UCF [%]	62.73	74.85	99.98	99.63	66.68	98.88	99.95	100.00	100.00	100.00	100.00	99.96	91.90
LF [%]	62.55	75.40	100.00	100.00	66.68	97.03	96.22	97.56	97.91	100.11	100.53	100.97	91.25
OF [%]	75.81	79.02	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	96.29
FLR [%]	4.49	25.15	0.02	0.00	32.90	0.00	0.00	0.00	0.00	0.00	0.00	0.04	5.18
UCL [%]	2.95	25.15	0.02	0.00	32.70	0.00	0.00	0.00	0.00	0.00	0.00	0.04	5.02
PUF [%]	34.33	0.00	0.00	0.37	0.62	1.12	0.05	0.00	0.00	0.00	0.00	0.00	3.09
XUF [%]	0.00	0.00	0.00	0.00	0.00	1.48	3.56	2.60	2.03	0.46	0.33	0.04	0.88

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Historical Summary

Lifetime energy generation	:	133105.43 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	9.47 %
Cumulative Energy Availability Factor (EAF)	:	75.8 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.83 %
Cumulative Unit Capability Factor (UCF)	:	76.48 %	Cumulative Planned Unavailability Factor (PUF)	:	14.69 %
Cumulative Load Factor (LF)	:	75.67 %	Cumulative Externally cause unavailability (XUF)	:	0.68 %
Cumulative Operating Factor (OF)	:	78.97 %			

Electricity Production (net) [GWh]

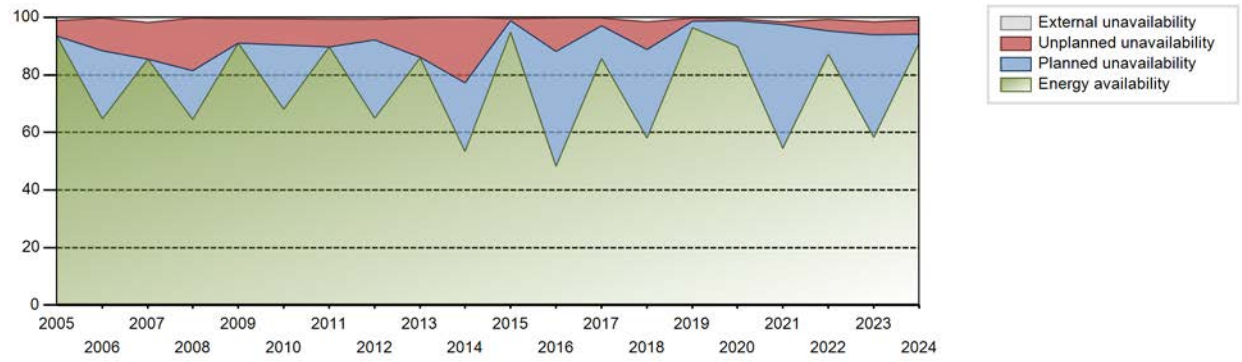


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	3792.31	8086	516	96.32	96.67	95.69	97.69	3.33	3.33	0.00	0.35
1987	3759.36	7585	516	83.31	84.70	83.17	86.59	2.09	1.81	13.49	1.38
1988	3710.38	7296	516	82.25	82.50	81.86	83.06	2.16	1.82	15.68	0.25
1989	4295.19	8569	516	95.37	96.61	95.02	97.82	3.29	3.29	0.10	1.24
1990	3014.65	6743	516	66.63	66.72	66.69	76.97	19.23	15.89	17.39	0.09
1991	4484.97	8759	516	98.89	99.52	99.22	99.99	0.48	0.48	0.00	0.63
1992	4211.99	8280	516	92.95	92.98	92.93	94.26	6.81	6.79	0.22	0.03
1993	3670.54	7233	516	81.73	82.15	81.20	82.57	2.50	2.11	15.74	0.41
1994	4341.88	8579	516	96.85	96.85	96.06	97.93	3.14	3.14	0.01	0.00
1995	4012.08	8066	516	89.04	89.42	88.76	92.08	10.58	10.58	0.00	0.38
1996	1300.26	2597	516	28.73	28.73	28.69	29.57	68.79	63.34	7.92	0.00
1997	360.81	995	516	7.96	7.96	7.96	11.33	44.06	6.27	85.77	0.00
1998	3493.62	7009	516	77.29	78.02	77.29	80.01	10.55	9.20	12.78	0.73
1999	3509.06	7077	516	77.63	78.44	77.63	80.79	2.49	2.00	19.56	0.81
2000	2711.21	5508	516	59.92	60.83	59.82	62.70	16.52	12.04	27.13	0.91
2001	3502.19	6999	516	77.47	78.22	77.48	79.90	8.46	7.23	14.55	0.75
2002	3605.36	7244	516	80.03	81.06	79.76	82.69	9.27	8.28	10.66	1.02
2003	3921.29	8026	516	86.90	89.68	86.75	91.62	10.32	10.32	0.00	2.78
2004	2489.46	5182	516	55.13	55.35	54.92	58.99	23.42	16.93	27.71	0.23
2005	4195.24	8431	516	93.40	94.60	92.81	96.24	5.40	5.40	0.00	1.20
2006	2908.54	5853	516	64.75	65.06	64.35	66.82	3.38	11.22	23.72	0.31
2007	3843.21	8015	516	85.51	87.28	85.02	91.50	12.72	12.72	0.00	1.77
2008	2918.75	6116	516	64.41	64.71	64.40	69.63	18.42	18.21	17.08	0.30
2009	4115.23	8520	516	91.04	91.61	91.04	97.26	8.39	8.39	0.00	0.57
2010	3081.07	6427	516	68.16	68.53	68.16	73.37	9.60	9.19	22.27	0.37
2011	4051.72	8345	516	89.64	90.30	89.64	95.26	9.61	9.60	0.10	0.66
2012	2936.38	5967	516	64.86	65.53	64.78	67.93	6.71	7.15	27.33	0.66
2013	3879.06	7979	516	85.97	86.34	85.82	91.08	13.57	13.55	0.11	0.37
2014	2411.29	5223	516	53.30	53.43	53.35	59.62	26.12	22.62	23.94	0.14
2015	4289.30	8440	516	94.91	95.37	94.89	96.35	0.76	0.73	3.90	0.46
2016	2197.88	4367	516	48.35	48.60	48.49	49.72	0.61	11.62	39.78	0.25
2017	3870.80	7787	516	85.68	85.96	85.63	88.89	2.90	2.57	11.47	0.28
2018	2626.93	5427	516	58.08	59.70	58.12	61.95	13.69	9.47	30.82	1.63
2019	4363.55	8571	516	96.44	96.71	96.54	97.84	1.03	1.01	2.28	0.27
2020	4070.63	8022	516	89.87	90.41	89.81	91.33	0.65	0.59	9.00	0.54
2021	2459.85	4932	516	54.47	56.12	54.42	56.30	1.38	0.78	43.10	1.65
2022	3941.06	7789	516	87.35	88.03	87.19	88.92	4.31	3.97	8.00	0.68

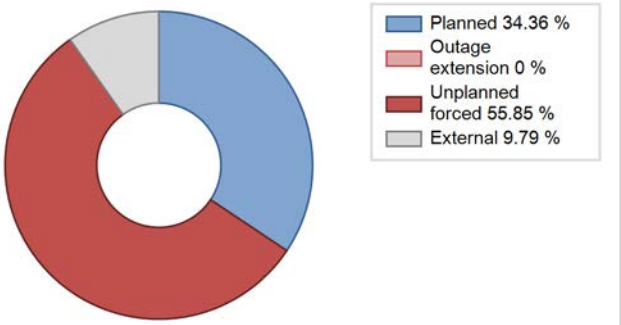
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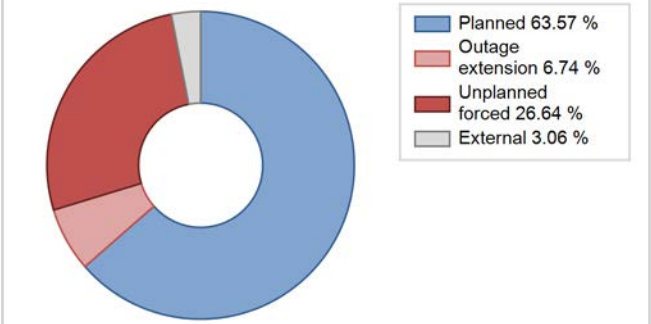
2023	2630.89	5280	516	58.31	59.82	58.20	60.27	7.12	4.58	35.60	1.50
2024	4135.95	8458	516	91.02	91.90	91.25	96.29	5.18	5.02	3.09	0.88

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1986 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		146			436	
C. Inspection, maintenance or repair combined with refuelling				68		
D. Inspection, maintenance or repair without refuelling	180			1049		
E. Testing of plant systems or components				1		
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					272	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						12
Z. Other					1	
Subtotal	180	146		1118	709	15
Total	**326**			**1842**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		31
12. Reactor I&C Systems	146	36
13. Reactor Auxiliary Systems		3
14. Safety Systems		33
15. Reactor Cooling Systems		77
16. Steam generation systems		27
21. Fuel Handling and Storage Facilities		86
31. Turbine and auxiliaries		47
32. Feedwater and Main Steam System		29
33. Circulating Water System		23
34. Miscellaneous Systems		12
35. All other I&C Systems		1
41. Main Generator Systems		15
42. Electrical Power Supply Systems		27
Total	**146**	**447**

Highlights (2024)

Pickering unit 8 experienced a forced outage in 2024.

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2024 Operating Experience

CA-17 POINT LEPREAU CANADA



Status at end of year	:	**Operational**
Operator	:	NBEPC (NEW BRUNSWICK ELECTRIC POWER COMMISSION)
Owner	:	NBEPC (NEW BRUNSWICK ELECTRIC POWER COMMISSION)
Reactor Supplier	:	AECL (ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	NEI/PARS (NEI-PARSONS)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 6
Thermal power	:	2180 MWth
Gross electrical power	:	705 MWe
Reference unit power (net)	:	660 MWe

Key Dates

Construction Date	:	1975-05-01
Grid Date	:	1982-09-11
Commercial Date	:	1983-02-01
Age at end of year	:	42 years

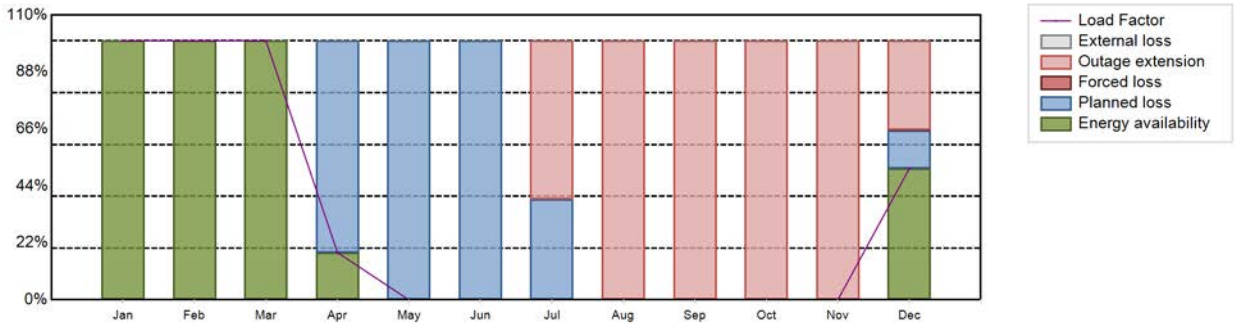
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	11.55
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	310
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	-
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.3
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	8000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	6.28	HP cylinder inlet steam pressure [MPa]	:	4.64
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	4560	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	59.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	21	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	1777.3 GW(e).h	Forced Loss Rate (FLR)	:	0.09 %
Energy Availability Factor (EAF)	:	30.66 %	Unplanned Capability Loss Factor (UCL)	:	41.47 %
Unit Capability Factor (UCF)	:	30.66 %	Planned Unavailability Factor (PUF)	:	27.88 %
Load Factor (LF)	:	30.66 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	31.92 %	Total off-line time	:	5980 hours

Annual Summary



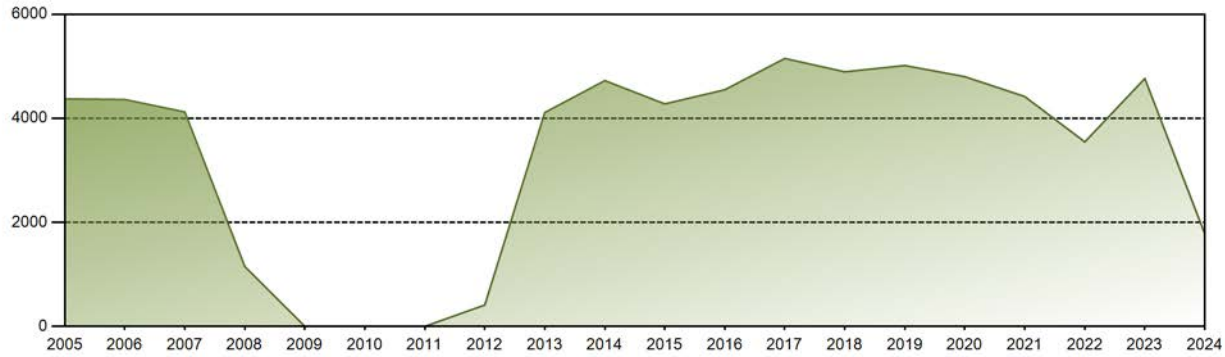
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	491.04	459.36	491.04	86.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	249.03	1777.30
EAF [%]	100.00	100.00	100.00	18.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.71	30.66
UCF [%]	100.00	100.00	100.00	18.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.71	30.66
LF [%]	100.00	100.00	100.00	18.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.71	30.66
OF [%]	100.00	100.00	100.00	18.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65.59	31.92
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.09
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	61.29	100.00	100.00	100.00	100.00	34.74	41.47
PUF [%]	0.00	0.00	0.00	81.73	100.00	100.00	38.71	0.00	0.00	0.00	0.00	14.54	27.88
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	172124.01 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.12 %
Cumulative Energy Availability Factor (EAF)	:	71.35 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.88 %
Cumulative Unit Capability Factor (UCF)	:	72.04 %	Cumulative Planned Unavailability Factor (PUF)	:	20.08 %
Cumulative Load Factor (LF)	:	70.79 %	Cumulative Externally cause unavailability (XUF)	:	0.69 %
Cumulative Operating Factor (OF)	:	73.49 %			

Electricity Production (net) [GWh]

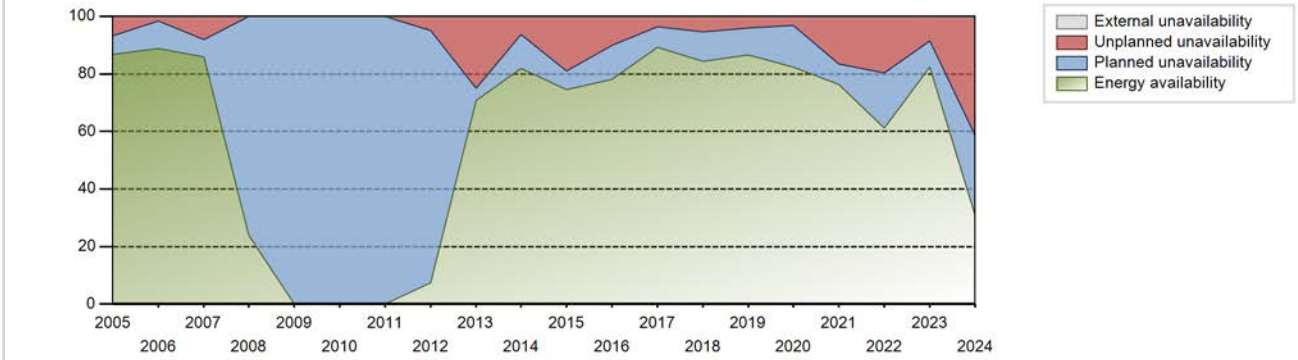


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	4742.90	7875	640	86.03	86.03	85.85	89.37	8.10	7.58	6.39	0.00
1984	5000.94	7927	635	88.94	88.97	89.66	90.24	3.03	2.78	8.25	0.03
1985	5421.91	8547	635	96.87	96.93	97.47	97.57	1.25	1.23	1.84	0.06
1986	5223.09	8257	635	93.41	94.00	93.90	94.26	0.90	0.85	5.15	0.59
1987	5107.73	8110	635	91.23	91.25	91.82	92.58	3.32	3.14	5.61	0.02
1988	5338.25	8383	635	94.85	94.85	95.70	95.43	0.38	0.36	4.79	0.00
1989	5266.67	8271	635	93.60	93.81	94.68	94.42	0.89	0.84	5.34	0.22
1990	5333.71	8384	635	94.70	94.99	95.89	95.71	2.92	2.86	2.15	0.29
1991	5437.17	8500	635	96.68	96.72	97.75	97.03	0.55	0.54	2.74	0.04
1992	4829.78	7748	635	85.76	85.76	86.59	88.21	3.99	3.57	10.67	0.00
1993	5320.00	8391	635	95.09	95.09	95.64	95.79	1.42	1.37	3.54	0.00
1994	5230.10	8270	635	93.46	93.46	94.02	94.41	0.34	0.32	6.22	0.00
1995	1611.40	2615	635	28.98	28.98	28.97	29.85	43.54	22.34	48.68	0.00
1996	4587.83	7363	635	81.41	81.41	82.25	83.82	13.97	13.22	5.37	0.00
1997	3455.59	5564	635	61.60	62.19	62.12	63.52	24.86	20.57	17.24	0.59
1998	3782.35	6111	635	66.04	67.11	68.00	69.76	20.20	16.99	15.90	1.06
1999	4082.74	6797	635	71.99	75.52	73.40	77.59	11.47	9.78	14.70	3.53
2000	3966.85	6792	635	70.52	77.64	71.12	77.32	0.00	0.00	22.36	7.12
2001	4451.33	7418	635	79.08	84.61	80.02	84.68	15.33	15.31	0.08	5.53
2002	3760.64	6107	635	67.59	71.59	67.61	69.71	6.62	10.30	18.12	4.00
2003	4739.52	7869	635	84.39	89.77	85.20	89.83	0.70	4.18	6.05	5.38
2004	4299.74	7310	635	82.58	83.32	77.09	83.22	6.13	6.56	10.12	0.74
2005	4372.64	7632	635	86.79	86.79	78.61	87.12	2.13	6.68	6.53	0.00
2006	4361.99	7755	635	88.74	88.74	78.42	88.53	0.88	1.59	9.67	0.00
2007	4121.82	7511	635	85.95	85.95	74.10	85.74	7.79	8.02	6.04	0.00
2008	1150.56	2111	635	24.03	24.03	20.63	24.03	0.00	0.00	75.97	0.00
2009	0.00	0	635	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2010	0.00	0	635	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2011	0.00	0	635	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2012	411.48	966	660	7.53	7.53	7.30	11.00	39.71	4.96	87.51	0.00
2013	4111.15	7879	660	70.80	70.80	71.12	89.95	25.07	24.92	4.28	0.00
2014	4724.62	7229	660	81.86	81.86	81.72	82.52	1.50	6.29	11.85	0.00
2015	4277.04	6993	660	74.61	74.61	73.98	79.83	20.21	18.89	6.50	0.00
2016	4548.99	6989	660	78.20	78.20	78.47	79.57	2.65	10.10	11.71	0.00
2017	5151.32	7928	660	89.25	89.25	89.10	90.50	2.44	3.65	7.10	0.00
2018	4894.15	7469	660	84.46	84.46	84.65	85.26	0.53	5.32	10.22	0.00
2019	5015.68	7663	660	86.69	86.69	86.75	87.48	4.50	4.08	9.23	0.00

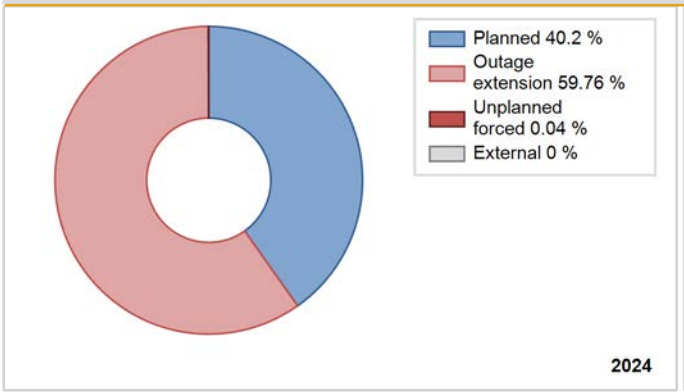
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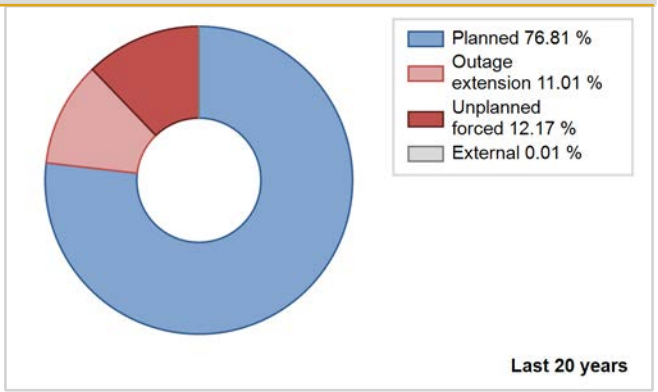
2020	4801.00	7302	660	82.46	82.46	82.81	83.13	0.23	3.08	14.45	0.00
2021	4418.52	7038	660	76.40	76.40	76.42	80.34	17.86	16.61	6.99	0.00
2022	3546.75	5499	660	61.28	61.28	61.35	62.77	12.21	19.70	19.02	0.00
2023	4764.67	7366	660	82.41	82.46	82.41	84.09	4.34	8.46	9.08	0.05
2024	1777.30	2804	660	30.66	30.66	30.66	31.92	0.09	41.47	27.88	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1983 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		3640			409	
C.	Inspection, maintenance or repair combined with refuelling				116		
D.	Inspection, maintenance or repair without refuelling	2340			444		
E.	Testing of plant systems or components				29	7	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				968		
G.	Major backfitting, refurbishment or upgrading activities without refuelling				21		
H.	Nuclear regulatory requirements					1	
J.	Grid limitation, failure or grid unavailability						1
L.	Human factor related					62	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						3
Z.	Other				2	45	
Subtotal		2340	3640		1580	524	4
Total		**5980**			**2108**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		18
12. Reactor I&C Systems		16
13. Reactor Auxiliary Systems		10
14. Safety Systems		20
15. Reactor Cooling Systems		93
16. Steam generation systems		37
17. Safety I&C Systems (excluding reactor I&C)		4
21. Fuel Handling and Storage Facilities		22
31. Turbine and auxiliaries		50
32. Feedwater and Main Steam System		53
34. Miscellaneous Systems		26
41. Main Generator Systems	3640	115
42. Electrical Power Supply Systems		35
Total	**3640**	**499**

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2024 Operating Experience

CN-36 CHANGJIANG-1 CHINA

Status at end of year	:	**Operational**
Operator	:	HNPC (Hainan Nuclear Power Company)
Owner	:	HNPC (Hainan Nuclear Power Company)
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)



Reactor Unit Details

Reactor type and model	:	PWR / CNP-600
Thermal power	:	1930 MWth
Gross electrical power	:	650 MWe
Reference unit power (net)	:	601 MWe

Key Dates

Construction Date	:	2010-04-25
Grid Date	:	2015-11-07
Commercial Date	:	2015-12-25
Age at end of year	:	9 years

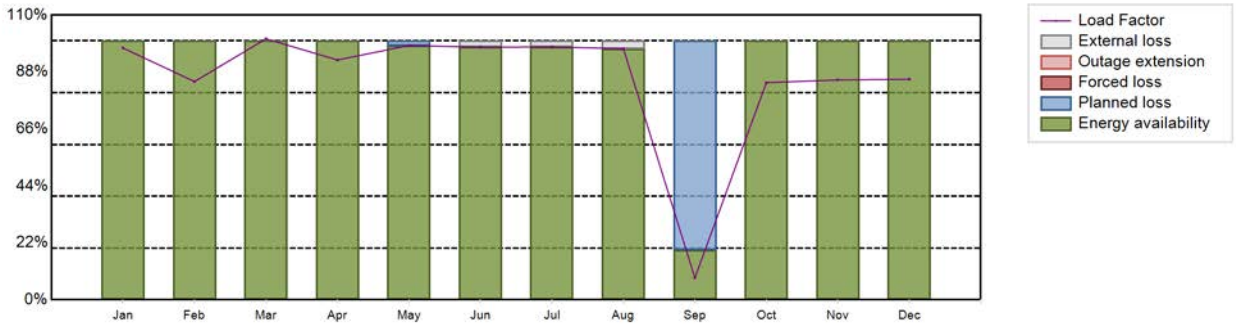
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	326.6
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.35
Average fuel enrichment [% of U235]	:	2.53	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	29.75	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	2.67	HP cylinder inlet steam pressure [MPa]	:	6.41
Active core height/length [m]	:	3.66	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	121	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.09	Number of main condensate pumps	:	3
Number of control rod assemblies	:	33	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4531.37 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	92.58 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	93.23 %	Planned Unavailability Factor (PUF)	:	6.77 %
Load Factor (LF)	:	85.83 %	Externally cause unavailability (XUF)	:	0.65 %
Operating Factor (OF)	:	93.39 %	Total off-line time	:	581 hours

Annual Summary



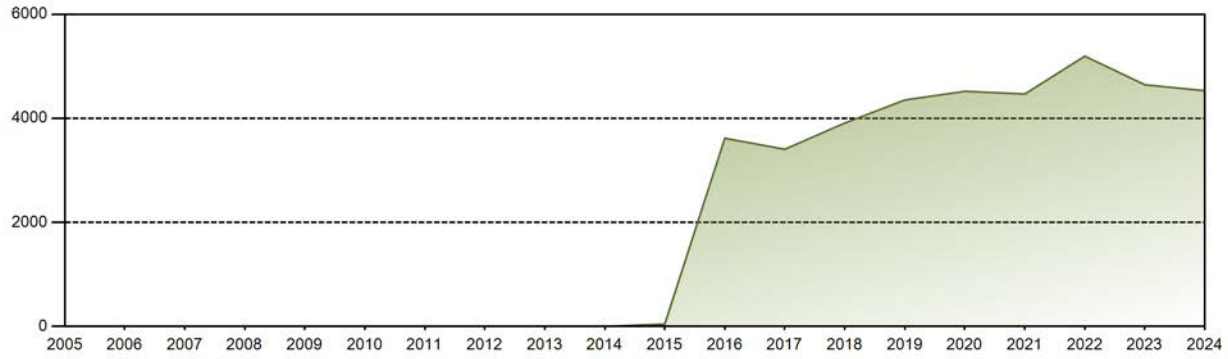
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	434.89	352.63	450.73	400.93	439.16	422.20	436.78	433.75	36.82	375.03	367.48	380.96	4531.37
EAF [%]	100.00	100.00	100.00	100.00	98.22	97.57	97.68	97.01	19.25	100.00	100.00	100.00	92.58
UCF [%]	100.00	100.00	100.00	100.00	98.22	100.00	100.00	100.00	19.25	100.00	100.00	100.00	93.23
LF [%]	97.26	84.30	100.80	92.65	98.22	97.57	97.68	97.01	8.51	83.87	84.92	85.20	85.83
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	19.31	100.00	100.00	100.00	93.39
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	1.78	0.00	0.00	0.00	80.75	0.00	0.00	0.00	6.77
XUF [%]	0.00	0.00	0.00	0.00	0.00	2.43	2.32	2.99	0.00	0.00	0.00	0.00	0.65

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Historical Summary

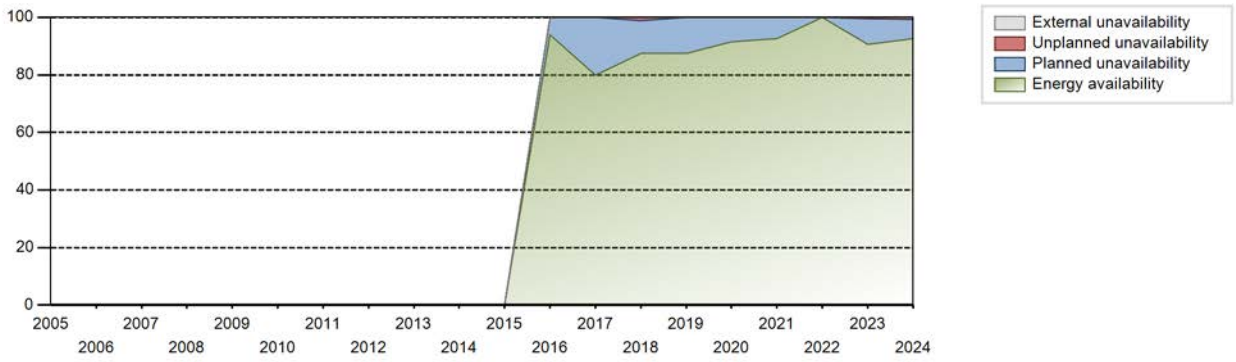
Lifetime energy generation	:	38686.6 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.2 %
Cumulative Energy Availability Factor (EAF)	:	90.67 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.18 %
Cumulative Unit Capability Factor (UCF)	:	90.76 %	Cumulative Planned Unavailability Factor (PUF)	:	9.06 %
Cumulative Load Factor (LF)	:	81.51 %	Cumulative Externally cause unavailability (XUF)	:	0.09 %
Cumulative Operating Factor (OF)	:	90.7 %			

Electricity Production (net) [GWh]



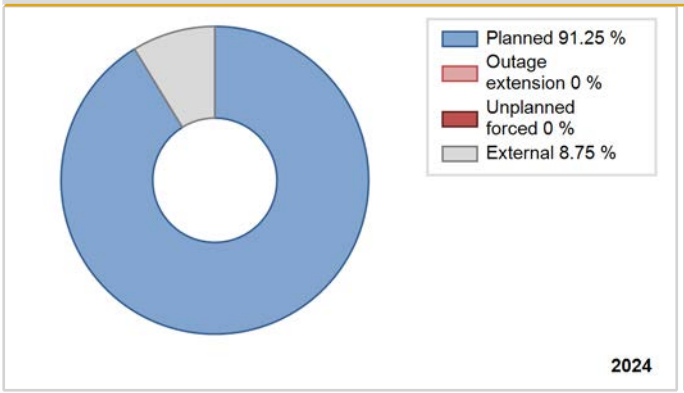
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2015	43.73	1006	610	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	3617.23	8185	601	93.96	93.96	68.52	93.18	0.00	0.00	6.04	0.00
2017	3405.19	7006	601	79.95	79.95	64.68	79.98	0.00	0.00	20.05	0.00
2018	3909.29	7711	601	87.53	87.53	74.25	88.03	1.36	1.21	11.26	0.00
2019	4352.30	7741	601	87.46	87.46	82.67	88.37	0.00	0.00	12.54	0.00
2020	4519.05	7933	601	91.48	91.48	85.86	90.31	0.00	0.00	8.52	0.00
2021	4467.67	8044	601	92.65	92.65	84.86	91.83	0.00	0.00	7.35	0.00
2022	5195.39	8760	601	99.88	99.88	98.68	100.00	0.00	0.00	0.12	0.00
2023	4645.34	7992	601	90.49	90.68	88.23	91.23	0.43	0.39	8.92	0.19
2024	4531.37	8203	601	92.58	93.23	85.83	93.39	0.00	0.00	6.77	0.65

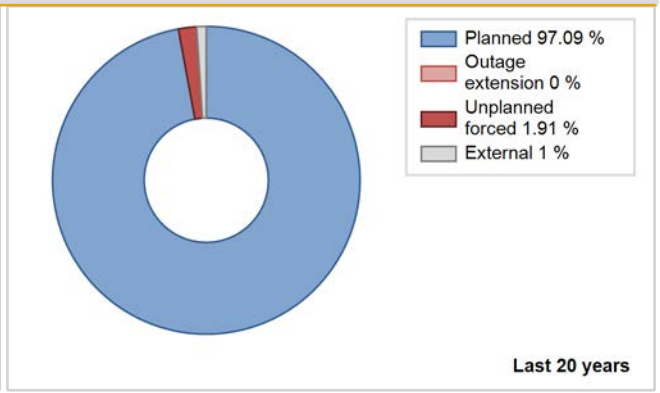
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2015 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					6	
C. Inspection, maintenance or repair combined with refuelling	581			688		
D. Inspection, maintenance or repair without refuelling				68		
I. Grid capacity limitation						12
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						41
Subtotal	581			756	6	53
Total	**581**			**815**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2015 to 2024
	Hours Lost	Average hours lost per reactor-year
31. Turbine and auxiliaries		2
33. Circulating Water System		3
34. Miscellaneous Systems		27
Total		**32**

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2024 Operating Experience

CN-37 CHANGJIANG-2 CHINA



Status at end of year	:	**Operational**
Operator	:	HNPC (Hainan Nuclear Power Company)
Owner	:	CNNC (CHINA NATIONAL NUCLEAR CORPORATION)
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-600
Thermal power	:	1930 MWth
Gross electrical power	:	650 MWe
Reference unit power (net)	:	601 MWe

Key Dates

Construction Date	:	2010-11-21
Grid Date	:	2016-06-20
Commercial Date	:	2016-08-12
Age at end of year	:	8 years

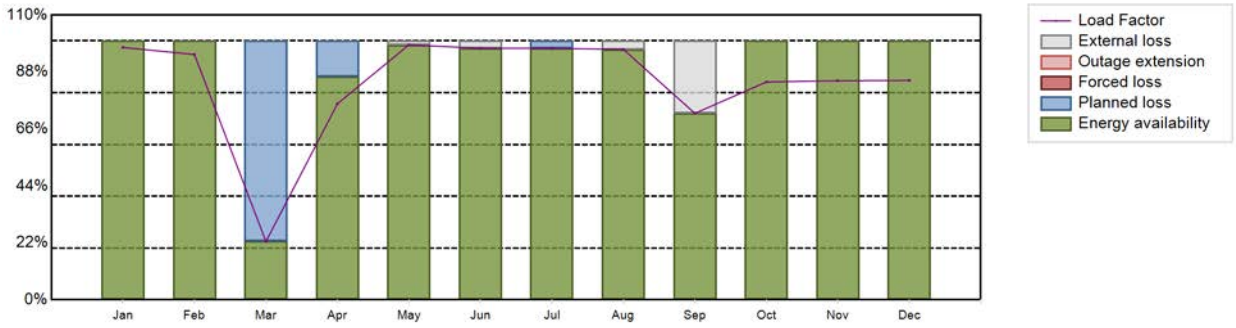
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	326.6
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.35
Average fuel enrichment [% of U235]	:	2.53	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	29.75	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	2.67	HP cylinder inlet steam pressure [MPa]	:	6.41
Active core height/length [m]	:	3.66	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	121	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.09	Number of main condensate pumps	:	3
Number of control rod assemblies	:	33	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4421.19 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	89.14 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	92.08 %	Planned Unavailability Factor (PUF)	:	7.92 %
Load Factor (LF)	:	83.75 %	Externally cause unavailability (XUF)	:	2.93 %
Operating Factor (OF)	:	92.32 %	Total off-line time	:	675 hours

Annual Summary



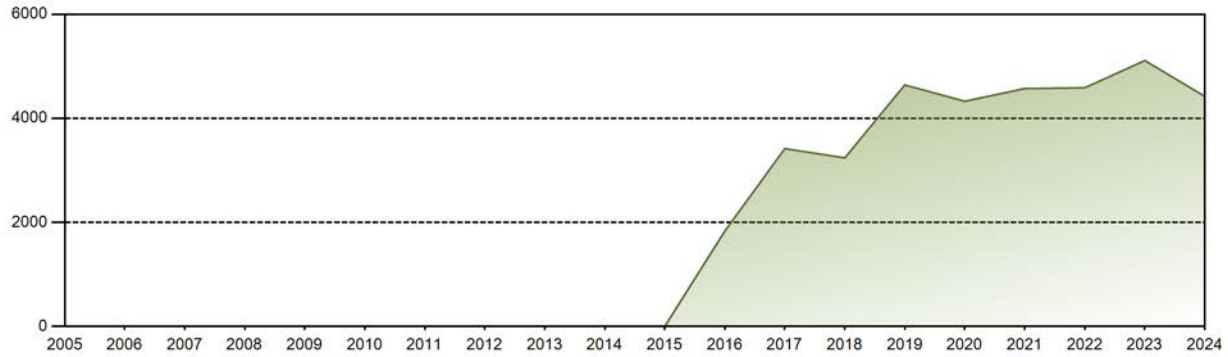
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	435.81	396.35	100.69	327.79	440.36	420.42	434.32	432.45	311.68	376.24	366.16	378.91	4421.19
EAF [%]	100.00	100.00	22.58	86.31	98.48	97.16	97.13	96.71	72.03	100.00	100.00	100.00	89.14
UCF [%]	100.00	100.00	22.58	86.31	100.00	100.00	97.13	100.00	100.00	100.00	100.00	100.00	92.08
LF [%]	97.46	94.75	22.52	75.75	98.48	97.16	97.13	96.71	72.03	84.14	84.62	84.74	83.75
OF [%]	100.00	100.00	22.58	86.25	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.32
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	77.42	13.69	0.00	0.00	2.87	0.00	0.00	0.00	0.00	0.00	7.92
XUF [%]	0.00	0.00	0.00	0.00	1.52	2.84	0.00	3.29	27.97	0.00	0.00	0.00	2.93

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Historical Summary

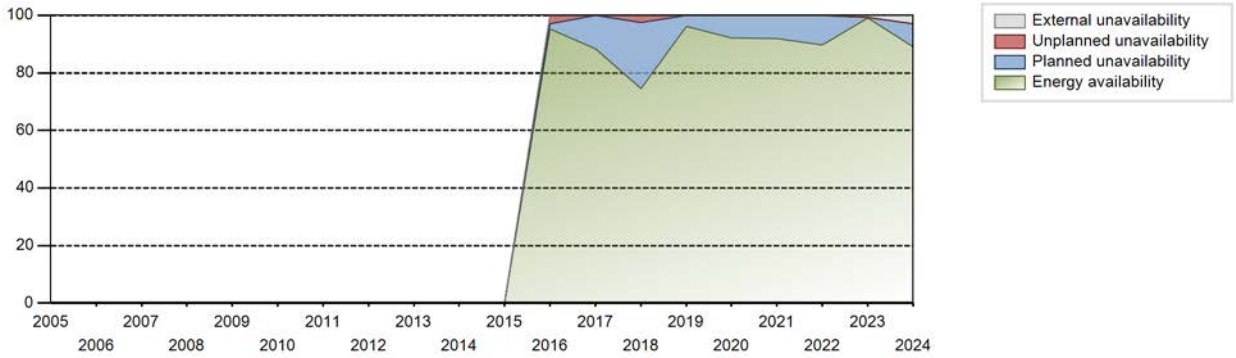
Lifetime energy generation	:	36149.15 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.34 %
Cumulative Energy Availability Factor (EAF)	:	90.4 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.44 %
Cumulative Unit Capability Factor (UCF)	:	90.84 %	Cumulative Planned Unavailability Factor (PUF)	:	8.72 %
Cumulative Load Factor (LF)	:	81.01 %	Cumulative Externally cause unavailability (XUF)	:	0.44 %
Cumulative Operating Factor (OF)	:	90.31 %			

Electricity Production (net) [GWh]

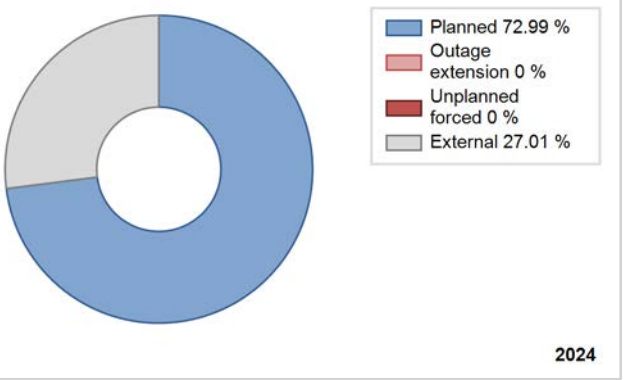


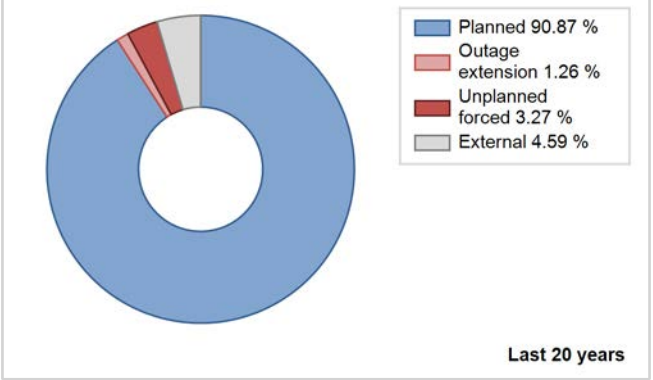
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	1831.25	4180	601	95.30	95.30	72.98	95.89	3.07	3.02	1.68	0.00
2017	3417.22	7524	601	88.44	88.44	64.91	85.89	0.00	0.00	11.56	0.00
2018	3239.86	6531	601	74.48	74.48	61.54	74.55	1.82	2.40	23.12	0.00
2019	4641.87	8483	601	96.23	96.23	88.17	96.84	0.00	0.00	3.77	0.00
2020	4328.28	7689	601	92.11	92.11	81.99	87.53	0.00	0.00	7.89	0.00
2021	4572.65	8147	601	91.96	91.96	86.85	93.00	0.00	0.00	8.04	0.00
2022	4587.19	7882	601	89.67	89.67	87.13	89.98	0.00	0.00	10.33	0.00
2023	5110.99	8760	601	99.12	99.90	97.08	100.00	0.00	0.00	0.10	0.77
2024	4421.19	8109	601	89.14	92.08	83.75	92.32	0.00	0.00	7.92	2.93

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					35	
C. Inspection, maintenance or repair combined with refuelling	675			724		
E. Testing of plant systems or components				38		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						94
Subtotal	675			762	35	94
Total	**675**			**891**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		3
14. Safety Systems		10
16. Steam generation systems		5
31. Turbine and auxiliaries		9
33. Circulating Water System		16
34. Miscellaneous Systems		45
Total		**88**

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2024 Operating Experience

CN-2 DAYA BAY-1 CHINA



Status at end of year	:	**Operational**
Operator	:	DNMC (Daya Bay Nuclear Power Operations and Management Co, Ltd.)
Owner	:	GNPJVC (GUANGDONG NUCLEAR POWER JOINT VENTURE COMPANY LIMITED)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	PWR / M310
Thermal power	:	2905 MWth
Gross electrical power	:	984 MWe
Reference unit power (net)	:	944 MWe

Key Dates

Construction Date	:	1987-08-07
Grid Date	:	1993-08-31
Commercial Date	:	1994-02-01
Age at end of year	:	31 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.45
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	46
Average discharge burnup [MWd/t]	:	43000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

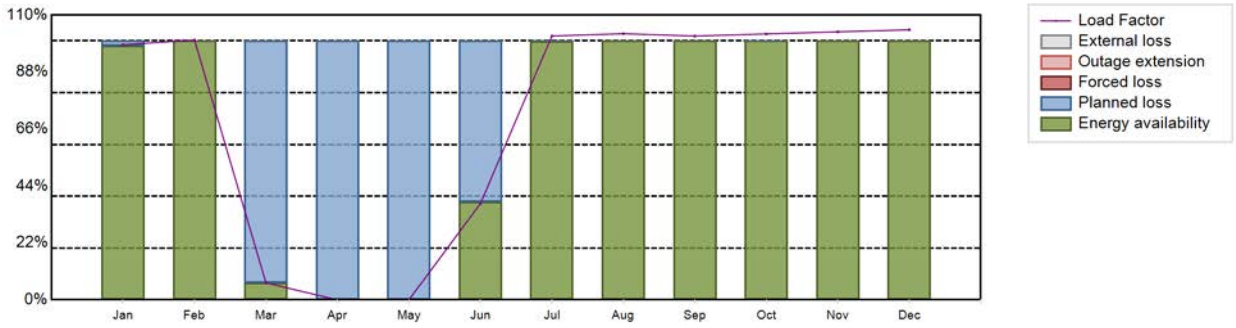
Operating coolant pressure [MPa]	:	15.81
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.43
Output voltage [kV]	:	26
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5937.65 GW(e).h
Energy Availability Factor (EAF)	:	70.16 %
Unit Capability Factor (UCF)	:	70.16 %
Load Factor (LF)	:	71.61 %
Operating Factor (OF)	:	72.35 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	29.84 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	2429 hours

Annual Summary



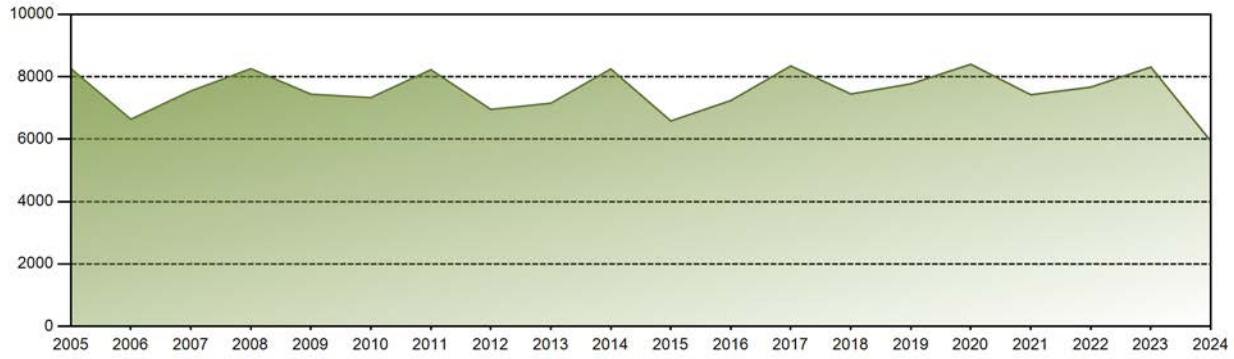
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	692.07	659.35	46.04	0.00	0.00	252.77	715.69	721.89	692.52	721.30	703.55	732.47	5937.65
EAF [%]	98.14	100.00	6.59	0.00	0.00	37.74	99.95	100.00	100.00	99.99	100.00	100.00	70.16
UCF [%]	98.14	100.00	6.59	0.00	0.00	37.74	99.95	100.00	100.00	99.99	100.00	100.00	70.16
LF [%]	98.54	100.35	6.56	0.00	0.00	37.19	101.90	102.78	101.89	102.70	103.51	104.29	71.61
OF [%]	100.00	100.00	6.85	0.00	0.00	62.22	100.00	100.00	100.00	100.00	100.00	100.00	72.35
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	1.86	0.00	93.41	100.00	100.00	62.26	0.05	0.00	0.00	0.01	0.00	0.00	29.84
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	221794.84 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.12 %
Cumulative Energy Availability Factor (EAF)	:	86.61 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.16 %
Cumulative Unit Capability Factor (UCF)	:	88.71 %	Cumulative Planned Unavailability Factor (PUF)	:	10.12 %
Cumulative Load Factor (LF)	:	86.97 %	Cumulative Externally cause unavailability (XUF)	:	2.11 %
Cumulative Operating Factor (OF)	:	88.23 %			

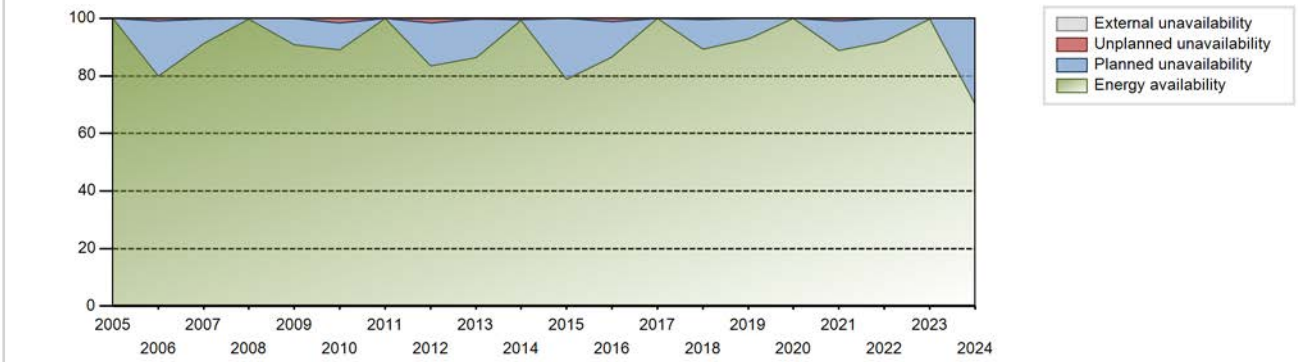
Electricity Production (net) [GWh]



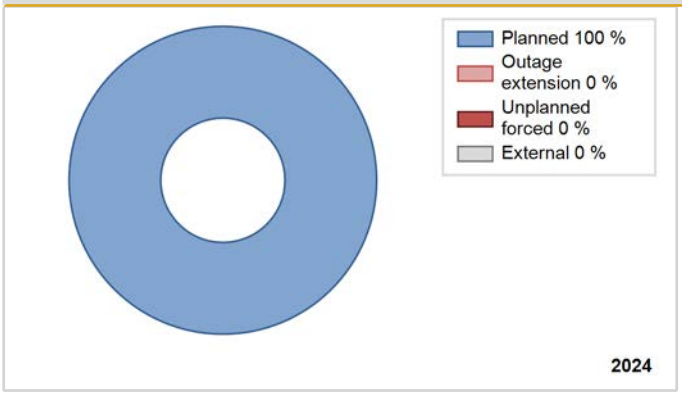
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1994	5917.39	6539	944	76.26	77.44	76.76	79.65	18.87	18.01	4.55	1.18
1995	3723.63	4088	944	46.21	84.61	45.03	46.67	0.45	0.38	15.00	38.40
1996	6252.67	6847	944	76.01	76.77	75.41	77.95	5.09	4.12	19.11	0.75
1997	6491.23	7272	944	74.61	82.05	78.50	83.01	0.26	0.21	17.74	7.44
1998	6040.47	7344	944	71.99	79.64	73.05	83.84	5.64	4.76	15.60	7.65
1999	6723.65	7680	944	82.71	87.65	81.30	87.66	0.02	0.02	12.33	4.94
2000	6986.58	7641	944	85.18	85.44	84.26	86.99	2.85	2.50	12.06	0.26
2001	7009.34	7619	944	84.81	87.49	84.76	86.97	0.36	0.32	12.19	2.68
2002	7387.25	7924	944	89.52	89.62	89.33	90.46	0.27	0.24	10.13	0.10
2003	7400.76	7958	944	90.42	90.95	89.50	90.84	0.07	0.06	8.99	0.53
2004	7540.90	7789	944	88.21	88.45	90.94	88.67	0.00	0.00	11.55	0.24
2005	8260.49	8760	944	99.97	99.97	99.89	100.00	0.03	0.03	0.01	0.00
2006	6635.15	7133	944	79.86	79.86	80.24	81.43	1.10	0.89	19.26	0.00
2007	7542.13	8074	944	91.20	91.20	91.20	92.17	0.22	0.20	8.59	0.00
2008	8255.49	8774	944	99.84	99.97	99.56	99.89	0.01	0.01	0.02	0.13
2009	7439.13	8055	944	90.81	90.86	89.96	91.95	0.02	0.02	9.12	0.05
2010	7328.51	7876	944	88.95	88.95	88.62	89.91	0.00	1.61	9.44	0.00
2011	8222.61	8760	944	99.98	99.98	99.43	100.00	0.00	0.00	0.02	0.00
2012	6952.17	7452	944	83.56	83.90	83.84	84.84	0.14	1.36	14.74	0.35
2013	7150.01	7682	944	86.41	86.68	86.46	87.69	0.01	0.01	13.31	0.26
2014	8247.51	8735	944	99.33	99.53	99.73	99.71	0.31	0.31	0.15	0.20
2015	6581.67	6954	944	78.84	78.84	79.59	79.38	0.00	0.00	21.16	0.00
2016	7235.87	7671	944	86.58	86.58	87.26	87.33	0.04	1.24	12.18	0.00
2017	8343.32	8760	944	99.98	99.98	100.89	100.00	0.00	0.00	0.01	0.00
2018	7444.51	7871	944	89.18	89.25	90.02	89.85	0.42	0.38	10.37	0.07
2019	7771.68	8186	944	92.94	92.94	93.98	93.45	0.00	0.00	7.06	0.00
2020	8398.23	8784	944	99.99	99.99	101.28	100.00	0.00	0.00	0.01	0.00
2021	7421.56	7834	944	88.92	88.92	89.75	89.43	0.00	0.84	10.24	0.00
2022	7666.03	8101	944	91.84	91.84	92.70	92.48	0.00	0.00	8.16	0.00
2023	8307.47	8760	944	99.64	99.64	100.46	100.00	0.00	0.00	0.36	0.00
2024	5937.65	6355	944	70.16	70.16	71.61	72.35	0.00	0.00	29.84	0.00

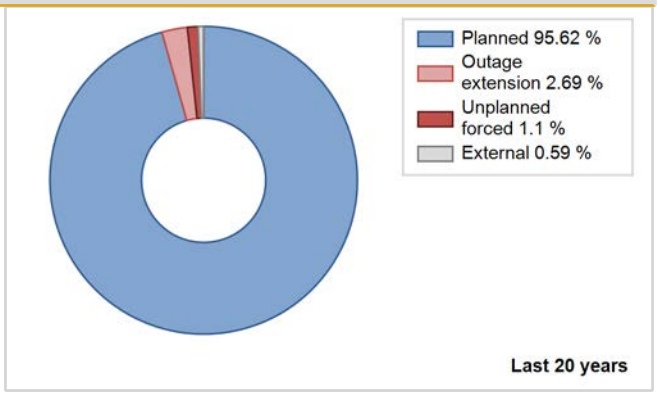
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1994 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					83	
C. Inspection, maintenance or repair combined with refuelling	2429			833		
D. Inspection, maintenance or repair without refuelling				9		
E. Testing of plant systems or components					0	
J. Grid limitation, failure or grid unavailability						10
Z. Other						100
Subtotal	2429			842	83	110
Total	**2429**			**1035**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1994 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		3
15. Reactor Cooling Systems		8
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		10
33. Circulating Water System		2
34. Miscellaneous Systems		2
41. Main Generator Systems		31
42. Electrical Power Supply Systems		18
Total		**83**

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2024 Operating Experience

CN-3 DAYA BAY-2 CHINA



Status at end of year	:	**Operational**
Operator	:	DNMC (Daya Bay Nuclear Power Operations and Management Co, Ltd.)
Owner	:	GNPJVC (GUANGDONG NUCLEAR POWER JOINT VENTURE COMPANY LIMITED)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	PWR / M310
Thermal power	:	2905 MWth
Gross electrical power	:	1026 MWe
Reference unit power (net)	:	986 MWe

Key Dates

Construction Date	:	1988-04-07
Grid Date	:	1994-02-07
Commercial Date	:	1994-05-06
Age at end of year	:	30 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.45
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	46
Average discharge burnup [MWd/t]	:	43000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

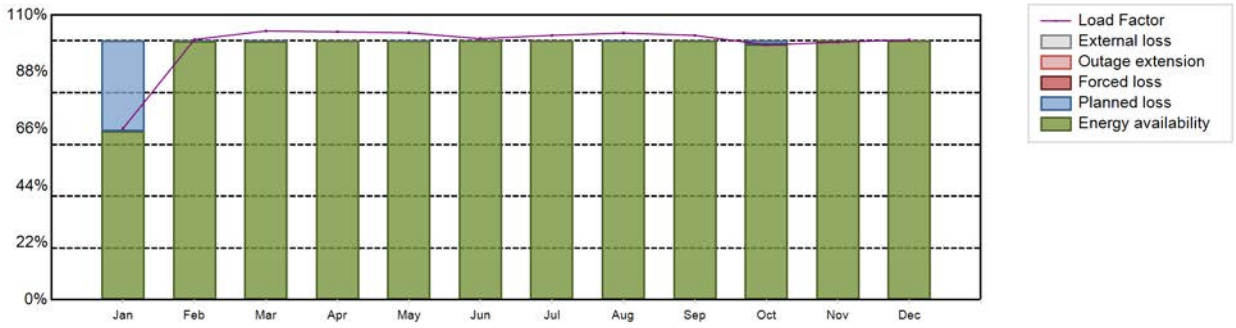
Operating coolant pressure [MPa]	:	15.81
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.43
Output voltage [kV]	:	26
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8267.91 GW(e).h
Energy Availability Factor (EAF)	:	96.94 %
Unit Capability Factor (UCF)	:	96.94 %
Load Factor (LF)	:	98.61 %
Operating Factor (OF)	:	98.83 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	3.06 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	103 hours

Annual Summary



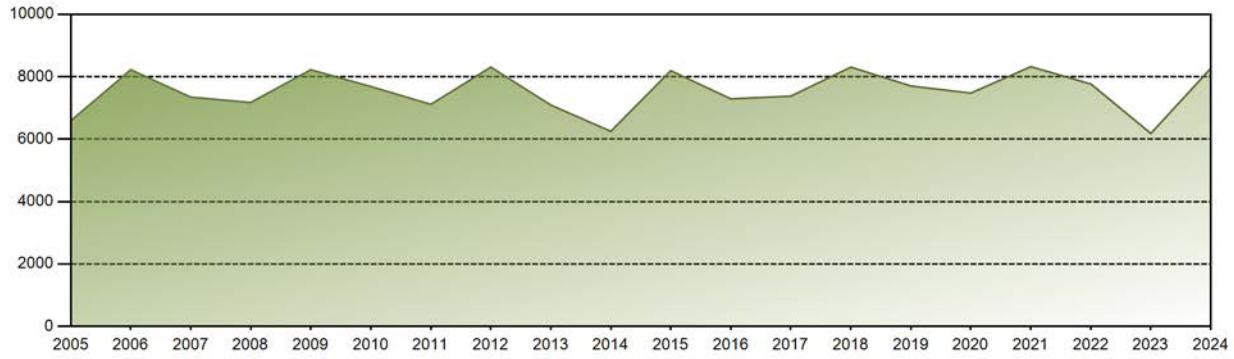
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	464.62	660.58	729.24	703.43	724.31	685.56	717.38	723.41	694.17	722.11	706.63	736.45	8267.91
EAF [%]	65.18	99.97	99.85	100.00	99.99	100.00	100.00	99.99	100.00	98.56	100.00	100.00	96.94
UCF [%]	65.18	99.97	99.85	100.00	99.99	100.00	100.00	99.99	100.00	98.56	100.00	100.00	96.94
LF [%]	66.15	100.54	103.83	103.49	103.13	100.87	102.14	103.00	102.13	98.44	99.54	100.39	98.61
OF [%]	86.16	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.83
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	34.82	0.03	0.15	0.00	0.01	0.00	0.00	0.01	0.00	1.44	0.00	0.00	3.06
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	220287.14 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.36 %
Cumulative Energy Availability Factor (EAF)	:	86.76 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.92 %
Cumulative Unit Capability Factor (UCF)	:	87.74 %	Cumulative Planned Unavailability Factor (PUF)	:	10.34 %
Cumulative Load Factor (LF)	:	87 %	Cumulative Externally cause unavailability (XUF)	:	0.98 %
Cumulative Operating Factor (OF)	:	88.17 %			

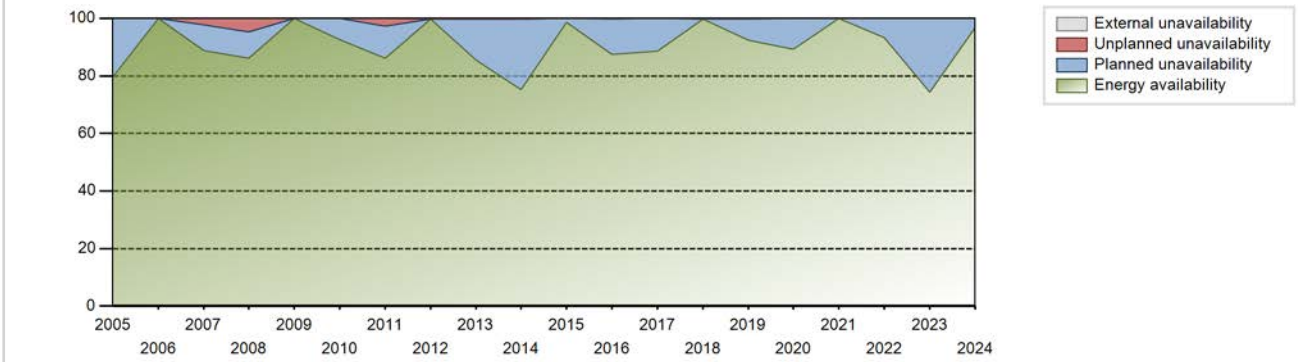
Electricity Production (net) [GWh]



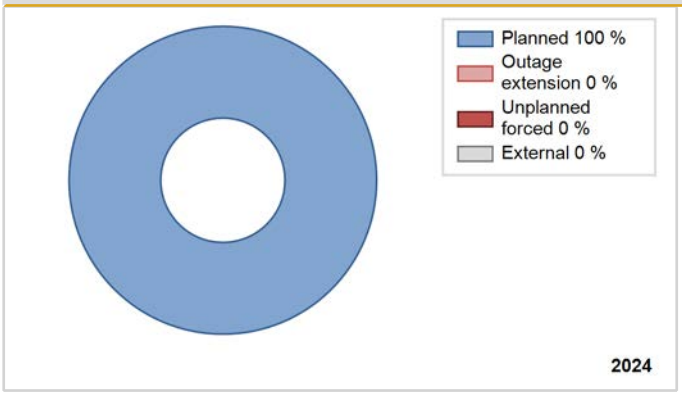
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1994	5741.21	6889	944	92.32	99.39	90.33	97.98	0.60	0.60	0.01	7.07
1995	6343.33	7146	944	77.48	81.09	76.71	81.58	1.35	1.11	17.80	3.60
1996	5276.90	5740	944	63.92	67.43	63.64	65.35	13.49	10.51	22.05	3.51
1997	5914.84	6194	944	67.41	70.10	71.53	70.71	2.15	1.54	28.37	2.69
1998	6259.05	7302	944	74.71	82.90	75.69	83.36	2.15	1.82	15.27	8.19
1999	6789.46	7594	944	83.32	86.18	82.10	86.69	0.00	0.00	13.82	2.87
2000	6995.52	7840	944	88.39	89.13	84.36	89.25	0.05	0.05	10.83	0.73
2001	7355.47	7986	944	89.46	91.12	88.95	91.16	0.19	0.18	8.70	1.66
2002	6728.92	7224	944	81.62	82.22	81.37	82.47	15.12	14.64	3.14	0.60
2003	6983.05	7503	944	84.53	84.62	84.44	85.65	0.53	1.17	14.21	0.09
2004	6358.88	6580	944	74.23	74.39	76.69	74.91	0.10	16.74	8.87	0.17
2005	6586.98	7075	944	79.62	79.62	79.65	80.76	0.03	0.02	20.36	0.00
2006	8222.79	8760	944	99.89	99.89	99.44	100.00	0.04	0.04	0.07	0.00
2007	7344.17	7858	944	88.81	88.81	88.81	89.70	0.90	2.27	8.92	0.00
2008	7174.36	7667	944	86.25	86.25	86.52	87.28	5.20	4.73	9.02	0.00
2009	8222.61	8760	944	99.98	99.99	99.43	100.00	0.00	0.00	0.01	0.01
2010	7685.64	8197	944	92.50	92.50	92.94	93.57	0.01	0.01	7.49	0.00
2011	7113.12	7649	944	86.23	86.34	86.02	87.32	0.00	2.65	11.00	0.11
2012	8304.98	8784	944	99.66	99.97	100.16	100.00	0.00	0.00	0.03	0.31
2013	7091.41	7605	944	85.58	85.81	85.75	86.82	0.02	0.02	14.17	0.23
2014	6249.97	6629	944	75.23	75.57	75.58	75.67	0.04	0.03	24.41	0.34
2015	8193.18	8700	944	98.65	98.65	99.08	99.32	0.01	0.01	1.34	0.01
2016	7290.17	7750	944	87.39	87.39	87.92	88.23	0.30	0.30	12.32	0.00
2017	7376.85	7819	944	88.63	88.74	89.21	89.26	0.01	0.01	11.25	0.11
2018	8306.97	8739	944	99.65	99.72	100.45	99.76	0.27	0.27	0.01	0.06
2019	7704.07	8143	944	92.35	92.35	93.16	92.96	0.04	0.24	7.40	0.00
2020	7475.32	7889	944	89.21	89.21	90.15	89.81	0.13	0.12	10.67	0.00
2021	8321.42	8760	944	99.89	99.98	100.63	100.00	0.00	0.00	0.02	0.09
2022	7767.89	8209	944	93.24	93.24	93.93	93.71	0.00	0.00	6.76	0.00
2023	6181.83	6511	944	74.25	74.25	74.76	74.33	0.00	0.00	25.75	0.00
2024	8267.91	8681	986	96.94	96.94	98.61	98.83	0.00	0.00	3.06	0.00

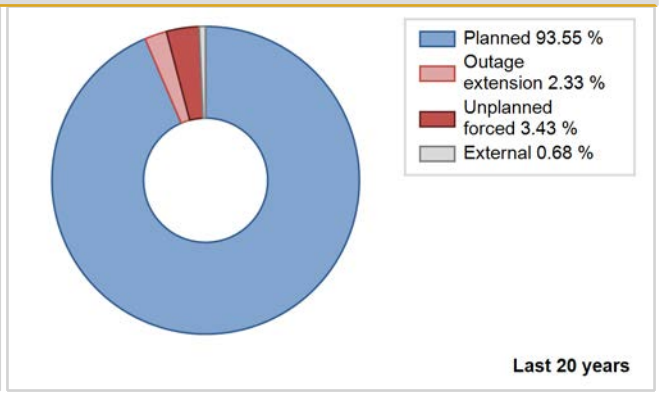
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1994 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					90	
C. Inspection, maintenance or repair combined with refuelling	103			811	7	
D. Inspection, maintenance or repair without refuelling				9		
G. Major backfitting, refurbishment or upgrading activities without refuelling				24		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						11
L. Human factor related					14	
Subtotal	103			844	111	11
Total	**103**			**966**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1994 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		1
12. Reactor I&C Systems		4
14. Safety Systems		0
15. Reactor Cooling Systems		1
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		35
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		1
35. All other I&C Systems		1
41. Main Generator Systems		42
42. Electrical Power Supply Systems		14
Total		**102**

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RUP revision during the year (2024) due to power uprate

RUP at the end of previous year : 944 [MWe]

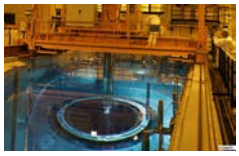
Month	Capacity [MWe]	Power Uprate	Main modifications	Description
October	986	Stretch power uprate (2-7%)	Primary systems	the nameplate power modification of the generator unit was completed on September 27,with the net power increased from 944MWe to986MWe and the gross power increasde from 984MWe to 1026MWe.

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2024 Operating Experience

CN-38 FANGCHENGGANG-1 CHINA

Status at end of year	:	**Operational**
Operator	:	GFNPC (Guangxi Fangchenggang Nuclear Power Company, Ltd.)
Owner	:	GFNPC (Guangxi Fangchenggang Nuclear Power Company, Ltd.)
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)



Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1086 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2010-07-30
Grid Date	:	2015-10-25
Commercial Date	:	2016-01-01
Age at end of year	:	9 years

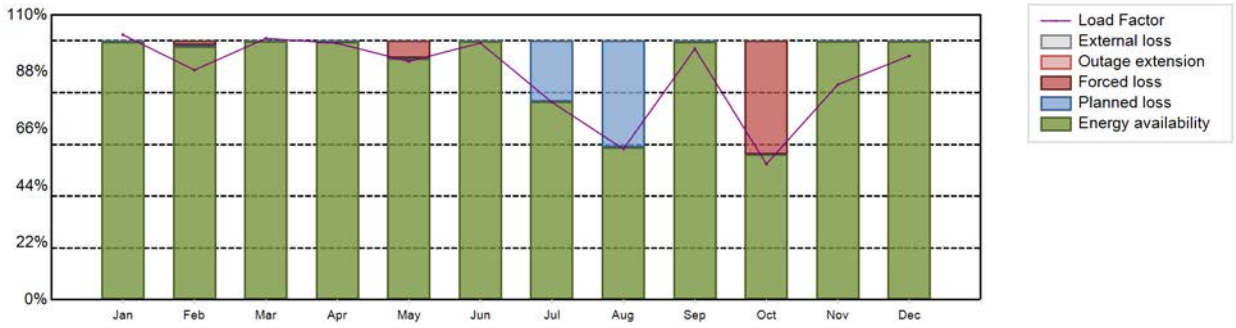
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	2.43	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	44.6	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	NA	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7632.5 GW(e).h	Forced Loss Rate (FLR)	:	4.66 %
Energy Availability Factor (EAF)	:	89.93 %	Unplanned Capability Loss Factor (UCL)	:	4.39 %
Unit Capability Factor (UCF)	:	89.93 %	Planned Unavailability Factor (PUF)	:	5.67 %
Load Factor (LF)	:	86.89 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	90.56 %	Total off-line time	:	829 hours

Annual Summary



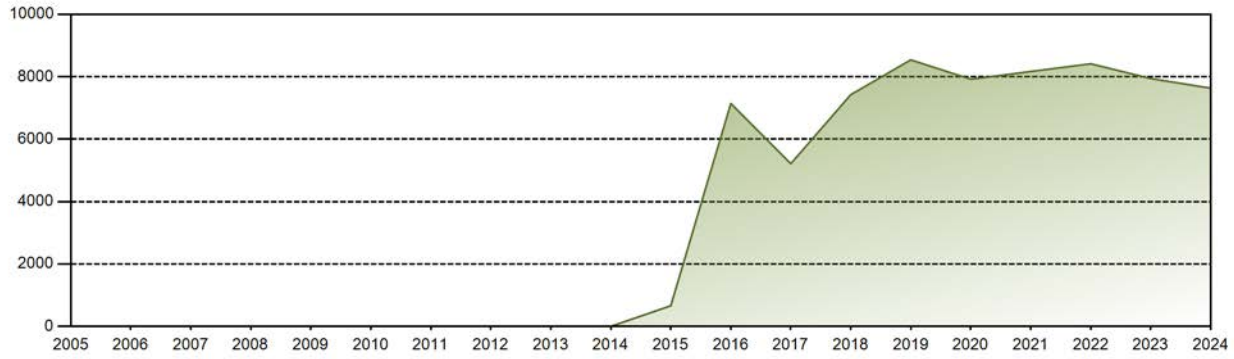
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	761.57	617.72	751.23	713.29	685.04	714.26	567.96	433.39	698.03	390.02	598.69	701.29	7632.50
EAF [%]	99.73	97.99	99.75	99.74	93.20	99.75	76.57	58.89	99.73	56.14	99.75	99.75	89.93
UCF [%]	99.73	97.99	99.75	99.74	93.20	99.75	76.57	58.89	99.73	56.14	99.75	99.75	89.93
LF [%]	102.36	88.75	100.97	99.07	92.08	99.20	76.34	58.25	96.95	52.42	83.15	94.26	86.89
OF [%]	100.00	98.28	100.00	100.00	93.41	100.00	77.69	62.90	100.00	56.18	100.00	100.00	90.56
FLR [%]	0.00	1.69	0.00	0.00	6.57	0.00	0.00	0.00	0.00	43.80	0.00	0.00	4.66
UCL [%]	0.00	1.69	0.00	0.00	6.55	0.00	0.00	0.00	0.00	43.75	0.00	0.00	4.39
PUF [%]	0.27	0.32	0.25	0.26	0.25	0.25	23.43	41.11	0.27	0.11	0.25	0.25	5.67
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

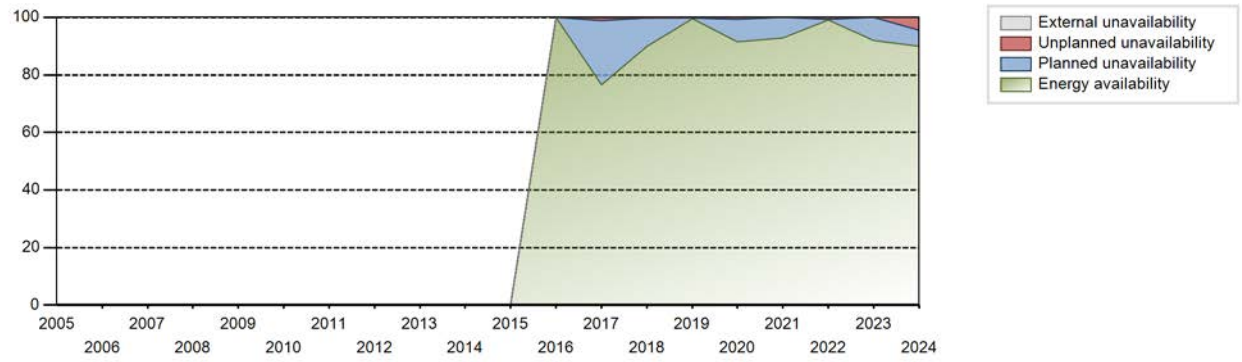
Lifetime energy generation	:	69058.39 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.75 %
Cumulative Energy Availability Factor (EAF)	:	92.4 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.8 %
Cumulative Unit Capability Factor (UCF)	:	92.43 %	Cumulative Planned Unavailability Factor (PUF)	:	6.77 %
Cumulative Load Factor (LF)	:	86.67 %	Cumulative Externally cause unavailability (XUF)	:	0.04 %
Cumulative Operating Factor (OF)	:	89.7 %			

Electricity Production (net) [GWh]

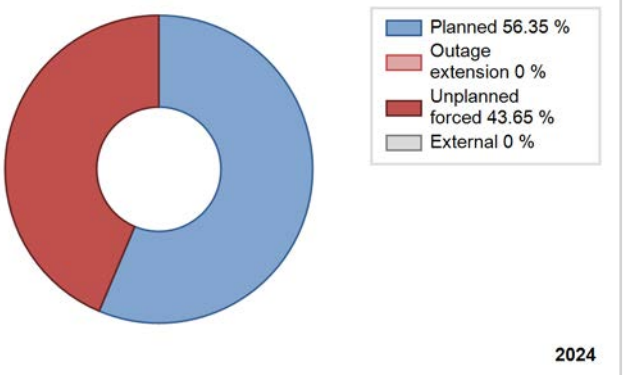


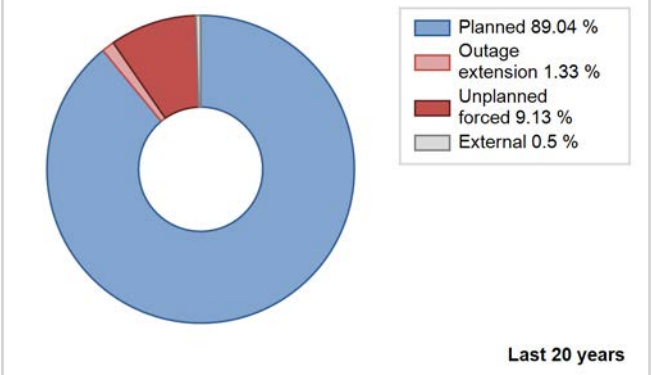
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	7141.83	7761	1000	99.97	99.97	81.30	88.35	0.00	0.00	0.03	0.01
2017	5212.98	5794	1000	76.66	76.82	59.51	66.14	0.00	0.91	22.27	0.16
2018	7425.87	7622	1000	90.01	90.19	84.77	87.01	0.01	0.01	9.80	0.18
2019	8540.31	8736	1000	99.62	99.62	97.49	99.73	0.36	0.36	0.02	0.00
2020	7919.20	8140	1000	91.43	91.43	90.15	92.67	0.72	0.66	7.91	0.00
2021	8168.79	8179	1000	92.90	92.90	93.25	93.37	0.00	0.00	7.09	0.00
2022	8414.60	8499	1000	99.18	99.18	96.06	97.02	0.81	0.81	0.01	0.00
2023	7940.89	8098	1000	91.84	91.84	90.65	92.44	0.00	0.00	8.16	0.00
2024	7632.50	7955	1000	89.93	89.93	86.89	90.56	4.66	4.39	5.67	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					19	
C. Inspection, maintenance or repair combined with refuelling	443			558		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						283
Z. Other		386			43	
Subtotal	443	386		558	62	283
Total	**829**			**903**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
14. Safety Systems		9
15. Reactor Cooling Systems		7
31. Turbine and auxiliaries		3
34. Miscellaneous Systems	386	65
Total	**386**	**84**

Highlights (2024)

1.CN38 was basically operated in base-load mode.There was no scram in 2024.
2.At the request of grid system,CN38 deloaded for some holidays and weekends and other reasons.
3.CN38 was bearing its fifth refuelling outage form Jul 25 to Aug 12,lasting 18.42 days.

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2024 Operating Experience

CN-39 FANGCHENGGANG-2 CHINA

Status at end of year	:	**Operational**
Operator	:	GFNPC (Guangxi Fangchenggang Nuclear Power Company, Ltd.)
Owner	:	GFNPC (Guangxi Fangchenggang Nuclear Power Company, Ltd.)
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)



Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1086 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2010-12-23
Grid Date	:	2016-07-15
Commercial Date	:	2016-10-01
Age at end of year	:	8 years

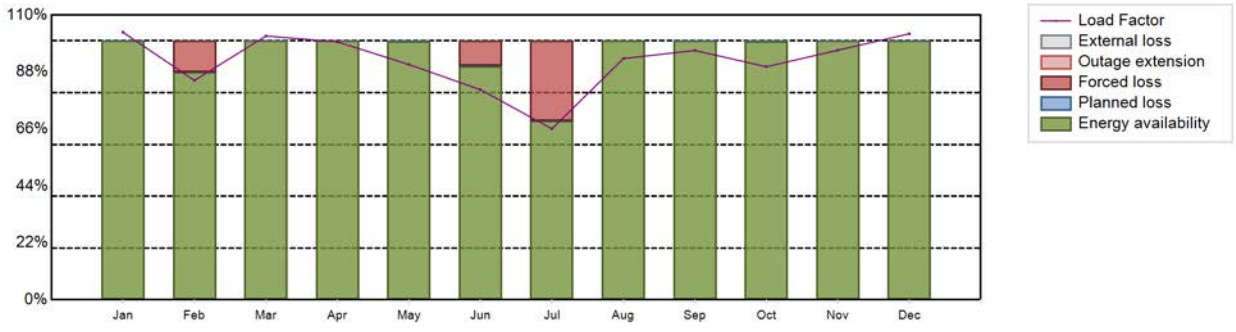
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	2.43	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	44.6	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	NA	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8101.59 GW(e).h	Forced Loss Rate (FLR)	:	4.36 %
Energy Availability Factor (EAF)	:	95.62 %	Unplanned Capability Loss Factor (UCL)	:	4.36 %
Unit Capability Factor (UCF)	:	95.62 %	Planned Unavailability Factor (PUF)	:	0.02 %
Load Factor (LF)	:	92.23 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	95.64 %	Total off-line time	:	383 hours

Annual Summary



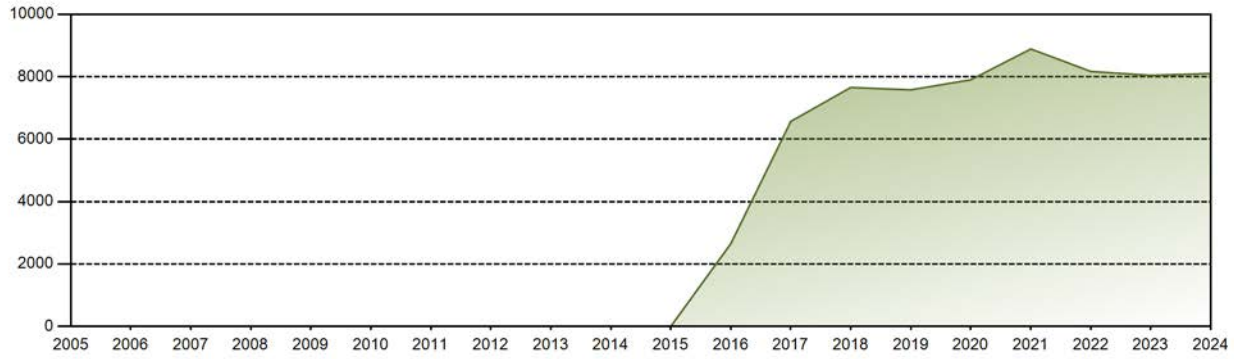
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	768.95	589.79	758.12	717.40	676.07	584.52	491.50	693.28	693.44	669.81	694.18	764.52	8101.59
EAF [%]	100.00	87.99	100.00	100.00	99.92	90.30	69.03	100.00	100.00	99.97	100.00	100.00	95.62
UCF [%]	100.00	87.99	100.00	100.00	99.92	90.30	69.03	100.00	100.00	99.97	100.00	100.00	95.62
LF [%]	103.35	84.74	101.90	99.64	90.87	81.18	66.06	93.18	96.31	90.03	96.41	102.76	92.23
OF [%]	100.00	88.07	100.00	100.00	100.00	90.28	69.09	100.00	100.00	100.00	100.00	100.00	95.64
FLR [%]	0.00	11.97	0.00	0.00	0.00	9.69	30.96	0.00	0.00	0.00	0.00	0.00	4.36
UCL [%]	0.00	11.96	0.00	0.00	0.00	9.69	30.95	0.00	0.00	0.00	0.00	0.00	4.36
PUF [%]	0.00	0.04	0.00	0.00	0.08	0.01	0.03	0.00	0.00	0.03	0.00	0.00	0.02
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

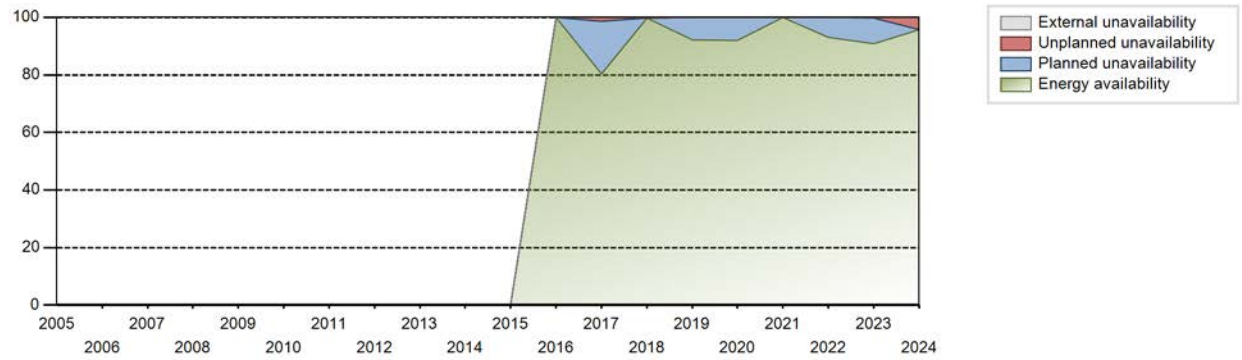
Lifetime energy generation	:	65460.88 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.78 %
Cumulative Energy Availability Factor (EAF)	:	93.17 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.73 %
Cumulative Unit Capability Factor (UCF)	:	93.2 %	Cumulative Planned Unavailability Factor (PUF)	:	6.07 %
Cumulative Load Factor (LF)	:	89.75 %	Cumulative Externally cause unavailability (XUF)	:	0.04 %
Cumulative Operating Factor (OF)	:	90.46 %			

Electricity Production (net) [GWh]

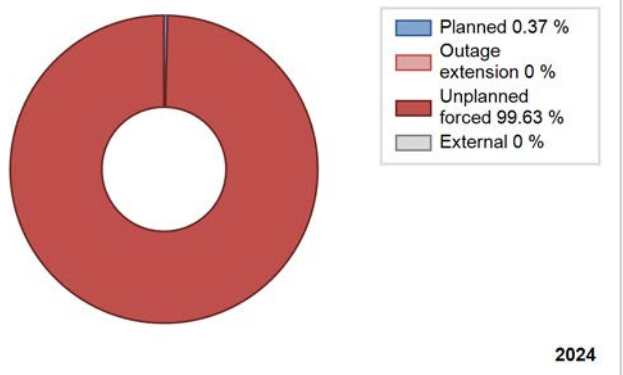


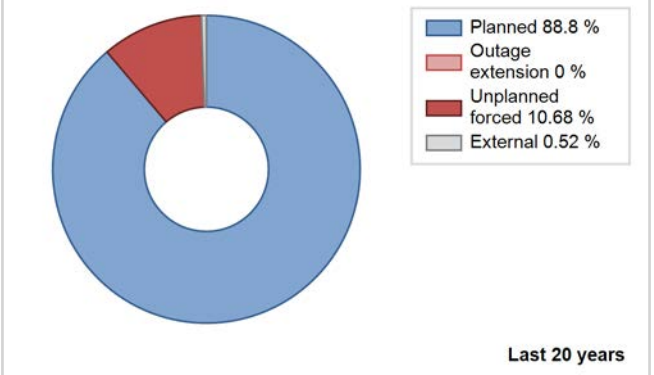
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	2648.30	3297	1000	100.00	100.00	91.13	88.22	0.00	0.00	0.00	0.00
2017	6569.07	6827	1000	80.27	80.38	74.99	77.93	1.63	1.33	18.29	0.12
2018	7655.73	7816	1000	99.81	99.98	87.39	89.22	0.01	0.01	0.01	0.18
2019	7579.32	7625	1000	92.14	92.14	86.52	87.04	0.08	0.08	7.78	0.00
2020	7901.00	7911	1000	91.98	91.98	89.95	90.06	0.00	0.00	8.02	0.00
2021	8888.26	8760	1000	99.99	99.99	101.46	100.00	0.00	0.00	0.01	0.00
2022	8168.69	8129	1000	93.04	93.04	93.25	92.80	0.00	0.00	6.96	0.00
2023	8044.34	8018	1000	90.78	90.78	91.83	91.53	0.26	0.23	8.99	0.00
2024	8101.59	8401	1000	95.62	95.62	92.23	95.64	4.36	4.36	0.02	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					15	
C. Inspection, maintenance or repair combined with refuelling				504		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						272
Z. Other		383			46	
Subtotal		383		504	61	272
Total		**383**			**837**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
31. Turbine and auxiliaries		14
34. Miscellaneous Systems	383	133
Total	**383**	**147**

Highlights (2024)

1.CN39 was basically operated in base-load mode.There was no scram in 2024.
2.At the request of grid system,CN39 deloaded for some holidays and weekends and other reasons.

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2024 Operating Experience

CN-55 FANGCHENGGANG-3 CHINA



Status at end of year	:	**Operational**
Operator	:	GFNPC (Guangxi Fangchenggang Nuclear Power Company, Ltd.)
Owner	:	GFNPC (Guangxi Fangchenggang Nuclear Power Company, Ltd.)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	SEG (Shanghai Electric Group)

Reactor Unit Details

Reactor type and model	:	PWR / HPR1000
Thermal power	:	3150 MWth
Gross electrical power	:	1180 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2015-12-24
Grid Date	:	2023-01-10
Commercial Date	:	2023-03-25
Age at end of year	:	1 years

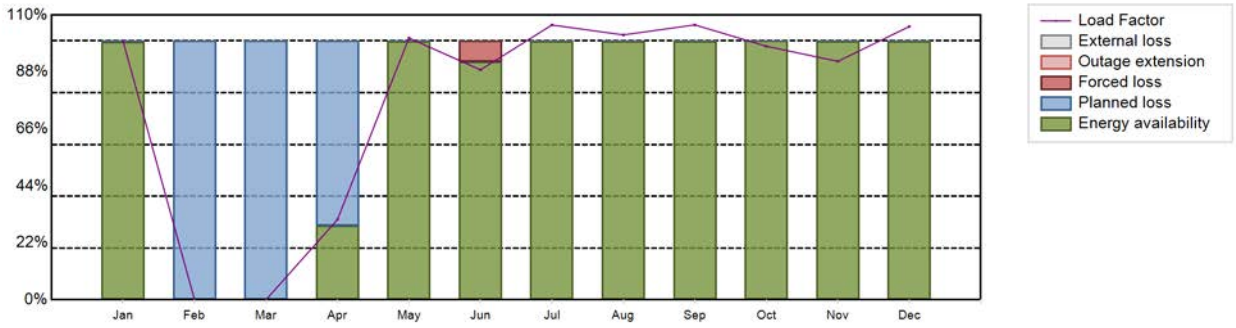
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.45
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	40.7
Average discharge burnup [MWd/t]	:	47400
Active core diameter [m]	:	3.23
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.95
Number of control rod assemblies	:	68
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	324.5
Number of SG	:	3
Containment type	:	Double
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.45
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6852.87 GW(e).h
Energy Availability Factor (EAF)	:	77.07 %
Unit Capability Factor (UCF)	:	77.07 %
Load Factor (LF)	:	78.02 %
Operating Factor (OF)	:	77.48 %
Forced Loss Rate (FLR)	:	0.85 %
Unplanned Capability Loss Factor (UCL)	:	0.66 %
Planned Unavailability Factor (PUF)	:	22.28 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1978 hours

Annual Summary



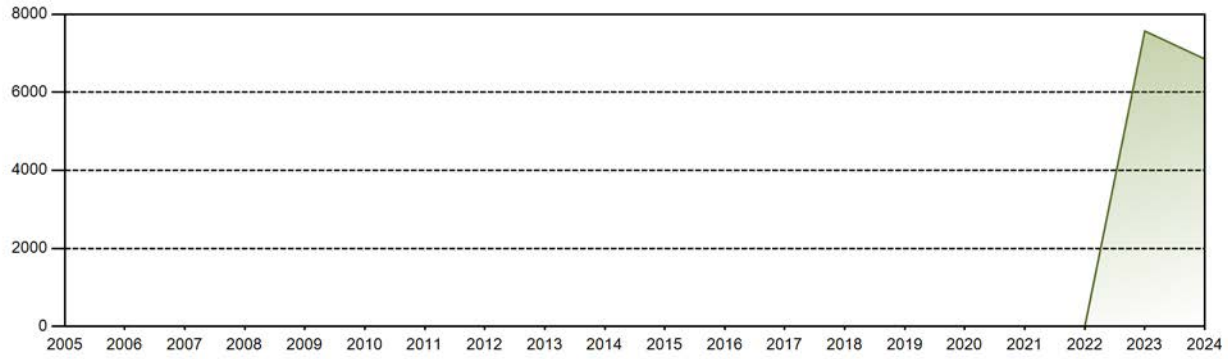
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	744.00	0.79	0.00	223.18	752.41	639.54	789.80	761.33	764.56	728.64	663.22	785.39	6852.87
EAF [%]	99.73	0.09	0.00	28.71	99.96	91.92	99.97	99.96	99.96	100.00	99.96	99.95	77.07
UCF [%]	99.73	0.09	0.00	28.71	99.96	91.92	99.97	99.96	99.96	100.00	99.96	99.95	77.07
LF [%]	100.00	0.11	0.00	31.00	101.13	88.83	106.16	102.33	106.19	97.94	92.11	105.56	78.02
OF [%]	100.00	0.29	0.00	33.06	100.00	91.94	100.00	100.00	100.00	100.00	100.00	100.00	77.48
FLR [%]	0.00	0.00	0.00	0.00	0.00	8.03	0.00	0.00	0.00	0.00	0.00	0.00	0.85
UCL [%]	0.00	0.00	0.00	0.00	0.00	8.02	0.00	0.00	0.00	0.00	0.00	0.00	0.66
PUF [%]	0.27	99.91	100.00	71.29	0.04	0.06	0.03	0.04	0.04	0.00	0.04	0.05	22.28
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

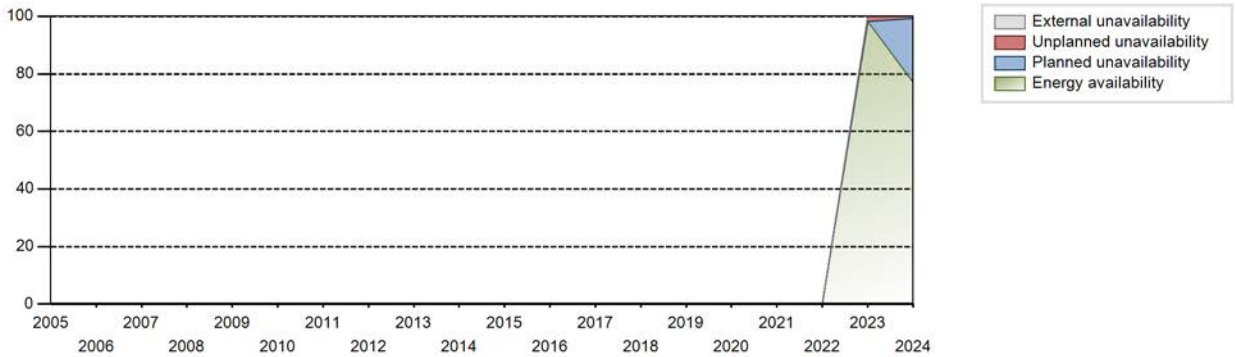
Lifetime energy generation	:	14519 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.31 %
Cumulative Energy Availability Factor (EAF)	:	86.13 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.14 %
Cumulative Unit Capability Factor (UCF)	:	86.13 %	Cumulative Planned Unavailability Factor (PUF)	:	12.73 %
Cumulative Load Factor (LF)	:	90.27 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	86.36 %			

Electricity Production (net) [GWh]

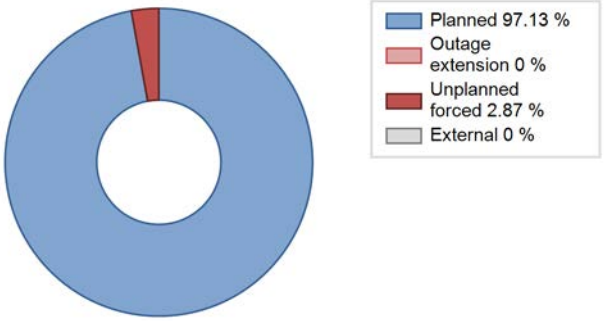


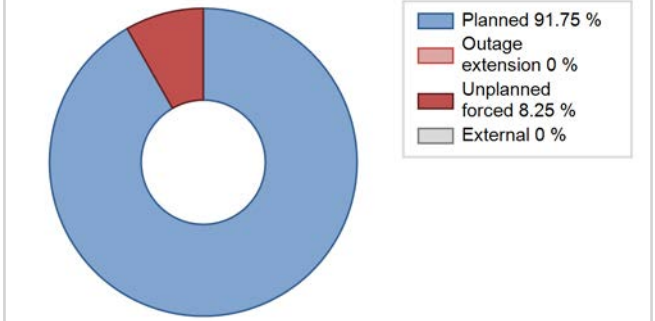
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2023	7569.94	6641	1000	98.19	98.19	106.57	98.18	1.79	1.79	0.02	0.00
2024	6852.87	6806	1000	77.07	77.07	78.02	77.48	0.85	0.66	22.28	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2023 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					69	
C. Inspection, maintenance or repair combined with refuelling	1920			1097		
Z. Other		58			33	
Subtotal	1920	58		1097	102	
Total		**1978**			**1199**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2023 to 2024
	Hours Lost	Average hours lost per reactor-year
31. Turbine and auxiliaries		60
34. Miscellaneous Systems	58	29
Total	**58**	**89**

Highlights (2024)

1.CN55 was basically operated in base-load mode.There was no scram in 2024.
2.At the request of grid system,CN55 deloaded for some holidays and weekends and other reasons.
3.CN55 was bearing its first refuelling outage form Feb 1 to Apr 21,lasting 79.98 days.

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2024 Operating Experience

CN-56 FANGCHENGGANG-4 CHINA



Status at end of year	:	**Operational**
Operator	:	GFNPC (Guangxi Fangchenggang Nuclear Power Company, Ltd.)
Owner	:	GFNPC (Guangxi Fangchenggang Nuclear Power Company, Ltd.)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	SEG (Shanghai Electric Group)

Reactor Unit Details

Reactor type and model	:	PWR / HPR1000
Thermal power	:	3150 MWth
Gross electrical power	:	1180 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2016-12-23
Grid Date	:	2024-04-09
Commercial Date	:	2024-05-25
Age at end of year	:	0 years

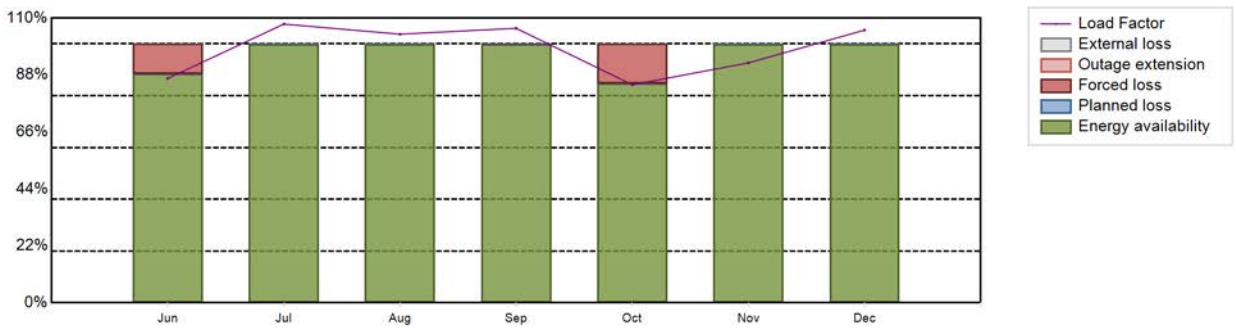
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	324.5
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	4.45	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	40.7	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	47400	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.23	HP cylinder inlet steam pressure [MPa]	:	6.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	177	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.95	Number of main condensate pumps	:	3
Number of control rod assemblies	:	68	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5216.64 GW(e).h	Forced Loss Rate (FLR)	:	3.82 %
Energy Availability Factor (EAF)	:	96.15 %	Unplanned Capability Loss Factor (UCL)	:	3.82 %
Unit Capability Factor (UCF)	:	96.15 %	Planned Unavailability Factor (PUF)	:	0.03 %
Load Factor (LF)	:	98.09 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	96.18 %	Total off-line time	:	1308 hours

Annual Summary



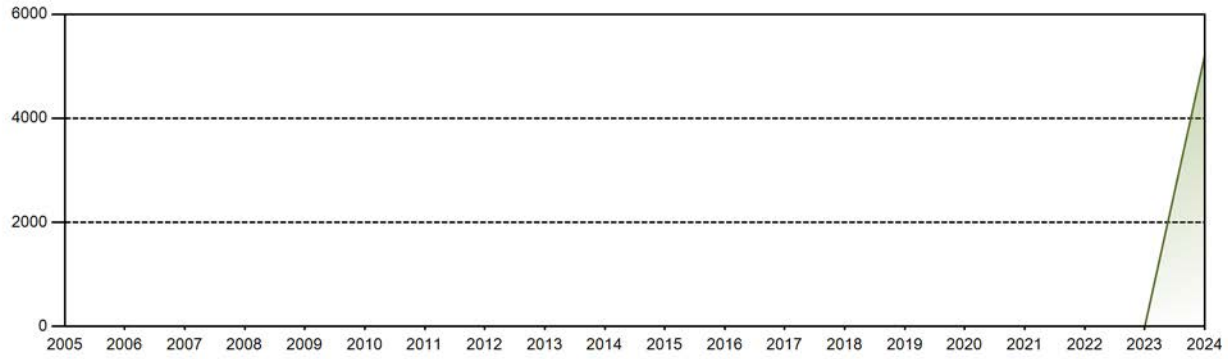
	May	Jan	Feb	Mar	Apr	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h						623.92	800.94	772.00	763.36	626.73	667.31	783.80	5038.06
EAF [%]						88.43	99.97	99.96	99.93	84.82	99.97	99.97	96.15
UCF [%]						88.43	99.97	99.96	99.93	84.82	99.97	99.97	96.15
LF [%]						86.66	107.65	103.76	106.02	84.24	92.68	105.35	98.09
OF [%]						88.47	100.00	100.00	100.00	84.81	100.00	100.00	96.18
FLR [%]						11.53	0.00	0.00	0.03	15.16	0.00	0.00	3.82
UCL [%]						11.53	0.00	0.00	0.03	15.15	0.00	0.00	3.82
PUF [%]						0.04	0.03	0.04	0.04	0.03	0.03	0.03	0.03
XUF [%]						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

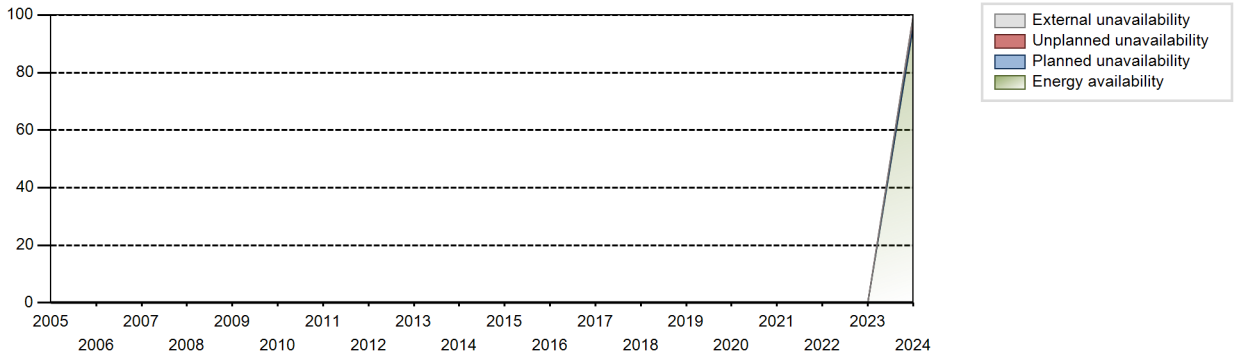
Lifetime energy generation	:	5216.64 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.82 %
Cumulative Energy Availability Factor (EAF)	:	96.15 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.82 %
Cumulative Unit Capability Factor (UCF)	:	96.15 %	Cumulative Planned Unavailability Factor (PUF)	:	0.03 %
Cumulative Load Factor (LF)	:	98.09 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	96.18 %			

Electricity Production (net) [GWh]

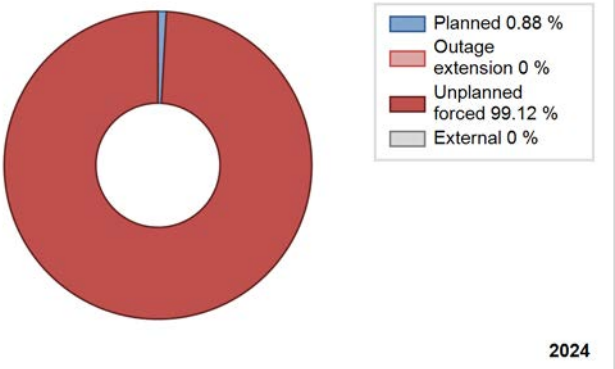


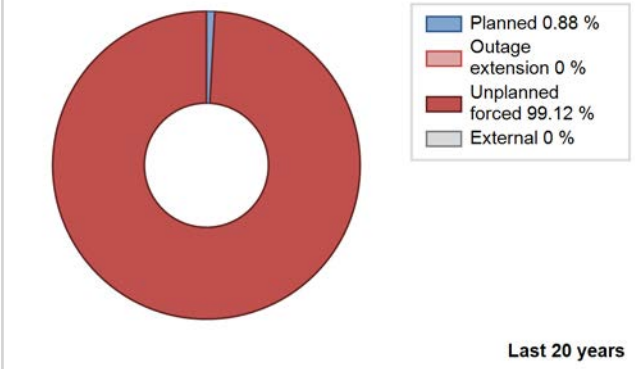
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2024	5216.64	5100	1000	96.15	96.15	98.09	96.18	3.82	3.82	0.03	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2024 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
Z. Other		196			336	
Subtotal		196			336	
Total		**196**			**336**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2024 to 2024
	Hours Lost	Average hours lost per reactor-year
34. Miscellaneous Systems	196	261
Total	**196**	**261**

Highlights (2024)

1.CN56 was officially put into commercial operation on May 25, 2024.There was no scram in 2024.
2.At the request of grid system,CN56 deloaded for some holidays and weekends and other reasons.

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2024 Operating Experience

CN-24 FANGJIASHAN-1 CHINA

Status at end of year	:	**Operational**
Operator	:	CNNO (CNNC Nuclear Operation Management Company Limited)
Owner	:	QNPC (QINSHAN NUCLEAR POWER COMPANY)
Reactor Supplier	:	NPIC (Nuclear Power Institute of China)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1012 MWe

Key Dates

Construction Date	:	2008-12-26
Grid Date	:	2014-11-04
Commercial Date	:	2014-12-15
Age at end of year	:	10 years

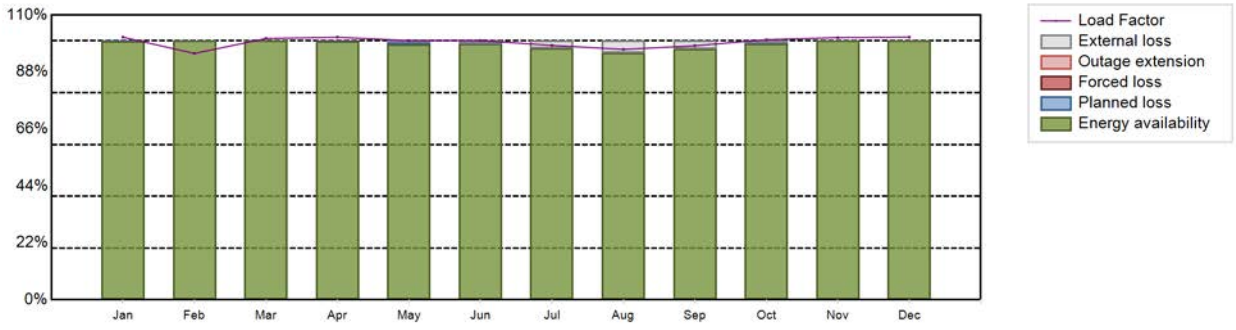
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	2.4	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8858.04 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	98.8 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	99.92 %	Planned Unavailability Factor (PUF)	:	0.08 %
Load Factor (LF)	:	99.65 %	Externally cause unavailability (XUF)	:	1.12 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



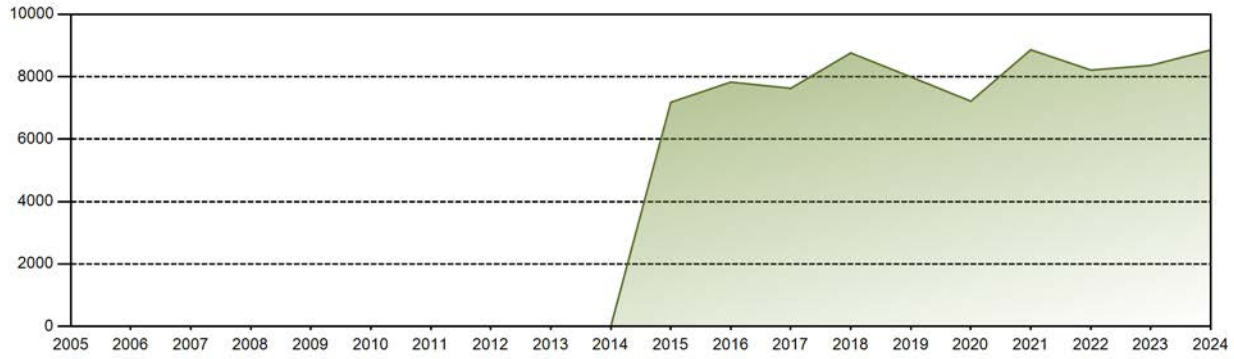
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	763.72	670.20	759.92	738.94	753.96	729.68	739.88	728.28	715.08	756.48	737.98	763.92	8858.04
EAF [%]	99.98	100.00	100.00	99.95	98.69	98.76	97.11	95.45	96.77	98.98	100.00	100.00	98.80
UCF [%]	99.98	100.00	100.00	99.95	99.31	99.98	100.00	100.00	100.00	99.85	100.00	100.00	99.92
LF [%]	101.43	95.15	100.93	101.41	100.14	100.14	98.27	96.73	98.14	100.47	101.28	101.46	99.65
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.02	0.00	0.00	0.02	0.69	0.02	0.00	0.00	0.00	0.15	0.00	0.00	0.08
XUF [%]	0.00	0.00	0.00	0.00	0.62	1.22	2.89	4.55	3.23	0.87	0.00	0.00	1.12

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Historical Summary

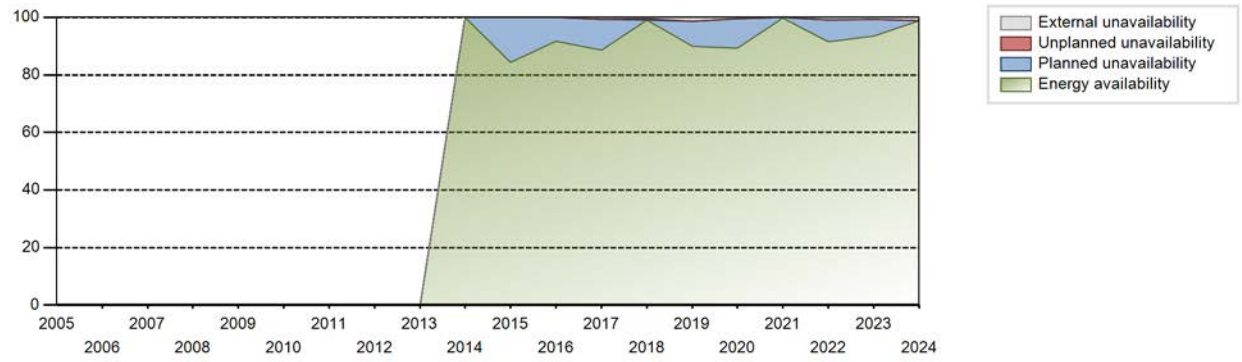
Lifetime energy generation	:	80902.89 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.06 %
Cumulative Energy Availability Factor (EAF)	:	92.71 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.05 %
Cumulative Unit Capability Factor (UCF)	:	93.29 %	Cumulative Planned Unavailability Factor (PUF)	:	6.66 %
Cumulative Load Factor (LF)	:	90.43 %	Cumulative Externally cause unavailability (XUF)	:	0.57 %
Cumulative Operating Factor (OF)	:	91.46 %			

Electricity Production (net) [GWh]



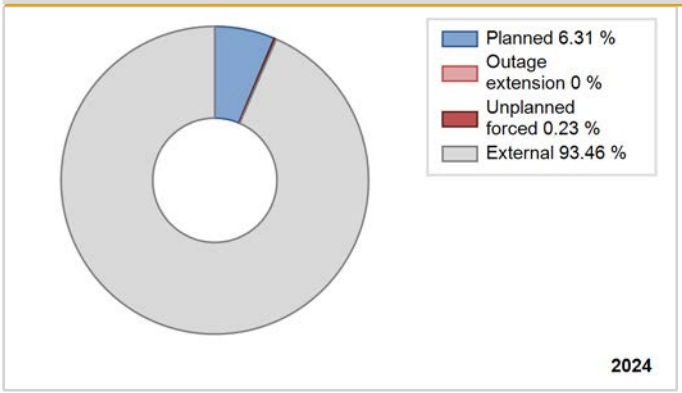
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2014	0.00	0	1000	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	7180.23	7289	1012	84.47	84.47	80.99	83.21	0.00	0.00	15.53	0.00
2016	7827.38	7910	1012	91.68	91.68	88.05	90.05	0.04	0.04	8.28	0.00
2017	7628.57	7676	1012	88.54	89.14	86.05	87.63	0.08	0.07	10.79	0.60
2018	8761.17	8732	1012	99.06	99.61	98.83	99.68	0.39	0.39	0.00	0.55
2019	7992.84	8048	1012	89.85	91.12	90.16	91.87	0.00	0.00	8.88	1.28
2020	7214.92	7218	1012	89.30	89.77	81.16	82.17	0.00	0.00	10.23	0.46
2021	8862.47	8760	1012	99.76	99.86	99.97	100.00	0.00	0.00	0.14	0.09
2022	8212.68	8150	1012	91.55	92.46	92.64	93.04	0.00	0.00	7.54	0.90
2023	8364.58	8297	1012	93.49	94.26	94.35	94.71	0.03	0.03	5.71	0.77
2024	8858.04	8784	1012	98.80	99.92	99.65	100.00	0.00	0.00	0.08	1.12

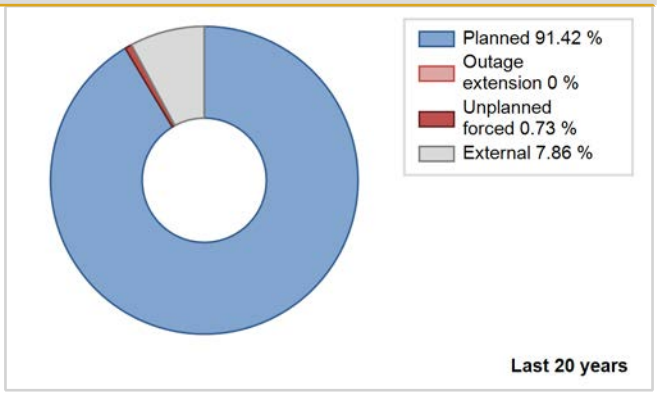
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2014 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
C. Inspection, maintenance or repair combined with refuelling				510		
D. Inspection, maintenance or repair without refuelling				46		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						122
L. Human factor related					3	
Subtotal				556	3	122
Total		**0**			**681**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2014 to 2024 Average hours lost per reactor-year
34. Miscellaneous Systems		73
Total		**73**

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2024 Operating Experience

CN-25 FANGJIASHAN-2 CHINA

Status at end of year	:	**Operational**
Operator	:	CNNO (CNNC Nuclear Operation Management Company Limited)
Owner	:	QNPC (QINSHAN NUCLEAR POWER COMPANY)
Reactor Supplier	:	NPIC (Nuclear Power Institute of China)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1012 MWe

Key Dates

Construction Date	:	2009-07-17
Grid Date	:	2015-01-12
Commercial Date	:	2015-02-12
Age at end of year	:	9 years

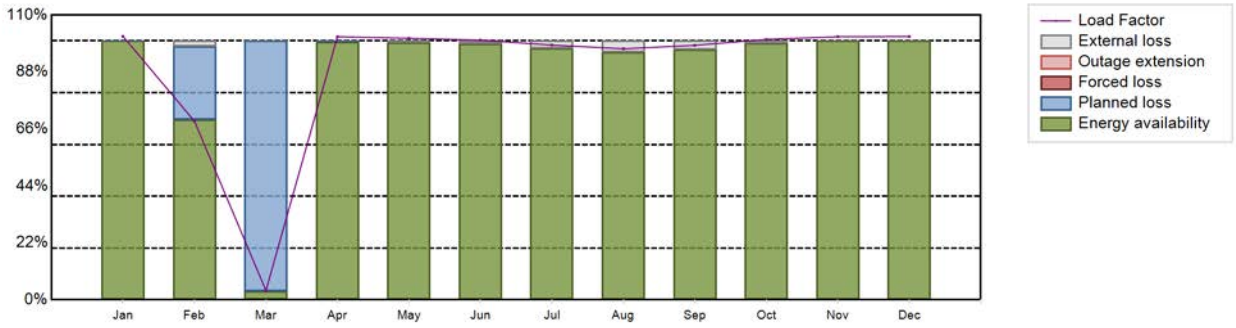
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	2.4	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7961.68 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	88.24 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	89.53 %	Planned Unavailability Factor (PUF)	:	10.47 %
Load Factor (LF)	:	89.56 %	Externally cause unavailability (XUF)	:	1.29 %
Operating Factor (OF)	:	89.98 %	Total off-line time	:	880 hours

Annual Summary



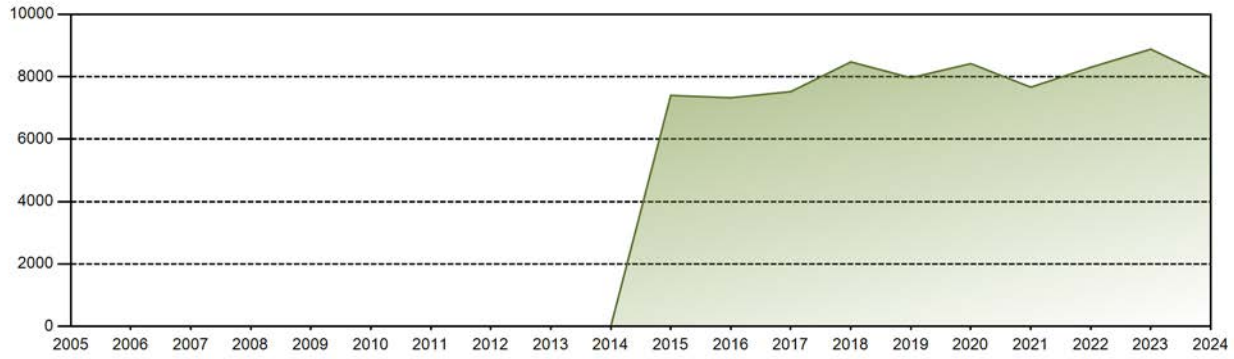
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	766.32	485.92	26.92	740.42	760.58	730.86	740.88	730.08	716.22	757.36	740.34	765.78	7961.68
EAF [%]	99.99	69.56	3.31	99.61	99.39	98.76	97.10	95.52	96.74	99.04	100.00	100.00	88.24
UCF [%]	99.99	71.57	3.31	99.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.53
LF [%]	101.78	68.99	3.58	101.62	101.02	100.30	98.40	96.97	98.30	100.59	101.61	101.71	89.56
OF [%]	100.00	72.41	7.53	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.98
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.01	28.43	96.69	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.47
XUF [%]	0.00	2.01	0.00	0.00	0.61	1.24	2.90	4.48	3.26	0.96	0.00	0.00	1.29

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Historical Summary

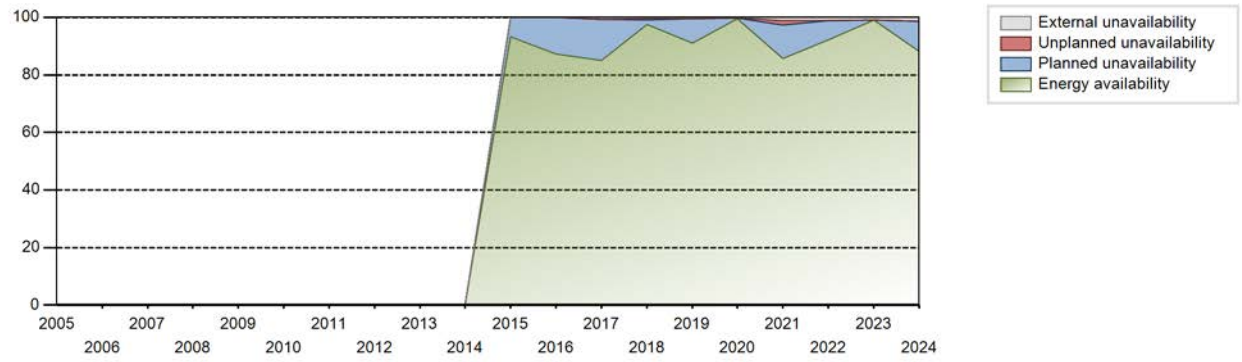
Lifetime energy generation	:	79912.82 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.22 %
Cumulative Energy Availability Factor (EAF)	:	91.88 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.2 %
Cumulative Unit Capability Factor (UCF)	:	92.54 %	Cumulative Planned Unavailability Factor (PUF)	:	7.26 %
Cumulative Load Factor (LF)	:	90.72 %	Cumulative Externally cause unavailability (XUF)	:	0.66 %
Cumulative Operating Factor (OF)	:	91.97 %			

Electricity Production (net) [GWh]



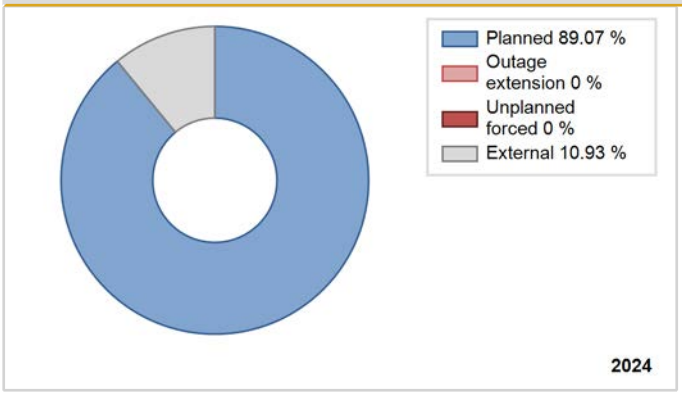
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2015	7400.55	7747	1012	93.22	93.22	89.98	92.90	0.02	0.02	6.76	0.00
2016	7324.84	7529	1012	87.29	87.29	82.40	85.71	0.00	0.00	12.71	0.00
2017	7521.75	7563	1012	84.95	85.72	84.85	86.34	0.00	0.00	14.28	0.77
2018	8472.42	8483	1012	97.62	98.08	95.57	96.84	0.48	0.47	1.45	0.46
2019	7965.85	7963	1012	90.97	91.45	89.86	90.90	0.00	0.00	8.55	0.48
2020	8418.73	8376	1012	99.62	99.93	94.71	95.36	0.04	0.04	0.03	0.31
2021	7663.47	7704	1012	85.78	86.96	86.45	87.95	1.70	1.50	11.54	1.18
2022	8301.13	8219	1012	92.15	93.24	93.64	93.82	0.00	0.00	6.76	1.09
2023	8882.44	8760	1012	99.03	100.00	100.20	100.00	0.00	0.00	0.00	0.97
2024	7961.68	7904	1012	88.24	89.53	89.56	89.98	0.00	0.00	10.47	1.29

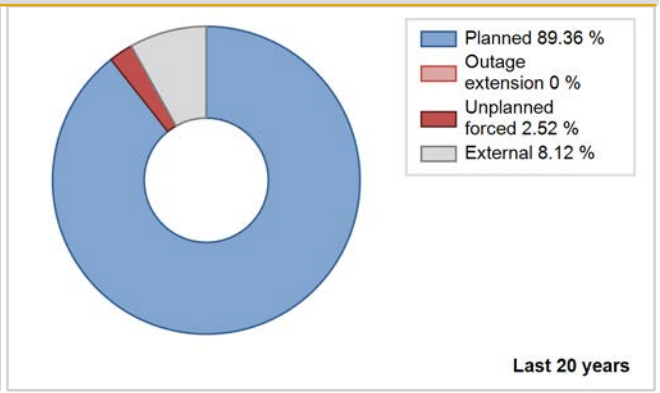
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2015 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					15	
C. Inspection, maintenance or repair combined with refuelling	879			596		
D. Inspection, maintenance or repair without refuelling				8		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						79
Subtotal	879			604	15	79
Total	**879**			**698**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2015 to 2024 Average hours lost per reactor-year
31. Turbine and auxiliaries		3
32. Feedwater and Main Steam System		0
34. Miscellaneous Systems		38
41. Main Generator Systems		12
Total		**53**

Highlights (2024)

The unit was shutdown for 207 refuelling outage from February 22 to April 3.

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2024 Operating Experience

CN-20 FUQING-1 CHINA

Status at end of year	:	**Operational**
Operator	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Owner	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Reactor Supplier	:	NPIC (Nuclear Power Institute of China)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2008-11-21
Grid Date	:	2014-08-20
Commercial Date	:	2014-11-22
Age at end of year	:	10 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.4
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

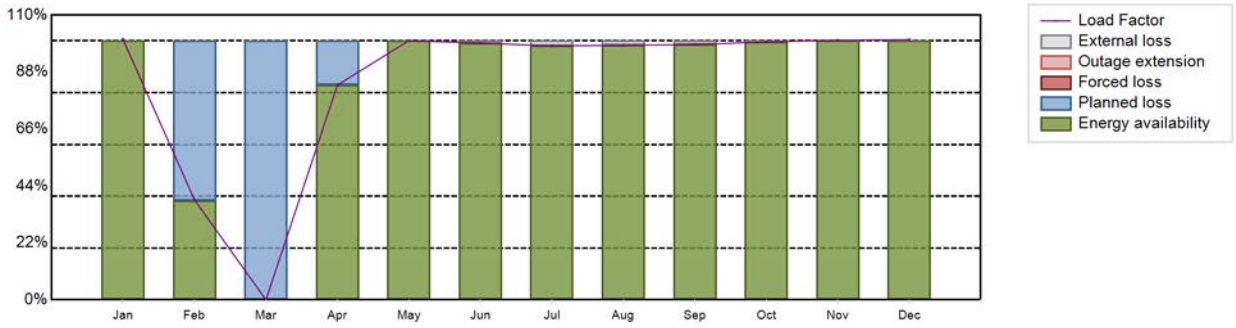
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.43
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7454.85 GW(e).h
Energy Availability Factor (EAF)	:	84.73 %
Unit Capability Factor (UCF)	:	85.25 %
Load Factor (LF)	:	84.87 %
Operating Factor (OF)	:	85.67 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	14.75 %
Externally cause unavailability (XUF)	:	0.52 %
Total off-line time	:	1259 hours

Annual Summary



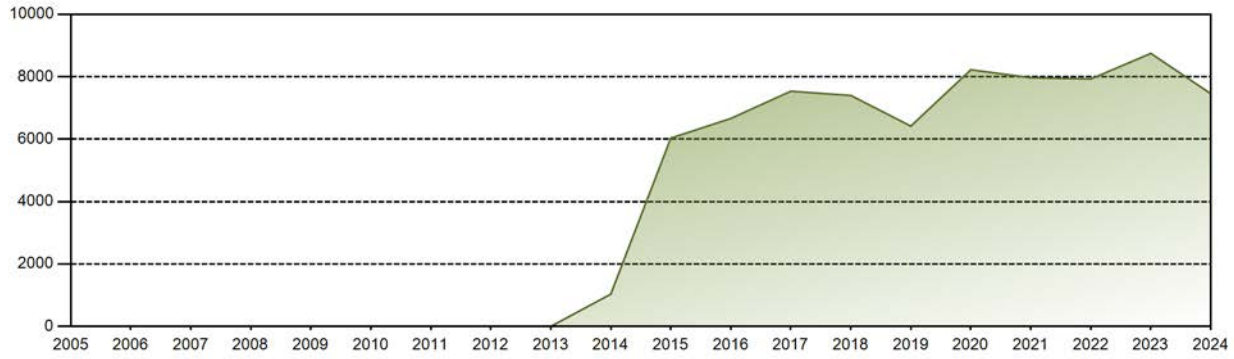
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	748.47	268.82	0.00	597.27	744.73	713.89	729.60	731.37	709.89	741.22	722.01	747.58	7454.85
EAF [%]	100.00	38.34	0.00	83.04	100.00	99.15	98.06	98.30	98.60	99.63	100.00	100.00	84.73
UCF [%]	100.00	38.34	0.00	83.04	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	85.25
LF [%]	100.60	38.62	0.00	82.95	100.10	99.15	98.06	98.30	98.60	99.63	100.28	100.48	84.87
OF [%]	100.00	39.08	0.00	87.36	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	85.67
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	61.66	100.00	16.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.75
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.85	1.94	1.70	1.40	0.37	0.00	0.00	0.52

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Historical Summary

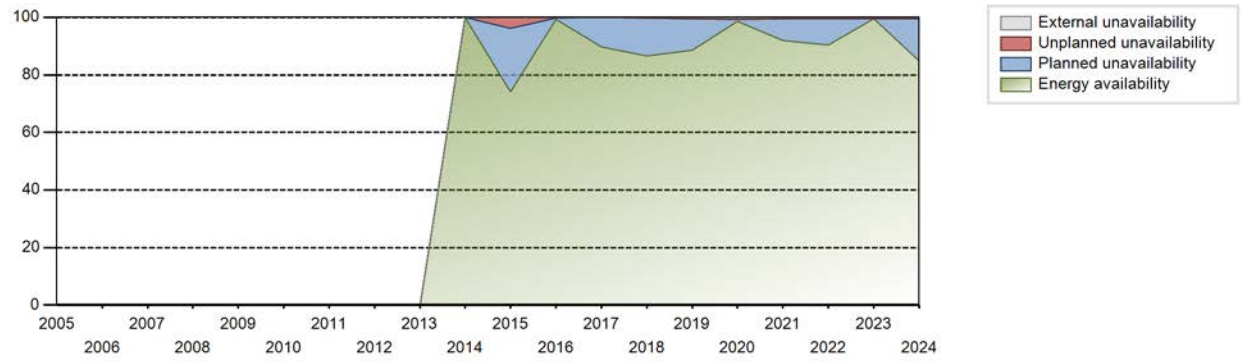
Lifetime energy generation	:	75398.3 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.18 %
Cumulative Energy Availability Factor (EAF)	:	90.45 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.39 %
Cumulative Unit Capability Factor (UCF)	:	90.77 %	Cumulative Planned Unavailability Factor (PUF)	:	8.84 %
Cumulative Load Factor (LF)	:	85.03 %	Cumulative Externally cause unavailability (XUF)	:	0.32 %
Cumulative Operating Factor (OF)	:	88.93 %			

Electricity Production (net) [GWh]



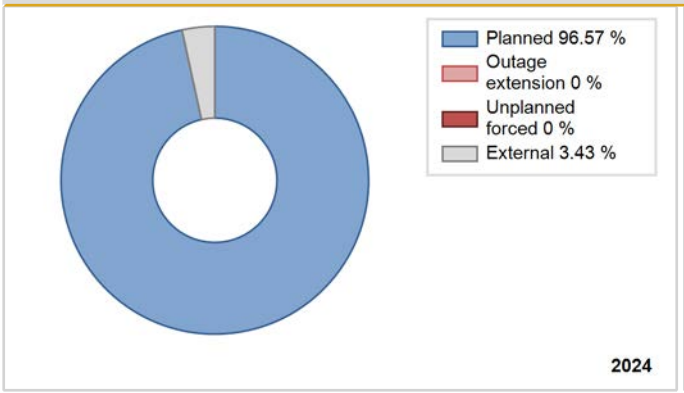
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2014	1033.07	949	1000	100.00	100.00	109.00	100.00	0.00	0.00	0.00	0.00
2015	6032.38	6514	1000	74.11	74.11	68.86	74.36	1.98	3.77	22.12	0.00
2016	6662.04	7511	1000	99.31	99.31	75.84	85.51	0.20	0.20	0.50	0.00
2017	7535.41	7930	1000	89.81	89.81	86.02	90.53	0.00	0.00	10.19	0.00
2018	7398.98	7702	1000	86.59	86.78	84.46	87.92	0.00	0.00	13.22	0.19
2019	6417.64	7072	1000	88.64	89.03	73.26	80.73	0.00	0.00	10.97	0.39
2020	8222.85	8706	1000	98.58	99.30	93.61	99.11	0.01	0.01	0.70	0.72
2021	7967.88	8166	1000	91.98	92.54	90.96	93.22	0.00	0.00	7.46	0.56
2022	7927.14	8001	1000	90.32	90.73	90.49	91.34	0.00	0.00	9.27	0.40
2023	8746.94	8760	1000	99.59	100.00	99.85	100.00	0.00	0.00	0.00	0.41
2024	7454.85	7525	1000	84.73	85.25	84.87	85.67	0.00	0.00	14.75	0.52

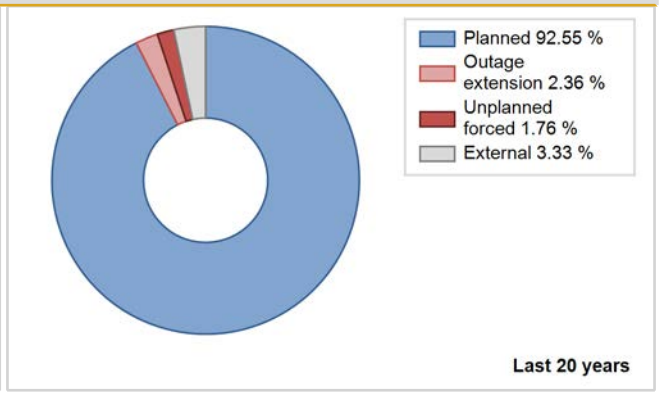
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2014 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					33	
C. Inspection, maintenance or repair combined with refuelling	1260			731		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						214
Subtotal	1260			731	33	214
Total	**1260**			**978**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2014 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		6
16. Steam generation systems		6
34. Miscellaneous Systems		8
42. Electrical Power Supply Systems		20
Total		**40**

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2024 Operating Experience

CN-21 FUQING-2 CHINA

Status at end of year	:	**Operational**
Operator	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Owner	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Reactor Supplier	:	NPIC (Nuclear Power Institute of China)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2009-06-17
Grid Date	:	2015-08-06
Commercial Date	:	2015-10-16
Age at end of year	:	9 years

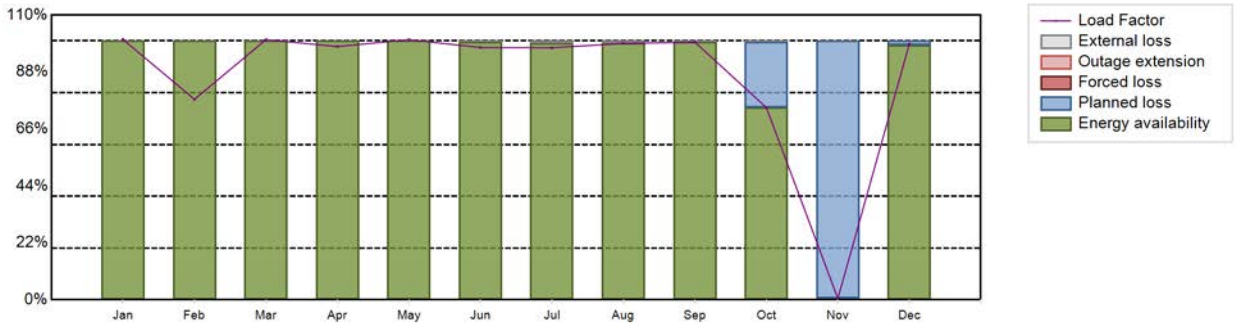
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.4
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.43
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7657.12 GW(e).h
Energy Availability Factor (EAF)	:	89.3 %
Unit Capability Factor (UCF)	:	89.56 %
Load Factor (LF)	:	87.17 %
Operating Factor (OF)	:	88.48 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	10.44 %
Externally cause unavailability (XUF)	:	0.25 %
Total off-line time	:	1012 hours

Annual Summary



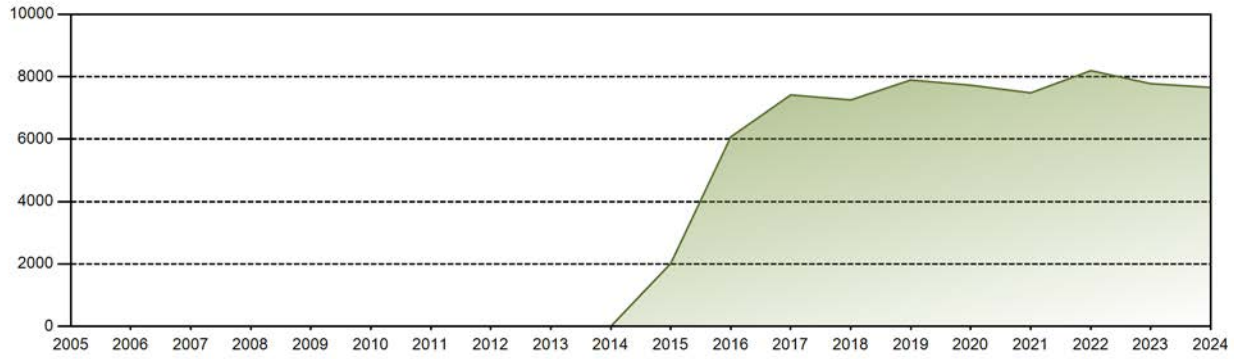
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	748.13	538.99	747.58	704.30	747.52	701.62	724.47	736.56	716.53	552.53	3.80	735.09	7657.12
EAF [%]	100.00	100.00	100.00	100.00	100.00	99.57	99.19	99.00	99.52	74.26	0.52	98.40	89.30
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	74.57	0.52	98.40	89.56
LF [%]	100.55	77.44	100.48	97.82	100.47	97.45	97.38	99.00	99.52	74.26	0.53	98.80	87.17
OF [%]	100.00	82.04	100.00	100.00	100.00	100.00	100.00	100.00	100.00	75.27	2.36	100.00	88.48
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.43	99.48	1.60	10.44
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.43	0.81	1.00	0.48	0.31	0.00	0.00	0.25

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Historical Summary

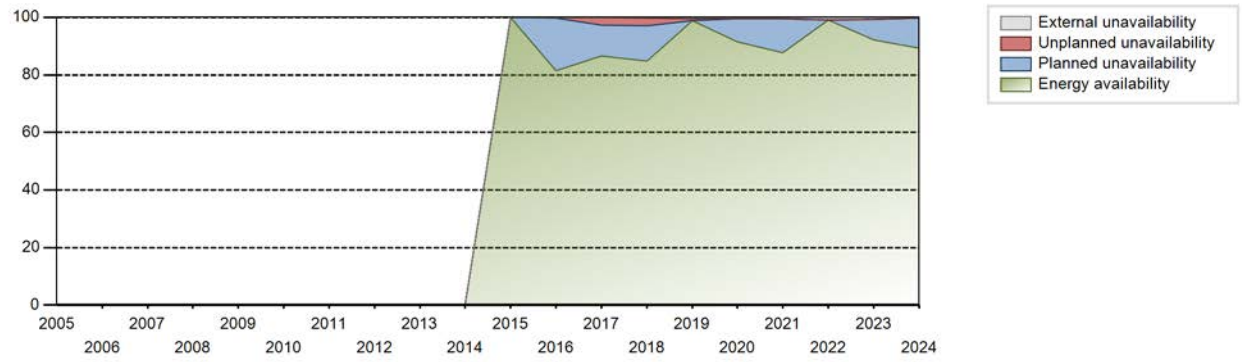
Lifetime energy generation	:	69482.41 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.75 %
Cumulative Energy Availability Factor (EAF)	:	90.35 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.69 %
Cumulative Unit Capability Factor (UCF)	:	90.73 %	Cumulative Planned Unavailability Factor (PUF)	:	8.58 %
Cumulative Load Factor (LF)	:	85.55 %	Cumulative Externally cause unavailability (XUF)	:	0.38 %
Cumulative Operating Factor (OF)	:	90.07 %			

Electricity Production (net) [GWh]



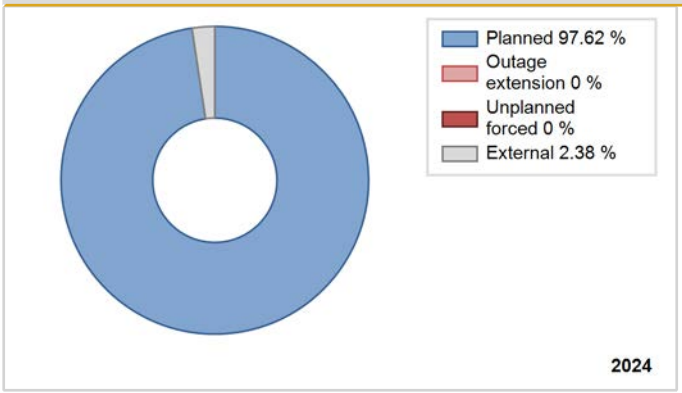
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2015	2017.22	3487	1000	100.00	100.00	87.75	100.00	0.00	0.00	0.00	0.00
2016	6070.84	6807	1000	81.46	81.46	69.11	77.49	0.34	0.27	18.26	0.00
2017	7416.83	7659	1000	86.58	86.58	84.67	87.43	3.03	2.71	10.71	0.00
2018	7255.87	7587	1000	84.82	84.97	82.83	86.61	3.06	2.68	12.34	0.16
2019	7893.35	8685	1000	98.89	99.35	90.11	99.14	0.65	0.65	0.00	0.46
2020	7726.34	8137	1000	91.54	92.02	87.96	92.63	0.00	0.00	7.98	0.49
2021	7482.49	7781	1000	87.73	88.17	85.42	88.82	0.00	0.00	11.83	0.43
2022	8194.52	8610	1000	99.05	100.00	93.54	98.29	0.00	0.00	0.00	0.95
2023	7775.95	7893	1000	92.19	92.93	88.77	90.10	0.00	0.00	7.07	0.73
2024	7657.12	7772	1000	89.30	89.56	87.17	88.48	0.00	0.00	10.44	0.25

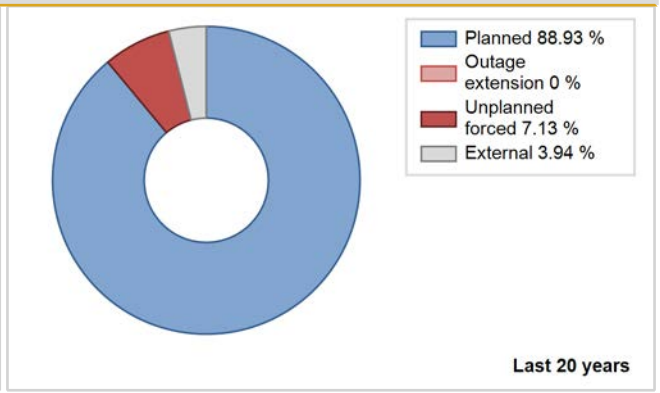
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2015 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					52	
C. Inspection, maintenance or repair combined with refuelling	887			704		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			125			118
Subtotal	887		125	704	52	118
Total	**1012**			**874**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2015 to 2024 Average hours lost per reactor-year
32. Feedwater and Main Steam System		1
33. Circulating Water System		41
34. Miscellaneous Systems	125	29
41. Main Generator Systems		2
42. Electrical Power Supply Systems		6
Total	**125**	**79**

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2024 Operating Experience

CN-42 FUQING-3 CHINA

Status at end of year	:	**Operational**
Operator	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Owner	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Reactor Supplier	:	NPIC (Nuclear Power Institute of China)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2010-12-31
Grid Date	:	2016-09-07
Commercial Date	:	2016-10-24
Age at end of year	:	8 years

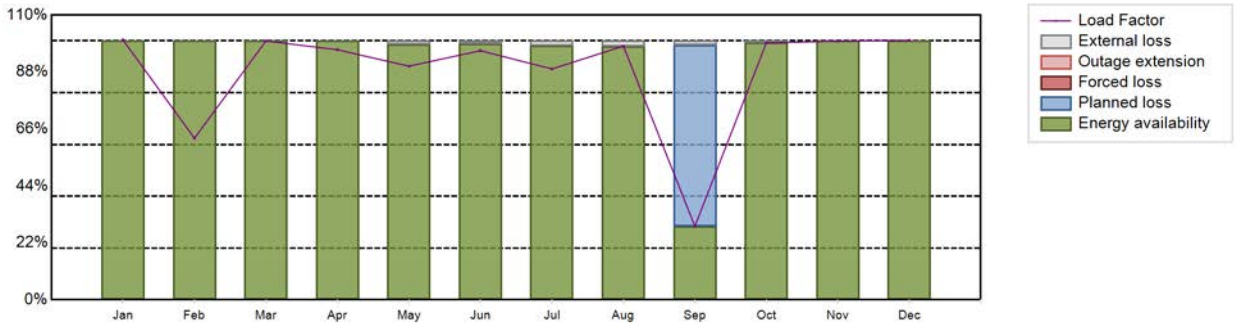
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.4
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.43
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7784.66 GW(e).h
Energy Availability Factor (EAF)	:	93.54 %
Unit Capability Factor (UCF)	:	94.27 %
Load Factor (LF)	:	88.62 %
Operating Factor (OF)	:	90.94 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	5.73 %
Externally cause unavailability (XUF)	:	0.73 %
Total off-line time	:	796 hours

Annual Summary



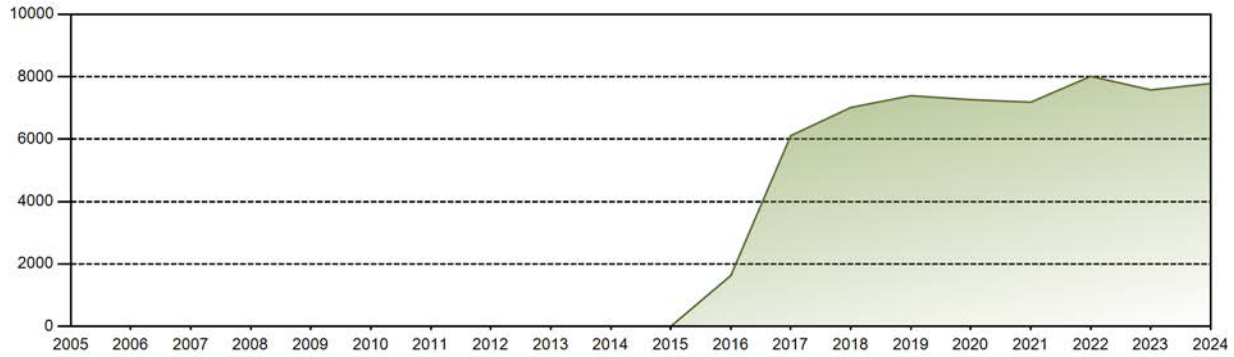
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	746.78	434.34	743.77	695.33	671.48	692.73	663.47	729.03	204.52	738.37	719.16	745.67	7784.66
EAF [%]	100.00	100.00	100.00	100.00	98.66	98.99	98.09	97.99	28.41	99.24	100.00	100.00	93.54
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	30.11	100.00	100.00	100.00	94.27
LF [%]	100.37	62.41	99.97	96.57	90.25	96.21	89.18	97.99	28.41	99.24	99.88	100.22	88.62
OF [%]	100.00	69.68	100.00	100.00	93.01	100.00	93.28	100.00	32.92	100.00	100.00	100.00	90.94
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69.89	0.00	0.00	0.00	5.73
XUF [%]	0.00	0.00	0.00	0.00	1.34	1.01	1.91	2.01	1.70	0.76	0.00	0.00	0.73

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Historical Summary

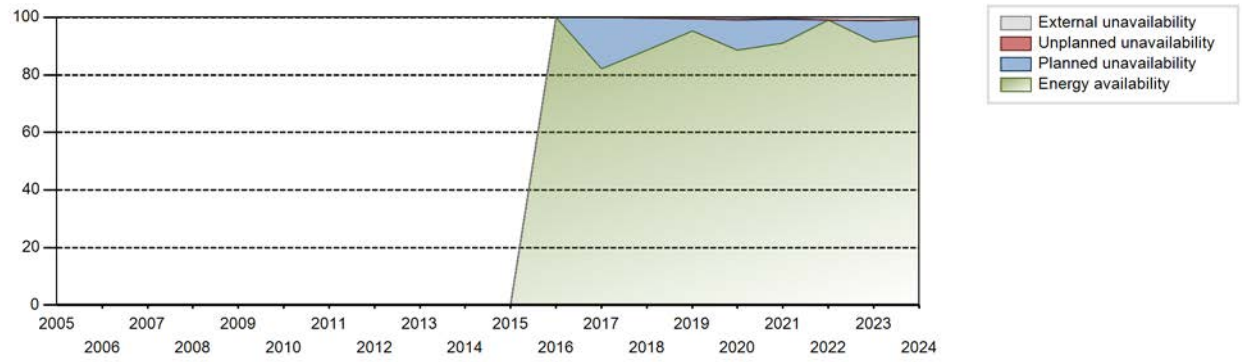
Lifetime energy generation	:	58499.58 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.09 %
Cumulative Energy Availability Factor (EAF)	:	91.39 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.09 %
Cumulative Unit Capability Factor (UCF)	:	91.9 %	Cumulative Planned Unavailability Factor (PUF)	:	8.01 %
Cumulative Load Factor (LF)	:	83.5 %	Cumulative Externally cause unavailability (XUF)	:	0.51 %
Cumulative Operating Factor (OF)	:	88.32 %			

Electricity Production (net) [GWh]

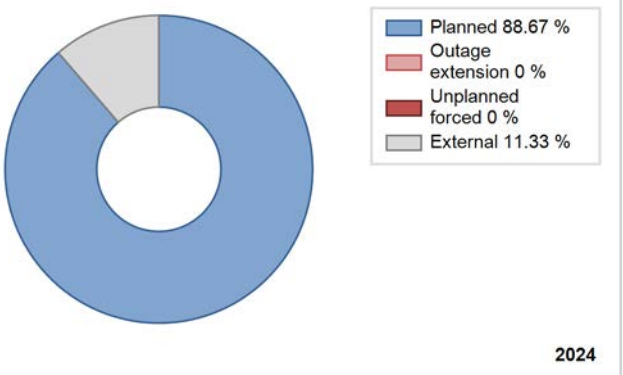


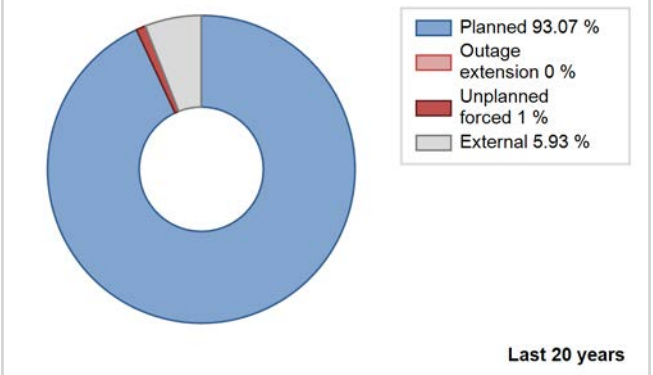
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	1628.31	1648	1000	100.00	100.00	98.60	100.00	0.00	0.00	0.00	0.00
2017	6110.93	6592	1000	82.12	82.12	69.76	75.25	0.00	0.00	17.88	0.00
2018	7013.40	7357	1000	88.67	88.88	80.06	83.98	0.00	0.00	11.12	0.21
2019	7390.94	8107	1000	95.23	95.78	84.37	92.55	0.00	0.00	4.22	0.55
2020	7265.42	7724	1000	88.61	89.24	82.71	87.93	0.22	0.20	10.56	0.63
2021	7184.22	7835	1000	90.97	91.13	82.01	89.44	0.55	0.51	8.36	0.17
2022	8011.27	8369	1000	99.16	100.00	91.45	95.54	0.00	0.00	0.00	0.84
2023	7576.01	7792	1000	91.42	92.46	86.48	88.95	0.00	0.00	7.54	1.04
2024	7784.66	7988	1000	93.54	94.27	88.62	90.94	0.00	0.00	5.73	0.73

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					5	
C. Inspection, maintenance or repair combined with refuelling	483			658		
H. Nuclear regulatory requirements						1
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			343			364
Subtotal	483		343	658	5	365
Total	**826**			**1028**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
34. Miscellaneous Systems	343	143
Total	**343**	**143**

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2024 Operating Experience

CN-43 FUQING-4 CHINA

Status at end of year	:	**Operational**
Operator	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Owner	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Reactor Supplier	:	NPIC (Nuclear Power Institute of China)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2012-11-17
Grid Date	:	2017-07-29
Commercial Date	:	2017-09-17
Age at end of year	:	7 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.4
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

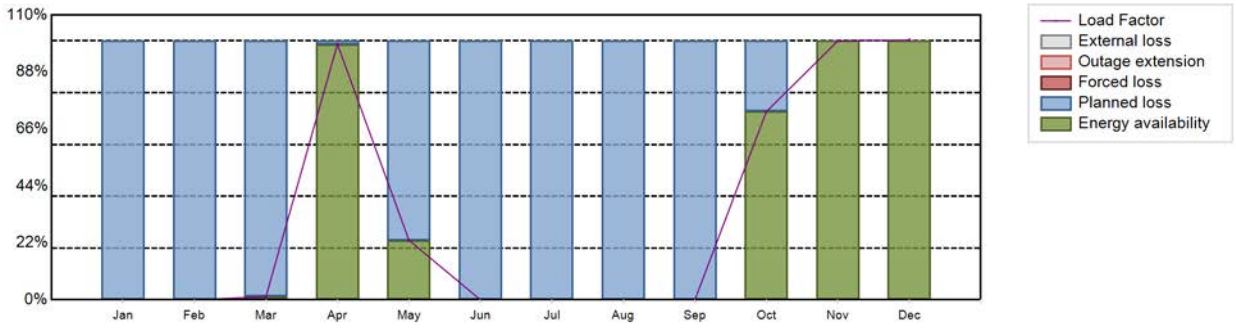
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.43
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2899.14 GW(e).h
Energy Availability Factor (EAF)	:	32.97 %
Unit Capability Factor (UCF)	:	32.97 %
Load Factor (LF)	:	33 %
Operating Factor (OF)	:	33.69 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	67.03 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	5825 hours

Annual Summary



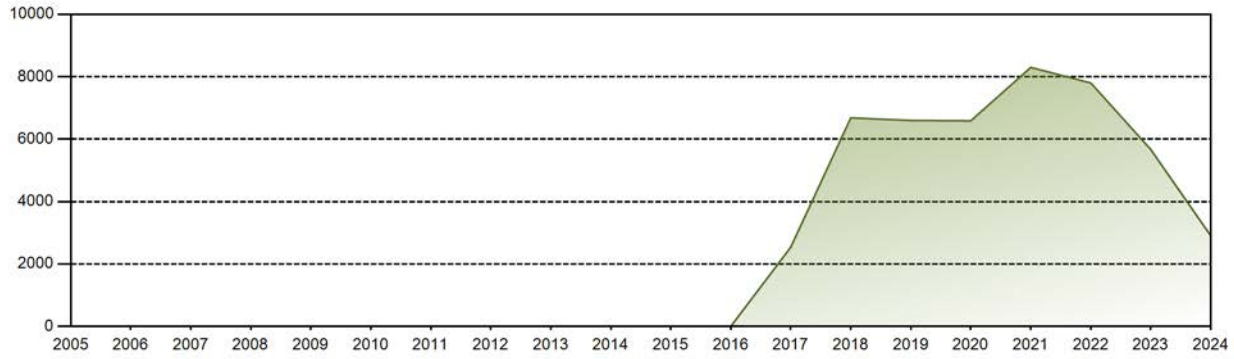
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	9.19	710.74	171.50	0.00	0.00	0.00	0.00	540.87	720.14	746.71	2899.14
EAF [%]	0.00	0.00	1.23	98.71	23.05	0.00	0.00	0.00	0.00	72.70	100.00	100.00	32.97
UCF [%]	0.00	0.00	1.23	98.71	23.05	0.00	0.00	0.00	0.00	72.70	100.00	100.00	32.97
LF [%]	0.00	0.00	1.23	98.71	23.05	0.00	0.00	0.00	0.00	72.70	100.02	100.36	33.00
OF [%]	0.00	0.00	4.03	100.00	23.66	0.00	0.00	0.00	0.00	76.48	100.00	100.00	33.69
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	100.00	100.00	98.77	1.29	76.95	100.00	100.00	100.00	100.00	27.30	0.00	0.00	67.03
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

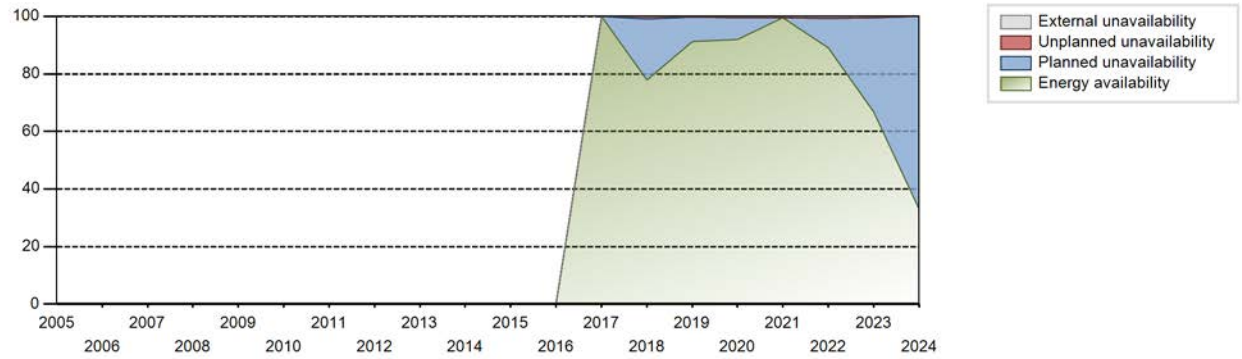
Lifetime energy generation	:	47071.5 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.13 %
Cumulative Energy Availability Factor (EAF)	:	79.21 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.11 %
Cumulative Unit Capability Factor (UCF)	:	79.56 %	Cumulative Planned Unavailability Factor (PUF)	:	20.32 %
Cumulative Load Factor (LF)	:	73.52 %	Cumulative Externally cause unavailability (XUF)	:	0.36 %
Cumulative Operating Factor (OF)	:	75.92 %			

Electricity Production (net) [GWh]

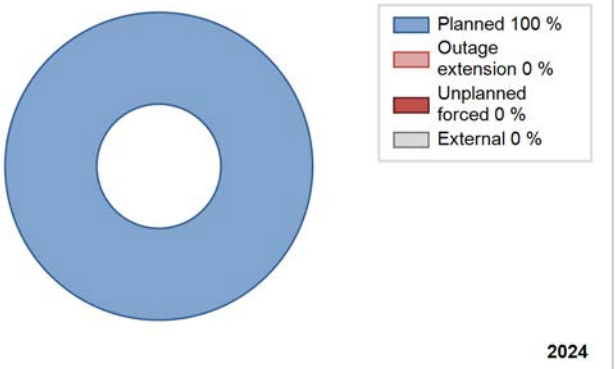


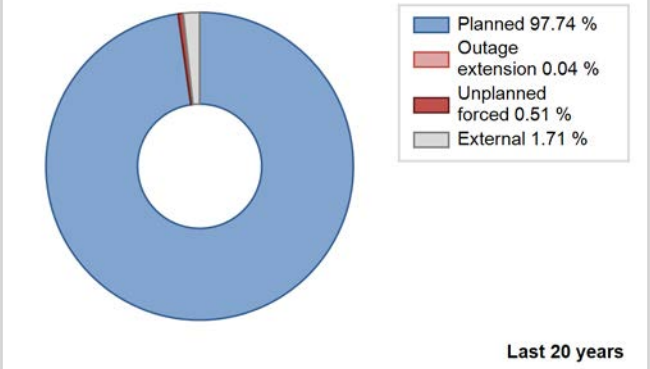
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2017	2540.07	2544	1000	100.00	100.00	100.00	100.00	0.00	0.00	0.00	0.00
2018	6682.09	6890	1000	77.79	77.91	76.28	78.65	0.98	0.77	21.32	0.12
2019	6599.78	7215	1000	91.31	91.68	75.34	82.36	0.00	0.00	8.32	0.36
2020	6587.82	6953	1000	92.01	92.47	75.00	79.16	0.00	0.00	7.53	0.45
2021	8297.78	8407	1000	99.44	100.00	94.72	95.97	0.00	0.00	0.00	0.56
2022	7799.96	7904	1000	88.99	89.60	89.04	90.23	0.00	0.00	10.40	0.61
2023	5665.02	5729	1000	66.78	67.26	64.67	65.40	0.00	0.05	32.68	0.48
2024	2899.14	2959	1000	32.97	32.97	33.00	33.69	0.00	0.00	67.03	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2017 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					7	
C. Inspection, maintenance or repair combined with refuelling				667		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						380
Z. Other	5826			1134		
Subtotal	5826			1801	7	380
Total	**5826**			**2188**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2017 to 2024 Average hours lost per reactor-year
32. Feedwater and Main Steam System		7
34. Miscellaneous Systems		227
Total		**234**

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2024 Operating Experience

CN-51 FUQING-5 CHINA

Status at end of year	:	**Operational**
Operator	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Owner	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Reactor Supplier	:	NPIC (Nuclear Power Institute of China)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / HPR1000
Thermal power	:	3050 MWth
Gross electrical power	:	1161 MWe
Reference unit power (net)	:	1075 MWe

Key Dates

Construction Date	:	2015-05-07
Grid Date	:	2020-11-27
Commercial Date	:	2021-01-30
Age at end of year	:	4 years

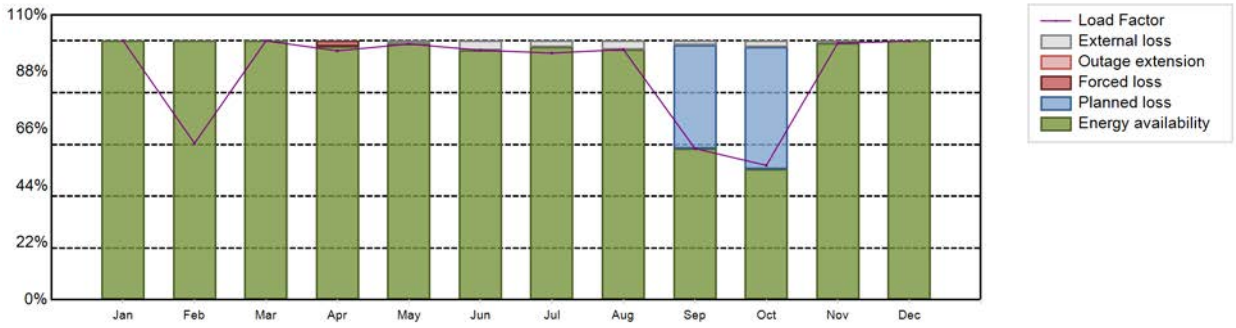
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.9
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	4.45	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	40	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	47000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.328	HP cylinder inlet steam pressure [MPa]	:	NA
Active core height/length [m]	:	3.567	Output voltage [kV]	:	27
Number of fissile fuel assemblies/bundles	:	177	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.12	Number of main condensate pumps	:	3
Number of control rod assemblies	:	69	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8303.43 GW(e).h	Forced Loss Rate (FLR)	:	0.18 %
Energy Availability Factor (EAF)	:	91.28 %	Unplanned Capability Loss Factor (UCL)	:	0.17 %
Unit Capability Factor (UCF)	:	92.56 %	Planned Unavailability Factor (PUF)	:	7.28 %
Load Factor (LF)	:	87.93 %	Externally cause unavailability (XUF)	:	1.28 %
Operating Factor (OF)	:	90.16 %	Total off-line time	:	864 hours

Annual Summary



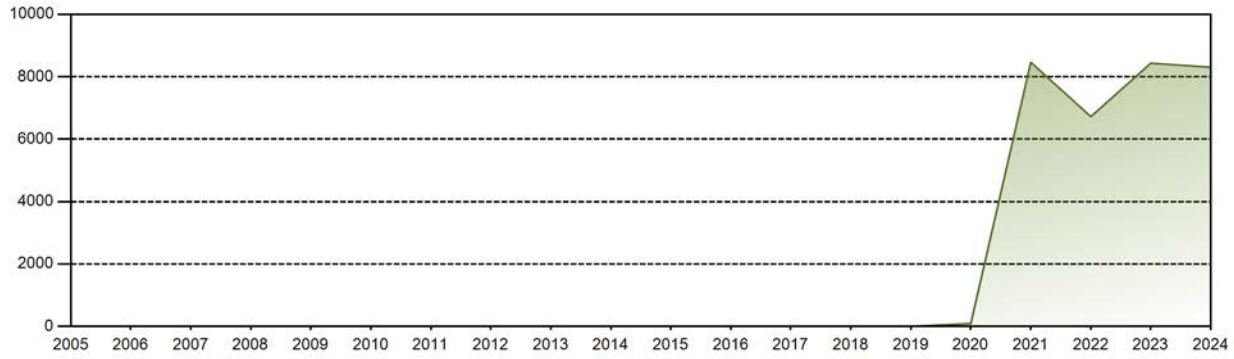
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	800.87	452.12	799.94	744.40	790.15	746.25	762.28	773.24	452.39	415.28	767.59	798.93	8303.43
EAF [%]	100.00	100.00	100.00	97.97	98.79	96.41	97.59	96.68	58.45	50.39	99.17	100.00	91.28
UCF [%]	100.00	100.00	100.00	97.97	100.00	100.00	100.00	100.00	60.16	52.65	100.00	100.00	92.56
LF [%]	100.13	60.43	100.02	96.18	98.79	96.41	95.31	96.68	58.45	51.92	99.17	99.89	87.93
OF [%]	100.00	63.07	100.00	100.00	100.00	100.00	100.00	100.00	61.11	56.05	100.00	100.00	90.16
FLR [%]	0.00	0.00	0.00	2.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
UCL [%]	0.00	0.00	0.00	2.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.84	47.35	0.00	0.00	7.28
XUF [%]	0.00	0.00	0.00	0.00	1.21	3.59	2.41	3.32	1.72	2.26	0.83	0.00	1.28

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Historical Summary

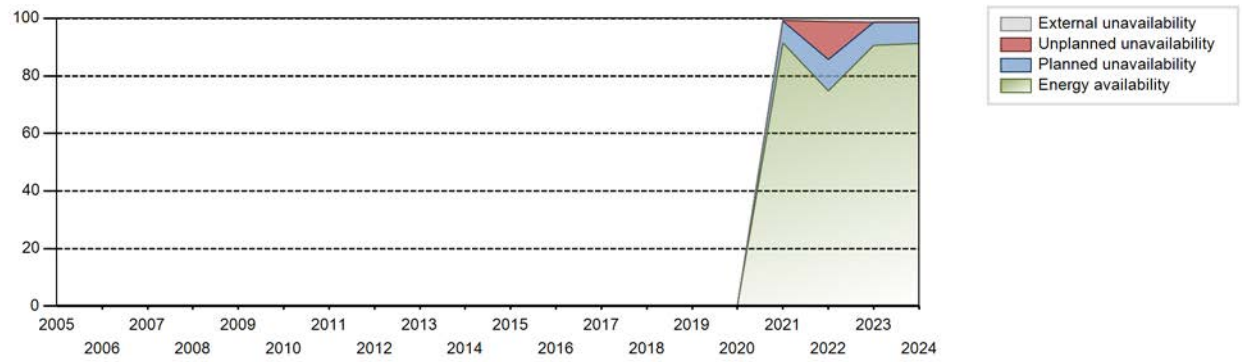
Lifetime energy generation	:	32012.02 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.3 %
Cumulative Energy Availability Factor (EAF)	:	86.96 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.46 %
Cumulative Unit Capability Factor (UCF)	:	88.09 %	Cumulative Planned Unavailability Factor (PUF)	:	8.45 %
Cumulative Load Factor (LF)	:	84.36 %	Cumulative Externally cause unavailability (XUF)	:	1.14 %
Cumulative Operating Factor (OF)	:	86.47 %			

Electricity Production (net) [GWh]

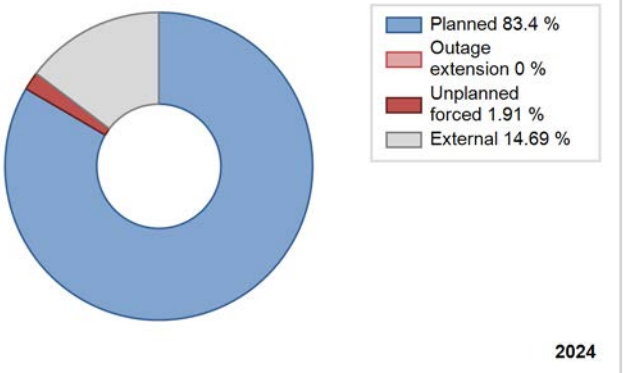


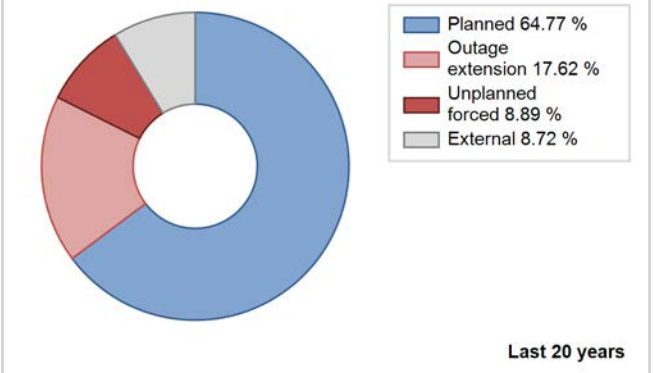
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2021	8461.95	7965	1075	91.50	92.11	88.97	90.08	0.22	0.20	7.68	0.61
2022	6721.77	6441	1075	74.86	76.03	71.38	73.53	5.23	13.20	10.78	1.17
2023	8433.14	8094	1075	90.56	92.00	89.55	92.40	0.00	0.00	8.00	1.45
2024	8303.43	7920	1075	91.28	92.56	87.93	90.16	0.18	0.17	7.28	1.28

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2021 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					86	
C. Inspection, maintenance or repair combined with refuelling	607			723		
E. Testing of plant systems or components				134		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			270			167
L. Human factor related					8	
Z. Other					201	
Subtotal	607		270	857	295	167
Total	**877**			**1319**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2021 to 2024
	Hours Lost	Average hours lost per reactor-year
34. Miscellaneous Systems	270	434
Total	**270**	**434**

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2024 Operating Experience

CN-52 FUQING-6 CHINA

Status at end of year	:	**Operational**
Operator	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Owner	:	FQNP (CNNC Fujian Fuqing Nuclear Power Co., LTD)
Reactor Supplier	:	NPIC (Nuclear Power Institute of China)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / HPR1000
Thermal power	:	3060 MWth
Gross electrical power	:	1150 MWe
Reference unit power (net)	:	1075 MWe

Key Dates

Construction Date	:	2015-12-22
Grid Date	:	2022-01-01
Commercial Date	:	2022-03-25
Age at end of year	:	2 years

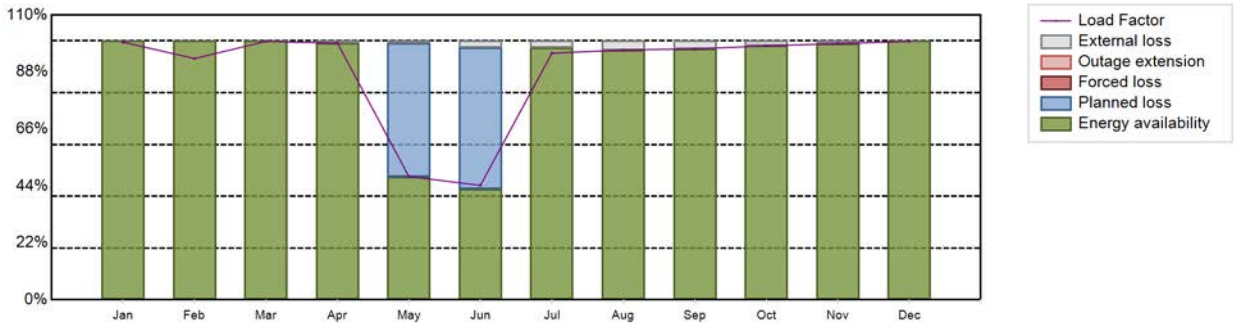
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.4
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	46410
Active core diameter [m]	:	3.228
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.38
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	328.5
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.5
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8413.86 GW(e).h
Energy Availability Factor (EAF)	:	89.78 %
Unit Capability Factor (UCF)	:	91.18 %
Load Factor (LF)	:	89.1 %
Operating Factor (OF)	:	91.55 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	8.82 %
Externally cause unavailability (XUF)	:	1.4 %
Total off-line time	:	742 hours

Annual Summary



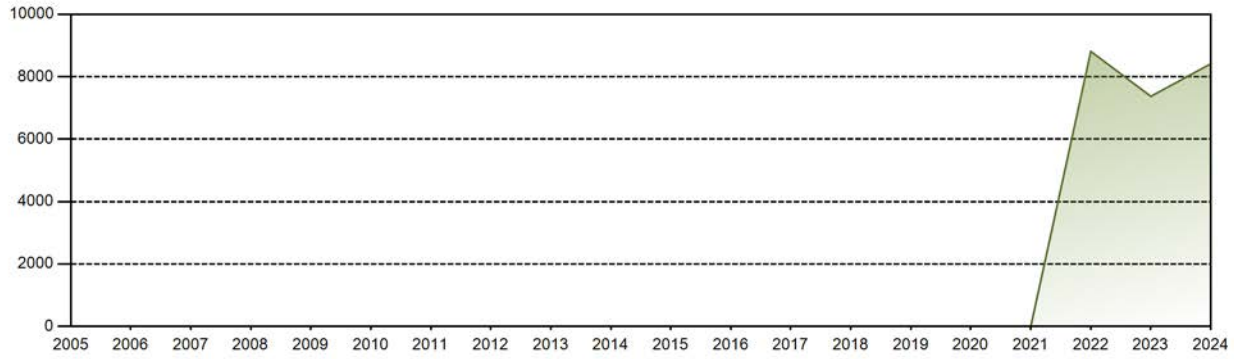
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	795.86	697.23	798.20	767.22	380.71	342.31	761.84	771.84	750.04	784.51	765.94	798.17	8413.86
EAF [%]	100.00	100.00	100.00	99.12	47.60	42.82	97.33	96.50	96.90	98.09	98.96	100.00	89.78
UCF [%]	100.00	100.00	100.00	100.00	48.60	45.48	100.00	100.00	100.00	100.00	100.00	100.00	91.18
LF [%]	99.51	93.19	99.80	99.12	47.60	44.23	95.25	96.50	96.90	98.09	98.96	99.80	89.10
OF [%]	100.00	100.00	100.00	100.00	49.46	49.17	100.00	100.00	100.00	100.00	100.00	100.00	91.55
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	51.40	54.52	0.00	0.00	0.00	0.00	0.00	0.00	8.82
XUF [%]	0.00	0.00	0.00	0.88	1.00	2.67	2.67	3.50	3.10	1.91	1.04	0.00	1.40

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Historical Summary

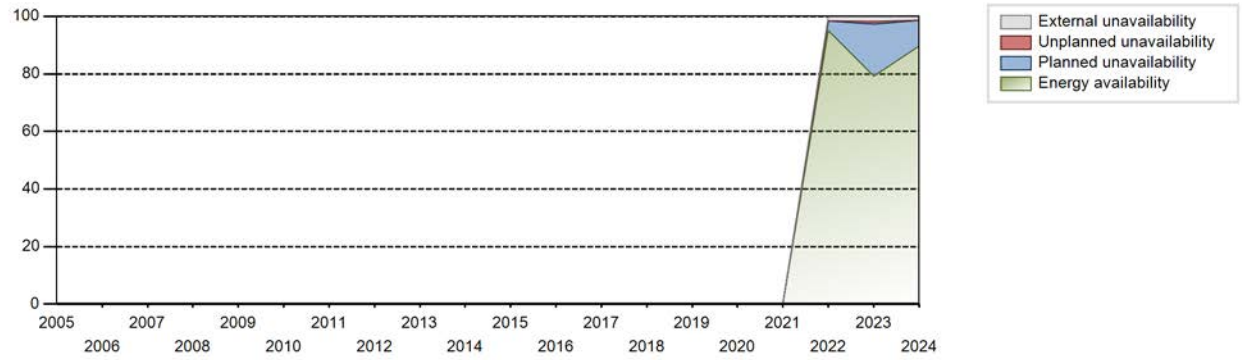
Lifetime energy generation	:	22439.2 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0 %
Cumulative Energy Availability Factor (EAF)	:	87.44 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.37 %
Cumulative Unit Capability Factor (UCF)	:	89.01 %	Cumulative Planned Unavailability Factor (PUF)	:	10.62 %
Cumulative Load Factor (LF)	:	85.9 %	Cumulative Externally cause unavailability (XUF)	:	1.57 %
Cumulative Operating Factor (OF)	:	88.8 %			

Electricity Production (net) [GWh]

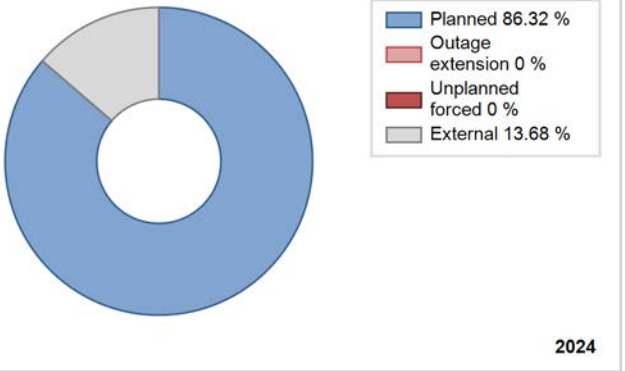


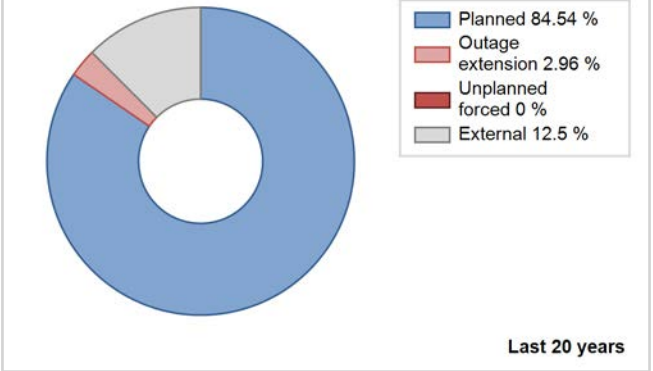
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2022	8810.67	8449	1075	95.16	96.76	91.74	95.29	0.00	0.00	3.24	1.60
2023	7371.42	7110	1075	79.29	81.00	78.28	81.16	0.00	1.02	17.97	1.72
2024	8413.86	8042	1075	89.78	91.18	89.10	91.55	0.00	0.00	8.82	1.40

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2022 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
C. Inspection, maintenance or repair combined with refuelling	742			837		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						39
Z. Other				74	33	
Subtotal	742			911	33	39
Total	**742**			**983**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2022 to 2024
	Hours Lost	Average hours lost per reactor-year
34. Miscellaneous Systems		65
Total		**65**

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2024 Operating Experience

CN-30 HAIYANG-1 CHINA

Status at end of year	:	**Operational**
Operator	:	SDNPC (Shandong Nuclear Power Company, Ltd.)
Owner	:	CPIG (China Power Investment Group)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / AP-1000
Thermal power	:	3415 MWth
Gross electrical power	:	1250 MWe
Reference unit power (net)	:	1170 MWe

Key Dates

Construction Date	:	2009-09-24
Grid Date	:	2018-08-17
Commercial Date	:	2018-10-22
Age at end of year	:	6 years

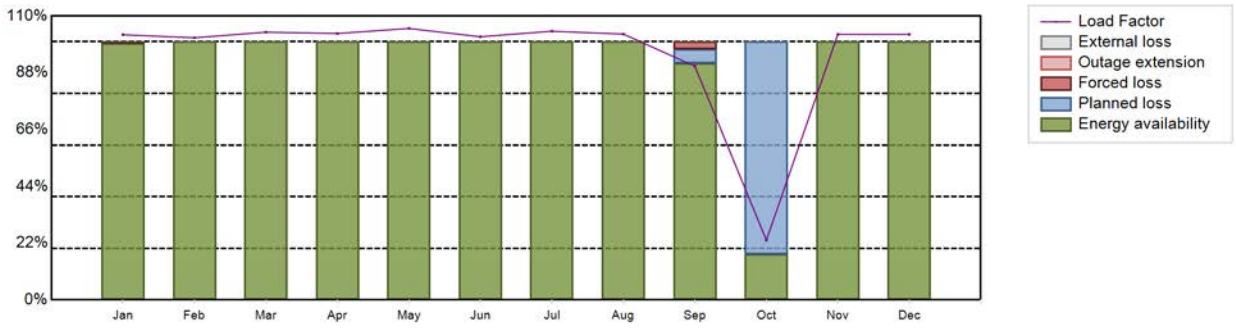
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.7239
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	40.76
Average discharge burnup [MWd/t]	:	50000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	4.2672
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.76
Number of control rod assemblies	:	69
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.513
Reactor outlet temperature [°C]	:	321.11
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.407
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.38
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	9796.12 GW(e).h	Forced Loss Rate (FLR)	:	0.32 %
Energy Availability Factor (EAF)	:	92.31 %	Unplanned Capability Loss Factor (UCL)	:	0.29 %
Unit Capability Factor (UCF)	:	92.31 %	Planned Unavailability Factor (PUF)	:	7.4 %
Load Factor (LF)	:	95.32 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	92.36 %	Total off-line time	:	671 hours
Equivalent non-electrical energy generated (NEG)	:	588.9 GW(e).h			

Annual Summary



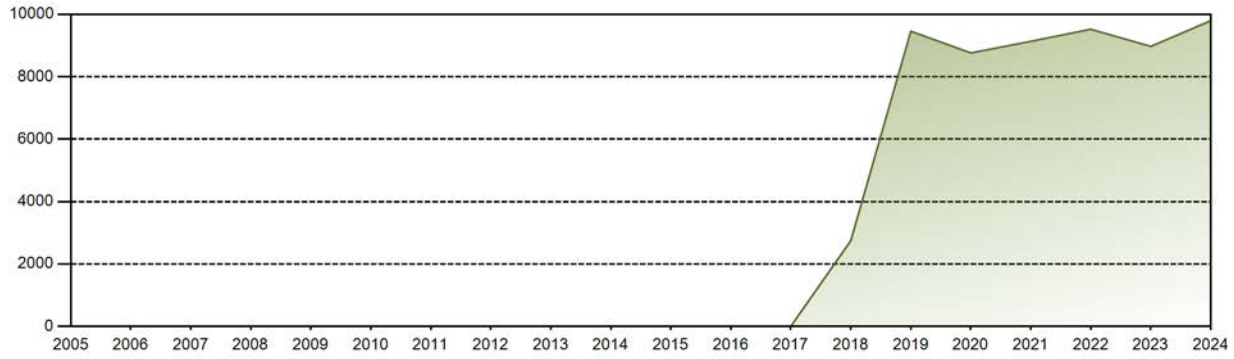
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	894.24	826.91	902.81	869.40	915.33	858.78	906.07	896.40	762.54	201.66	866.57	895.42	9796.12
EAF [%]	99.42	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.74	17.76	100.00	100.00	92.31
UCF [%]	99.42	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.74	17.76	100.00	100.00	92.31
LF [%]	102.73	101.55	103.71	103.21	105.15	101.94	104.09	102.98	90.52	23.17	102.87	102.86	95.32
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.81	17.74	100.00	100.00	92.36
FLR [%]	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.14	0.00	0.00	0.00	0.32
UCL [%]	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.98	0.00	0.00	0.00	0.29
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.28	82.24	0.00	0.00	7.40
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

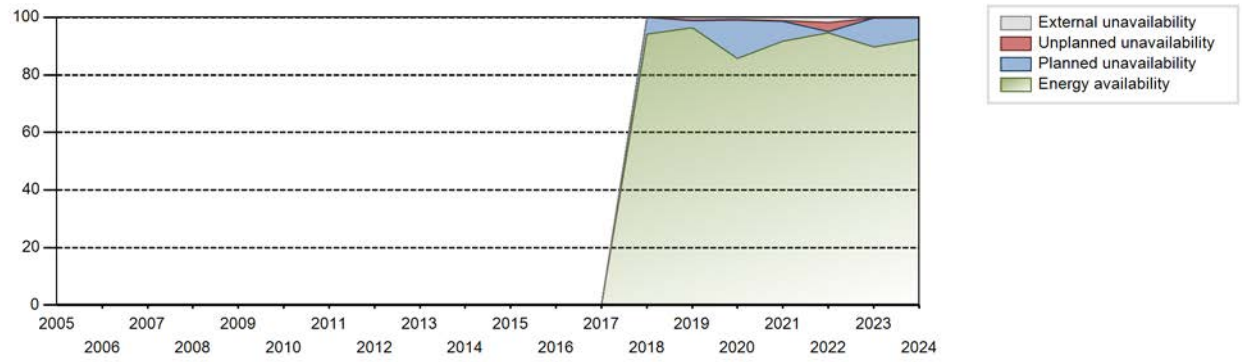
Lifetime energy generation	:	58387.43 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.71 %
Cumulative Energy Availability Factor (EAF)	:	91.81 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.66 %
Cumulative Unit Capability Factor (UCF)	:	92.59 %	Cumulative Planned Unavailability Factor (PUF)	:	6.75 %
Cumulative Load Factor (LF)	:	90.49 %	Cumulative Externally cause unavailability (XUF)	:	0.78 %
Cumulative Operating Factor (OF)	:	92.01 %			

Electricity Production (net) [GWh]

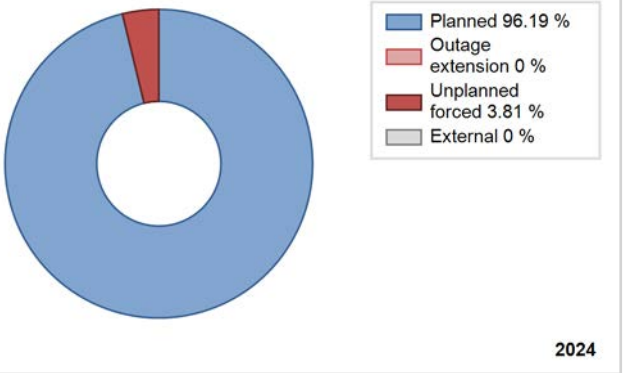


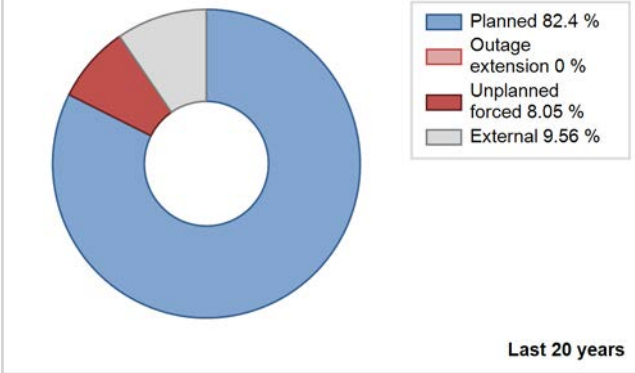
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2018	2746.03	2870	1170	94.20	94.20	93.91	95.29	0.00	0.00	5.80	0.00
2019	9456.75	8221	1170	96.46	97.39	92.27	93.85	0.16	0.16	2.45	0.93
2020	8762.30	7701	1170	85.68	86.31	85.26	87.67	0.31	0.27	13.42	0.63
2021	9133.85	8030	1170	91.78	92.90	89.12	91.67	0.30	0.28	6.82	1.12
2022	9520.82	8409	1170	94.61	96.45	92.89	95.99	3.08	3.06	0.49	1.83
2023	8971.59	7882	1170	89.65	89.95	87.53	89.98	0.00	0.00	10.04	0.31
2024	9796.12	8113	1170	92.31	92.31	95.32	92.36	0.32	0.29	7.40	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2018 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		21			44	
C. Inspection, maintenance or repair combined with refuelling	650			471		
D. Inspection, maintenance or repair without refuelling				103		
G. Major backfitting, refurbishment or upgrading activities without refuelling				40		
I. Grid capacity limitation						47
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						54
L. Human factor related					1	
Subtotal	650	21		614	45	101
Total	**671**			**760**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2018 to 2024
	Hours Lost	Average hours lost per reactor-year
15. Reactor Cooling Systems	21	3
34. Miscellaneous Systems		45
41. Main Generator Systems		1
42. Electrical Power Supply Systems		39
Total	**21**	**88**

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2024 Operating Experience

CN-31 HAIYANG-2 CHINA

Status at end of year	:	**Operational**
Operator	:	SDNPC (Shandong Nuclear Power Company, Ltd.)
Owner	:	CPIG (China Power Investment Group)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / AP-1000
Thermal power	:	3415 MWth
Gross electrical power	:	1250 MWe
Reference unit power (net)	:	1170 MWe

Key Dates

Construction Date	:	2010-06-20
Grid Date	:	2018-10-13
Commercial Date	:	2019-01-09
Age at end of year	:	6 years

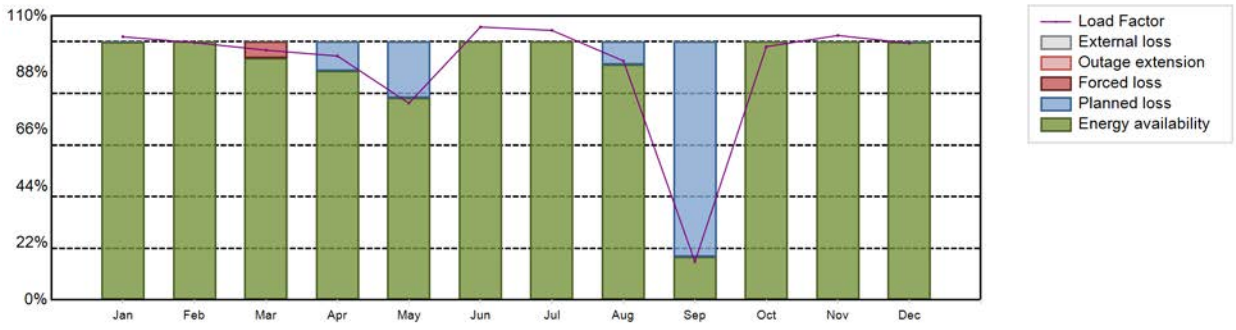
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.513
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321.11
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.407
Average fuel enrichment [% of U235]	:	2.7239	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	40.76	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	50000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.38
Active core height/length [m]	:	4.2672	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.76	Number of main condensate pumps	:	3
Number of control rod assemblies	:	69	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	DH

Annual Production Results (2024)

Net Energy Production	:	9313.27 GW(e).h	Forced Loss Rate (FLR)	:	0.6 %
Energy Availability Factor (EAF)	:	89.08 %	Unplanned Capability Loss Factor (UCL)	:	0.54 %
Unit Capability Factor (UCF)	:	89.08 %	Planned Unavailability Factor (PUF)	:	10.38 %
Load Factor (LF)	:	90.62 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	89.38 %	Total off-line time	:	933 hours
Equivalent non-electrical energy generated (NEG)	:	773 GW(e).h			

Annual Summary



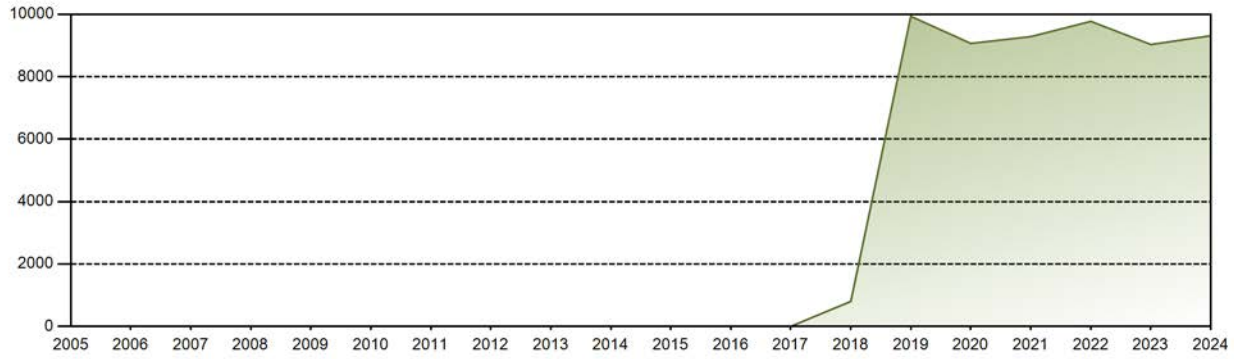
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	887.13	811.65	842.16	795.93	663.30	890.56	908.97	806.05	125.03	854.09	862.82	865.57	9313.27
EAF [%]	99.92	100.00	93.62	88.66	78.25	100.00	100.00	91.08	16.66	100.00	100.00	99.84	89.08
UCF [%]	99.92	100.00	93.62	88.66	78.25	100.00	100.00	91.08	16.66	100.00	100.00	99.84	89.08
LF [%]	101.91	99.67	96.75	94.48	76.20	105.72	104.42	92.60	14.84	98.12	102.42	99.44	90.62
OF [%]	100.00	100.00	95.03	90.00	81.05	100.00	100.00	90.32	16.67	100.00	100.00	98.52	89.38
FLR [%]	0.00	0.00	6.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60
UCL [%]	0.00	0.00	6.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54
PUF [%]	0.08	0.00	0.00	11.34	21.75	0.00	0.00	8.92	83.34	0.00	0.00	0.16	10.38
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

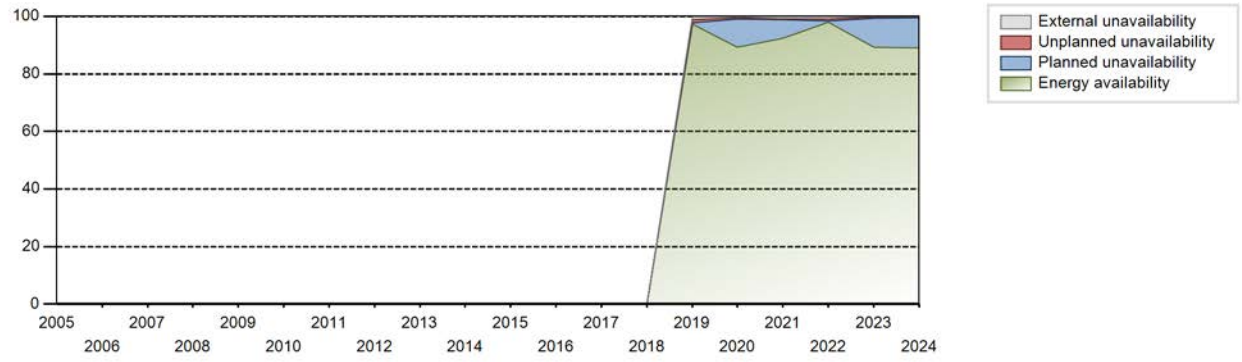
Lifetime energy generation	:	57207.52 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.64 %
Cumulative Energy Availability Factor (EAF)	:	92.59 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.6 %
Cumulative Unit Capability Factor (UCF)	:	93.17 %	Cumulative Planned Unavailability Factor (PUF)	:	6.23 %
Cumulative Load Factor (LF)	:	91.64 %	Cumulative Externally cause unavailability (XUF)	:	0.58 %
Cumulative Operating Factor (OF)	:	93.34 %			

Electricity Production (net) [GWh]

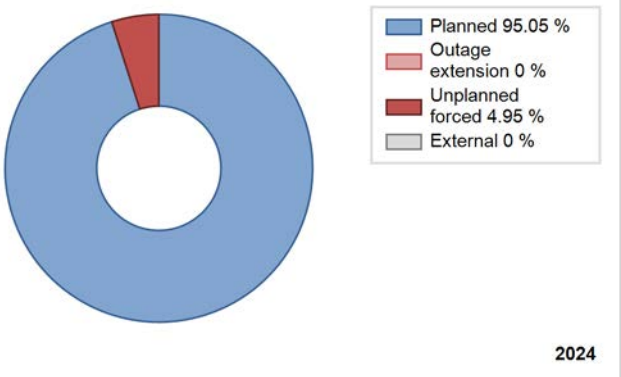


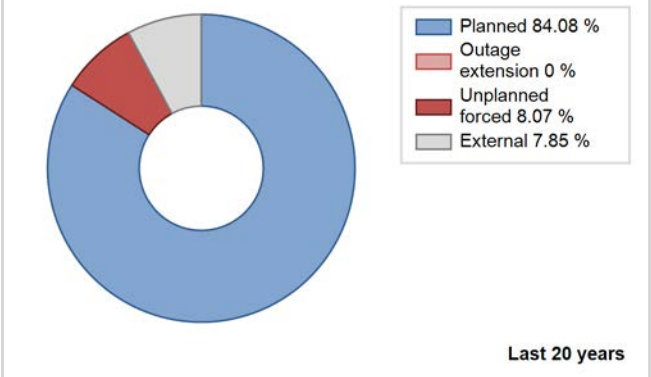
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2019	9935.22	8711	1170	97.38	98.43	96.94	99.44	1.25	1.25	0.32	1.05
2020	9066.38	7983	1170	89.33	89.91	88.22	90.88	0.44	0.40	9.69	0.58
2021	9286.00	8139	1170	92.49	93.32	90.60	92.91	0.33	0.31	6.38	0.83
2022	9773.92	8519	1170	98.04	98.92	95.36	97.25	0.61	0.61	0.47	0.88
2023	9032.01	7900	1170	89.23	89.39	88.12	90.18	0.53	0.48	10.13	0.16
2024	9313.27	7851	1170	89.08	89.08	90.62	89.38	0.60	0.54	10.38	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2019 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		47			35	
C. Inspection, maintenance or repair combined with refuelling	666			434		
D. Inspection, maintenance or repair without refuelling	243			118		
E. Testing of plant systems or components				16		
G. Major backfitting, refurbishment or upgrading activities without refuelling				35		
I. Grid capacity limitation						43
L. Human factor related					55	
Subtotal	909	47		603	90	43
Total	**956**			**736**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2019 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		6
15. Reactor Cooling Systems	47	24
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		55
34. Miscellaneous Systems		41
Total	**47**	**128**

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2024 Operating Experience

CN-16 HONGYANHE-1 CHINA

Status at end of year	:	**Operational**
Operator	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Owner	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)



Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1119 MWe
Reference unit power (net)	:	1061 MWe

Key Dates

Construction Date	:	2007-08-18
Grid Date	:	2013-02-17
Commercial Date	:	2013-06-06
Age at end of year	:	11 years

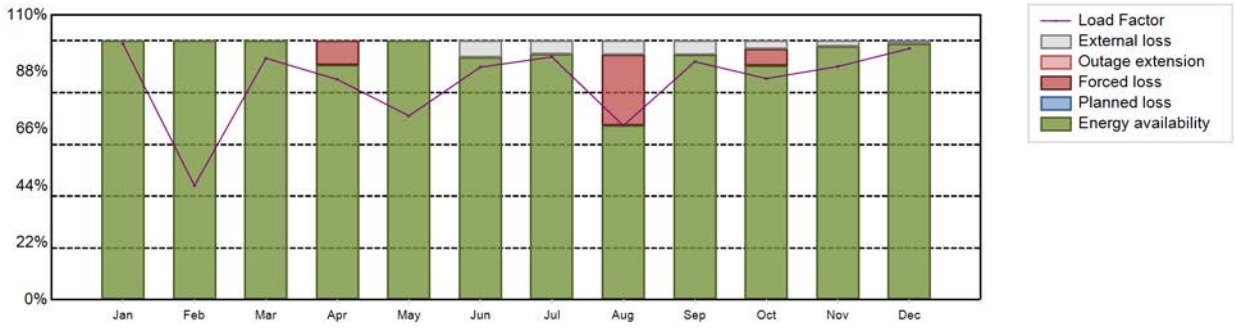
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	2.43	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	NA	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.11
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7843.8 GW(e).h	Forced Loss Rate (FLR)	:	3.64 %
Energy Availability Factor (EAF)	:	94 %	Unplanned Capability Loss Factor (UCL)	:	3.64 %
Unit Capability Factor (UCF)	:	96.36 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	84.16 %	Externally cause unavailability (XUF)	:	2.36 %
Operating Factor (OF)	:	91.06 %	Total off-line time	:	785 hours

Annual Summary



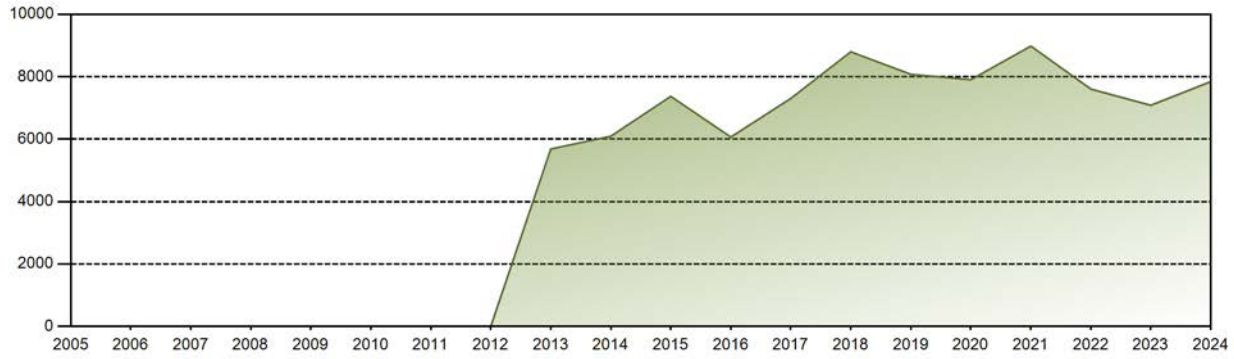
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	780.48	325.61	736.66	650.08	561.03	686.66	740.40	530.99	702.80	674.66	688.48	765.95	7843.80
EAF [%]	100.00	100.00	100.00	90.66	100.00	93.69	94.88	67.30	94.71	90.38	97.94	98.86	94.00
UCF [%]	100.00	100.00	100.00	90.66	100.00	100.00	100.00	72.54	99.99	93.56	100.00	100.00	96.36
LF [%]	98.87	44.09	93.32	85.10	71.07	89.89	93.79	67.27	92.00	85.47	90.12	97.03	84.16
OF [%]	100.00	45.83	100.00	87.78	84.41	100.00	100.00	72.58	100.00	100.00	100.00	100.00	91.06
FLR [%]	0.00	0.00	0.00	9.34	0.00	0.00	0.00	27.46	0.01	6.44	0.00	0.00	3.64
UCL [%]	0.00	0.00	0.00	9.34	0.00	0.00	0.00	27.46	0.01	6.44	0.00	0.00	3.64
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	6.31	5.12	5.24	5.28	3.18	2.06	1.14	2.36

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Historical Summary

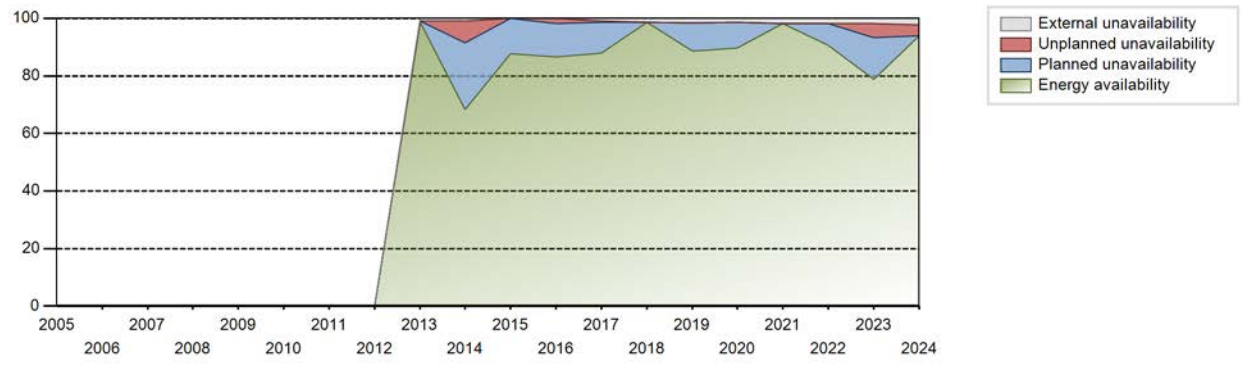
Lifetime energy generation	:	88903.71 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.44 %
Cumulative Energy Availability Factor (EAF)	:	88.61 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.59 %
Cumulative Unit Capability Factor (UCF)	:	89.89 %	Cumulative Planned Unavailability Factor (PUF)	:	8.52 %
Cumulative Load Factor (LF)	:	82.32 %	Cumulative Externally cause unavailability (XUF)	:	1.28 %
Cumulative Operating Factor (OF)	:	88.41 %			

Electricity Production (net) [GWh]



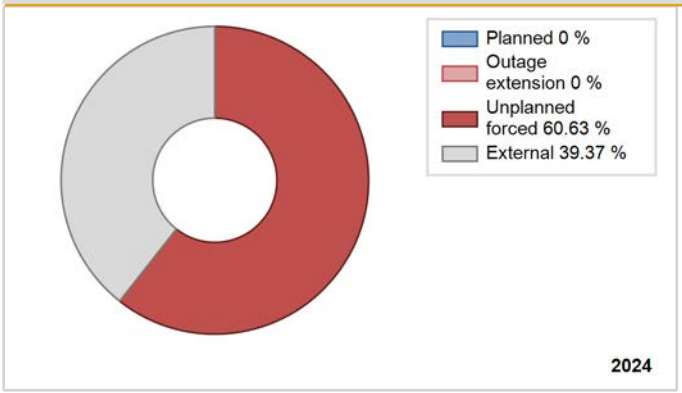
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2013	5683.38	7632	1061	98.62	99.55	102.41	100.00	0.01	0.01	0.44	0.94
2014	6093.20	6218	1061	68.38	69.32	65.56	70.98	9.71	7.65	23.03	0.95
2015	7369.75	7756	1061	87.80	87.80	79.29	88.54	0.01	0.01	12.19	0.00
2016	6066.04	6694	1061	86.62	86.62	65.09	76.21	2.14	1.93	11.45	0.00
2017	7304.12	7720	1061	87.92	88.92	78.59	88.13	0.43	0.38	10.69	1.01
2018	8797.86	8760	1061	98.55	99.98	94.66	100.00	0.00	0.00	0.01	1.43
2019	8077.71	7954	1061	88.51	90.20	86.91	90.80	0.00	0.00	9.80	1.68
2020	7903.95	8033	1061	89.65	91.10	84.81	91.45	0.00	0.00	8.90	1.44
2021	8980.89	8760	1061	98.15	100.00	96.63	100.00	0.00	0.00	0.00	1.85
2022	7605.00	7696	1061	90.56	92.32	81.82	87.85	0.00	0.00	7.68	1.76
2023	7084.46	7071	1061	78.71	80.50	76.22	80.72	2.19	4.83	14.67	1.79
2024	7843.80	7999	1061	94.00	96.36	84.16	91.06	3.64	3.64	0.00	2.36

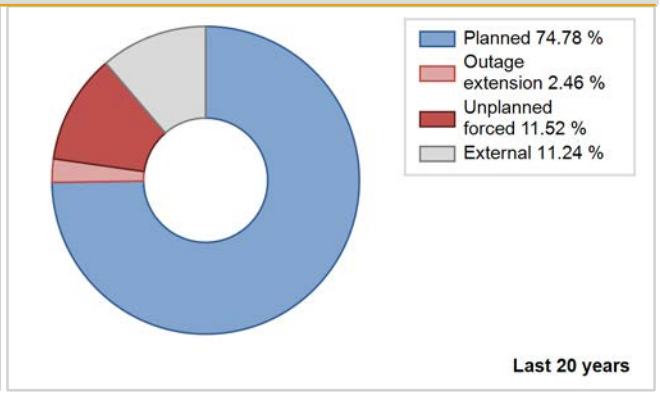
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2013 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		274			116	
C. Inspection, maintenance or repair combined with refuelling				706		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			520			197
Subtotal		274	520	706	116	197
Total		**794**			**1019**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2013 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories	520	103
15. Reactor Cooling Systems	204	17
31. Turbine and auxiliaries		0
32. Feedwater and Main Steam System	70	6
33. Circulating Water System		25
41. Main Generator Systems		42
42. Electrical Power Supply Systems		1
Total	**794**	**194**

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2024 Operating Experience

CN-17 HONGYANHE-2 CHINA



Status at end of year	:	**Operational**
Operator	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Owner	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1119 MWe
Reference unit power (net)	:	1061 MWe

Key Dates

Construction Date	:	2008-03-28
Grid Date	:	2013-11-23
Commercial Date	:	2014-05-13
Age at end of year	:	11 years

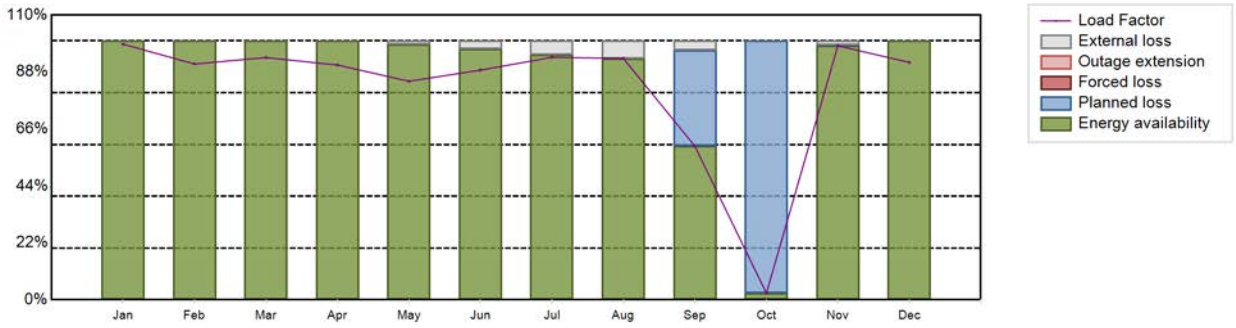
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	2.43	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	NA	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	NA
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7649.97 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	86.85 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	88.68 %	Planned Unavailability Factor (PUF)	:	11.32 %
Load Factor (LF)	:	82.08 %	Externally cause unavailability (XUF)	:	1.83 %
Operating Factor (OF)	:	89.08 %	Total off-line time	:	959 hours

Annual Summary



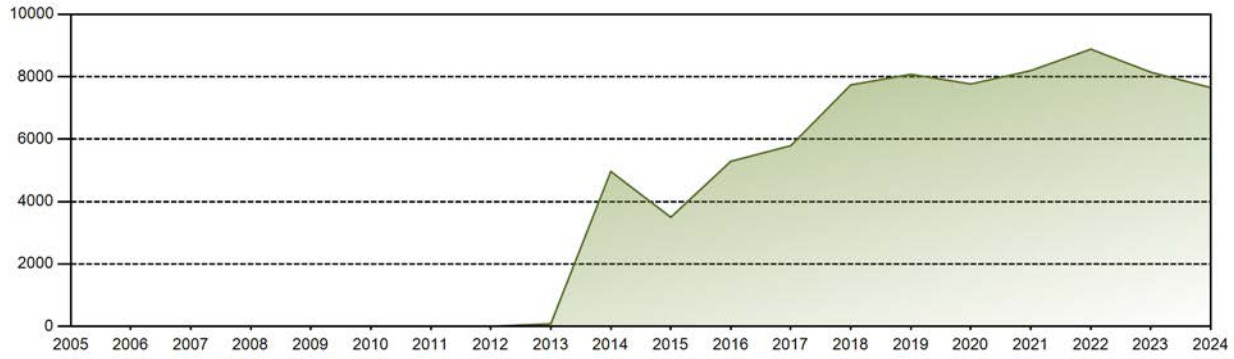
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	779.45	672.64	738.55	692.83	666.37	677.71	739.34	735.98	453.48	20.23	749.50	723.90	7649.97
EAF [%]	100.00	100.00	100.00	100.00	98.52	96.83	94.68	93.23	59.36	2.56	98.11	100.00	86.85
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	63.00	2.56	99.63	100.00	88.68
LF [%]	98.74	91.09	93.56	90.69	84.42	88.72	93.66	93.23	59.36	2.56	98.11	91.70	82.08
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	63.33	6.59	100.00	100.00	89.08
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.00	97.44	0.37	0.00	11.32
XUF [%]	0.00	0.00	0.00	0.00	1.48	3.17	5.32	6.77	3.64	0.00	1.52	0.00	1.83

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Historical Summary

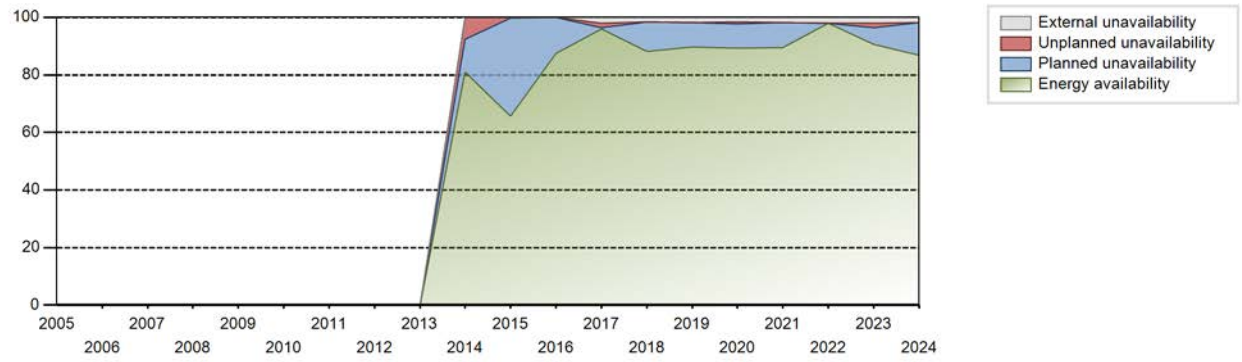
Lifetime energy generation	:	76071.48 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.73 %
Cumulative Energy Availability Factor (EAF)	:	87.66 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.88 %
Cumulative Unit Capability Factor (UCF)	:	89.05 %	Cumulative Planned Unavailability Factor (PUF)	:	10.07 %
Cumulative Load Factor (LF)	:	76.11 %	Cumulative Externally cause unavailability (XUF)	:	1.39 %
Cumulative Operating Factor (OF)	:	82.26 %			

Electricity Production (net) [GWh]



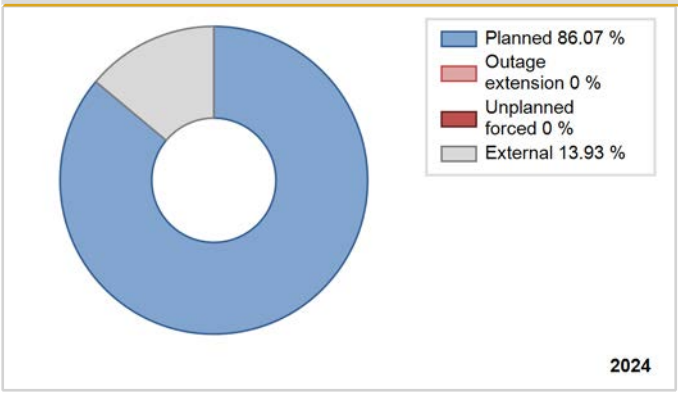
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2014	4963.31	5053	1061	81.06	81.06	72.46	79.81	8.62	7.64	11.29	0.00
2015	3496.01	3925	1061	65.63	65.63	37.61	44.81	0.16	0.34	34.03	0.00
2016	5288.78	5542	1061	87.53	87.53	56.75	63.09	0.01	0.01	12.47	0.00
2017	5790.37	6250	1061	95.98	98.08	62.30	71.35	0.00	1.53	0.40	2.10
2018	7737.78	7723	1061	88.18	89.80	83.25	88.16	0.00	0.00	10.20	1.63
2019	8077.34	8056	1061	89.72	91.62	86.91	91.96	0.00	0.00	8.38	1.89
2020	7767.35	8018	1061	89.29	90.88	83.34	91.28	0.00	0.70	8.42	1.59
2021	8195.34	8027	1061	89.41	91.17	88.18	91.63	0.00	0.00	8.83	1.76
2022	8882.06	8760	1061	97.96	100.00	95.56	100.00	0.00	0.00	0.00	2.04
2023	8143.39	8140	1061	90.50	92.44	87.62	92.92	1.82	1.71	5.84	1.95
2024	7649.97	7825	1061	86.85	88.68	82.08	89.08	0.00	0.00	11.32	1.83

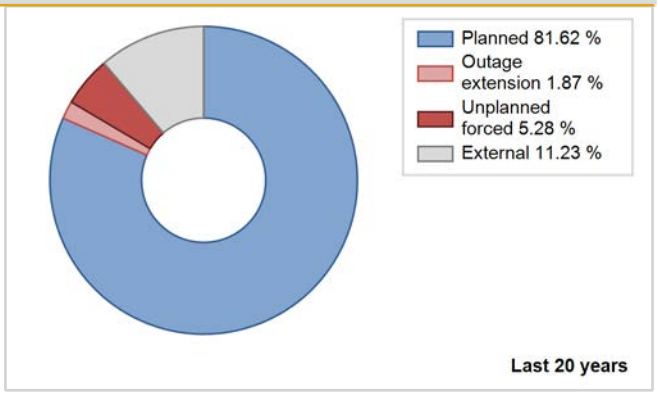
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2014 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					74	
C. Inspection, maintenance or repair combined with refuelling	958			846		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						626
Subtotal	958			846	74	626
Total	**958**			**1546**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2014 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		6
15. Reactor Cooling Systems		12
31. Turbine and auxiliaries		17
33. Circulating Water System		38
Total		**73**

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2024 Operating Experience

CN-26 HONGYANHE-3 CHINA



Status at end of year	:	**Operational**
Operator	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Owner	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1119 MWe
Reference unit power (net)	:	1061 MWe

Key Dates

Construction Date	:	2009-03-07
Grid Date	:	2015-03-23
Commercial Date	:	2015-08-16
Age at end of year	:	9 years

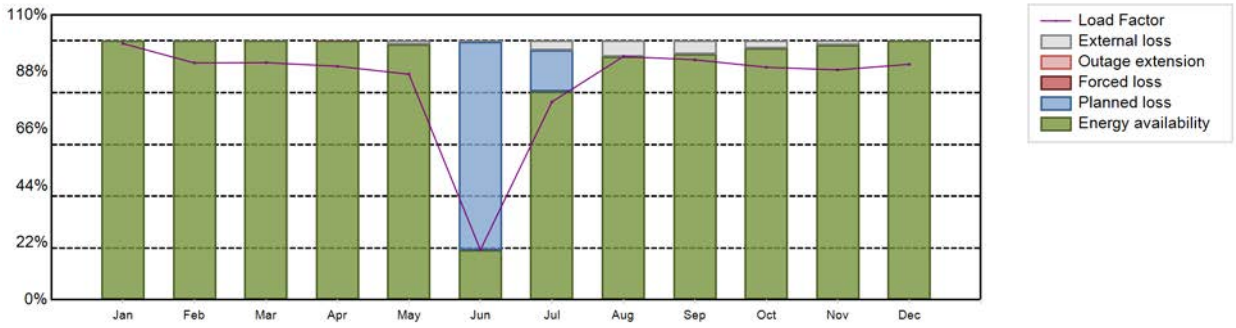
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.43
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	NA
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.11
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7863.64 GW(e).h
Energy Availability Factor (EAF)	:	90.33 %
Unit Capability Factor (UCF)	:	92.07 %
Load Factor (LF)	:	84.38 %
Operating Factor (OF)	:	92.13 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	7.93 %
Externally cause unavailability (XUF)	:	1.74 %
Total off-line time	:	691 hours

Annual Summary



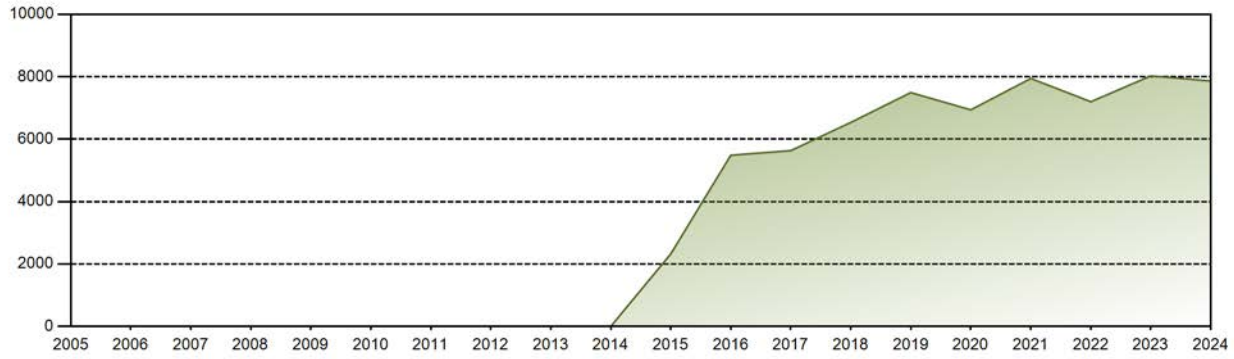
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	781.29	675.61	723.24	689.06	687.94	147.38	603.39	741.84	708.25	708.97	678.42	718.25	7863.64
EAF [%]	100.00	100.00	100.00	100.00	98.60	19.29	80.58	94.01	94.91	97.19	98.44	100.00	90.33
UCF [%]	100.00	100.00	100.00	100.00	100.00	19.66	84.18	100.00	100.00	100.00	100.00	100.00	92.07
LF [%]	98.97	91.49	91.62	90.20	87.15	19.29	76.44	93.98	92.71	89.81	88.81	90.99	84.38
OF [%]	100.00	100.00	100.00	100.00	100.00	20.14	84.41	100.00	100.00	100.00	100.00	100.00	92.13
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	80.34	15.82	0.00	0.00	0.00	0.00	0.00	7.93
XUF [%]	0.00	0.00	0.00	0.00	1.40	0.37	3.60	5.99	5.09	2.81	1.56	0.00	1.74

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Historical Summary

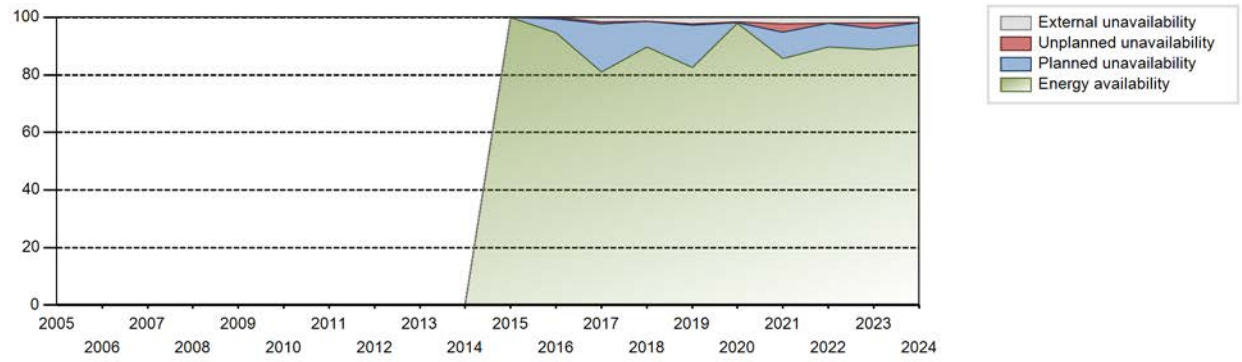
Lifetime energy generation	:	65417.67 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.4 %
Cumulative Energy Availability Factor (EAF)	:	89.37 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.67 %
Cumulative Unit Capability Factor (UCF)	:	91 %	Cumulative Planned Unavailability Factor (PUF)	:	8.34 %
Cumulative Load Factor (LF)	:	74.23 %	Cumulative Externally cause unavailability (XUF)	:	1.62 %
Cumulative Operating Factor (OF)	:	80.24 %			

Electricity Production (net) [GWh]



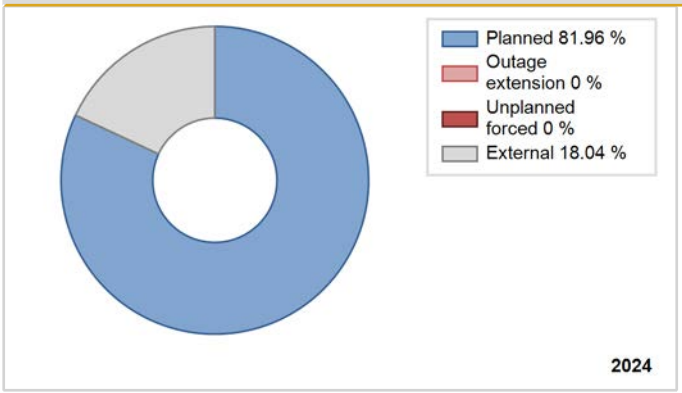
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2015	2322.53	2835	1061	99.98	99.98	43.20	47.98	0.01	0.01	0.01	0.00
2016	5483.99	5764	1061	94.69	94.69	58.84	65.62	0.55	0.52	4.79	0.00
2017	5631.50	5975	1061	80.94	82.61	60.59	68.21	0.67	0.56	16.83	1.67
2018	6535.98	6697	1061	89.74	91.17	70.32	76.45	0.00	0.00	8.82	1.44
2019	7491.34	7481	1061	82.68	84.95	80.60	85.40	0.60	0.51	14.53	2.27
2020	6938.56	7116	1061	98.05	99.73	74.45	81.01	0.09	0.09	0.18	1.69
2021	7943.87	7670	1061	85.80	88.06	85.47	87.56	0.00	2.84	9.10	2.26
2022	7198.11	7472	1061	89.71	91.81	77.45	85.30	0.00	0.00	8.19	2.10
2023	8025.66	7996	1061	88.82	90.82	86.35	91.28	1.85	1.71	7.46	2.00
2024	7863.64	8093	1061	90.33	92.07	84.38	92.13	0.00	0.00	7.93	1.74

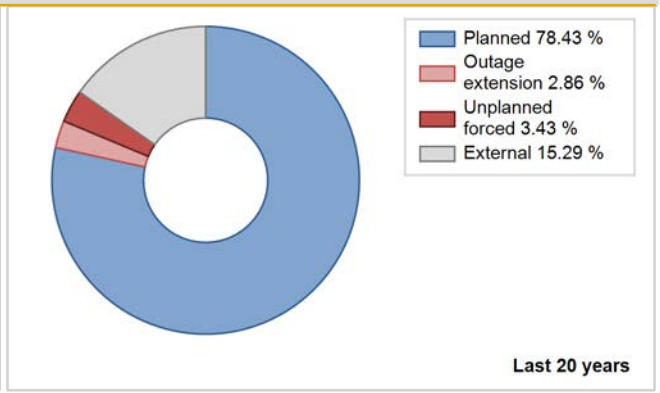
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2015 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					52	
C. Inspection, maintenance or repair combined with refuelling	656			701		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			35			981
Subtotal	656		35	701	52	981
Total	**691**			**1734**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2015 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories	35	269
12. Reactor I&C Systems		5
33. Circulating Water System		20
Total	**35**	**294**

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2024 Operating Experience

CN-27 HONGYANHE-4 CHINA

Status at end of year	:	**Operational**
Operator	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Owner	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)



Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1119 MWe
Reference unit power (net)	:	1061 MWe

Key Dates

Construction Date	:	2009-08-15
Grid Date	:	2016-04-01
Commercial Date	:	2016-06-08
Age at end of year	:	8 years

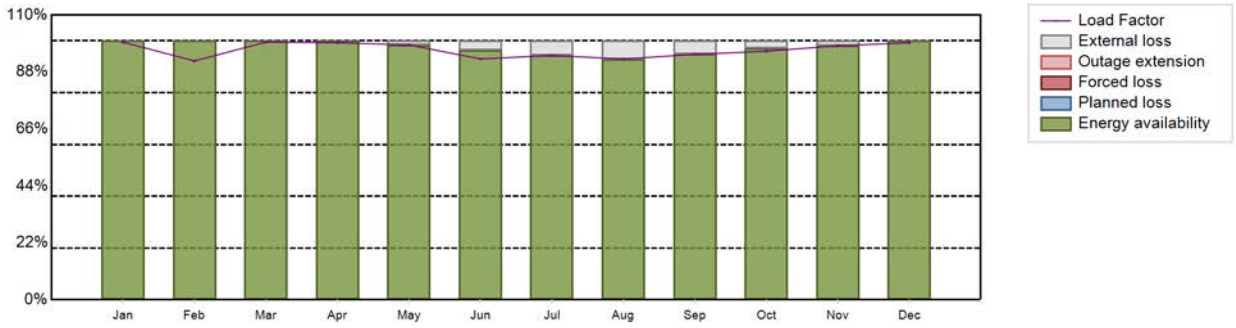
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	2.43	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	NA	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	NA
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8993.96 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	97.7 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	96.5 %	Externally cause unavailability (XUF)	:	2.3 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



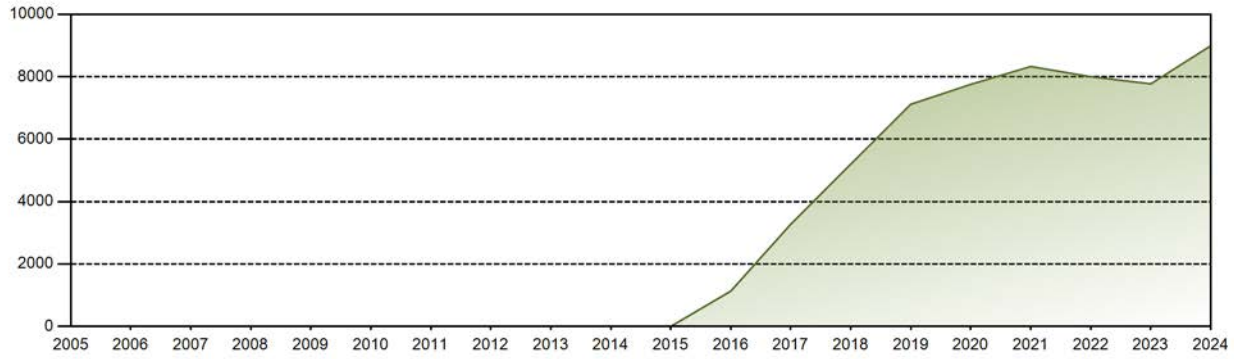
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	785.50	681.27	785.68	758.64	777.19	710.75	744.97	734.23	724.28	757.86	749.71	783.88	8993.96
EAF [%]	100.00	100.00	100.00	100.00	98.45	96.48	94.37	93.01	94.81	97.21	98.14	100.00	97.70
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	99.51	92.26	99.53	99.31	98.45	93.04	94.37	93.01	94.81	96.01	98.14	99.30	96.50
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	1.55	3.52	5.63	6.99	5.19	2.79	1.86	0.00	2.30

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Historical Summary

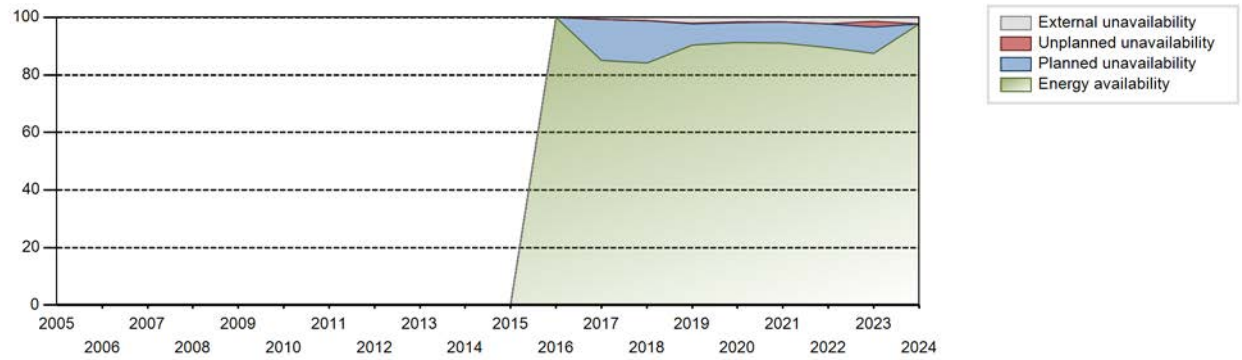
Lifetime energy generation	:	58286.7 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.32 %
Cumulative Energy Availability Factor (EAF)	:	90.25 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.33 %
Cumulative Unit Capability Factor (UCF)	:	91.77 %	Cumulative Planned Unavailability Factor (PUF)	:	7.9 %
Cumulative Load Factor (LF)	:	72.38 %	Cumulative Externally cause unavailability (XUF)	:	1.52 %
Cumulative Operating Factor (OF)	:	77.21 %			

Electricity Production (net) [GWh]

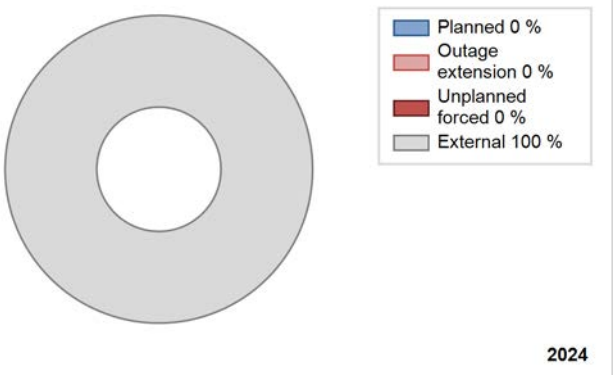


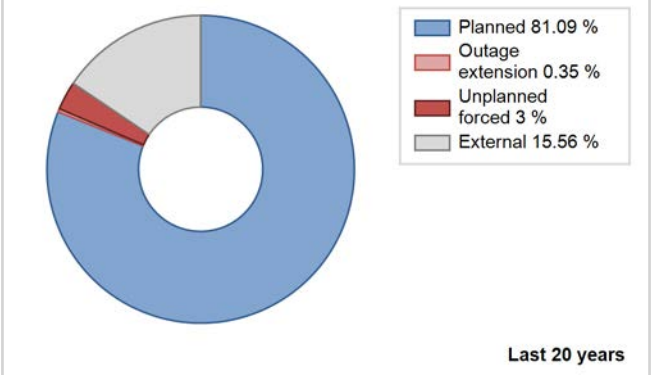
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	1130.44	1200	1000	99.99	99.99	22.01	23.36	0.00	0.00	0.01	0.00
2017	3276.06	3638	1061	85.13	85.76	35.25	41.53	0.17	0.15	14.10	0.63
2018	5198.53	5361	1061	84.08	85.16	55.93	61.20	0.03	0.03	14.82	1.08
2019	7117.14	7035	1061	90.39	92.47	76.57	80.31	0.21	0.20	7.33	2.09
2020	7755.39	8183	1061	91.28	92.78	83.21	93.16	0.37	0.35	6.87	1.50
2021	8327.55	8177	1061	91.15	92.83	89.60	93.34	0.00	0.00	7.17	1.68
2022	8000.10	8076	1061	89.50	91.81	86.07	92.19	0.00	0.00	8.19	2.30
2023	7771.55	7655	1061	87.41	88.79	83.62	87.39	1.97	2.08	9.13	1.38
2024	8993.96	8784	1061	97.70	100.00	96.50	100.00	0.00	0.00	0.00	2.30

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					27	
C. Inspection, maintenance or repair combined with refuelling				666		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						997
Subtotal				666	27	997
Total		**0**			**1690**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		21
32. Feedwater and Main Steam System		2
33. Circulating Water System		22
Total		**45**

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2024 Operating Experience

CN-49 HONGYANHE-5 CHINA

Status at end of year	:	**Operational**
Operator	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Owner	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)



Reactor Unit Details

Reactor type and model	:	PWR / ACPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1119 MWe
Reference unit power (net)	:	1061 MWe

Key Dates

Construction Date	:	2015-03-29
Grid Date	:	2021-06-25
Commercial Date	:	2021-07-31
Age at end of year	:	3 years

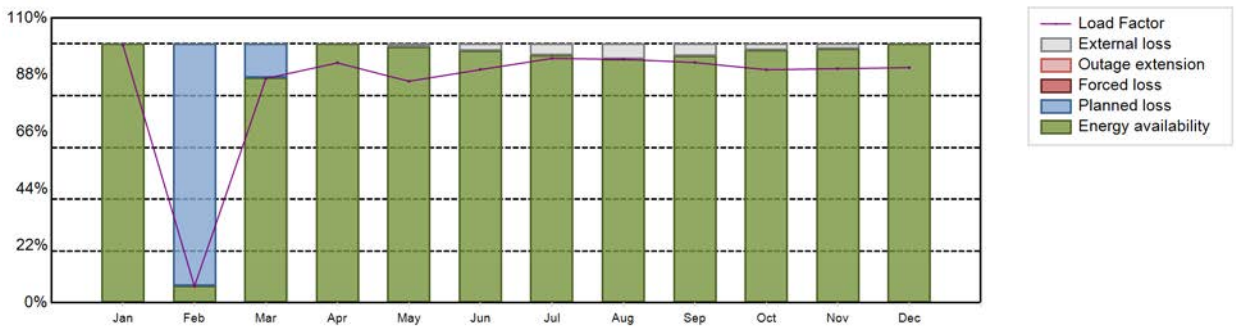
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7903.36 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	89.58 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	91.49 %	Planned Unavailability Factor (PUF)	:	8.51 %
Load Factor (LF)	:	84.8 %	Externally cause unavailability (XUF)	:	1.9 %
Operating Factor (OF)	:	91.88 %	Total off-line time	:	713 hours

Annual Summary



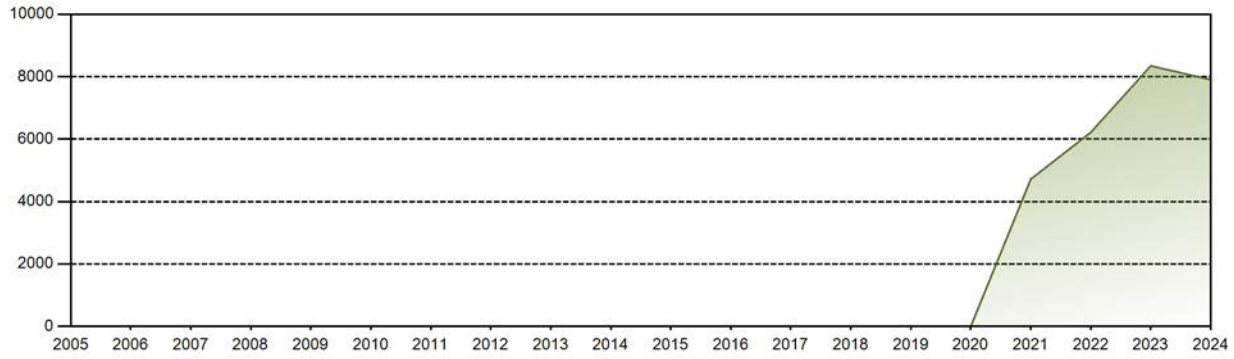
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	785.57	47.20	683.98	707.92	675.45	688.05	745.08	742.37	709.04	710.56	690.86	717.27	7903.36
EAF [%]	100.00	6.45	86.99	100.00	98.92	97.47	95.52	94.08	95.50	97.51	98.21	100.00	89.58
UCF [%]	100.00	6.45	86.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.49
LF [%]	99.52	6.39	86.65	92.67	85.57	90.07	94.39	94.04	92.82	90.01	90.44	90.86	84.80
OF [%]	100.00	6.90	91.26	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.88
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	93.55	13.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.51
XUF [%]	0.00	0.00	0.00	0.00	1.08	2.53	4.48	5.92	4.50	2.49	1.79	0.00	1.90

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Historical Summary

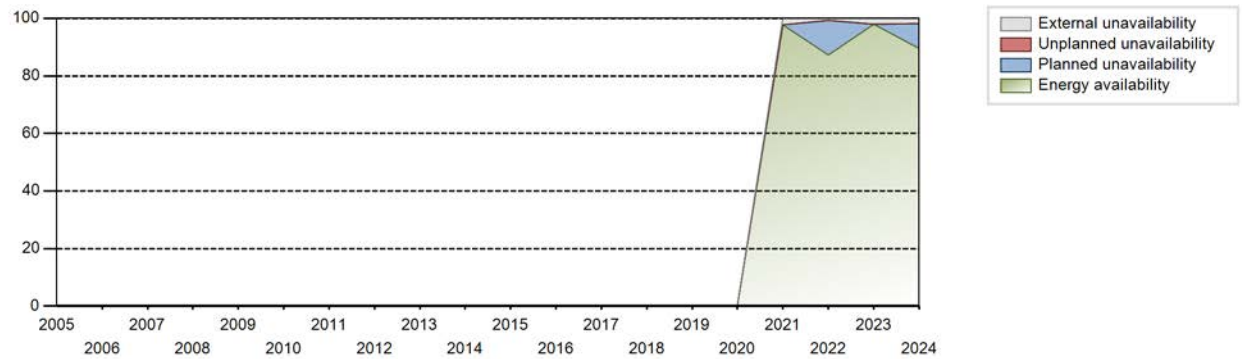
Lifetime energy generation	:	26244.87 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.03 %
Cumulative Energy Availability Factor (EAF)	:	92.34 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.03 %
Cumulative Unit Capability Factor (UCF)	:	93.95 %	Cumulative Planned Unavailability Factor (PUF)	:	6.03 %
Cumulative Load Factor (LF)	:	82.52 %	Cumulative Externally cause unavailability (XUF)	:	1.61 %
Cumulative Operating Factor (OF)	:	88.65 %			

Electricity Production (net) [GWh]

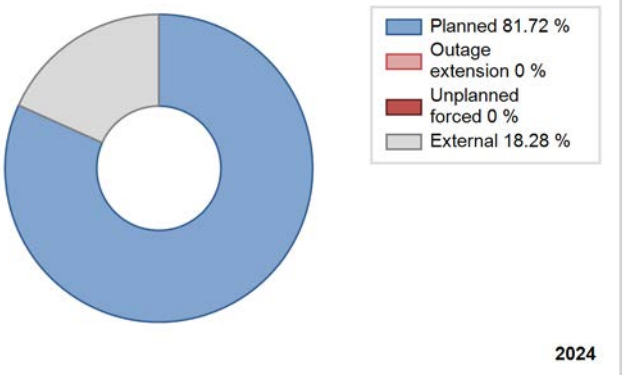


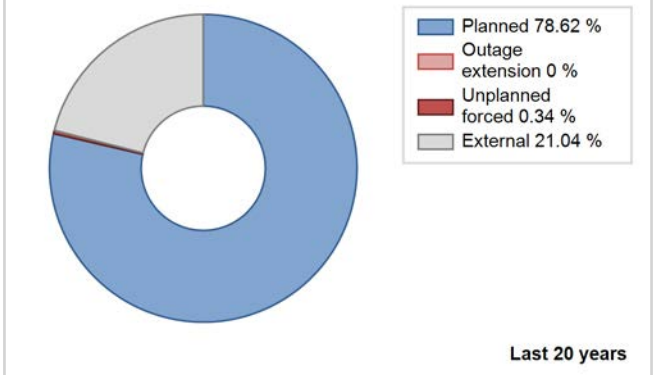
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2021	4718.48	4560	1061	97.74	100.00	96.93	100.00	0.00	0.00	0.00	2.26
2022	6217.30	6490	1061	87.26	87.92	66.89	74.09	0.00	0.00	12.08	0.66
2023	8347.90	8340	1061	97.91	99.91	89.82	95.21	0.09	0.09	0.00	2.00
2024	7903.36	8071	1061	89.58	91.49	84.80	91.88	0.00	0.00	8.51	1.90

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2021 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
C. Inspection, maintenance or repair combined with refuelling	712			508		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						485
L. Human factor related					2	
Subtotal	712			508	2	485
Total	**712**			**995**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2021 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		465
Total		**465**

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2024 Operating Experience

CN-50 HONGYANHE-6 CHINA



Status at end of year	:	**Operational**
Operator	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Owner	:	LHNPC (Liaoning Hongyanhe Nuclear Power Co. Ltd. (LHNPC))
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / ACPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1119 MWe
Reference unit power (net)	:	1061 MWe

Key Dates

Construction Date	:	2015-07-24
Grid Date	:	2022-05-02
Commercial Date	:	2022-06-23
Age at end of year	:	2 years

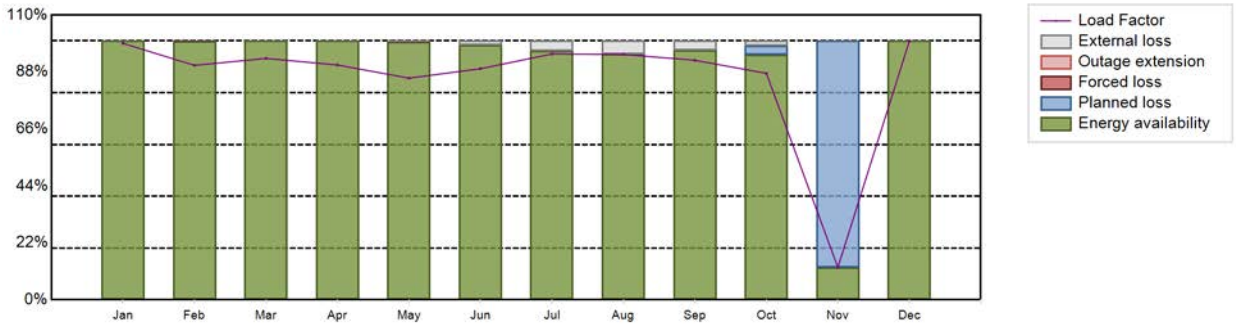
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8016.6 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	91.15 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	92.53 %	Planned Unavailability Factor (PUF)	:	7.46 %
Load Factor (LF)	:	86.02 %	Externally cause unavailability (XUF)	:	1.38 %
Operating Factor (OF)	:	92.91 %	Total off-line time	:	623 hours

Annual Summary



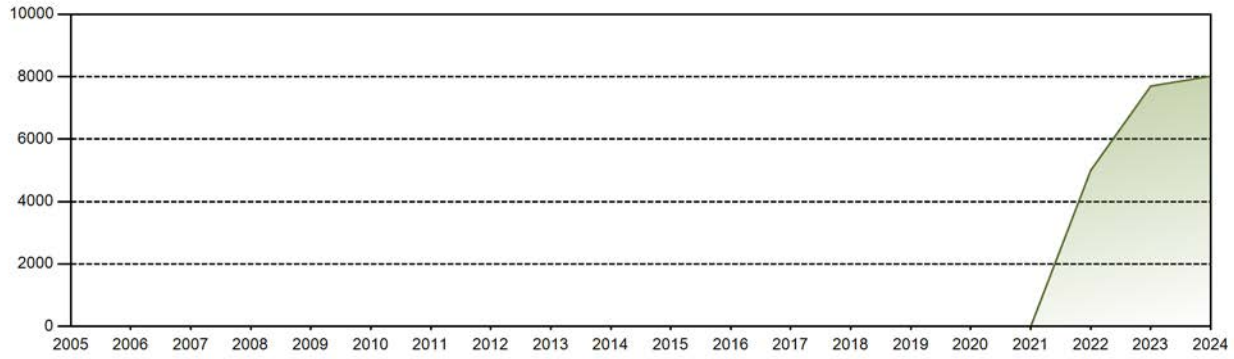
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	781.87	668.79	736.07	692.83	675.87	681.87	749.46	748.10	706.84	690.51	95.60	788.78	8016.60
EAF [%]	100.00	99.98	100.00	100.00	99.62	98.35	96.13	94.83	96.33	94.66	12.62	100.00	91.15
UCF [%]	100.00	99.98	100.00	100.00	99.98	100.00	100.00	100.00	100.00	96.44	12.62	100.00	92.53
LF [%]	99.05	90.57	93.25	90.69	85.62	89.26	94.94	94.77	92.53	87.47	12.51	99.92	86.02
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	96.77	16.81	100.00	92.91
FLR [%]	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.56	87.38	0.00	7.46
XUF [%]	0.00	0.00	0.00	0.00	0.35	1.65	3.87	5.17	3.67	1.78	0.00	0.00	1.38

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Historical Summary

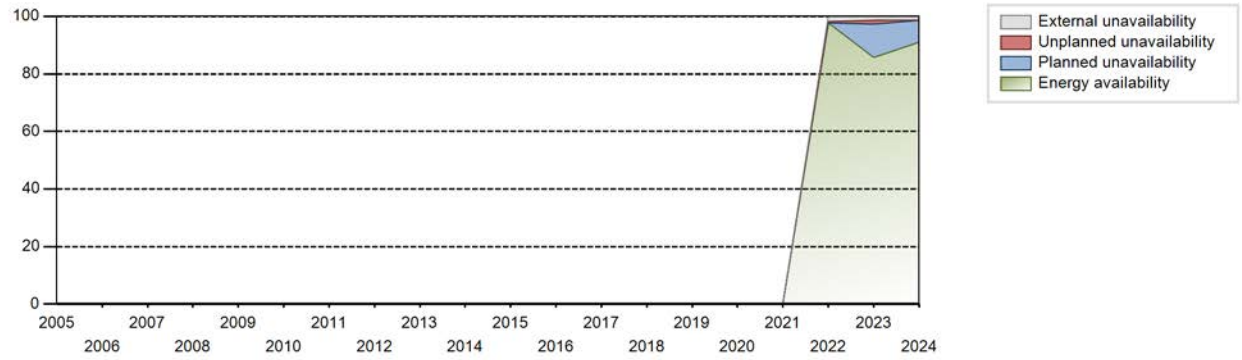
Lifetime energy generation	:	19954.79 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.63 %
Cumulative Energy Availability Factor (EAF)	:	90.29 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.58 %
Cumulative Unit Capability Factor (UCF)	:	91.75 %	Cumulative Planned Unavailability Factor (PUF)	:	7.67 %
Cumulative Load Factor (LF)	:	83.92 %	Cumulative Externally cause unavailability (XUF)	:	1.46 %
Cumulative Operating Factor (OF)	:	89.85 %			

Electricity Production (net) [GWh]

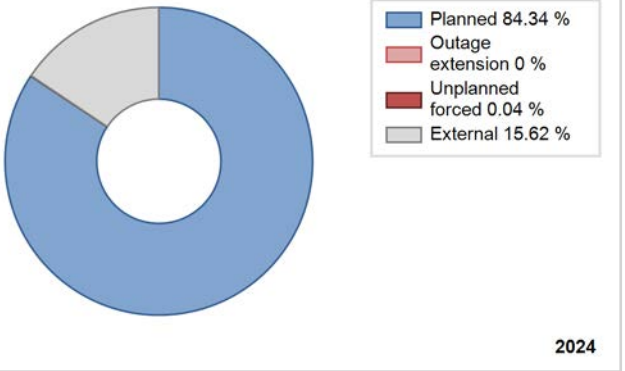


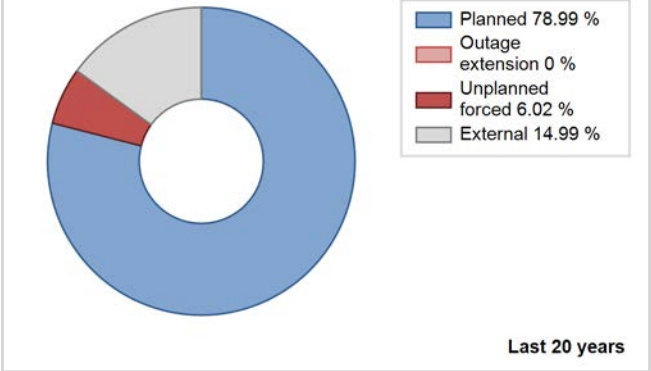
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2022	5000.45	5007	1061	97.84	99.75	81.83	88.50	0.25	0.25	0.00	1.91
2023	7701.66	7661	1061	85.63	86.93	82.86	87.45	1.51	1.34	11.74	1.30
2024	8016.60	8161	1061	91.15	92.53	86.02	92.91	0.00	0.00	7.46	1.38

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2022 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					51	
C. Inspection, maintenance or repair combined with refuelling	622			644		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						338
Subtotal	622			644	51	338
Total	**622**			**1033**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2022 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		317
32. Feedwater and Main Steam System		48
Total		**365**

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2024 Operating Experience

CN-6 LING AO-1 CHINA

Status at end of year	:	**Operational**
Operator	:	DNMC (Daya Bay Nuclear Power Operations and Management Co, Ltd.)
Owner	:	LANPC (LINGAO NUCLEAR POWER COMPANY LTD.)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	PWR / M310
Thermal power	:	2905 MWth
Gross electrical power	:	990 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1997-05-15
Grid Date	:	2002-02-26
Commercial Date	:	2002-05-28
Age at end of year	:	22 years

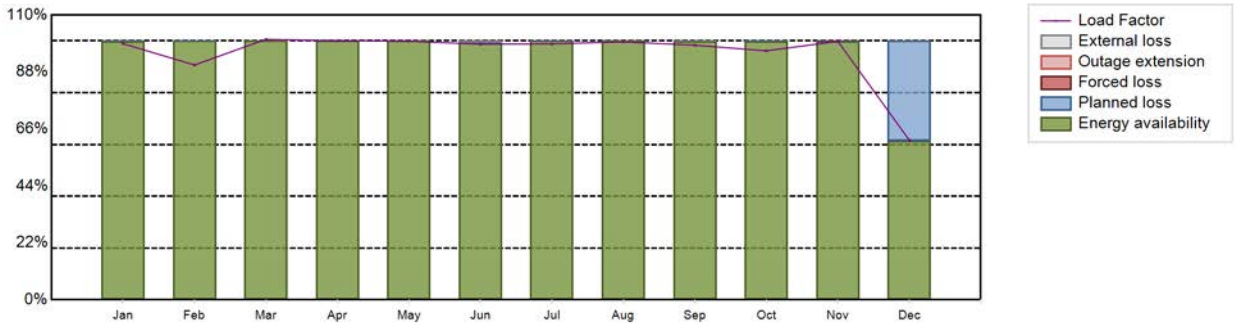
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.81
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	4.45	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	40	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	46000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	26
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7950.18 GW(e).h	Forced Loss Rate (FLR)	:	0.01 %
Energy Availability Factor (EAF)	:	96.65 %	Unplanned Capability Loss Factor (UCL)	:	0.01 %
Unit Capability Factor (UCF)	:	96.72 %	Planned Unavailability Factor (PUF)	:	3.27 %
Load Factor (LF)	:	95.27 %	Externally cause unavailability (XUF)	:	0.07 %
Operating Factor (OF)	:	96.79 %	Total off-line time	:	282 hours

Annual Summary



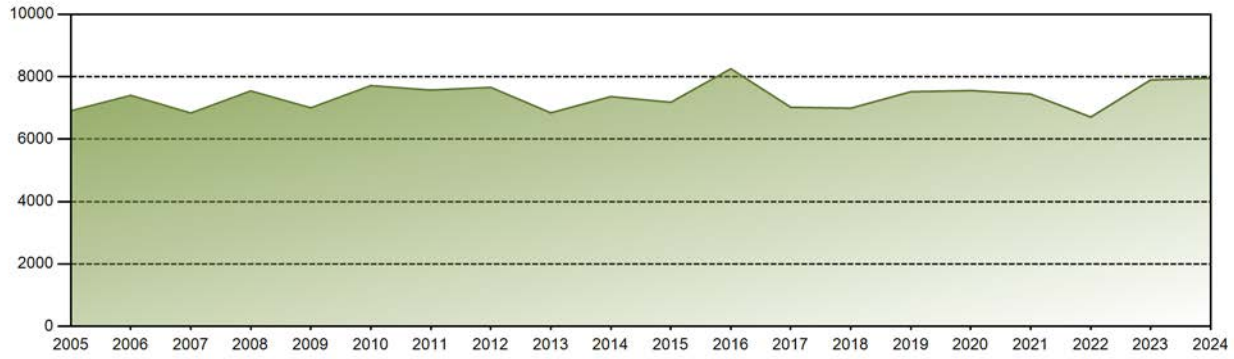
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	699.26	599.77	711.07	684.60	705.92	675.41	698.67	704.35	672.64	679.82	682.88	435.80	7950.18
EAF [%]	99.98	100.00	100.00	99.99	100.00	99.37	99.99	100.00	99.82	99.99	99.86	61.46	96.65
UCF [%]	99.98	100.00	100.00	99.99	100.00	100.00	99.99	100.00	100.00	99.99	99.86	61.46	96.72
LF [%]	98.93	90.71	100.60	100.09	99.88	98.74	98.85	99.65	98.34	96.18	99.84	61.66	95.27
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	62.10	96.79
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.01
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.01
PUF [%]	0.02	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.06	38.54	3.27
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.18	0.00	0.00	0.00	0.07

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Historical Summary

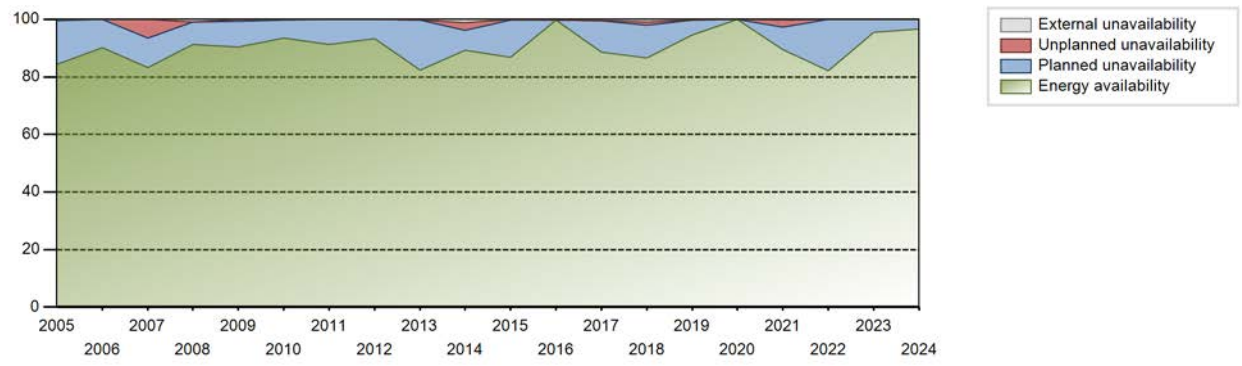
Lifetime energy generation	:	166043.45 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.37 %
Cumulative Energy Availability Factor (EAF)	:	90.05 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.92 %
Cumulative Unit Capability Factor (UCF)	:	90.37 %	Cumulative Planned Unavailability Factor (PUF)	:	8.71 %
Cumulative Load Factor (LF)	:	88.55 %	Cumulative Externally cause unavailability (XUF)	:	0.32 %
Cumulative Operating Factor (OF)	:	90.82 %			

Electricity Production (net) [GWh]



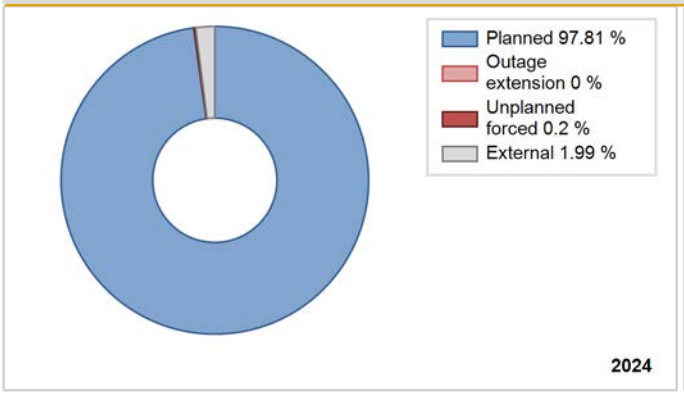
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2002	4583.85	5184	938	95.06	95.06	93.54	99.51	0.00	0.00	4.94	0.00
2003	6375.05	7215	938	80.36	82.30	77.58	82.36	6.17	5.41	12.30	1.93
2004	7331.36	7884	938	88.69	88.95	88.98	89.75	0.51	0.91	10.13	0.26
2005	6906.43	7424	938	84.27	84.27	84.05	84.75	0.46	0.39	15.34	0.00
2006	7401.01	7964	938	90.12	90.12	90.07	90.91	0.01	0.01	9.87	0.00
2007	6835.04	7345	938	83.18	83.18	83.18	83.85	0.00	6.58	10.24	0.00
2008	7542.85	8163	938	91.20	92.11	91.55	92.93	0.09	0.08	7.81	0.91
2009	7002.52	7997	938	90.35	90.39	85.22	91.29	0.69	0.63	8.99	0.04
2010	7714.57	8288	938	93.60	93.66	93.89	94.61	0.18	0.17	6.18	0.05
2011	7571.37	8072	938	91.16	91.16	92.14	92.15	0.00	0.00	8.84	0.00
2012	7657.29	8286	938	93.35	93.47	92.94	94.33	0.01	0.01	6.52	0.12
2013	6841.69	7340	950	82.46	82.80	82.30	83.79	0.03	0.02	17.18	0.34
2014	7361.90	7899	950	89.37	90.44	88.46	90.17	0.03	2.71	6.86	1.06
2015	7180.10	7656	950	86.80	86.80	86.28	87.40	0.07	0.34	12.86	0.00
2016	8253.13	8784	950	99.66	99.98	98.90	100.00	0.01	0.01	0.02	0.31
2017	7020.49	7538	950	88.57	89.15	84.36	86.05	0.01	0.01	10.84	0.58
2018	6990.81	7667	950	86.52	87.40	84.00	87.52	0.28	1.27	11.33	0.88
2019	7518.48	8363	950	94.72	95.04	90.34	95.47	0.00	0.00	4.96	0.33
2020	7556.54	8784	950	99.99	99.99	90.55	100.00	0.00	0.00	0.01	0.00
2021	7441.92	7896	950	89.39	89.67	89.42	90.14	0.00	2.32	8.01	0.28
2022	6706.96	7226	950	82.02	82.03	80.59	82.49	0.00	0.00	17.97	0.01
2023	7899.06	8428	950	95.53	95.53	94.92	96.21	0.00	0.00	4.47	0.00
2024	7950.18	8502	950	96.65	96.72	95.27	96.79	0.01	0.01	3.27	0.07

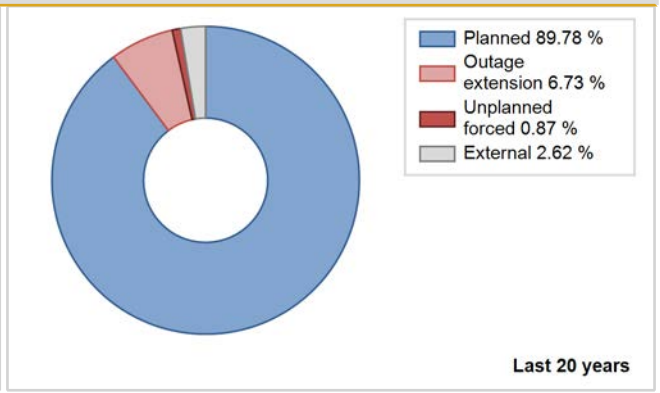
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2002 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					67	
C. Inspection, maintenance or repair combined with refuelling	289			710	11	
J. Grid limitation, failure or grid unavailability						1
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						17
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
Z. Other				16		
Subtotal	289			726	78	20
Total	**289**			**824**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2002 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		9
12. Reactor I&C Systems		1
15. Reactor Cooling Systems		26
16. Steam generation systems		2
31. Turbine and auxiliaries		2
42. Electrical Power Supply Systems		27
Total		**67**

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2024 Operating Experience

CN-7 LING AO-2 CHINA

Status at end of year	:	**Operational**
Operator	:	DNMC (Daya Bay Nuclear Power Operations and Management Co, Ltd.)
Owner	:	LANPC (LINGAO NUCLEAR POWER COMPANY LTD.)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	PWR / M310
Thermal power	:	2905 MWth
Gross electrical power	:	990 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1997-11-28
Grid Date	:	2002-09-14
Commercial Date	:	2003-01-08
Age at end of year	:	22 years

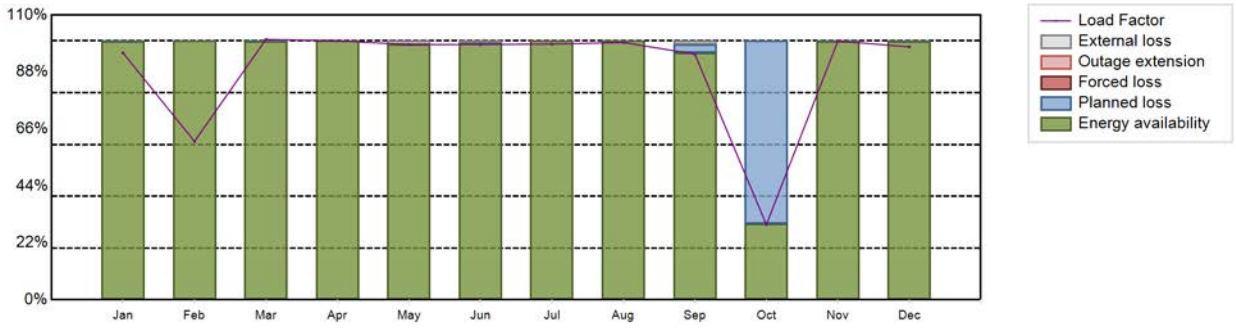
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.45
Refuelling frequency [month]	:	16
Part of the core refuelled [%]	:	40
Average discharge burnup [MWd/t]	:	46000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.81
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.43
Output voltage [kV]	:	26
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7474.46 GW(e).h
Energy Availability Factor (EAF)	:	93.47 %
Unit Capability Factor (UCF)	:	93.75 %
Load Factor (LF)	:	89.57 %
Operating Factor (OF)	:	92.12 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	6.25 %
Externally cause unavailability (XUF)	:	0.28 %
Total off-line time	:	692 hours

Annual Summary



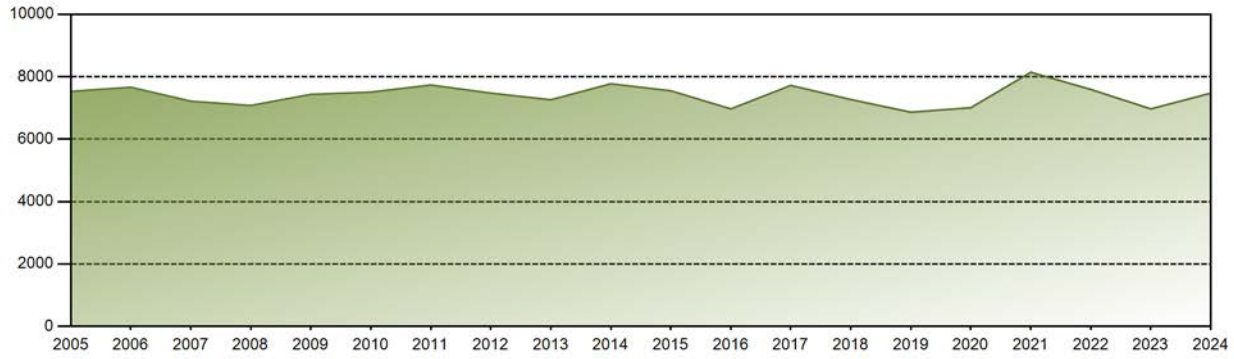
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	674.16	404.53	710.91	684.38	696.71	674.52	698.13	702.61	649.02	205.36	683.65	690.49	7474.46
EAF [%]	99.95	100.00	99.99	100.00	98.71	99.27	100.00	100.00	95.39	29.47	99.95	99.97	93.47
UCF [%]	99.95	100.00	99.99	100.00	100.00	99.98	100.00	100.00	96.78	29.47	99.95	99.97	93.75
LF [%]	95.38	61.18	100.58	100.05	98.57	98.61	98.77	99.41	94.89	29.06	99.95	97.69	89.57
OF [%]	100.00	69.25	100.00	100.00	100.00	100.00	100.00	100.00	97.78	37.90	100.00	100.00	92.12
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.05	0.00	0.01	0.00	0.00	0.02	0.00	0.00	3.22	70.53	0.05	0.03	6.25
XUF [%]	0.00	0.00	0.00	0.00	1.29	0.71	0.00	0.00	1.39	0.00	0.00	0.00	0.28

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Historical Summary

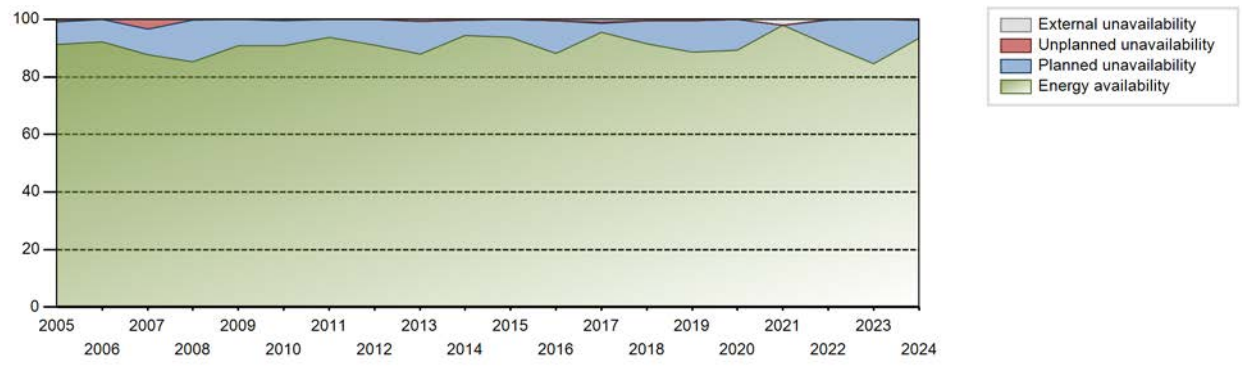
Lifetime energy generation	:	161888.69 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.37 %
Cumulative Energy Availability Factor (EAF)	:	90.39 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.37 %
Cumulative Unit Capability Factor (UCF)	:	90.7 %	Cumulative Planned Unavailability Factor (PUF)	:	8.93 %
Cumulative Load Factor (LF)	:	88.83 %	Cumulative Externally cause unavailability (XUF)	:	0.31 %
Cumulative Operating Factor (OF)	:	90.66 %			

Electricity Production (net) [GWh]



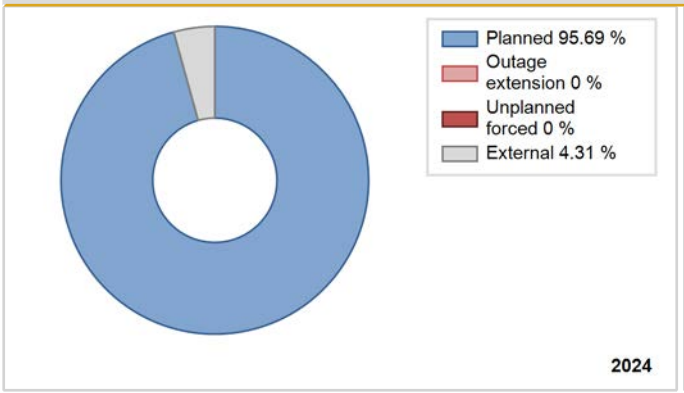
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2003	6934.88	7494	938	89.94	90.58	84.40	85.55	0.08	0.08	9.35	0.64
2004	6669.41	7109	938	79.80	79.85	80.95	80.93	2.01	2.33	17.82	0.05
2005	7530.93	8075	938	91.25	91.55	91.65	92.18	0.70	0.64	7.81	0.30
2006	7660.99	8164	938	92.08	92.08	93.23	93.20	0.02	0.02	7.90	0.00
2007	7215.07	7796	938	87.81	87.81	87.81	89.00	3.81	3.47	8.72	0.00
2008	7077.15	7577	938	85.24	85.24	85.89	86.26	0.20	0.17	14.59	0.00
2009	7433.81	8052	938	90.89	90.89	90.47	91.92	0.01	0.01	9.09	0.00
2010	7505.55	8112	938	90.84	90.84	91.34	92.60	0.58	0.53	8.63	0.00
2011	7734.34	8284	938	93.74	93.74	94.13	94.57	0.02	0.02	6.24	0.00
2012	7474.47	8113	938	90.95	91.09	90.72	92.36	0.00	0.00	8.91	0.15
2013	7261.33	7804	950	87.91	88.62	87.25	89.09	0.02	0.02	11.36	0.71
2014	7773.26	8363	950	94.31	94.47	93.41	95.47	0.21	0.20	5.33	0.16
2015	7548.19	8114	950	93.63	93.68	90.70	92.63	0.03	0.03	6.29	0.05
2016	6969.06	7514	950	88.13	88.66	83.51	85.54	0.07	0.06	11.28	0.53
2017	7720.79	8404	950	95.50	96.32	92.78	95.94	0.48	0.46	3.21	0.82
2018	7269.80	8108	950	91.53	92.09	87.36	92.56	0.01	0.00	7.90	0.57
2019	6863.24	7531	950	88.63	89.17	82.47	85.97	0.00	0.00	10.83	0.54
2020	7007.26	7907	950	89.17	89.17	83.97	90.02	0.00	0.00	10.83	0.00
2021	8143.18	8760	950	98.00	99.98	97.85	100.00	0.00	0.00	0.02	1.98
2022	7593.07	8030	950	91.11	91.14	91.24	91.67	0.00	0.12	8.74	0.03
2023	6968.32	7453	950	84.56	84.56	83.73	85.08	0.00	0.00	15.44	0.00
2024	7474.46	8092	950	93.47	93.75	89.57	92.12	0.00	0.00	6.25	0.28

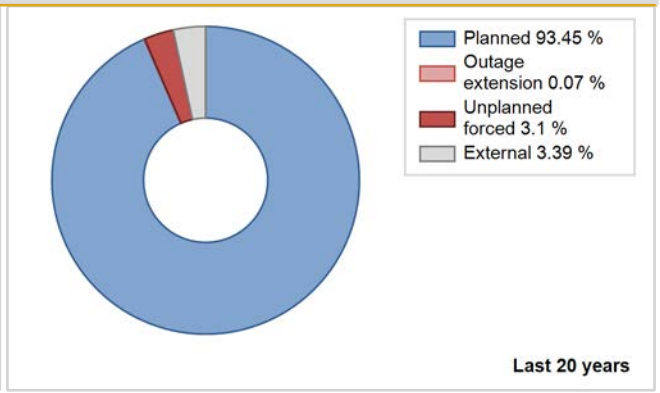
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2003 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					19	
C. Inspection, maintenance or repair combined with refuelling	504			716		
D. Inspection, maintenance or repair without refuelling				12		
J. Grid limitation, failure or grid unavailability			233			11
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						40
L. Human factor related					0	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z. Other					0	
Subtotal	504		233	728	19	52
Total	**737**			**799**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2003 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		1
13. Reactor Auxiliary Systems		1
31. Turbine and auxiliaries		0
32. Feedwater and Main Steam System		2
33. Circulating Water System		1
34. Miscellaneous Systems	233	11
41. Main Generator Systems		15
Total	**233**	**31**

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2024 Operating Experience

CN-12 LING AO-3 CHINA

Status at end of year	:	**Operational**
Operator	:	DNMC (Daya Bay Nuclear Power Operations and Management Co, Ltd.)
Owner	:	LDNPC (Lingdong Nuclear Power Company Ltd.)
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1086 MWe
Reference unit power (net)	:	1007 MWe

Key Dates

Construction Date	:	2005-12-15
Grid Date	:	2010-07-15
Commercial Date	:	2010-09-15
Age at end of year	:	14 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.2
Refuelling frequency [month]	:	16
Part of the core refuelled [%]	:	40
Average discharge burnup [MWd/t]	:	46000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

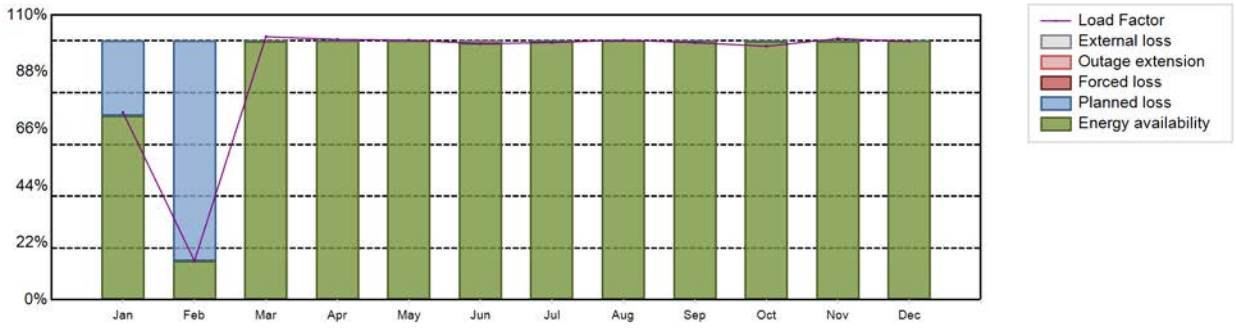
Operating coolant pressure [MPa]	:	15.81
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.43
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8036.05 GW(e).h
Energy Availability Factor (EAF)	:	90.74 %
Unit Capability Factor (UCF)	:	90.82 %
Load Factor (LF)	:	90.85 %
Operating Factor (OF)	:	91.58 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	9.18 %
Externally cause unavailability (XUF)	:	0.08 %
Total off-line time	:	740 hours

Annual Summary



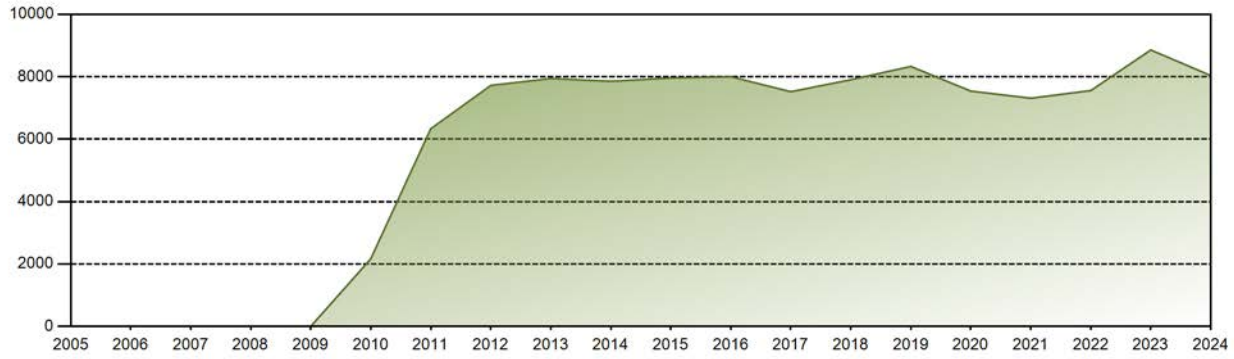
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	542.20	105.53	761.45	729.02	751.59	717.20	744.60	751.44	720.14	733.77	731.39	747.73	8036.05
EAF [%]	71.16	15.09	99.97	99.99	100.00	99.06	100.00	99.99	100.00	99.97	99.96	99.99	90.74
UCF [%]	71.16	15.09	99.97	99.99	100.00	100.00	100.00	99.99	100.00	99.97	99.96	99.99	90.82
LF [%]	72.37	15.06	101.63	100.55	100.32	98.92	99.38	100.30	99.32	97.94	100.88	99.80	90.85
OF [%]	71.77	23.85	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.58
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	28.84	84.91	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.03	0.04	0.01	9.18
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.08

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Historical Summary

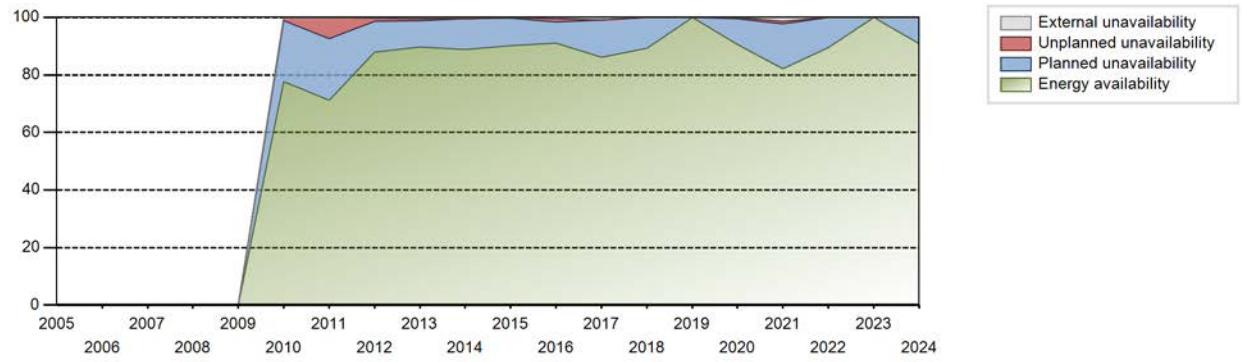
Lifetime energy generation	:	110475.54 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.67 %
Cumulative Energy Availability Factor (EAF)	:	88.85 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.86 %
Cumulative Unit Capability Factor (UCF)	:	89.13 %	Cumulative Planned Unavailability Factor (PUF)	:	10.01 %
Cumulative Load Factor (LF)	:	87.44 %	Cumulative Externally cause unavailability (XUF)	:	0.28 %
Cumulative Operating Factor (OF)	:	89.53 %			

Electricity Production (net) [GWh]



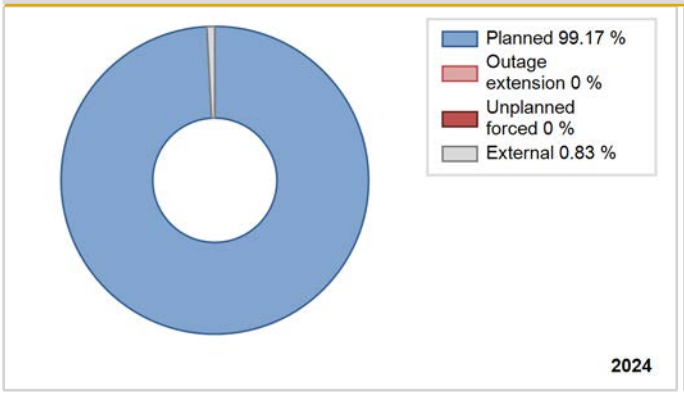
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2010	2164.44	2642	1007	77.65	77.65	62.01	64.34	1.39	1.09	21.26	0.00
2011	6333.19	6866	1007	71.31	71.31	71.79	78.38	7.44	7.39	21.30	0.00
2012	7720.90	7877	1020	88.02	88.26	86.82	89.67	1.18	1.06	10.69	0.24
2013	7942.05	8017	1007	89.63	90.10	90.03	91.52	0.71	0.64	9.26	0.48
2014	7854.08	7901	1007	88.91	89.37	89.04	90.19	0.05	0.05	10.58	0.46
2015	7958.52	7969	1007	90.10	90.10	90.22	90.97	0.23	0.35	9.55	0.00
2016	7999.24	8004	1007	91.09	91.63	90.43	91.12	0.01	1.03	7.34	0.53
2017	7519.94	7668	1007	86.12	86.99	85.25	87.53	0.03	0.02	12.99	0.86
2018	7903.44	7865	1007	89.32	89.32	89.59	89.78	0.01	0.01	10.67	0.00
2019	8329.82	8760	1007	99.98	99.98	94.43	100.00	0.00	0.00	0.02	0.00
2020	7539.38	7987	1007	90.71	90.71	85.23	90.93	0.56	0.51	8.78	0.00
2021	7311.51	7347	1007	82.09	83.40	82.88	83.87	0.02	0.90	15.70	1.31
2022	7556.80	7558	1007	89.58	89.65	85.67	86.28	0.04	0.03	10.32	0.07
2023	8857.80	8760	1007	99.99	99.99	100.41	100.00	0.00	0.00	0.01	0.00
2024	8036.05	8044	1007	90.74	90.82	90.85	91.58	0.00	0.00	9.18	0.08

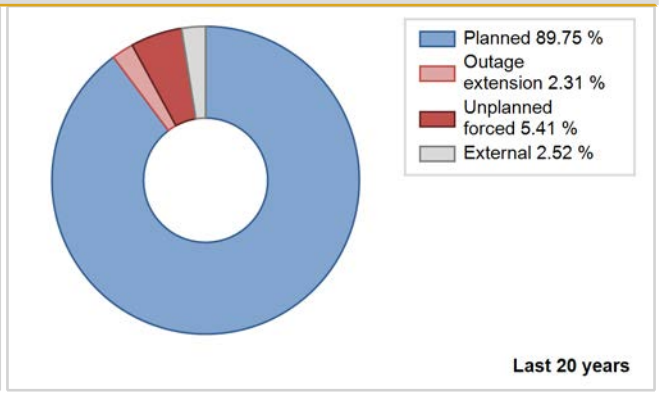
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2010 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					28	
C. Inspection, maintenance or repair combined with refuelling	764			781		
D. Inspection, maintenance or repair without refuelling				68		
J. Grid limitation, failure or grid unavailability						24
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						11
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
Subtotal	764			849	28	37
Total	**764**			**914**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2010 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		5
15. Reactor Cooling Systems		10
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		9
34. Miscellaneous Systems		4
41. Main Generator Systems		1
Total		**31**

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2024 Operating Experience

CN-13 LING AO-4 CHINA

Status at end of year	:	**Operational**
Operator	:	DNMC (Daya Bay Nuclear Power Operations and Management Co, Ltd.)
Owner	:	LDNPC (Lingdong Nuclear Power Company Ltd.)
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1086 MWe
Reference unit power (net)	:	1007 MWe

Key Dates

Construction Date	:	2006-06-15
Grid Date	:	2011-05-03
Commercial Date	:	2011-08-07
Age at end of year	:	13 years

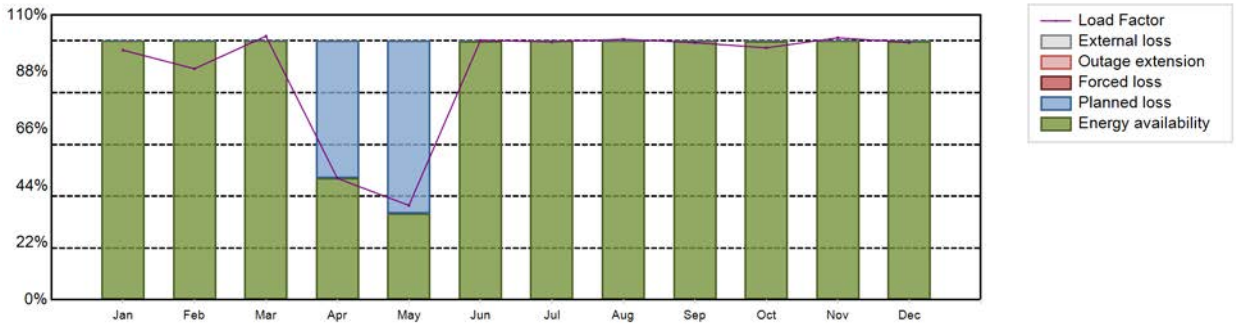
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.2
Refuelling frequency [month]	:	16
Part of the core refuelled [%]	:	40
Average discharge burnup [MWd/t]	:	46000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.81
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.43
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7878.87 GW(e).h
Energy Availability Factor (EAF)	:	89.98 %
Unit Capability Factor (UCF)	:	89.98 %
Load Factor (LF)	:	89.07 %
Operating Factor (OF)	:	90.49 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	10.02 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	835 hours

Annual Summary



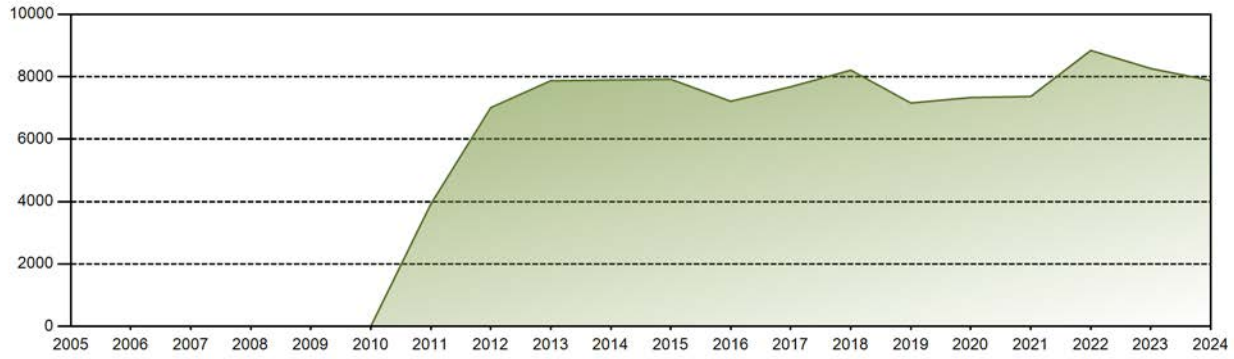
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	722.45	625.56	762.86	340.04	273.29	726.67	746.38	754.22	720.02	729.22	733.75	744.41	7878.87
EAF [%]	99.99	99.99	100.00	46.89	33.24	99.97	100.00	99.99	99.99	99.97	100.00	99.96	89.98
UCF [%]	99.99	99.99	100.00	46.89	33.24	99.97	100.00	99.99	99.99	99.97	100.00	99.96	89.98
LF [%]	96.43	89.25	101.82	46.90	36.48	100.22	99.62	100.67	99.31	97.33	101.20	99.36	89.07
OF [%]	100.00	100.00	100.00	47.78	38.31	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.49
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.01	0.01	0.00	53.11	66.76	0.03	0.00	0.01	0.01	0.03	0.00	0.04	10.02
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

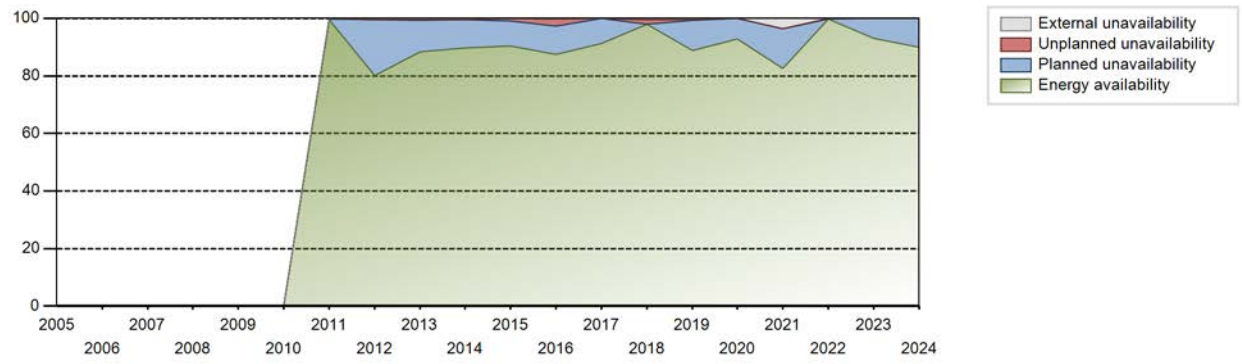
Lifetime energy generation	:	104171.85 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.2 %
Cumulative Energy Availability Factor (EAF)	:	90.46 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.41 %
Cumulative Unit Capability Factor (UCF)	:	90.93 %	Cumulative Planned Unavailability Factor (PUF)	:	8.65 %
Cumulative Load Factor (LF)	:	87.85 %	Cumulative Externally cause unavailability (XUF)	:	0.48 %
Cumulative Operating Factor (OF)	:	90.2 %			

Electricity Production (net) [GWh]



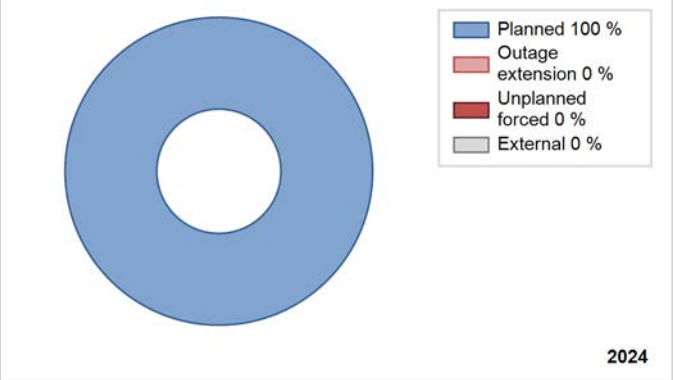
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2011	3914.72	5268	1007	99.60	99.60	96.00	100.00	0.35	0.35	0.05	0.00
2012	7009.72	7156	1020	80.10	80.55	78.24	81.47	0.01	0.01	19.44	0.45
2013	7870.25	7880	1007	88.42	88.99	89.22	89.95	0.19	0.17	10.84	0.58
2014	7895.97	7972	1007	89.82	90.25	89.51	91.00	0.00	0.00	9.75	0.43
2015	7916.59	7963	1007	90.29	90.29	89.74	90.90	0.00	0.88	8.83	0.00
2016	7211.42	7329	1007	87.55	87.85	81.53	83.44	0.18	2.39	9.76	0.30
2017	7677.26	7668	1007	91.24	91.33	87.03	87.53	0.00	0.00	8.67	0.09
2018	8207.81	8447	1007	97.86	98.34	93.05	96.43	1.65	1.65	0.01	0.48
2019	7157.30	7588	1007	88.75	89.29	81.14	86.62	0.07	0.06	10.65	0.55
2020	7333.57	8185	1007	92.77	92.77	82.91	93.18	0.00	0.00	7.23	0.00
2021	7366.90	7331	1007	82.58	86.11	83.51	83.69	0.00	0.00	13.89	3.52
2022	8841.24	8744	1007	99.77	99.77	100.23	99.82	0.22	0.22	0.01	0.00
2023	8260.89	8229	1007	93.15	93.15	93.65	93.94	0.00	0.00	6.85	0.00
2024	7878.87	7949	1007	89.98	89.98	89.07	90.49	0.00	0.00	10.02	0.00

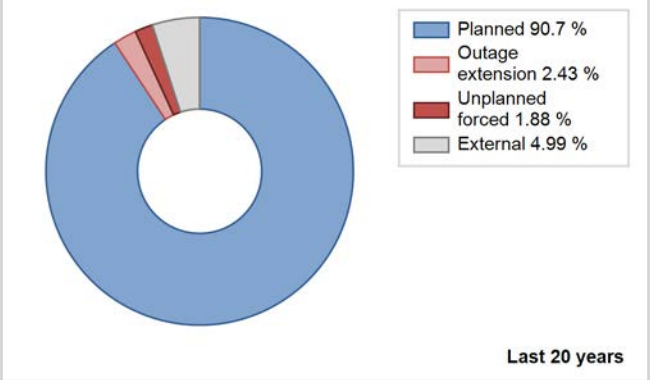
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2011 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					16	
C. Inspection, maintenance or repair combined with refuelling	838			716		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						97
L. Human factor related					15	
Z. Other						19
Subtotal	838			716	31	116
Total	**838**			**863**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2011 to 2024
	Hours Lost	Average hours lost per reactor-year
15. Reactor Cooling Systems		6
31. Turbine and auxiliaries		7
33. Circulating Water System		2
34. Miscellaneous Systems		23
Total		**38**

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2024 Operating Experience

CN-18 NINGDE-1 CHINA

Status at end of year	:	**Operational**
Operator	:	NDNP (Fujian Ningde Nuclear Power Company, Ltd.)
Owner	:	NDNP (Fujian Ningde Nuclear Power Company, Ltd.)
Reactor Supplier	:	DEC (Dongfang Electric Corporation)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1018 MWe

Key Dates

Construction Date	:	2008-02-18
Grid Date	:	2012-12-28
Commercial Date	:	2013-04-15
Age at end of year	:	12 years

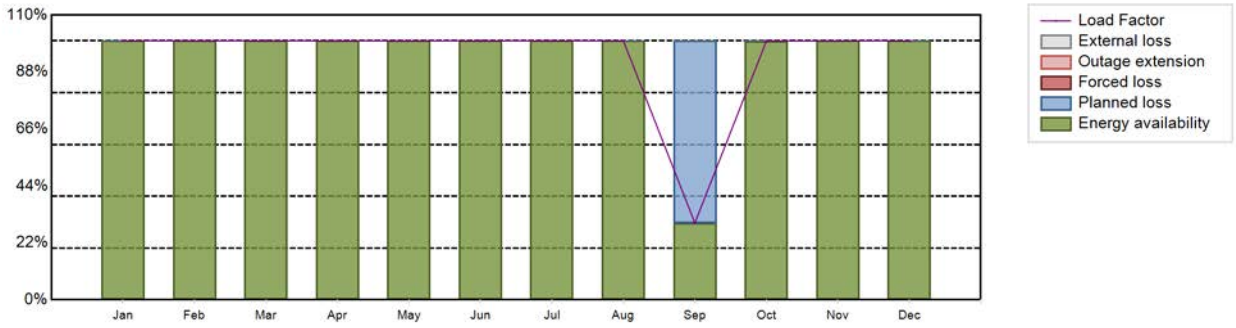
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	2.43	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	44.6	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8425.89 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	94.23 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	94.23 %	Planned Unavailability Factor (PUF)	:	5.77 %
Load Factor (LF)	:	94.23 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	94.67 %	Total off-line time	:	468 hours

Annual Summary



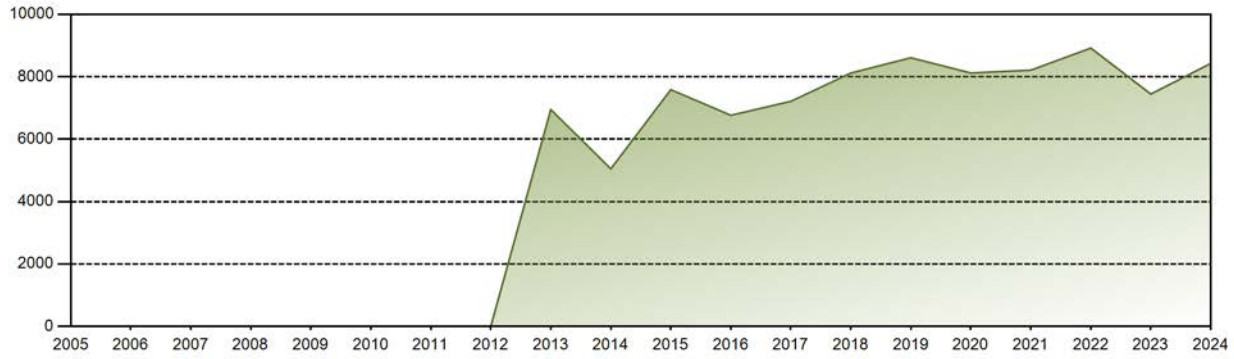
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	757.29	708.47	757.37	732.88	757.39	732.86	757.39	757.30	217.73	756.88	732.96	757.38	8425.89
EAF [%]	99.99	99.99	100.00	99.99	100.00	99.99	100.00	99.99	29.71	99.93	100.00	100.00	94.23
UCF [%]	99.99	99.99	100.00	99.99	100.00	99.99	100.00	99.99	29.71	99.93	100.00	100.00	94.23
LF [%]	99.99	99.99	100.00	99.99	100.00	99.99	100.00	99.99	29.71	99.93	100.00	100.00	94.23
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	35.00	100.00	100.00	100.00	94.67
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.01	70.29	0.07	0.00	0.00	5.77
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

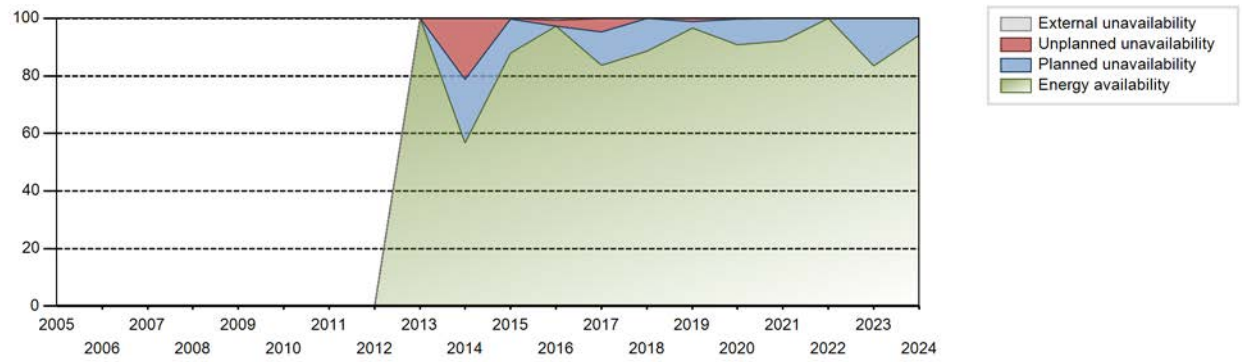
Lifetime energy generation	:	91394.37 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.3 %
Cumulative Energy Availability Factor (EAF)	:	89.06 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.52 %
Cumulative Unit Capability Factor (UCF)	:	89.13 %	Cumulative Planned Unavailability Factor (PUF)	:	8.36 %
Cumulative Load Factor (LF)	:	86.7 %	Cumulative Externally cause unavailability (XUF)	:	0.06 %
Cumulative Operating Factor (OF)	:	88.12 %			

Electricity Production (net) [GWh]



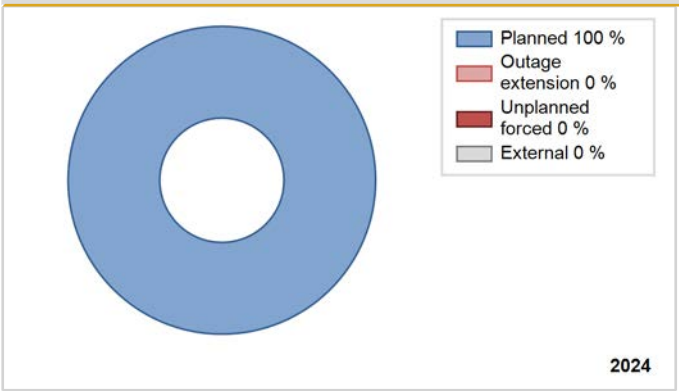
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2013	6947.98	7369	1018	99.94	99.94	96.64	99.33	0.03	0.03	0.04	0.00
2014	5047.23	5119	1018	56.73	56.73	56.60	58.44	23.57	21.32	21.96	0.00
2015	7583.95	7798	1018	88.02	88.02	85.04	89.02	0.20	0.18	11.80	0.00
2016	6764.98	7207	1018	97.33	98.07	75.65	82.05	1.93	1.93	0.00	0.74
2017	7210.58	7177	1018	83.79	83.79	80.86	81.93	4.26	4.80	11.40	0.00
2018	8116.45	7756	1018	88.50	88.50	91.02	88.54	0.00	0.00	11.50	0.00
2019	8608.23	8567	1018	96.53	96.53	96.53	97.80	1.09	1.07	2.40	0.00
2020	8119.41	8007	1018	90.80	90.80	90.80	91.15	0.33	0.30	8.90	0.00
2021	8209.23	8070	1018	92.06	92.06	92.06	92.12	0.00	0.00	7.94	0.00
2022	8917.03	8760	1018	99.99	99.99	99.99	100.00	0.00	0.00	0.01	0.00
2023	7443.81	7454	1018	83.47	83.47	83.47	85.09	0.00	0.00	16.53	0.00
2024	8425.89	8316	1018	94.23	94.23	94.23	94.67	0.00	0.00	5.77	0.00

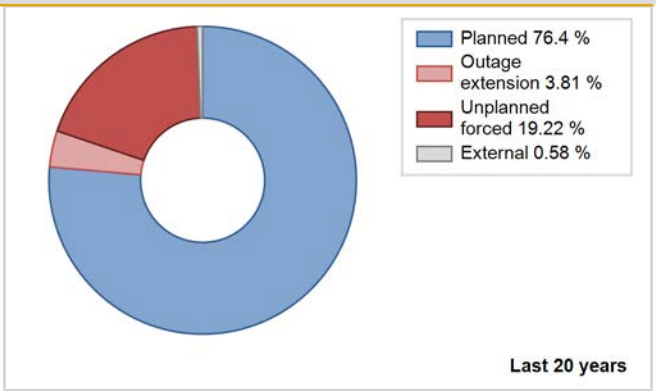
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2013 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					177	
C. Inspection, maintenance or repair combined with refuelling	468			687		
D. Inspection, maintenance or repair without refuelling				3		
H. Nuclear regulatory requirements					27	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						139
M. Governmental requirements or court decisions						0
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					8	
Subtotal	468			690	212	139
Total	**468**			**1041**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2013 to 2024 Average hours lost per reactor-year
16. Steam generation systems		5
31. Turbine and auxiliaries		125
32. Feedwater and Main Steam System		14
41. Main Generator Systems		9
42. Electrical Power Supply Systems		21
Total		**174**

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2024 Operating Experience

CN-19 NINGDE-2 CHINA

Status at end of year	:	**Operational**
Operator	:	NDNP (Fujian Ningde Nuclear Power Company, Ltd.)
Owner	:	NDNP (Fujian Ningde Nuclear Power Company, Ltd.)
Reactor Supplier	:	SHE (Shanghai Electric)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1018 MWe

Key Dates

Construction Date	:	2008-11-12
Grid Date	:	2014-01-04
Commercial Date	:	2014-05-04
Age at end of year	:	10 years

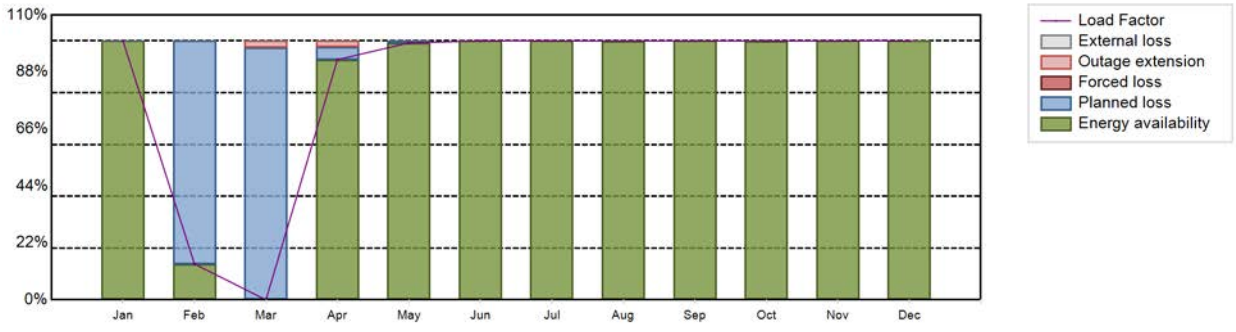
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	2.43	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	44.6	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7514.99 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	84.04 %	Unplanned Capability Loss Factor (UCL)	:	0.41 %
Unit Capability Factor (UCF)	:	84.04 %	Planned Unavailability Factor (PUF)	:	15.55 %
Load Factor (LF)	:	84.04 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	84.56 %	Total off-line time	:	1356 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	757.33	98.20	0.00	680.01	751.51	732.89	757.39	757.24	732.94	757.18	732.90	757.39	7514.99
EAF [%]	99.99	13.86	0.00	92.78	99.22	99.99	100.00	99.98	100.00	99.97	99.99	100.00	84.04
UCF [%]	99.99	13.86	0.00	92.78	99.22	99.99	100.00	99.98	100.00	99.97	99.99	100.00	84.04
LF [%]	99.99	13.86	0.00	92.78	99.22	99.99	100.00	99.98	100.00	99.97	99.99	100.00	84.04
OF [%]	100.00	14.51	0.00	97.64	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	84.56
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	2.56	2.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41
PUF [%]	0.01	86.14	97.44	4.87	0.78	0.01	0.00	0.02	0.00	0.03	0.01	0.00	15.55
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

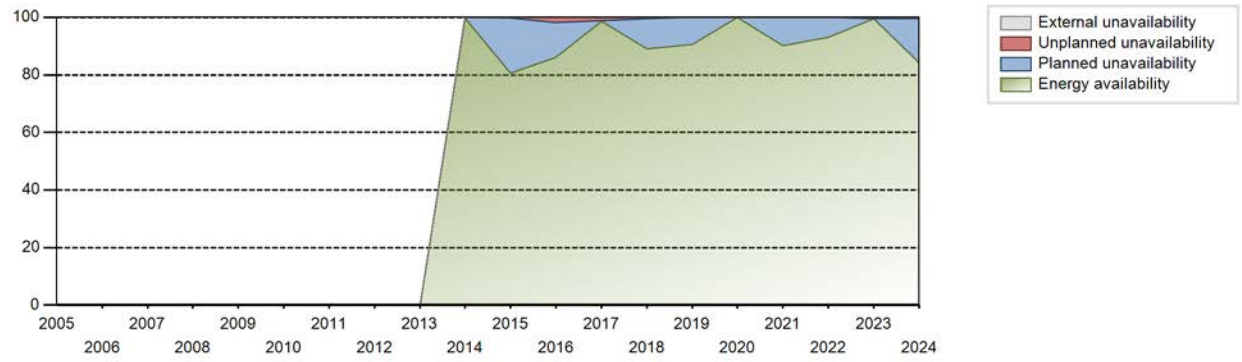
Lifetime energy generation	:	84774.22 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.27 %
Cumulative Energy Availability Factor (EAF)	:	91.74 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.41 %
Cumulative Unit Capability Factor (UCF)	:	91.76 %	Cumulative Planned Unavailability Factor (PUF)	:	7.83 %
Cumulative Load Factor (LF)	:	88.25 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	90.48 %			

Electricity Production (net) [GWh]



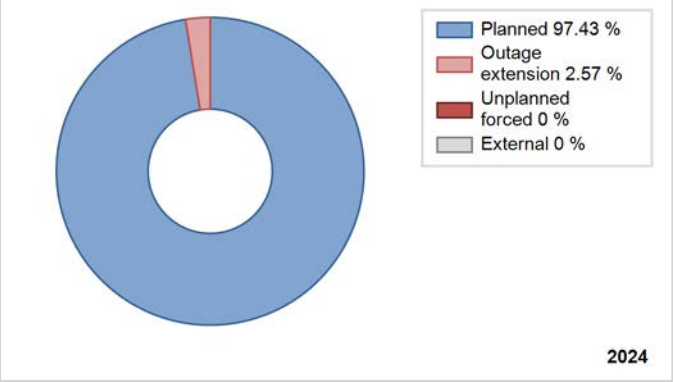
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2014	6568.05	7044	1018	99.85	99.85	97.55	100.00	0.02	0.01	0.14	0.00
2015	6528.23	7145	1018	80.58	80.58	73.21	81.56	0.22	0.18	19.24	0.00
2016	5714.85	6290	1018	86.24	86.39	63.91	71.61	0.32	1.62	12.00	0.14
2017	8252.86	8371	1018	98.72	98.72	92.54	95.56	1.26	1.26	0.02	0.00
2018	7953.87	7938	1018	89.03	89.03	89.19	90.62	0.44	0.40	10.57	0.00
2019	8079.09	8026	1018	90.60	90.60	90.60	91.62	0.01	0.00	9.40	0.00
2020	8940.50	8784	1018	99.98	99.98	99.98	100.00	0.00	0.00	0.01	0.00
2021	8043.49	7904	1018	90.20	90.20	90.20	90.23	0.00	0.00	9.80	0.00
2022	8303.72	8158	1018	93.12	93.12	93.12	93.13	0.00	0.00	6.88	0.00
2023	8874.52	8718	1018	99.52	99.52	99.52	99.52	0.48	0.48	0.01	0.00
2024	7514.99	7428	1018	84.04	84.04	84.04	84.56	0.00	0.41	15.55	0.00

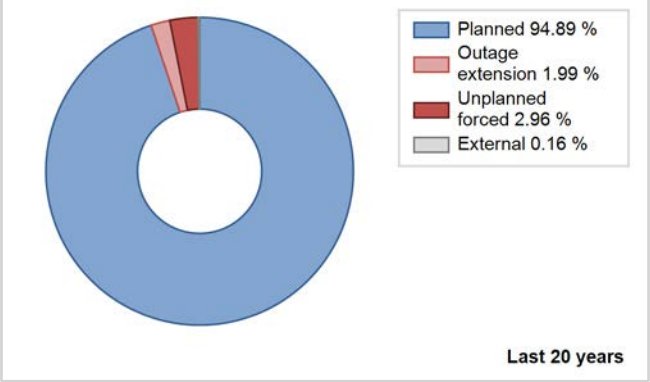
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2014 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					4	
C. Inspection, maintenance or repair combined with refuelling	1320			652		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						165
Z. Other		36			14	
Subtotal	1320	36		652	18	165
Total		**1356**			**835**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2014 to 2024 Average hours lost per reactor-year
32. Feedwater and Main Steam System		4
41. Main Generator Systems	36	3
Total	**36**	**7**

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2024 Operating Experience

CN-34 NINGDE-3 CHINA

Status at end of year	:	**Operational**
Operator	:	NDNP (Fujian Ningde Nuclear Power Company, Ltd.)
Owner	:	NDNP (Fujian Ningde Nuclear Power Company, Ltd.)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1018 MWe

Key Dates

Construction Date	:	2010-01-08
Grid Date	:	2015-03-21
Commercial Date	:	2015-06-10
Age at end of year	:	9 years

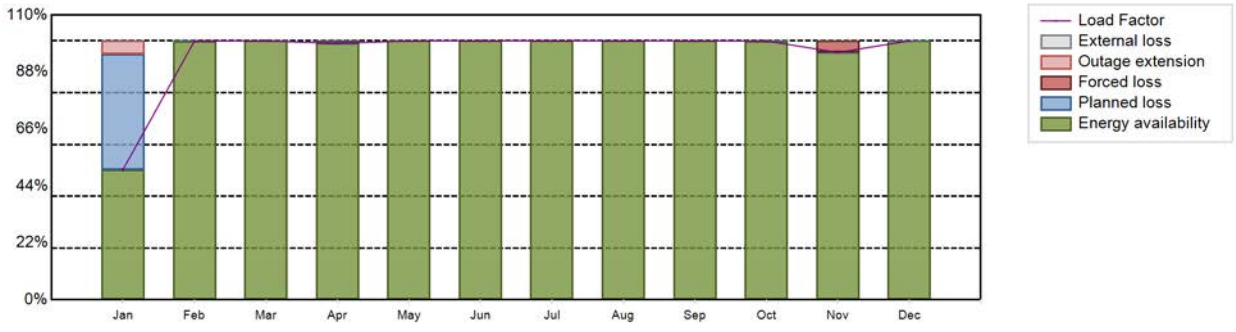
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.43
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	44.6
Average discharge burnup [MWd/t]	:	44000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.6
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.52
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.43
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8525.37 GW(e).h
Energy Availability Factor (EAF)	:	95.34 %
Unit Capability Factor (UCF)	:	95.34 %
Load Factor (LF)	:	95.34 %
Operating Factor (OF)	:	96.25 %
Forced Loss Rate (FLR)	:	0.38 %
Unplanned Capability Loss Factor (UCL)	:	0.8 %
Planned Unavailability Factor (PUF)	:	3.86 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	329 hours

Annual Summary



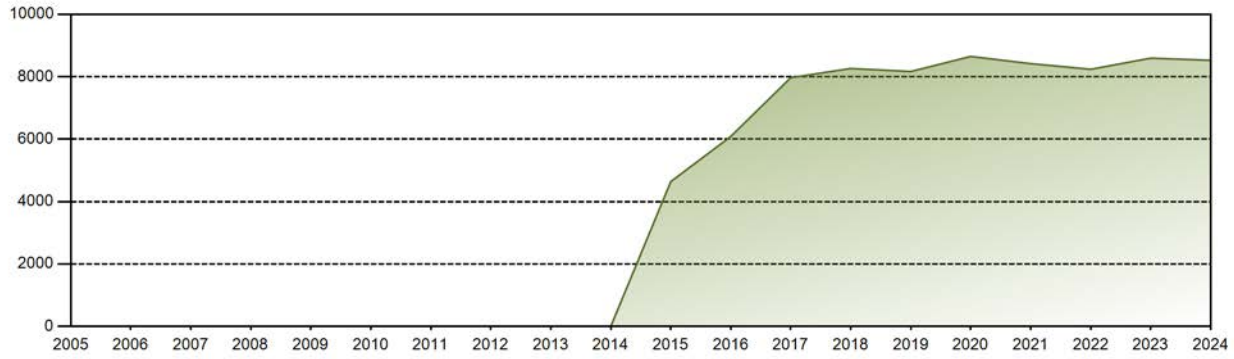
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	381.06	708.29	757.38	725.97	757.30	732.90	757.31	757.37	732.90	757.06	700.45	757.37	8525.37
EAF [%]	50.31	99.97	100.00	99.05	99.99	99.99	99.99	100.00	99.99	99.96	95.56	100.00	95.34
UCF [%]	50.31	99.97	100.00	99.05	99.99	99.99	99.99	100.00	99.99	99.96	95.56	100.00	95.34
LF [%]	50.31	99.97	100.00	99.05	99.99	99.99	99.99	100.00	99.99	99.96	95.56	100.00	95.34
OF [%]	55.78	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	96.25
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.43	0.00	0.38
UCL [%]	5.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.43	0.00	0.80
PUF [%]	44.54	0.03	0.00	0.95	0.01	0.01	0.01	0.00	0.01	0.04	0.01	0.00	3.86
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

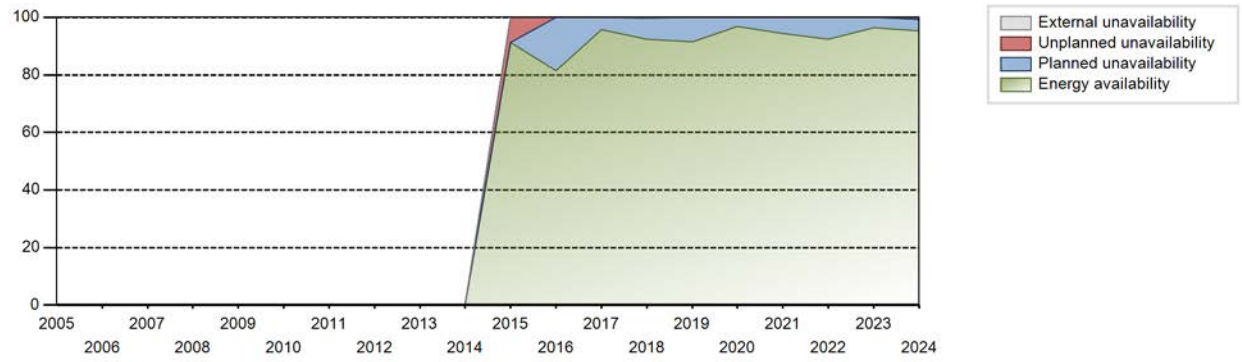
Lifetime energy generation	:	76951.11 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.64 %
Cumulative Energy Availability Factor (EAF)	:	92.81 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.65 %
Cumulative Unit Capability Factor (UCF)	:	92.82 %	Cumulative Planned Unavailability Factor (PUF)	:	6.53 %
Cumulative Load Factor (LF)	:	90.17 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	92.06 %			

Electricity Production (net) [GWh]



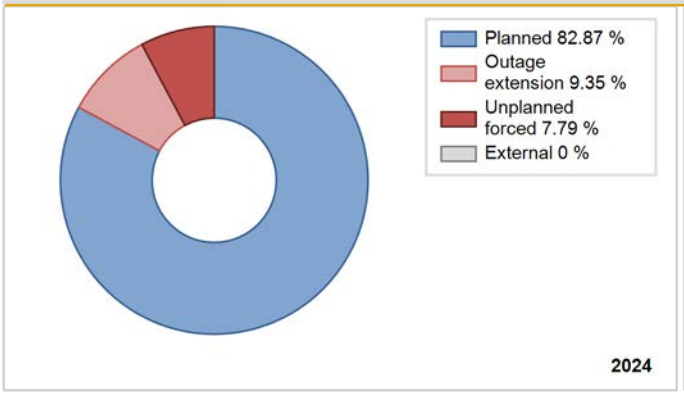
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2015	4638.75	5586	1018	91.25	91.25	80.88	92.85	8.74	8.74	0.01	0.00
2016	6086.41	6514	1018	81.37	81.37	68.06	74.16	0.02	0.02	18.62	0.00
2017	7971.03	8107	1018	95.64	95.64	89.38	92.55	0.01	0.00	4.35	0.00
2018	8264.16	8141	1018	92.40	92.44	92.67	92.93	0.28	0.26	7.29	0.05
2019	8167.27	8075	1018	91.59	91.59	91.59	92.18	0.00	0.00	8.41	0.00
2020	8650.70	8501	1018	96.74	96.74	96.74	96.78	0.00	0.00	3.26	0.00
2021	8418.61	8271	1018	94.40	94.40	94.40	94.42	0.00	0.00	5.60	0.00
2022	8239.00	8094	1018	92.39	92.39	92.39	92.40	0.00	0.00	7.61	0.00
2023	8595.73	8451	1018	96.39	96.39	96.39	96.47	0.00	0.00	3.61	0.00
2024	8525.37	8455	1018	95.34	95.34	95.34	96.25	0.38	0.80	3.86	0.00

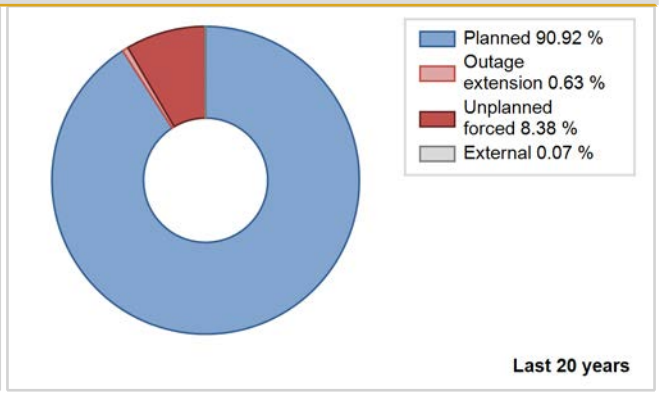
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2015 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					15	
C. Inspection, maintenance or repair combined with refuelling	291			553		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						98
L. Human factor related					29	
Z. Other		38			4	
Subtotal	291	38		553	48	98
Total		**329**			**699**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2015 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		28
31. Turbine and auxiliaries		5
33. Circulating Water System		10
41. Main Generator Systems	38	4
Total	**38**	**47**

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2024 Operating Experience

CN-35 NINGDE-4 CHINA

Status at end of year	:	**Operational**
Operator	:	NDNP (Fujian Ningde Nuclear Power Company, Ltd.)
Owner	:	NDNP (Fujian Ningde Nuclear Power Company, Ltd.)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1089 MWe
Reference unit power (net)	:	1018 MWe

Key Dates

Construction Date	:	2010-09-29
Grid Date	:	2016-03-29
Commercial Date	:	2016-07-21
Age at end of year	:	8 years

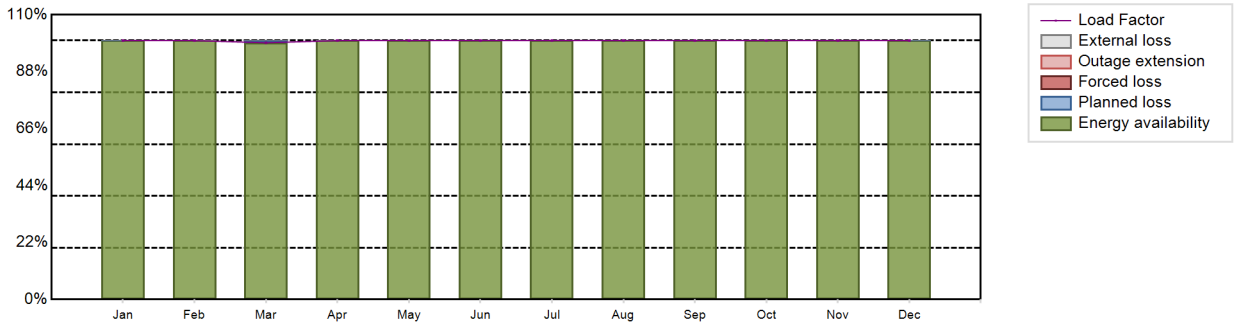
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.6
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	2.43	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	44.6	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8935.32 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	99.92 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	99.92 %	Planned Unavailability Factor (PUF)	:	0.08 %
Load Factor (LF)	:	99.92 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



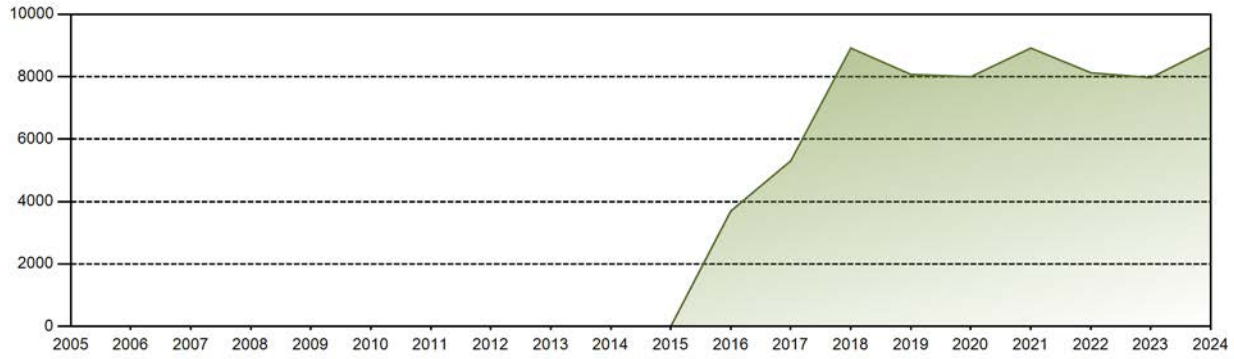
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	757.36	708.46	751.03	732.94	757.31	732.93	757.39	757.31	732.95	757.37	732.90	757.37	8935.32
EAF [%]	100.00	99.99	99.16	100.00	99.99	100.00	100.00	99.99	100.00	100.00	99.99	100.00	99.92
UCF [%]	100.00	99.99	99.16	100.00	99.99	100.00	100.00	99.99	100.00	100.00	99.99	100.00	99.92
LF [%]	100.00	99.99	99.16	100.00	99.99	100.00	100.00	99.99	100.00	100.00	99.99	100.00	99.92
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.01	0.84	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.08
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

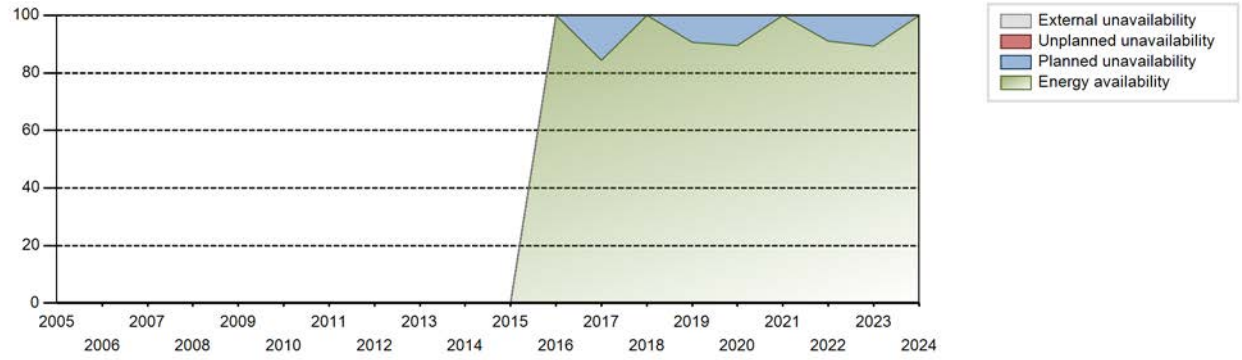
Lifetime energy generation	:	67934.32 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.02 %
Cumulative Energy Availability Factor (EAF)	:	93.43 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.02 %
Cumulative Unit Capability Factor (UCF)	:	93.43 %	Cumulative Planned Unavailability Factor (PUF)	:	6.55 %
Cumulative Load Factor (LF)	:	90.07 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	91.45 %			

Electricity Production (net) [GWh]

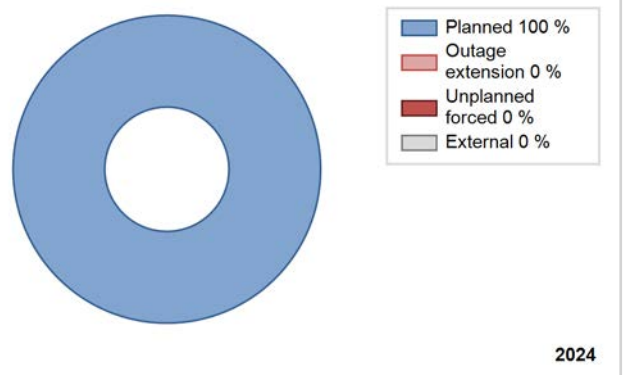


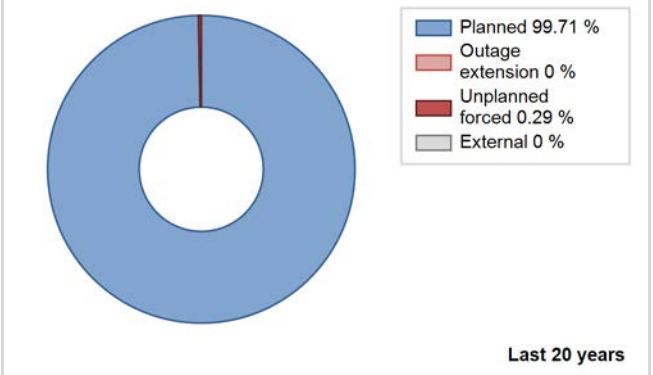
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	3694.87	3786	1018	99.87	99.87	91.83	95.92	0.12	0.12	0.00	0.00
2017	5303.77	5739	1018	84.33	84.33	59.47	65.51	0.12	0.10	15.57	0.00
2018	8917.08	8760	1018	99.99	99.99	99.99	100.00	0.00	0.00	0.01	0.00
2019	8074.33	7992	1018	90.54	90.54	90.54	91.23	0.00	0.00	9.46	0.00
2020	7998.17	8033	1018	89.45	89.45	89.44	91.45	0.00	0.00	10.55	0.00
2021	8916.45	8760	1018	99.99	99.99	99.99	100.00	0.00	0.00	0.01	0.00
2022	8126.58	7984	1018	91.13	91.13	91.13	91.14	0.01	0.01	8.87	0.00
2023	7967.67	7914	1018	89.35	89.35	89.35	90.34	0.00	0.00	10.65	0.00
2024	8935.32	8784	1018	99.92	99.92	99.92	100.00	0.00	0.00	0.08	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
C. Inspection, maintenance or repair combined with refuelling				507		
D. Inspection, maintenance or repair without refuelling				6		
J. Grid limitation, failure or grid unavailability						124
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						98
Z. Other				15		
Subtotal				528		222
Total		**0**			**750**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
Total		

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2024 Operating Experience

CN-4 QINSHAN 2-1 CHINA

Status at end of year	:	**Operational**
Operator	:	CNNO (CNNC Nuclear Operation Management Company Limited)
Owner	:	NPQJVC (NUCLEAR POWER PLANT QINSHAN JOINT VENTURE COMPANY LTD.)
Reactor Supplier	:	CNNC (CHINA NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	HTC (HARBIN TURBINE COMPANY LIMITED)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-600
Thermal power	:	1930 MWth
Gross electrical power	:	650 MWe
Reference unit power (net)	:	623 MWe

Key Dates

Construction Date	:	1996-06-02
Grid Date	:	2002-02-06
Commercial Date	:	2002-04-15
Age at end of year	:	22 years

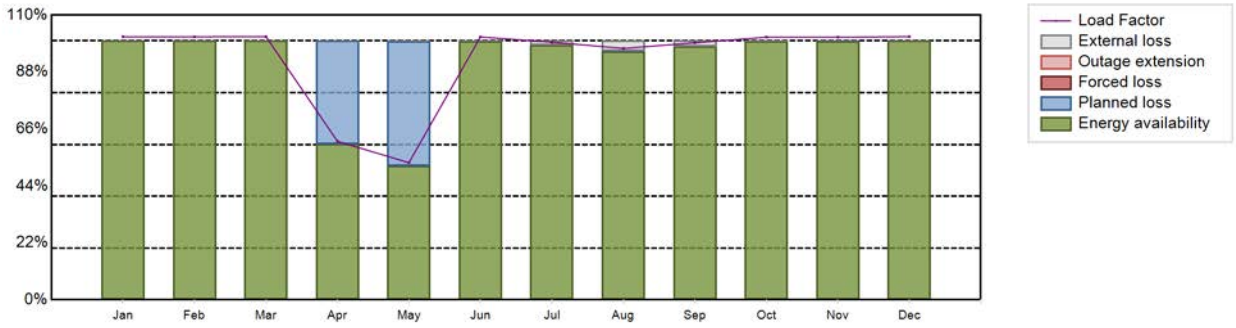
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.25
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	-
Active core diameter [m]	:	2.67
Active core height/length [m]	:	3.6576
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	16.09
Number of control rod assemblies	:	33
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	315.2
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.45
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.41
Output voltage [kV]	:	20
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5110.97 GW(e).h
Energy Availability Factor (EAF)	:	91.96 %
Unit Capability Factor (UCF)	:	92.61 %
Load Factor (LF)	:	93.39 %
Operating Factor (OF)	:	93.02 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	7.39 %
Externally cause unavailability (XUF)	:	0.64 %
Total off-line time	:	613 hours

Annual Summary



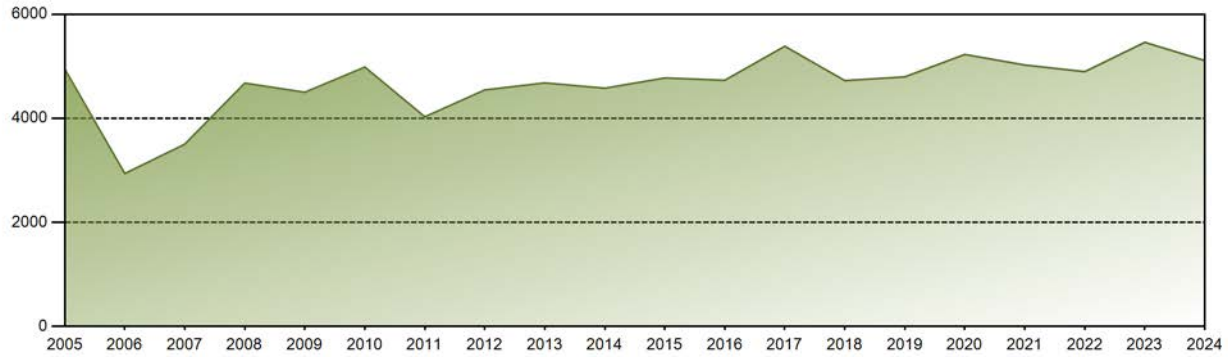
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	470.94	440.49	471.14	274.65	245.53	455.43	461.16	450.15	445.27	470.17	454.93	471.13	5110.97
EAF [%]	100.00	100.00	100.00	60.15	51.83	99.97	98.32	95.94	97.90	99.88	99.79	100.00	91.96
UCF [%]	100.00	100.00	100.00	60.15	51.85	100.00	100.00	99.76	100.00	99.89	99.79	100.00	92.61
LF [%]	101.60	101.59	101.65	61.23	52.97	101.53	99.49	97.12	99.27	101.44	101.42	101.64	93.39
OF [%]	100.00	100.00	100.00	60.28	56.05	100.00	100.00	100.00	100.00	100.00	100.00	100.00	93.02
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	39.85	48.15	0.00	0.00	0.24	0.00	0.11	0.21	0.00	7.39
XUF [%]	0.00	0.00	0.00	0.00	0.02	0.03	1.68	3.82	2.10	0.01	0.00	0.00	0.64

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Historical Summary

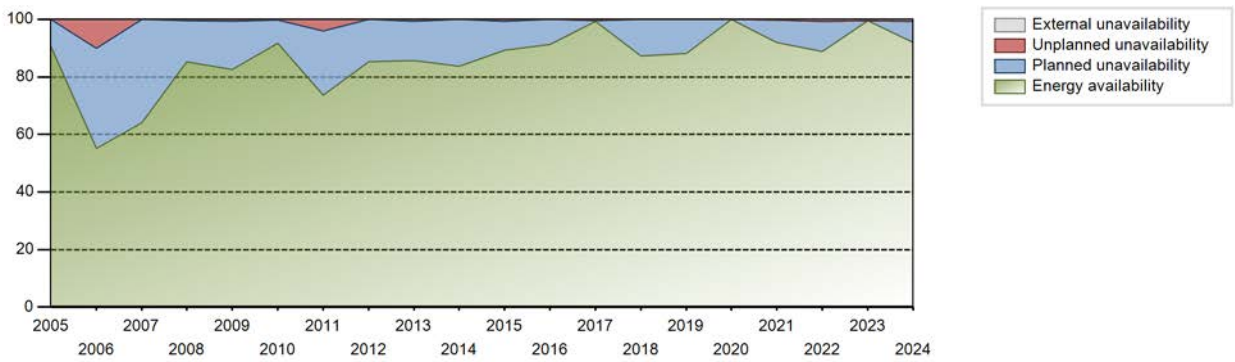
Lifetime energy generation	:	105492.58 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.71 %
Cumulative Energy Availability Factor (EAF)	:	85.62 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.58 %
Cumulative Unit Capability Factor (UCF)	:	85.73 %	Cumulative Planned Unavailability Factor (PUF)	:	12.68 %
Cumulative Load Factor (LF)	:	86.23 %	Cumulative Externally cause unavailability (XUF)	:	0.11 %
Cumulative Operating Factor (OF)	:	85.7 %			

Electricity Production (net) [GWh]



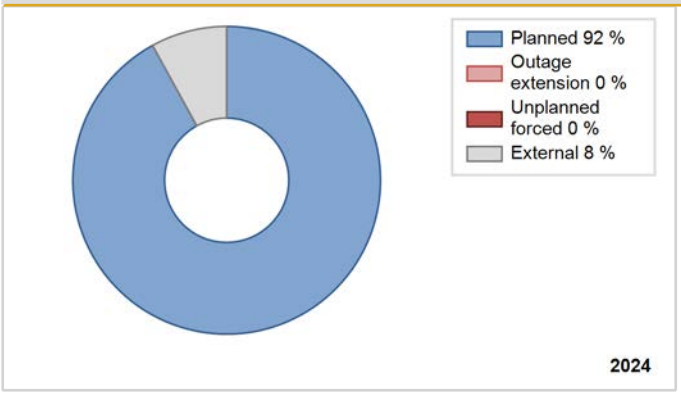
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2002	2965.29	4631	610	81.56	81.56	73.64	70.16	18.44	18.44	0.00	0.00
2003	4327.30	7123	610	80.90	80.95	80.98	81.31	2.61	2.17	16.88	0.05
2004	4395.68	7117	610	80.13	80.13	82.04	81.02	3.25	2.69	17.17	0.00
2005	4944.77	7982	610	90.61	90.61	92.54	91.12	0.01	0.01	9.37	0.00
2006	2938.16	4890	610	55.23	55.23	54.98	55.82	15.49	10.12	34.65	0.00
2007	3503.00	5681	610	64.12	64.12	65.56	64.85	0.00	0.00	35.88	0.00
2008	4677.61	7554	610	85.25	85.35	87.30	86.00	0.18	0.48	14.17	0.10
2009	4500.99	7256	610	82.66	82.66	84.23	82.83	0.74	0.62	16.72	0.00
2010	4985.39	8095	610	91.70	91.70	93.30	92.41	0.21	0.19	8.11	0.00
2011	4029.39	6521	610	73.66	73.66	75.41	74.44	2.90	3.97	22.37	0.00
2012	4545.92	7543	610	85.20	85.20	84.84	85.87	0.00	0.00	14.80	0.00
2013	4680.90	7561	610	85.75	85.75	87.60	86.31	0.87	0.75	13.50	0.00
2014	4579.16	7412	610	83.68	83.68	85.69	84.61	0.00	0.00	16.32	0.00
2015	4775.88	7859	610	89.35	89.35	89.38	89.71	0.84	0.76	9.90	0.00
2016	4732.19	7825	610	91.28	91.28	88.32	89.08	0.00	0.00	8.72	0.00
2017	5385.37	8732	610	99.32	99.52	100.78	99.68	0.36	0.36	0.13	0.20
2018	4725.63	7682	610	87.19	87.19	88.44	87.69	0.16	0.14	12.67	0.00
2019	4796.97	7781	610	88.15	88.20	89.77	88.82	0.00	0.00	11.80	0.06
2020	5228.19	8784	610	99.88	99.95	97.57	100.00	0.00	0.00	0.05	0.07
2021	5024.61	8118	610	91.98	92.17	94.03	92.67	0.00	0.00	7.83	0.19
2022	4897.42	7859	623	88.76	89.36	89.74	89.71	0.00	0.00	10.64	0.60
2023	5460.89	8760	623	99.49	99.97	100.06	100.00	0.00	0.00	0.03	0.48
2024	5110.97	8171	623	91.96	92.61	93.39	93.02	0.00	0.00	7.39	0.64

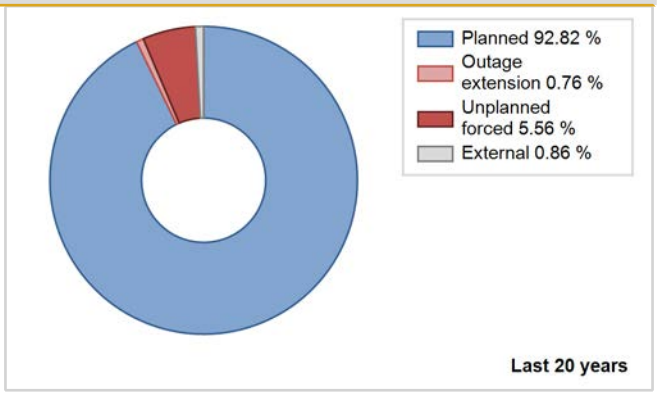
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2002 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					74	
C. Inspection, maintenance or repair combined with refuelling	613			923		
D. Inspection, maintenance or repair without refuelling				20		
E. Testing of plant systems or components					1	
G. Major backfitting, refurbishment or upgrading activities without refuelling				179		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						9
Z. Other					7	
Subtotal	613			1122	82	9
Total	**613**			**1213**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2002 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		1
13. Reactor Auxiliary Systems		33
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		14
32. Feedwater and Main Steam System		3
41. Main Generator Systems		23
42. Electrical Power Supply Systems		2
Total		**77**

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2024 Operating Experience

CN-5 QINSHAN 2-2 CHINA

Status at end of year	:	**Operational**
Operator	:	CNNO (CNNC Nuclear Operation Management Company Limited)
Owner	:	NPQJVC (NUCLEAR POWER PLANT QINSHAN JOINT VENTURE COMPANY LTD.)
Reactor Supplier	:	CNNC (CHINA NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	HTC (HARBIN TURBINE COMPANY LIMITED)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-600
Thermal power	:	1930 MWth
Gross electrical power	:	650 MWe
Reference unit power (net)	:	623 MWe

Key Dates

Construction Date	:	1997-04-01
Grid Date	:	2004-03-11
Commercial Date	:	2004-05-03
Age at end of year	:	20 years

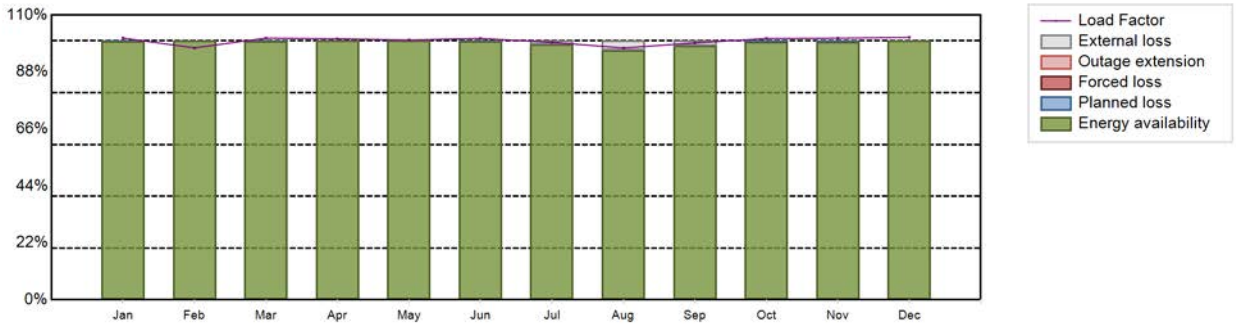
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	315.2
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.450
Average fuel enrichment [% of U235]	:	3.25	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	2.67	HP cylinder inlet steam pressure [MPa]	:	6.41
Active core height/length [m]	:	3.6576	Output voltage [kV]	:	20
Number of fissile fuel assemblies/bundles	:	121	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.09	Number of main condensate pumps	:	3
Number of control rod assemblies	:	33	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5477.32 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	99.33 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	99.89 %	Planned Unavailability Factor (PUF)	:	0.11 %
Load Factor (LF)	:	100.09 %	Externally cause unavailability (XUF)	:	0.56 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	468.63	421.94	468.58	452.25	465.24	452.92	460.86	450.87	445.07	467.76	453.32	469.86	5477.32
EAF [%]	99.76	100.00	99.79	100.00	100.00	99.77	98.62	96.45	98.21	99.65	99.73	100.00	99.33
UCF [%]	99.76	100.00	99.79	100.00	100.00	99.77	100.00	100.00	100.00	99.65	99.73	100.00	99.89
LF [%]	101.10	97.31	101.09	100.82	100.37	100.97	99.43	97.27	99.22	100.92	101.06	101.37	100.09
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.24	0.00	0.21	0.00	0.00	0.23	0.00	0.00	0.00	0.35	0.27	0.00	0.11
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	1.38	3.55	1.79	0.00	0.00	0.00	0.56

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Historical Summary

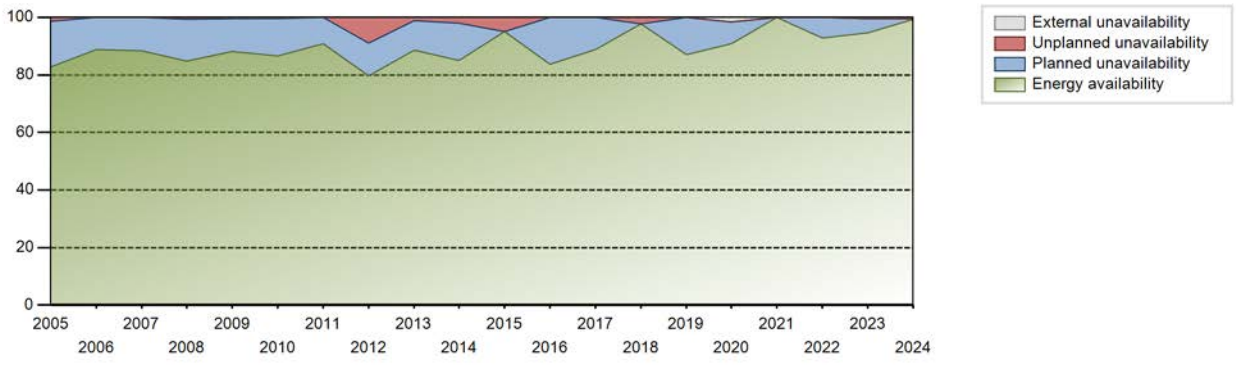
Lifetime energy generation	:	100748.91 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.19 %
Cumulative Energy Availability Factor (EAF)	:	89.91 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.08 %
Cumulative Unit Capability Factor (UCF)	:	90.06 %	Cumulative Planned Unavailability Factor (PUF)	:	8.86 %
Cumulative Load Factor (LF)	:	90.74 %	Cumulative Externally cause unavailability (XUF)	:	0.15 %
Cumulative Operating Factor (OF)	:	90.22 %			

Electricity Production (net) [GWh]



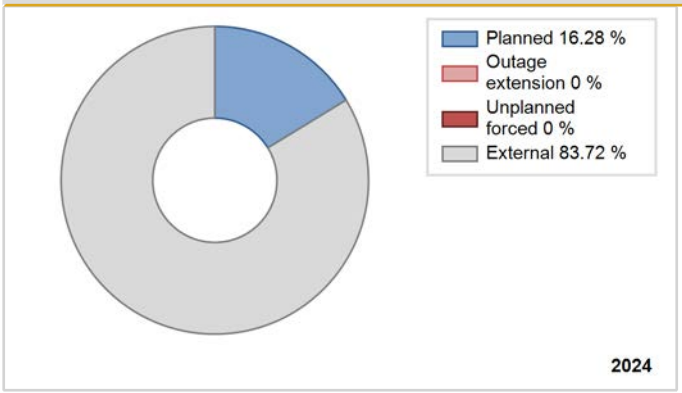
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2004	3764.39	6381	610	96.24	96.24	97.96	96.62	0.90	0.87	2.88	0.00
2005	4521.51	7331	610	82.69	82.77	84.62	83.69	1.65	1.39	15.84	0.08
2006	4790.44	7822	610	88.78	88.78	89.65	89.29	0.00	0.00	11.21	0.00
2007	4817.01	7792	610	88.30	88.30	90.15	88.95	0.00	0.00	11.70	0.00
2008	4635.51	7545	610	84.89	85.21	86.51	85.89	0.36	0.31	14.48	0.32
2009	4787.80	7821	610	88.22	88.22	89.60	89.28	0.62	0.55	11.24	0.00
2010	4715.04	7645	610	86.64	86.64	88.24	87.27	0.43	0.37	12.98	0.00
2011	4960.23	8014	610	90.91	90.91	92.83	91.48	0.00	0.00	9.09	0.00
2012	4335.54	7072	610	79.63	79.63	80.91	80.51	10.13	8.98	11.39	0.00
2013	4818.51	7826	610	88.70	88.70	90.17	89.34	1.23	1.11	10.19	0.00
2014	4626.25	7514	610	85.00	85.00	86.58	85.78	2.26	1.96	13.04	0.00
2015	4872.99	7990	610	95.14	95.14	91.19	91.21	4.84	4.83	0.03	0.00
2016	4525.57	7377	610	83.79	83.79	84.46	83.98	0.02	0.01	16.20	0.00
2017	4803.39	7830	610	88.83	88.83	89.89	89.38	0.01	0.01	11.16	0.00
2018	5306.28	8574	610	97.65	97.65	99.30	97.88	2.30	2.29	0.05	0.00
2019	4735.26	7680	610	87.10	87.16	88.62	87.67	0.00	0.00	12.84	0.06
2020	4758.46	8156	610	90.79	92.31	88.81	92.85	0.00	0.00	7.69	1.52
2021	5406.39	8760	610	99.91	99.91	101.17	100.00	0.00	0.00	0.09	0.00
2022	5064.37	8159	610	92.77	92.86	94.77	93.14	0.00	0.00	7.14	0.09
2023	5026.63	8106	623	94.58	94.99	92.11	92.53	0.00	0.00	5.01	0.41
2024	5477.32	8784	623	99.33	99.89	100.09	100.00	0.00	0.00	0.11	0.56

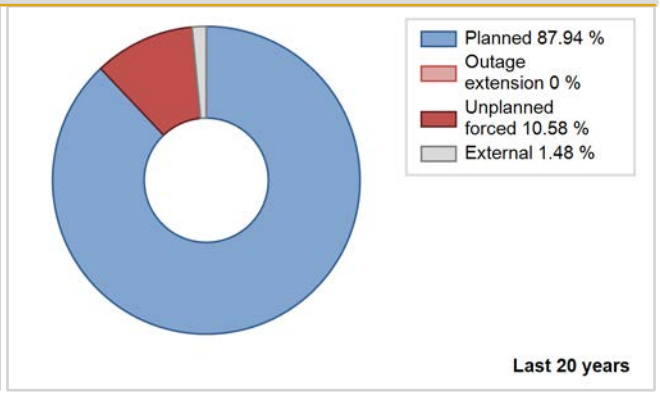
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2004 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					87	
C. Inspection, maintenance or repair combined with refuelling				730		
D. Inspection, maintenance or repair without refuelling				18		
G. Major backfitting, refurbishment or upgrading activities without refuelling				4		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						31
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Subtotal				752	87	32
Total		**0**			**871**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2004 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		5
15. Reactor Cooling Systems		9
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		69
32. Feedwater and Main Steam System		1
42. Electrical Power Supply Systems		2
Total		**87**

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2024 Operating Experience

CN-14 QINSHAN 2-3 CHINA

Status at end of year	:	**Operational**
Operator	:	CNNO (CNNC Nuclear Operation Management Company Limited)
Owner	:	NPQJVC (NUCLEAR POWER PLANT QINSHAN JOINT VENTURE COMPANY LTD.)
Reactor Supplier	:	CNNC (CHINA NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	HTC (HARBIN TURBINE COMPANY LIMITED)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-600
Thermal power	:	1930 MWth
Gross electrical power	:	660 MWe
Reference unit power (net)	:	623 MWe

Key Dates

Construction Date	:	2006-04-28
Grid Date	:	2010-08-01
Commercial Date	:	2010-10-05
Age at end of year	:	14 years

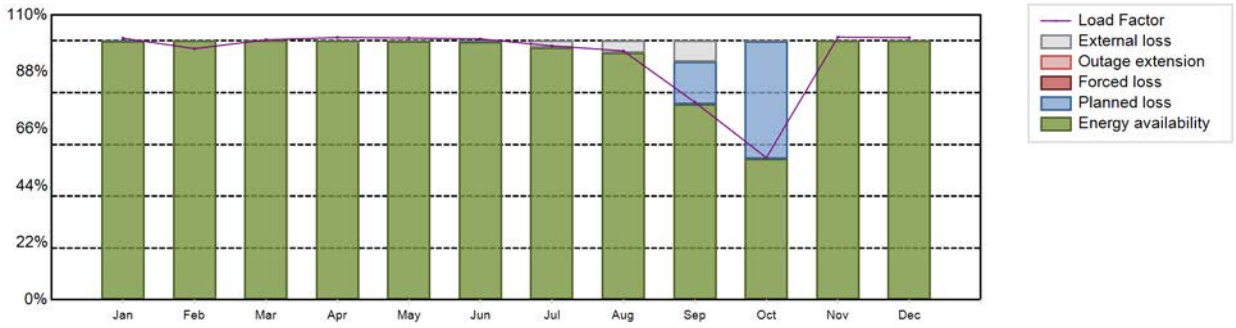
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	315.2
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.45
Average fuel enrichment [% of U235]	:	3.25	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	NA	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	2.67	HP cylinder inlet steam pressure [MPa]	:	6.41
Active core height/length [m]	:	3.6576	Output voltage [kV]	:	20
Number of fissile fuel assemblies/bundles	:	121	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.09	Number of main condensate pumps	:	3
Number of control rod assemblies	:	33	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5151.19 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	93.45 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	94.74 %	Planned Unavailability Factor (PUF)	:	5.26 %
Load Factor (LF)	:	94.13 %	Externally cause unavailability (XUF)	:	1.29 %
Operating Factor (OF)	:	95.13 %	Total off-line time	:	428 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	468.40	420.67	465.47	454.40	468.71	451.99	454.72	445.58	342.36	254.48	454.98	469.42	5151.19
EAF [%]	99.75	100.00	100.00	100.00	99.78	99.61	97.40	95.36	75.44	54.54	100.00	100.00	93.45
UCF [%]	99.75	100.00	100.00	100.00	99.78	99.76	100.00	100.00	83.46	54.58	100.00	100.00	94.74
LF [%]	101.06	97.02	100.42	101.30	101.12	100.76	98.10	96.13	76.32	54.90	101.43	101.27	94.13
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	83.61	58.33	100.00	100.00	95.13
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.25	0.00	0.00	0.00	0.22	0.24	0.00	0.00	16.54	45.42	0.00	0.00	5.26
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.15	2.60	4.64	8.02	0.05	0.00	0.00	1.29

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Historical Summary

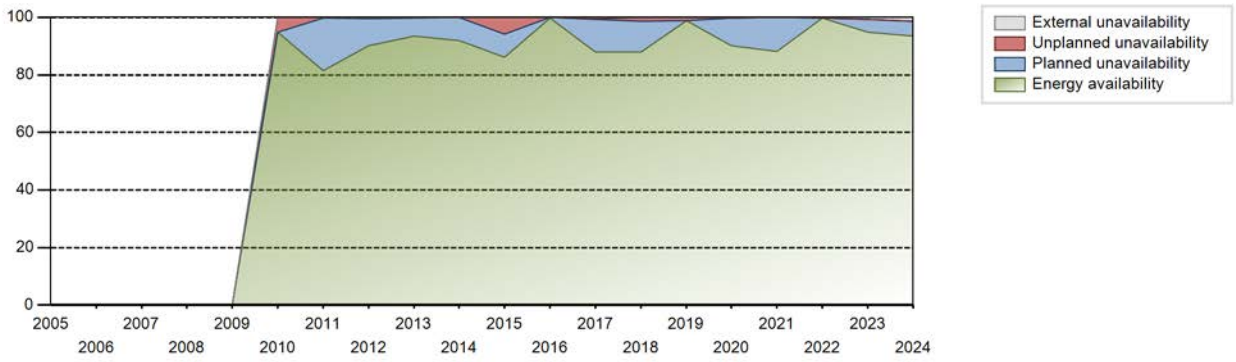
Lifetime energy generation	:	70752.94 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.83 %
Cumulative Energy Availability Factor (EAF)	:	91.78 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.77 %
Cumulative Unit Capability Factor (UCF)	:	92 %	Cumulative Planned Unavailability Factor (PUF)	:	7.23 %
Cumulative Load Factor (LF)	:	91.49 %	Cumulative Externally cause unavailability (XUF)	:	0.22 %
Cumulative Operating Factor (OF)	:	92.08 %			

Electricity Production (net) [GWh]



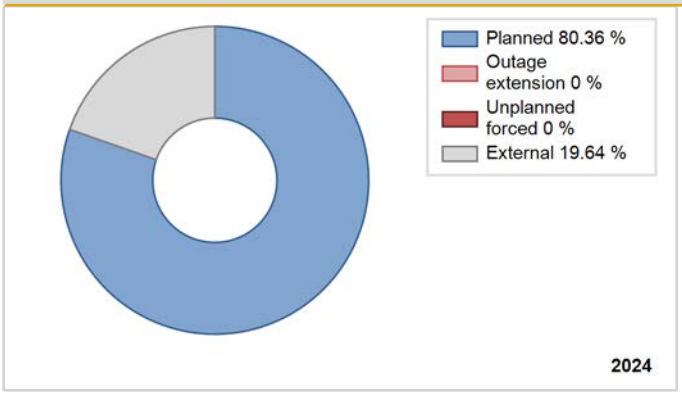
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2010	1465.17	2685	610	94.75	94.75	96.66	97.55	5.22	5.21	0.04	0.00
2011	4434.13	7226	610	81.55	81.56	82.98	82.49	0.21	0.17	18.27	0.01
2012	4846.78	7977	610	90.05	90.05	90.45	90.81	0.50	0.45	9.49	0.00
2013	5076.15	8243	610	93.46	93.46	94.99	94.10	0.17	0.16	6.38	0.00
2014	4929.31	8078	619	91.99	92.07	90.91	92.21	0.00	0.00	7.93	0.08
2015	4519.98	7410	619	86.17	86.17	83.36	84.59	6.43	5.93	7.91	0.00
2016	5259.45	8584	619	99.80	99.80	96.73	97.72	0.12	0.12	0.09	0.00
2017	4768.41	7804	619	87.96	88.41	87.94	89.09	0.38	0.34	11.25	0.45
2018	4767.33	7756	619	87.93	87.93	87.92	88.54	1.57	1.41	10.67	0.00
2019	5341.24	8664	619	98.82	98.82	98.50	98.90	1.11	1.11	0.07	0.00
2020	4753.88	7870	619	90.05	90.36	87.43	89.59	0.00	0.00	9.64	0.31
2021	4788.17	7768	619	88.15	88.19	88.30	88.68	0.00	0.00	11.81	0.04
2022	5468.09	8760	619	99.67	100.00	100.84	100.00	0.00	0.00	0.00	0.33
2023	5184.38	8397	623	94.92	95.53	95.00	95.86	0.00	0.00	4.47	0.61
2024	5151.19	8356	623	93.45	94.74	94.13	95.13	0.00	0.00	5.26	1.29

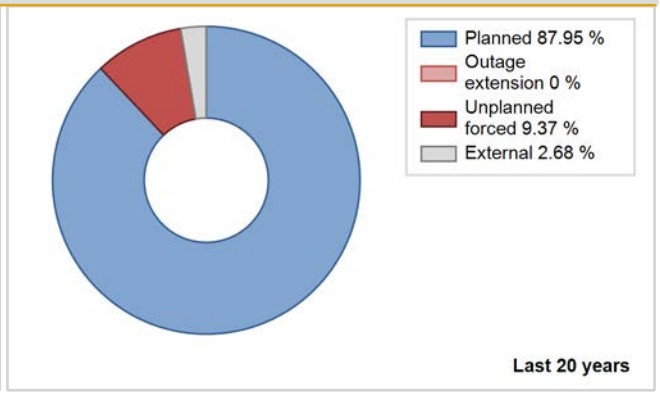
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2010 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					59	
C. Inspection, maintenance or repair combined with refuelling	429			613		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						34
L. Human factor related					0	
Subtotal	429			613	59	34
Total	**429**			**706**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2010 to 2024 Average hours lost per reactor-year
15. Reactor Cooling Systems		9
16. Steam generation systems		8
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		37
32. Feedwater and Main Steam System		0
34. Miscellaneous Systems		9
42. Electrical Power Supply Systems		3
Total		**68**

Highlights (2024)

The unit was shutdown for 311 refuelling outage from September 26 to October 13.

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2024 Operating Experience

CN-15 QINSHAN 2-4 CHINA

Status at end of year	:	**Operational**
Operator	:	CNNO (CNNC Nuclear Operation Management Company Limited)
Owner	:	NPQJVC (NUCLEAR POWER PLANT QINSHAN JOINT VENTURE COMPANY LTD.)
Reactor Supplier	:	CNNC (CHINA NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	HTC (HARBIN TURBINE COMPANY LIMITED)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-600
Thermal power	:	1930 MWth
Gross electrical power	:	660 MWe
Reference unit power (net)	:	623 MWe

Key Dates

Construction Date	:	2007-01-28
Grid Date	:	2011-11-25
Commercial Date	:	2011-12-30
Age at end of year	:	13 years

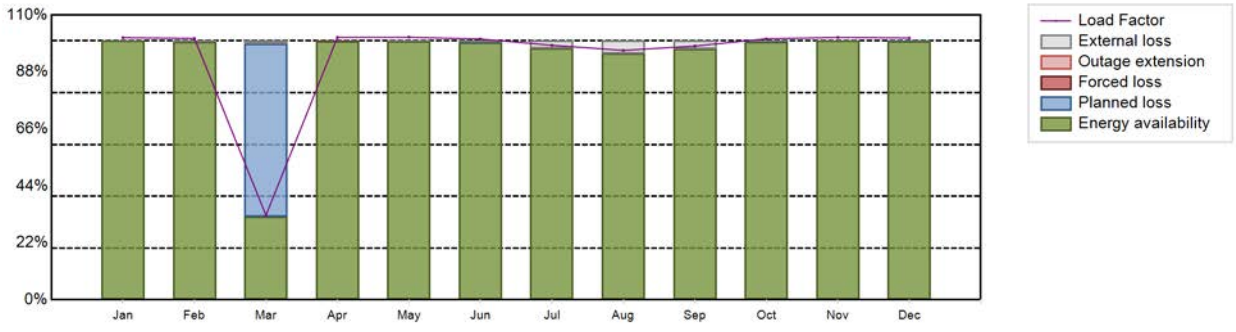
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.25
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	50000
Active core diameter [m]	:	2.67
Active core height/length [m]	:	3.6576
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	16.09
Number of control rod assemblies	:	33
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	315.2
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.45
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.41
Output voltage [kV]	:	20
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5167.99 GW(e).h
Energy Availability Factor (EAF)	:	93.21 %
Unit Capability Factor (UCF)	:	94.27 %
Load Factor (LF)	:	94.44 %
Operating Factor (OF)	:	94.49 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	5.73 %
Externally cause unavailability (XUF)	:	1.06 %
Total off-line time	:	484 hours

Annual Summary



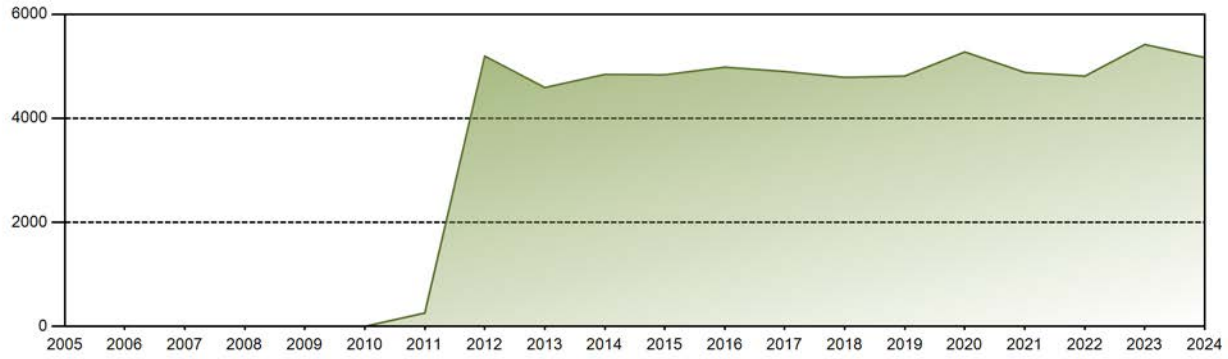
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	469.36	437.83	151.32	454.83	470.12	451.87	455.71	446.59	439.63	467.38	454.55	468.80	5167.99
EAF [%]	100.00	99.66	32.01	99.91	99.98	99.43	97.22	95.22	96.85	99.60	100.00	99.77	93.21
UCF [%]	100.00	100.00	33.11	99.91	100.00	99.76	100.00	100.00	100.00	99.76	100.00	99.77	94.27
LF [%]	101.26	100.97	32.65	101.40	101.42	100.74	98.32	96.35	98.01	100.84	101.34	101.14	94.44
OF [%]	100.00	100.00	34.95	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.49
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	66.89	0.09	0.00	0.24	0.00	0.00	0.00	0.24	0.00	0.23	5.73
XUF [%]	0.00	0.34	1.11	0.00	0.02	0.33	2.78	4.78	3.15	0.17	0.00	0.00	1.06

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Historical Summary

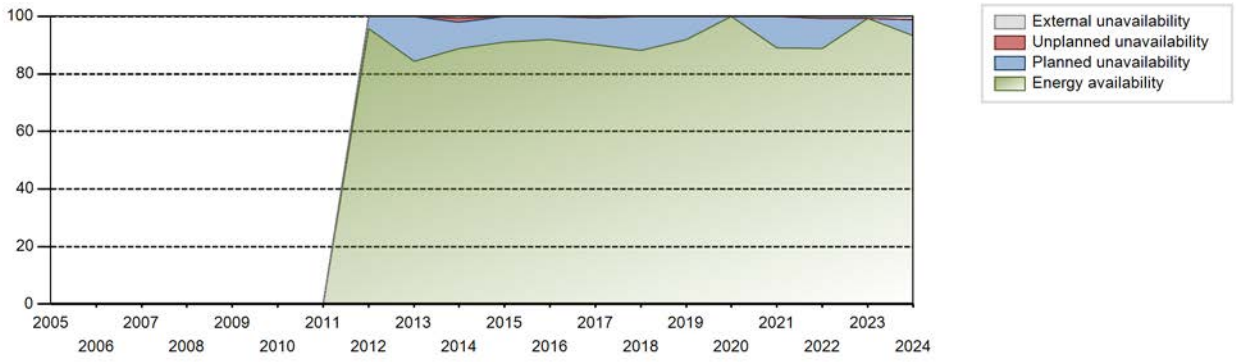
Lifetime energy generation	:	64767.31 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.12 %
Cumulative Energy Availability Factor (EAF)	:	91.74 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.11 %
Cumulative Unit Capability Factor (UCF)	:	92.02 %	Cumulative Planned Unavailability Factor (PUF)	:	7.88 %
Cumulative Load Factor (LF)	:	91.86 %	Cumulative Externally cause unavailability (XUF)	:	0.28 %
Cumulative Operating Factor (OF)	:	92.18 %			

Electricity Production (net) [GWh]



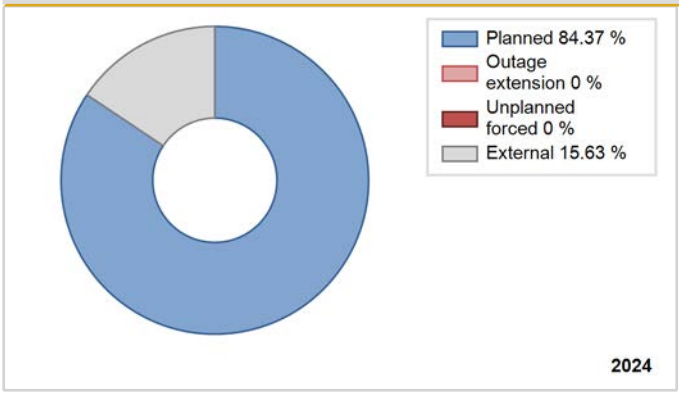
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2011	257.02	614	610	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	5195.81	8438	610	95.79	95.79	96.97	96.06	0.04	0.04	4.17	0.00
2013	4591.39	7428	610	84.25	84.25	85.92	84.79	0.00	0.00	15.75	0.00
2014	4844.49	7905	610	88.86	89.62	90.66	90.24	1.32	1.20	9.19	0.75
2015	4837.34	7994	610	91.06	91.06	90.53	91.26	0.00	0.00	8.94	0.00
2016	4983.82	8130	610	91.93	91.93	93.01	92.55	0.07	0.07	8.00	0.00
2017	4899.45	7993	619	90.14	90.61	90.35	91.24	0.00	0.00	9.39	0.48
2018	4786.77	7760	619	88.16	88.16	88.28	88.58	0.00	0.00	11.84	0.00
2019	4812.21	7815	619	91.91	91.91	88.75	89.21	0.10	0.09	8.00	0.00
2020	5276.68	8784	619	99.97	99.97	97.05	100.00	0.01	0.01	0.03	0.00
2021	4882.83	7898	619	88.97	89.04	90.05	90.16	0.00	0.00	10.96	0.07
2022	4812.10	7861	619	88.83	89.45	88.74	89.74	0.00	0.00	10.55	0.62
2023	5419.73	8760	623	99.35	99.96	99.31	100.00	0.00	0.00	0.04	0.61
2024	5167.99	8300	623	93.21	94.27	94.44	94.49	0.00	0.00	5.73	1.06

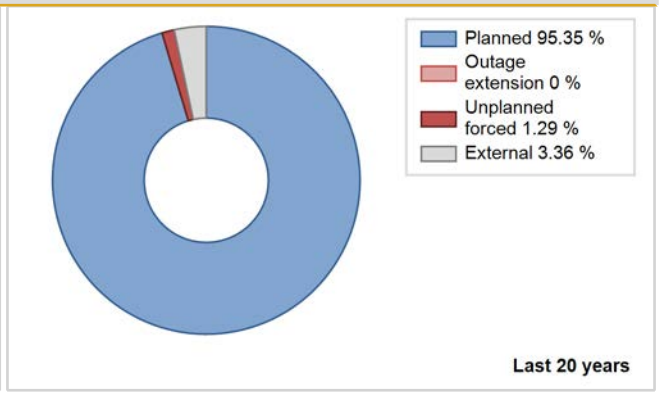
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2011 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					1	
C. Inspection, maintenance or repair combined with refuelling	470			630		
D. Inspection, maintenance or repair without refuelling				20		
E. Testing of plant systems or components				6		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						21
Subtotal	470			656	1	21
Total	**470**			**678**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2011 to 2024
	Hours Lost	Average hours lost per reactor-year
35. All other I&C Systems		1
Total		**1**

Highlights (2024)

The unit was shutdown for 410 refuelling outage from March 6 to March 25.

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2024 Operating Experience

CN-8 QINSHAN 3-1 CHINA



Status at end of year	:	**Operational**
Operator	:	CNNO (CNNC Nuclear Operation Management Company Limited)
Owner	:	TQNPC (Qinshan Third nuclear power Co., LTD)
Reactor Supplier	:	AECL (ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	Hit (Japan Hitachi Company.)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 6
Thermal power	:	2064 MWth
Gross electrical power	:	728 MWe
Reference unit power (net)	:	677 MWe

Key Dates

Construction Date	:	1998-06-08
Grid Date	:	2002-11-19
Commercial Date	:	2002-12-31
Age at end of year	:	22 years

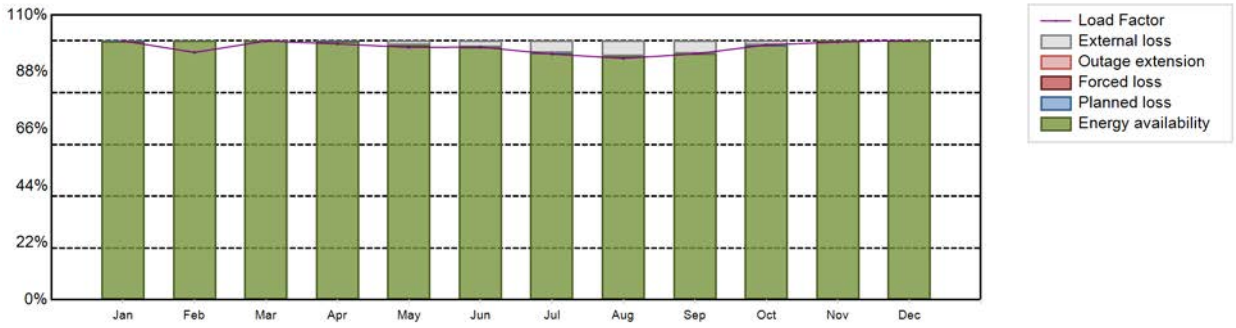
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	9.89
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	310
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	D2O	Containment design pressure [MPa]	:	0.124
Average fuel enrichment [% of U235]	:	0.71	**Secondary systems**		
Refuelling frequency [month]	:	60	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	NA	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	7186	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	6.28	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	4560	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	25.35	Number of main condensate pumps	:	-
Number of control rod assemblies	:	21	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5802.8 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	98.26 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	99.99 %	Planned Unavailability Factor (PUF)	:	0.01 %
Load Factor (LF)	:	97.58 %	Externally cause unavailability (XUF)	:	1.74 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	503.82	450.27	503.46	481.80	491.18	475.81	478.07	469.72	462.93	495.83	485.37	504.55	5802.80
EAF [%]	99.99	100.00	100.00	99.98	98.47	97.65	95.39	94.12	95.26	98.32	100.00	100.00	98.26
UCF [%]	99.99	100.00	100.00	99.98	100.00	100.00	99.98	100.00	100.00	99.95	100.00	100.00	99.99
LF [%]	100.03	95.56	99.95	98.84	97.52	97.61	94.91	93.26	94.97	98.44	99.58	100.17	97.58
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.01	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.05	0.00	0.00	0.01
XUF [%]	0.00	0.00	0.00	0.00	1.53	2.35	4.59	5.88	4.74	1.63	0.00	0.00	1.74

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Historical Summary

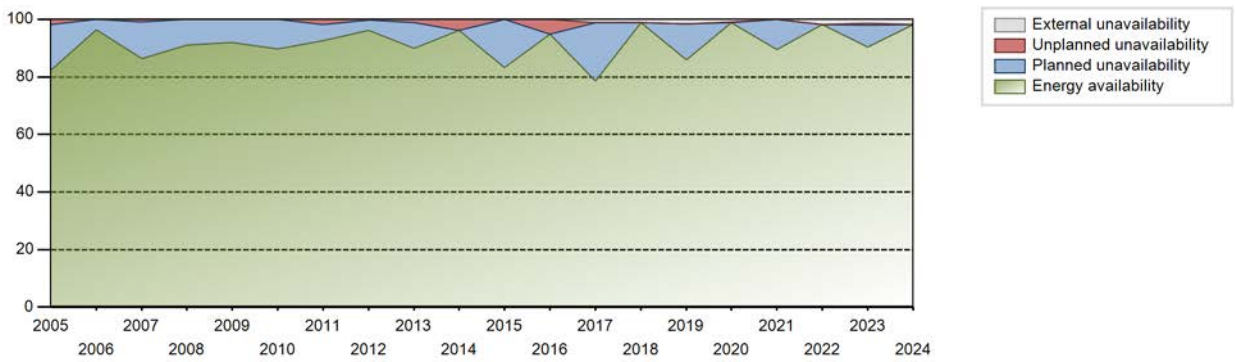
Lifetime energy generation	:	116137.88 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.36 %
Cumulative Energy Availability Factor (EAF)	:	90.55 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.25 %
Cumulative Unit Capability Factor (UCF)	:	91.16 %	Cumulative Planned Unavailability Factor (PUF)	:	7.59 %
Cumulative Load Factor (LF)	:	90.68 %	Cumulative Externally cause unavailability (XUF)	:	0.61 %
Cumulative Operating Factor (OF)	:	91.32 %			

Electricity Production (net) [GWh]



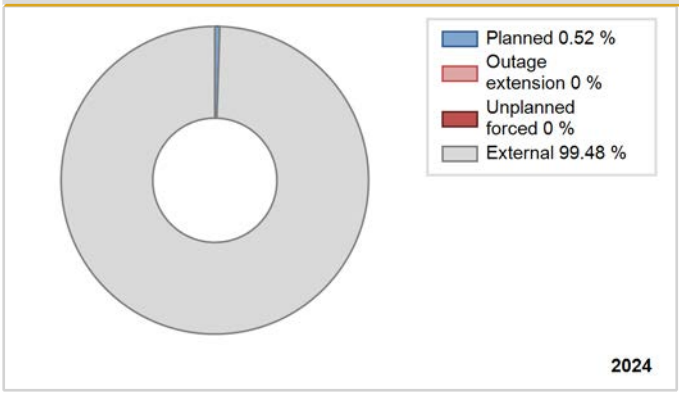
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2002	Data not provided										
2003	5174.75	7977	650	86.59	89.65	90.88	91.06	10.35	10.35	0.00	3.06
2004	4405.52	6745	650	75.60	75.61	77.16	76.79	2.31	1.78	22.61	0.01
2005	4781.60	7249	650	82.43	82.50	83.98	82.75	2.18	1.84	15.66	0.07
2006	5577.79	8484	650	96.34	96.34	97.96	96.85	0.07	0.07	3.60	0.00
2007	5020.40	7597	650	86.41	86.41	88.17	86.72	0.95	0.82	12.76	0.00
2008	5328.57	8051	650	91.11	91.21	93.33	91.66	0.00	0.00	8.79	0.10
2009	5326.22	8076	650	91.91	91.91	93.54	92.19	0.00	0.00	8.09	0.00
2010	5216.34	7884	650	89.71	89.71	91.61	90.00	0.03	0.03	10.27	0.00
2011	5388.51	8131	650	92.55	92.55	94.63	92.82	1.96	1.85	5.60	0.00
2012	5544.58	8462	650	96.25	96.25	97.11	96.33	0.34	0.33	3.41	0.00
2013	5237.40	7949	650	89.89	89.89	91.98	90.74	1.22	1.11	9.00	0.00
2014	5594.85	8451	650	96.13	96.13	98.26	96.47	3.83	3.83	0.04	0.00
2015	4758.34	7292	677	83.19	83.19	80.23	83.24	0.00	0.00	16.81	0.00
2016	5476.06	8351	677	94.90	94.90	92.08	95.07	5.08	5.08	0.02	0.00
2017	4542.77	7000	677	78.63	79.83	76.60	79.91	0.00	0.00	20.17	1.20
2018	5729.05	8657	677	98.76	99.96	96.60	98.82	0.00	0.00	0.04	1.20
2019	5061.34	7709	677	86.01	87.63	85.34	88.00	0.03	0.03	12.34	1.62
2020	5714.70	8699	677	98.95	99.92	96.10	99.03	0.07	0.07	0.01	0.97
2021	5073.94	7745	677	89.51	89.51	85.56	88.41	0.00	0.00	10.49	0.00
2022	5778.63	8760	677	98.11	99.90	97.44	100.00	0.00	0.00	0.09	1.80
2023	5291.35	8067	677	90.32	91.74	89.22	92.09	0.69	0.64	7.62	1.42
2024	5802.80	8784	677	98.26	99.99	97.58	100.00	0.00	0.00	0.01	1.74

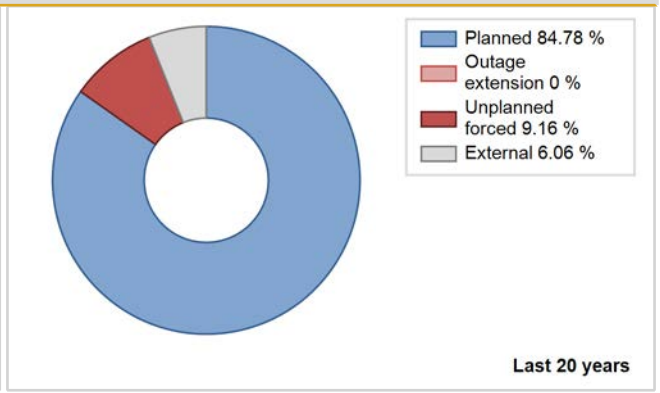
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2002 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					96	
D. Inspection, maintenance or repair without refuelling				650		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						10
Z. Other						4
Subtotal				650	96	14
Total		**0**			**760**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2002 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		6
15. Reactor Cooling Systems		32
16. Steam generation systems		9
21. Fuel Handling and Storage Facilities		9
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		2
34. Miscellaneous Systems		10
42. Electrical Power Supply Systems		34
Total		**107**

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2024 Operating Experience

CN-9 QINSHAN 3-2 CHINA



Status at end of year	:	**Operational**
Operator	:	CNNO (CNNC Nuclear Operation Management Company Limited)
Owner	:	TQNPC (Qinshan Third nuclear power Co., LTD)
Reactor Supplier	:	AECL (ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	Hit (Japan Hitachi Company.)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 6
Thermal power	:	2064 MWth
Gross electrical power	:	728 MWe
Reference unit power (net)	:	677 MWe

Key Dates

Construction Date	:	1998-09-25
Grid Date	:	2003-06-12
Commercial Date	:	2003-07-24
Age at end of year	:	21 years

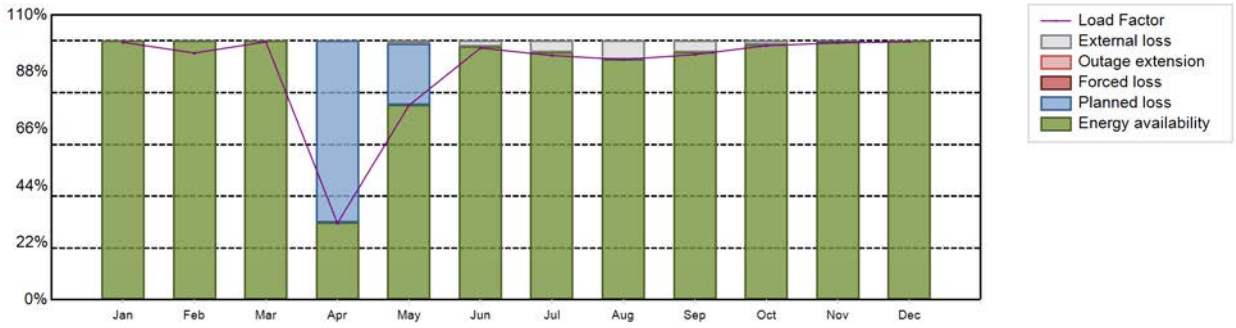
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	0.71
Refuelling frequency [month]	:	60
Part of the core refuelled [%]	:	NA
Average discharge burnup [MWd/t]	:	7186
Active core diameter [m]	:	6.28
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	4560
Fuel linear heat generation rate [kW/m]	:	25.35
Number of control rod assemblies	:	21
Number of external reactor coolant loops	:	2
Coolant type	:	D2O
Operating coolant pressure [MPa]	:	9.89
Reactor outlet temperature [°C]	:	310
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.124
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.51
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	2
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5333.29 GW(e).h
Energy Availability Factor (EAF)	:	90.54 %
Unit Capability Factor (UCF)	:	92.24 %
Load Factor (LF)	:	89.68 %
Operating Factor (OF)	:	92.41 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	7.76 %
Externally cause unavailability (XUF)	:	1.7 %
Total off-line time	:	667 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	500.95	449.10	501.87	144.08	378.33	474.02	475.30	467.43	461.71	494.44	483.89	502.17	5333.29
EAF [%]	100.00	100.00	100.00	29.84	75.24	97.83	95.69	92.99	95.66	98.62	99.99	100.00	90.54
UCF [%]	100.00	100.00	100.00	29.84	76.37	100.00	100.00	99.96	100.00	99.97	99.99	100.00	92.24
LF [%]	99.46	95.31	99.64	29.56	75.11	97.25	94.36	92.80	94.72	98.16	99.27	99.70	89.68
OF [%]	100.00	100.00	100.00	30.14	77.96	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.41
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	70.16	23.63	0.00	0.00	0.04	0.00	0.03	0.01	0.00	7.76
XUF [%]	0.00	0.00	0.00	0.00	1.13	2.17	4.31	6.98	4.34	1.35	0.00	0.00	1.70

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Historical Summary

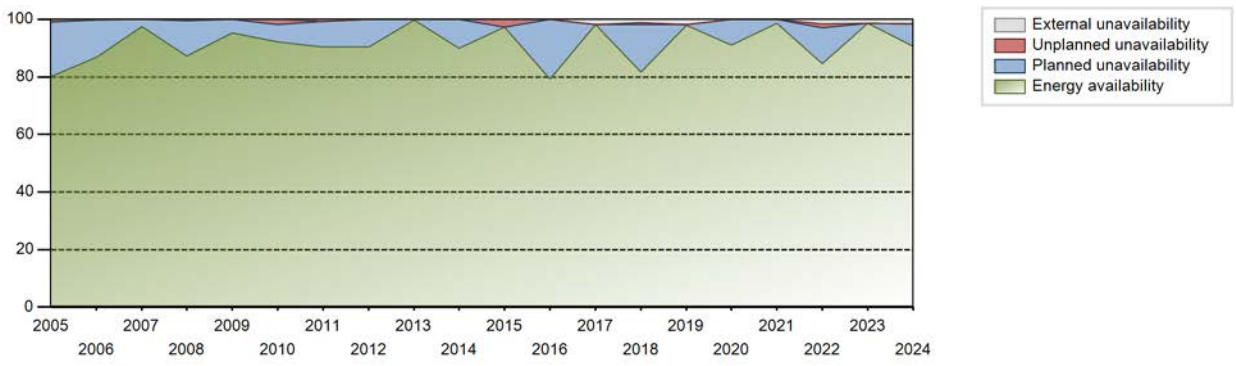
Lifetime energy generation	:	113333.29 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.49 %
Cumulative Energy Availability Factor (EAF)	:	91.42 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.51 %
Cumulative Unit Capability Factor (UCF)	:	91.94 %	Cumulative Planned Unavailability Factor (PUF)	:	7.55 %
Cumulative Load Factor (LF)	:	90.94 %	Cumulative Externally cause unavailability (XUF)	:	0.52 %
Cumulative Operating Factor (OF)	:	91.93 %			

Electricity Production (net) [GWh]



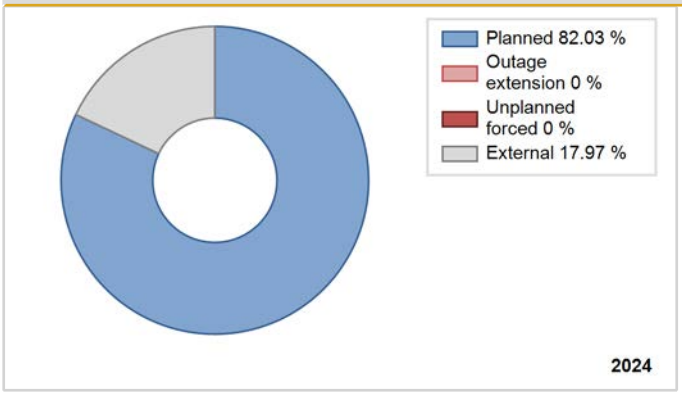
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2003	Data not provided										
2004	5358.59	8236	665	92.43	93.00	91.74	93.76	2.84	2.72	4.28	0.57
2005	4604.65	7014	665	80.14	80.24	79.04	80.07	0.90	0.73	19.03	0.11
2006	5038.17	7721	650	86.72	86.72	88.48	88.14	0.25	0.22	13.06	0.00
2007	5675.70	8559	650	97.55	97.55	99.68	97.71	0.00	0.00	2.45	0.00
2008	5083.41	7697	650	87.21	87.32	89.03	87.63	0.55	0.48	12.20	0.11
2009	5523.74	8359	650	95.36	95.36	97.01	95.42	0.00	0.00	4.64	0.00
2010	5341.46	8099	650	92.06	92.06	93.81	92.45	1.93	1.82	6.13	0.00
2011	5261.09	7951	650	90.34	91.00	92.40	90.76	0.00	0.00	9.00	0.66
2012	5210.75	7980	650	90.44	90.44	91.26	90.85	0.03	0.03	9.53	0.00
2013	5794.09	8760	650	99.85	99.85	101.76	100.00	0.00	0.00	0.15	0.00
2014	5223.32	7892	650	89.99	89.99	91.73	90.09	0.04	0.03	9.98	0.00
2015	5623.82	8553	677	97.30	97.30	94.83	97.64	2.69	2.69	0.02	0.00
2016	4555.03	6979	677	79.27	79.27	76.60	79.45	0.02	0.02	20.71	0.00
2017	5598.62	8580	677	98.19	99.96	94.40	97.95	0.03	0.03	0.01	1.76
2018	4685.15	7183	677	81.58	82.62	79.00	82.00	0.94	0.78	16.60	1.03
2019	5716.87	8686	677	98.02	99.85	96.40	99.16	0.00	0.00	0.15	1.83
2020	5261.05	8014	677	91.04	91.04	88.47	91.23	0.00	0.00	8.96	0.00
2021	5607.86	8540	677	98.61	98.61	94.56	97.49	0.00	0.00	1.39	0.00
2022	4979.49	7573	677	84.62	86.31	83.96	86.45	0.00	1.20	12.49	1.69
2023	5737.33	8760	677	98.61	100.00	96.74	100.00	0.00	0.00	0.00	1.39
2024	5333.29	8117	677	90.54	92.24	89.68	92.41	0.00	0.00	7.76	1.70

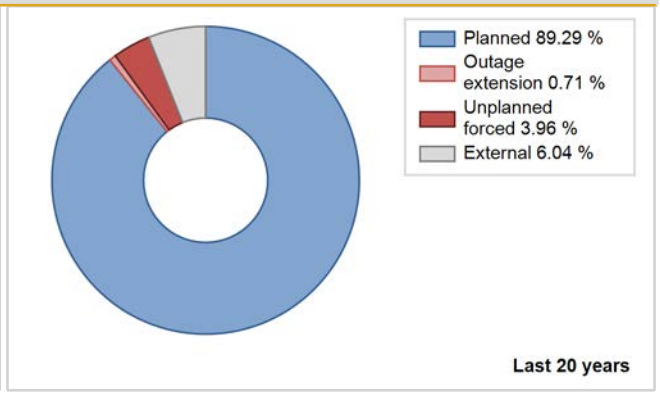
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2003 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					30	
C. Inspection, maintenance or repair combined with refuelling	667			118		
D. Inspection, maintenance or repair without refuelling				521		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						22
L. Human factor related					4	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						5
Z. Other					5	
Subtotal	667			639	39	27
Total	**667**			**705**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2003 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		10
12. Reactor I&C Systems		4
14. Safety Systems		8
16. Steam generation systems		2
21. Fuel Handling and Storage Facilities		3
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		3
34. Miscellaneous Systems		5
42. Electrical Power Supply Systems		4
Total		**41**

Highlights (2024)

The unit was shutdown for 12th planned outage from April 10 to May 7.

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2024 Operating Experience

CN-1 QINSHAN-1 CHINA

Status at end of year	:	**Operational**
Operator	:	CNNO (CNNC Nuclear Operation Management Company Limited)
Owner	:	QNPC (QINSHAN NUCLEAR POWER COMPANY)
Reactor Supplier	:	CNNC (CHINA NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	STC (Shanghai Turbine Co.)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-300
Thermal power	:	966 MWth
Gross electrical power	:	330 MWe
Reference unit power (net)	:	326 MWe

Key Dates

Construction Date	:	1985-03-20
Grid Date	:	1991-12-15
Commercial Date	:	1994-04-01
Age at end of year	:	33 years

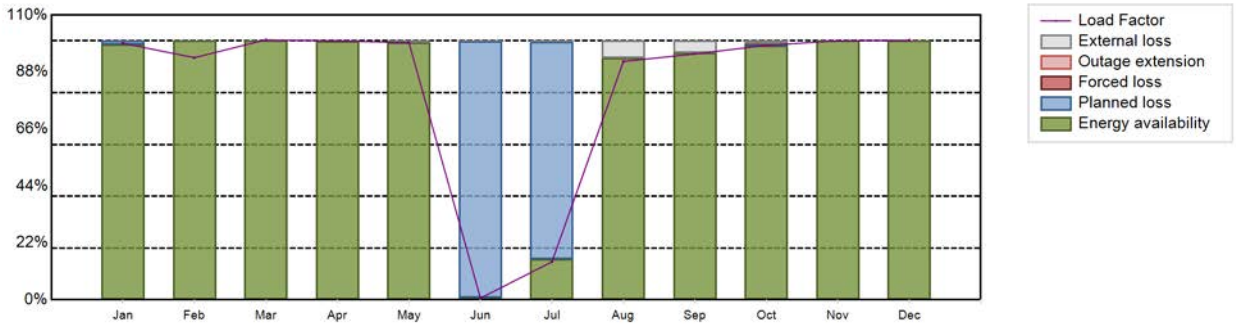
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.2
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	308.5
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	2.65
Average fuel enrichment [% of U235]	:	3.4	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.33	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	2.486	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	2.9	Output voltage [kV]	:	18
Number of fissile fuel assemblies/bundles	:	121	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	13.5	Number of main condensate pumps	:	3
Number of control rod assemblies	:	37	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	2371.28 GW(e).h	Forced Loss Rate (FLR)	:	0.01 %
Energy Availability Factor (EAF)	:	83.49 %	Unplanned Capability Loss Factor (UCL)	:	0.01 %
Unit Capability Factor (UCF)	:	84.62 %	Planned Unavailability Factor (PUF)	:	15.37 %
Load Factor (LF)	:	82.81 %	Externally cause unavailability (XUF)	:	1.13 %
Operating Factor (OF)	:	85.04 %	Total off-line time	:	1314 hours

Annual Summary



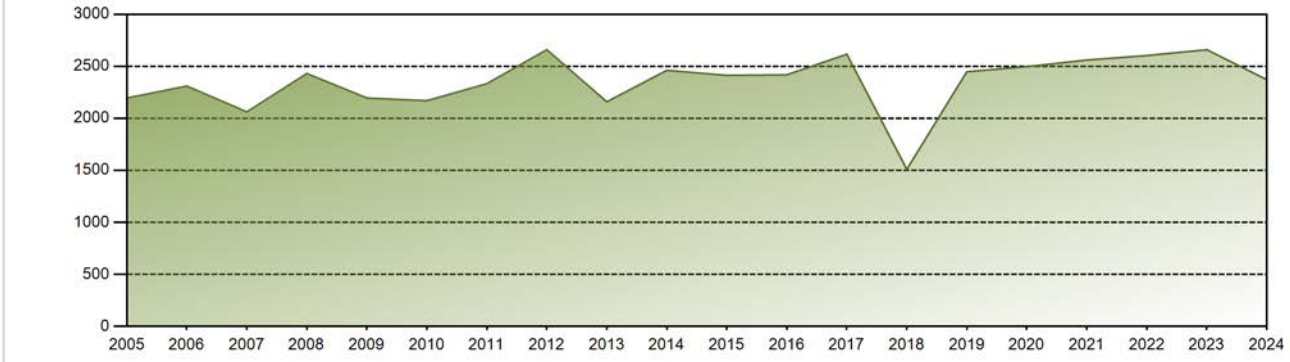
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	240.26	212.21	243.56	234.72	240.92	1.54	35.57	223.28	222.90	238.39	234.82	243.12	2371.28
EAF [%]	98.68	100.00	100.00	99.81	99.41	0.96	15.84	93.40	95.39	98.22	100.00	100.00	83.49
UCF [%]	98.68	100.00	100.00	99.81	100.00	1.00	16.31	100.00	100.00	99.41	100.00	100.00	84.62
LF [%]	99.06	93.53	100.42	100.00	99.33	0.66	14.66	92.06	94.96	98.29	100.04	100.24	82.81
OF [%]	100.00	100.00	100.00	100.00	100.00	1.53	18.68	100.00	100.00	100.00	100.00	100.00	85.04
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.01
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.01
PUF [%]	1.32	0.00	0.00	0.19	0.00	99.00	83.69	0.00	0.00	0.52	0.00	0.00	15.37
XUF [%]	0.00	0.00	0.00	0.00	0.59	0.04	0.46	6.60	4.61	1.18	0.00	0.00	1.13

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Historical Summary

Lifetime energy generation	:	69397.33 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.41 %
Cumulative Energy Availability Factor (EAF)	:	83.08 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.24 %
Cumulative Unit Capability Factor (UCF)	:	84.07 %	Cumulative Planned Unavailability Factor (PUF)	:	12.69 %
Cumulative Load Factor (LF)	:	84.27 %	Cumulative Externally cause unavailability (XUF)	:	0.99 %
Cumulative Operating Factor (OF)	:	84.63 %			

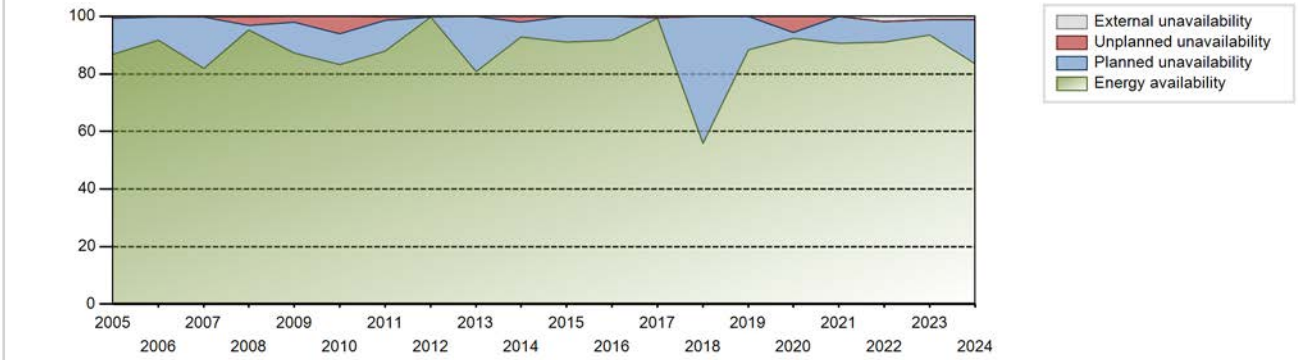
Electricity Production (net) [GWh]



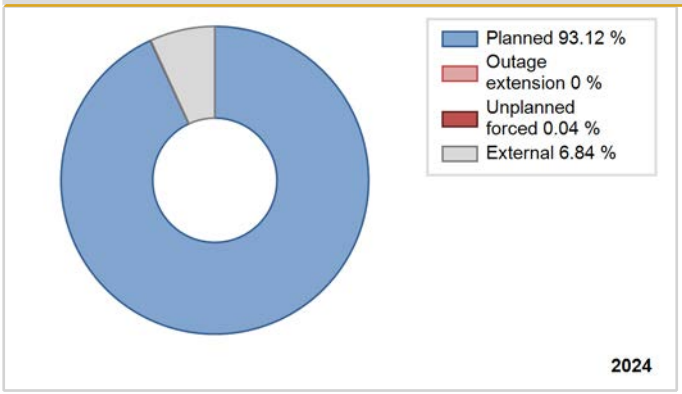
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1994	1648.58	6439	279	62.02	67.45	62.67	70.06	3.98	2.80	29.75	5.44
1995	2063.90	7886	300	82.32	86.80	78.53	90.02	2.25	2.00	11.20	4.49
1996	2073.72	7479	279	81.19	81.19	84.62	85.14	1.17	0.96	17.85	0.00
1997	2011.67	7185	300	76.11	81.78	76.55	82.02	2.87	2.42	15.80	5.67
1998	1149.49	4331	279	42.59	48.78	47.03	49.44	0.98	0.48	50.74	6.19
1999	680.88	2519	279	27.76	27.76	27.86	28.76	71.97	71.28	0.96	0.00
2000	2035.48	6840	300	77.61	77.61	77.24	77.87	2.79	2.23	20.16	0.00
2001	2319.37	8370	279	92.82	93.47	94.90	95.55	0.51	0.48	6.05	0.64
2002	1783.25	5989	279	66.31	69.21	72.96	68.37	1.40	0.98	29.81	2.90
2003	2256.57	7798	288	88.44	88.46	89.44	89.02	0.24	0.21	11.33	0.01
2004	2565.24	8784	288	99.08	99.79	101.40	100.00	0.11	0.11	0.10	0.71
2005	2194.56	7693	288	86.83	87.02	86.99	87.82	0.53	0.46	12.52	0.19
2006	2310.41	8086	288	91.81	91.81	91.58	92.31	0.05	0.29	7.89	0.00
2007	2061.43	7218	288	81.99	82.22	81.71	82.40	0.10	0.08	17.70	0.23
2008	2430.72	8434	288	95.38	95.54	96.08	96.02	1.02	2.99	1.47	0.16
2009	2195.44	7704	288	87.33	87.41	87.02	87.95	2.20	1.96	10.62	0.08
2010	2169.32	7398	298	83.24	83.33	84.27	84.45	0.47	6.03	10.64	0.09
2011	2332.64	7762	298	87.88	88.06	89.36	88.61	0.41	1.20	10.75	0.18
2012	2659.07	8784	298	99.80	99.94	101.58	100.00	0.02	0.02	0.05	0.14
2013	2158.84	7199	298	80.86	80.98	82.70	82.18	0.02	0.02	19.00	0.12
2014	2461.14	8221	298	92.93	92.93	94.28	93.85	2.07	1.97	5.10	0.00
2015	2413.17	8003	298	91.14	91.14	92.44	91.36	0.11	0.10	8.76	0.00
2016	2418.29	8084	298	91.75	91.75	92.38	92.03	0.02	0.02	8.23	0.00
2017	2615.97	8760	298	99.37	99.96	100.21	100.00	0.00	0.00	0.04	0.60
2018	1509.11	5147	298	55.80	55.80	57.81	58.76	0.00	0.00	44.20	0.00
2019	2447.78	7782	298	88.27	88.27	93.77	88.84	0.00	0.00	11.73	0.00
2020	2496.95	8132	308	92.28	92.28	92.29	92.58	5.67	5.54	2.18	0.00
2021	2560.13	7982	308	90.71	90.71	94.89	91.12	0.00	0.00	9.29	0.00
2022	2603.50	8161	326	91.09	92.97	91.17	93.16	0.00	0.00	7.03	1.88
2023	2659.67	8331	326	93.61	94.72	93.13	95.10	0.00	0.00	5.28	1.10
2024	2371.28	7470	326	83.49	84.62	82.81	85.04	0.01	0.01	15.37	1.13

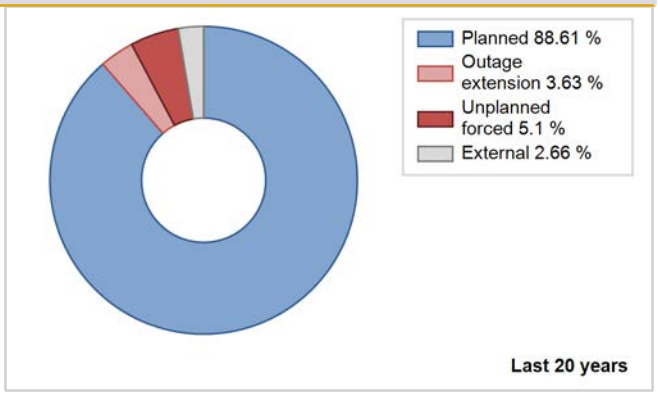
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1994 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					67	
C. Inspection, maintenance or repair combined with refuelling	1313			1022		
D. Inspection, maintenance or repair without refuelling				41		
E. Testing of plant systems or components				0	1	
L. Human factor related					12	
Z. Other					202	1
Subtotal	1313			1063	282	1
Total	**1313**			**1346**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1994 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		15
12. Reactor I&C Systems		11
13. Reactor Auxiliary Systems		3
15. Reactor Cooling Systems		6
16. Steam generation systems		0
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		4
32. Feedwater and Main Steam System		9
33. Circulating Water System		2
34. Miscellaneous Systems		1
35. All other I&C Systems		1
41. Main Generator Systems		16
Total		**69**

Highlights (2024)

The unit was shutdown for 23th planned outage from June 1 to July 26.

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2024 Operating Experience

CN-28 SANMEN-1 CHINA



Status at end of year	:	**Operational**
Operator	:	SMNPC (SANMEN NUCLEAR POWER CO., LTD.)
Owner	:	SMNPC (SANMEN NUCLEAR POWER CO., LTD.)
Reactor Supplier	:	WH/MHI (WESTINGHOUSE ELECTRIC CORPORATION / MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / AP-1000
Thermal power	:	3400 MWth
Gross electrical power	:	1251 MWe
Reference unit power (net)	:	1157 MWe

Key Dates

Construction Date	:	2009-04-19
Grid Date	:	2018-06-30
Commercial Date	:	2018-09-21
Age at end of year	:	6 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.7239
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	40.8
Average discharge burnup [MWd/t]	:	50558
Active core diameter [m]	:	3.04
Active core height/length [m]	:	4.267
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.77
Number of control rod assemblies	:	69
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

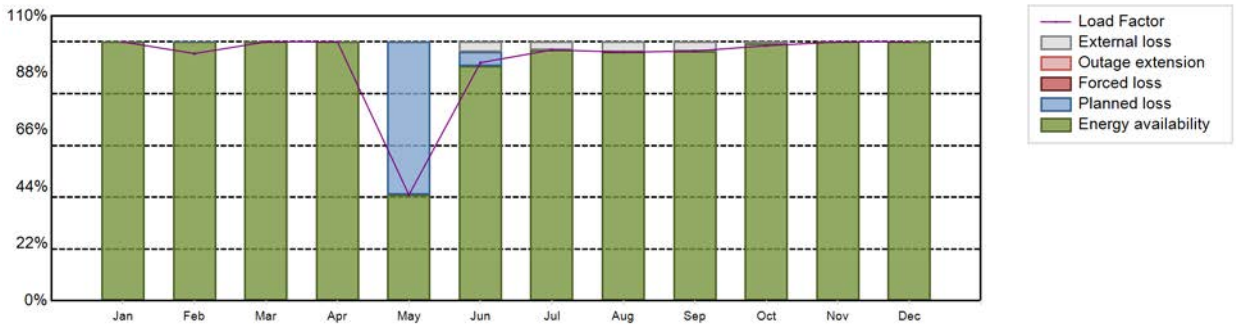
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	321
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.407
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.38
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	NA
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9448.9 GW(e).h
Energy Availability Factor (EAF)	:	93.3 %
Unit Capability Factor (UCF)	:	94.55 %
Load Factor (LF)	:	92.97 %
Operating Factor (OF)	:	94.77 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	5.45 %
Externally cause unavailability (XUF)	:	1.26 %
Total off-line time	:	459 hours

Annual Summary



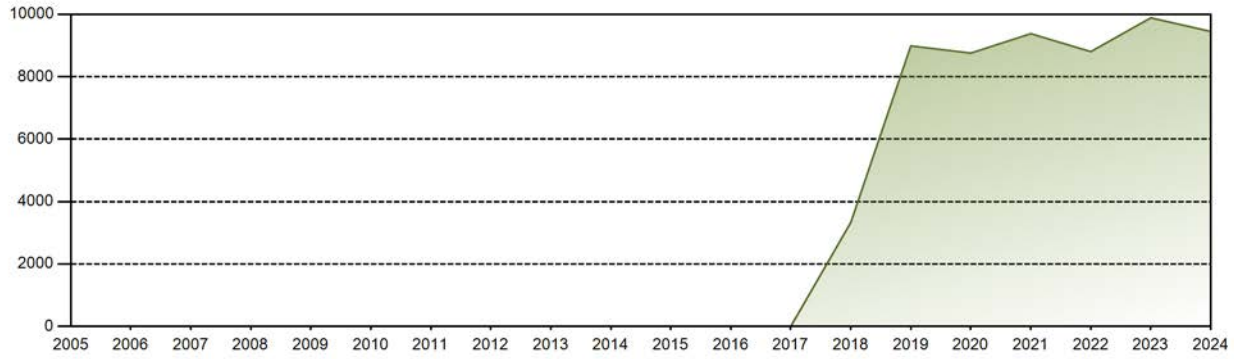
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	860.81	769.04	860.81	833.04	352.28	766.18	834.43	826.70	803.63	848.21	832.96	860.81	9448.90
EAF [%]	100.00	100.00	100.00	100.00	40.92	90.64	96.94	96.04	96.47	99.43	99.99	100.00	93.30
UCF [%]	100.00	100.00	100.00	100.00	40.92	94.60	100.00	99.99	100.00	100.00	99.99	100.00	94.55
LF [%]	100.00	95.50	100.00	100.00	40.92	91.97	96.94	96.04	96.47	98.54	99.99	100.00	92.97
OF [%]	100.00	100.00	100.00	100.00	41.40	96.81	100.00	100.00	100.00	100.00	100.00	100.00	94.77
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	59.08	5.40	0.00	0.00	0.00	0.00	0.00	0.00	5.45
XUF [%]	0.00	0.00	0.00	0.00	0.00	3.96	3.06	3.95	3.53	0.57	0.00	0.00	1.26

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Historical Summary

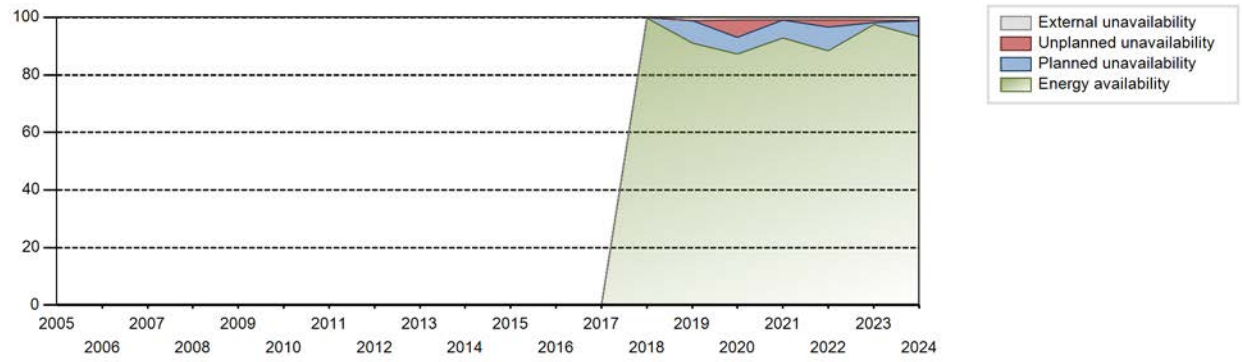
Lifetime energy generation	:	58596.86 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.58 %
Cumulative Energy Availability Factor (EAF)	:	92.1 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.5 %
Cumulative Unit Capability Factor (UCF)	:	93.08 %	Cumulative Planned Unavailability Factor (PUF)	:	5.42 %
Cumulative Load Factor (LF)	:	91.14 %	Cumulative Externally cause unavailability (XUF)	:	0.98 %
Cumulative Operating Factor (OF)	:	93.09 %			

Electricity Production (net) [GWh]

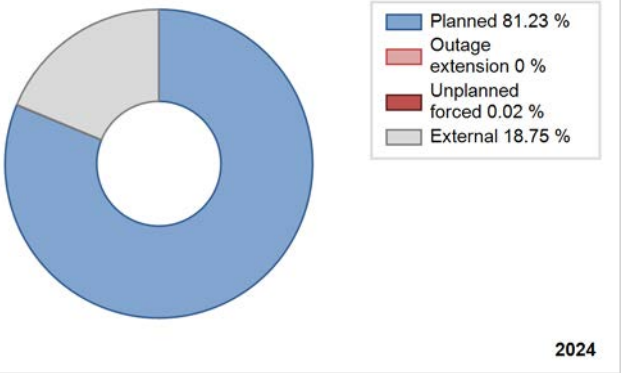


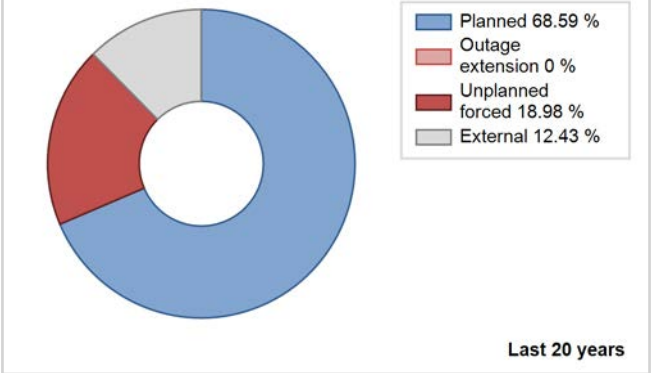
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2018	3330.63	3840	1157	99.85	99.98	99.39	100.00	0.00	0.00	0.02	0.13
2019	8987.29	7909	1157	91.14	92.26	88.67	90.29	0.00	0.00	7.74	1.12
2020	8757.82	7832	1157	87.29	88.13	86.17	89.16	6.47	6.09	5.78	0.84
2021	9379.74	8268	1157	92.91	93.90	92.55	94.38	0.00	0.00	6.10	0.99
2022	8805.20	7821	1157	88.42	89.31	86.88	89.28	2.63	2.41	8.29	0.88
2023	9887.28	8667	1157	97.62	98.63	97.55	98.94	0.86	0.85	0.52	1.01
2024	9448.90	8325	1157	93.30	94.55	92.97	94.77	0.00	0.00	5.45	1.26

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2018 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					119	
C. Inspection, maintenance or repair combined with refuelling	460			413		
D. Inspection, maintenance or repair without refuelling				51		
E. Testing of plant systems or components				50		
I. Grid capacity limitation						18
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						28
Z. Other				23		
Subtotal	460			537	119	46
Total	**460**			**702**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2018 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		6
15. Reactor Cooling Systems		107
41. Main Generator Systems		17
Total		**130**

Highlights (2024)

1. The overall operation of Unit 1 in 2024 is good, with a cumulative peak shaving of 14 times.
2. At 23:15 on June 1, 2024, the major overhaul of Unit 104 of Unit 1 was completed, lasting 19.16 days.

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2024 Operating Experience

CN-29 SANMEN-2 CHINA



Status at end of year	:	**Operational**
Operator	:	SMNPC (SANMEN NUCLEAR POWER CO., LTD.)
Owner	:	SMNPC (SANMEN NUCLEAR POWER CO., LTD.)
Reactor Supplier	:	WH/MHI (WESTINGHOUSE ELECTRIC CORPORATION / MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / AP-1000
Thermal power	:	3400 MWth
Gross electrical power	:	1251 MWe
Reference unit power (net)	:	1157 MWe

Key Dates

Construction Date	:	2009-12-15
Grid Date	:	2018-08-24
Commercial Date	:	2018-11-05
Age at end of year	:	6 years

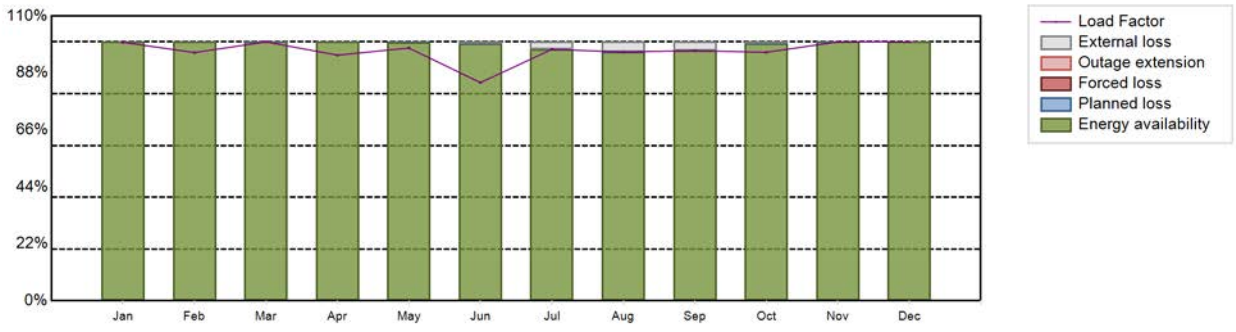
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.4
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.407
Average fuel enrichment [% of U235]	:	2.7239	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	40.8	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	50558	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.38
Active core height/length [m]	:	4.267	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.77	Number of main condensate pumps	:	3
Number of control rod assemblies	:	69	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9813.81 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	99.04 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	99.99 %	Planned Unavailability Factor (PUF)	:	0.01 %
Load Factor (LF)	:	96.56 %	Externally cause unavailability (XUF)	:	0.95 %
Operating Factor (OF)	:	98.67 %	Total off-line time	:	117 hours

Annual Summary



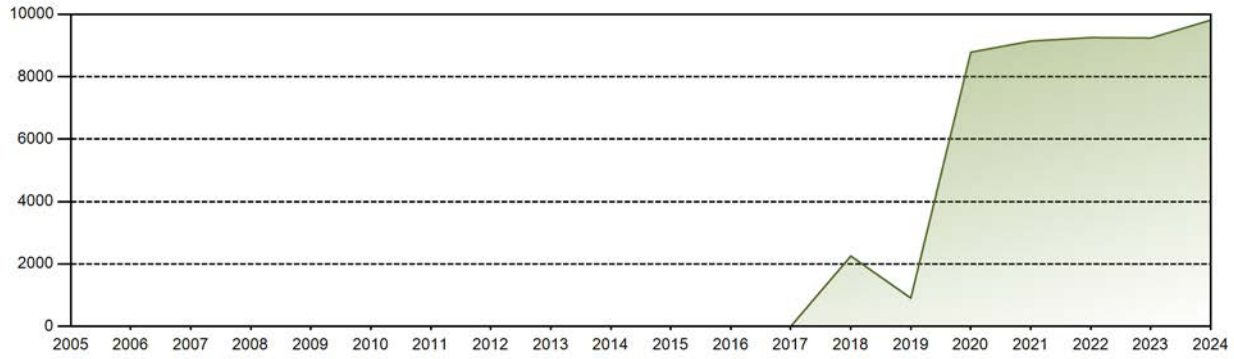
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	859.45	772.13	860.80	790.46	840.53	702.21	835.96	827.20	804.96	826.28	833.03	860.81	9813.81
EAF [%]	100.00	100.00	100.00	100.00	99.94	99.33	97.11	96.10	96.63	99.48	100.00	100.00	99.04
UCF [%]	100.00	100.00	100.00	100.00	99.94	99.98	100.00	100.00	100.00	100.00	100.00	100.00	99.99
LF [%]	99.84	95.88	100.00	94.89	97.64	84.29	97.11	96.10	96.63	95.99	100.00	100.00	96.56
OF [%]	100.00	100.00	100.00	96.67	100.00	88.33	100.00	100.00	100.00	98.79	100.00	100.00	98.67
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.65	2.89	3.90	3.37	0.52	0.00	0.00	0.95

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Historical Summary

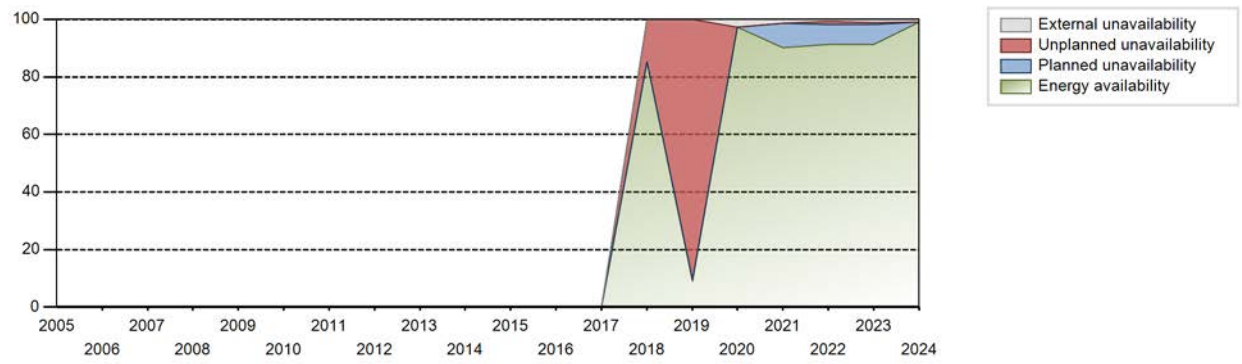
Lifetime energy generation	:	49393.72 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	15.81 %
Cumulative Energy Availability Factor (EAF)	:	79.82 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	15.37 %
Cumulative Unit Capability Factor (UCF)	:	80.92 %	Cumulative Planned Unavailability Factor (PUF)	:	3.71 %
Cumulative Load Factor (LF)	:	77.68 %	Cumulative Externally cause unavailability (XUF)	:	1.1 %
Cumulative Operating Factor (OF)	:	79.31 %			

Electricity Production (net) [GWh]

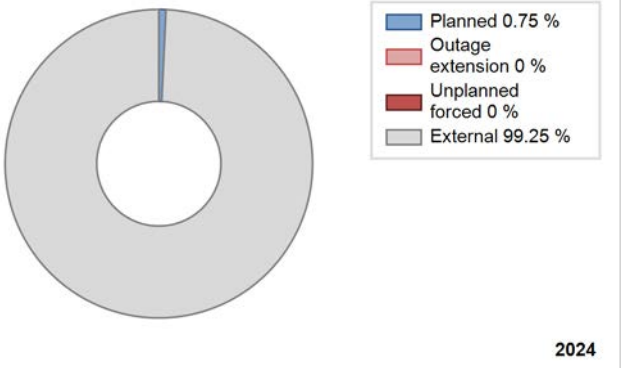


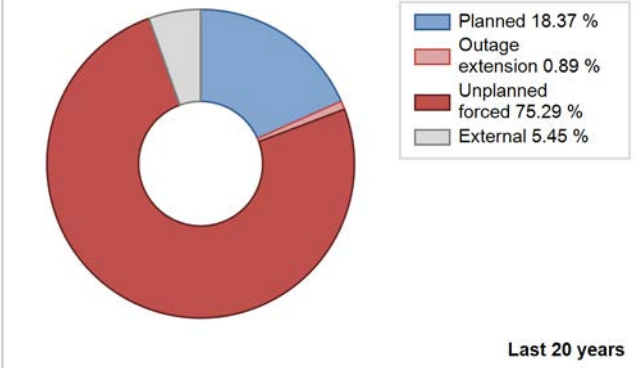
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2018	2252.77	2381	1157	85.14	85.14	85.84	85.18	14.85	14.84	0.02	0.00
2019	905.96	817	1157	8.94	8.94	8.94	9.33	91.02	90.64	0.42	0.00
2020	8786.18	7871	1157	97.25	99.99	86.45	89.61	0.00	0.00	0.01	2.74
2021	9140.14	8085	1157	90.21	91.48	90.18	92.29	0.00	0.00	8.52	1.27
2022	9254.09	8087	1157	91.31	92.09	91.31	92.32	0.00	1.11	6.80	0.78
2023	9240.77	8110	1157	91.17	92.21	91.17	92.58	0.71	0.66	7.12	1.04
2024	9813.81	8667	1157	99.04	99.99	96.56	98.67	0.00	0.00	0.01	0.95

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2018 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					1330	
C. Inspection, maintenance or repair combined with refuelling				301		
D. Inspection, maintenance or repair without refuelling				51		
E. Testing of plant systems or components				31		
I. Grid capacity limitation			116			19
O. Load dispatching, prioritization						148
Z. Other					16	
Subtotal			116	383	1346	167
Total		**116**			**1896**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2018 to 2024
	Hours Lost	Average hours lost per reactor-year
15. Reactor Cooling Systems		1279
34. Miscellaneous Systems	33	5
41. Main Generator Systems		15
Total	**33**	**1299**

Highlights (2024)

The overall operation of Unit 2 in 2024 is good, with a cumulative peak shaving of 15 times and mediation of 3 times

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2024 Operating Experience

CN-44 SHIDAO BAY-1 CHINA

Status at end of year	:	**Operational**
Operator	:	HSNPC (Huaneng Shandong Shidao Bay Nuclear Power Company, Ltd.)
Owner	:	CHNG (China Huaneng Group)
Reactor Supplier	:	TSINGHUA (Tsinghua university)
Turbine Supplier	:	STC (Shanghai Turbine Co.)

Reactor Unit Details

Reactor type and model	:	HTGR / HTR-PM
Thermal power	:	500 MWth
Gross electrical power	:	211 MWe
Reference unit power (net)	:	150 MWe

Key Dates

Construction Date	:	2012-12-09
Grid Date	:	2021-12-14
Commercial Date	:	2023-12-06
Age at end of year	:	3 years

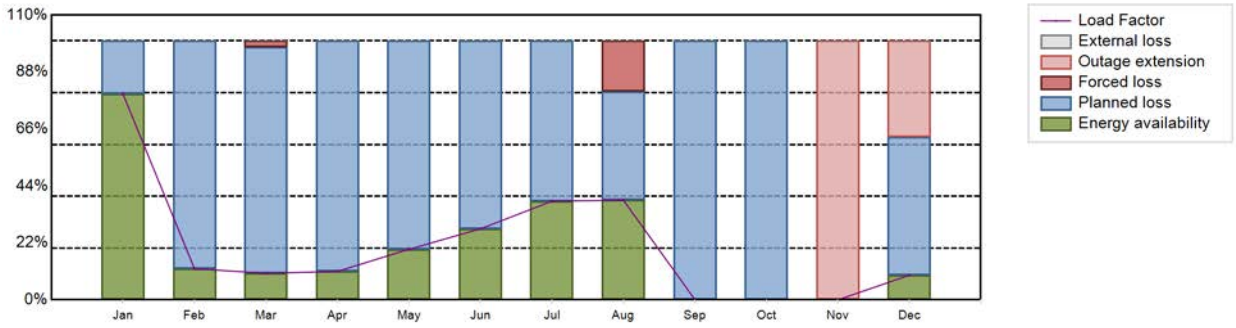
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	750
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	ON-line	Containment type	:	Single
Moderator material	:	GRAPHITE	Containment design pressure [MPa]	:	0.13
Average fuel enrichment [% of U235]	:	8.5	**Secondary systems**		
Refuelling frequency [month]	:	NA	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	NA	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	90000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3	HP cylinder inlet steam pressure [MPa]	:	13.24
Active core height/length [m]	:	11	Output voltage [kV]	:	18
Number of fissile fuel assemblies/bundles	:	420000	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	NA	Number of main condensate pumps	:	3
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	1	Number of on-site safety related diesel generators	:	-
Coolant type	:	Other	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	272.2 GW(e).h	Forced Loss Rate (FLR)	:	8.25 %
Energy Availability Factor (EAF)	:	20.66 %	Unplanned Capability Loss Factor (UCL)	:	13.21 %
Unit Capability Factor (UCF)	:	20.66 %	Planned Unavailability Factor (PUF)	:	66.13 %
Load Factor (LF)	:	20.66 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	72.05 %	Total off-line time	:	2455 hours

Annual Summary



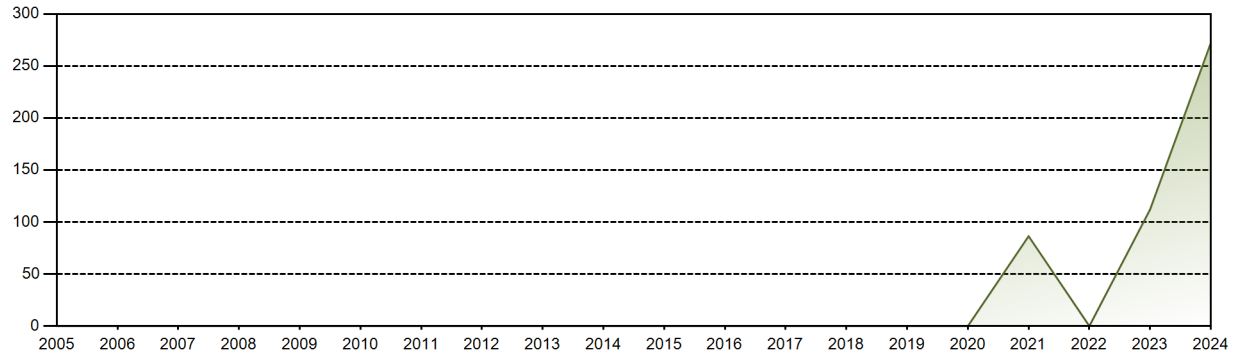
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	88.75	12.57	11.42	11.88	21.78	29.62	42.49	42.96	0.10	0.00	0.00	10.62	272.20
EAF [%]	79.50	12.04	10.24	11.00	19.52	27.43	38.07	38.49	0.10	0.00	0.00	9.52	20.66
UCF [%]	79.50	12.04	10.24	11.00	19.52	27.43	38.07	38.49	0.10	0.00	0.00	9.52	20.66
LF [%]	79.53	12.04	10.24	11.00	19.52	27.43	38.07	38.49	0.10	0.00	0.00	9.52	20.66
OF [%]	100.00	100.00	97.58	100.00	100.00	100.00	100.00	100.00	1.25	0.00	0.00	64.78	72.05
FLR [%]	0.00	0.00	19.55	0.00	0.00	0.00	0.00	33.58	0.00	0.00	0.00	0.00	8.25
UCL [%]	0.00	0.00	2.49	0.00	0.00	0.00	0.00	19.46	0.00	0.00	100.00	37.23	13.21
PUF [%]	20.50	87.96	87.28	89.00	80.48	72.57	61.93	42.05	99.90	100.00	0.00	53.25	66.13
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

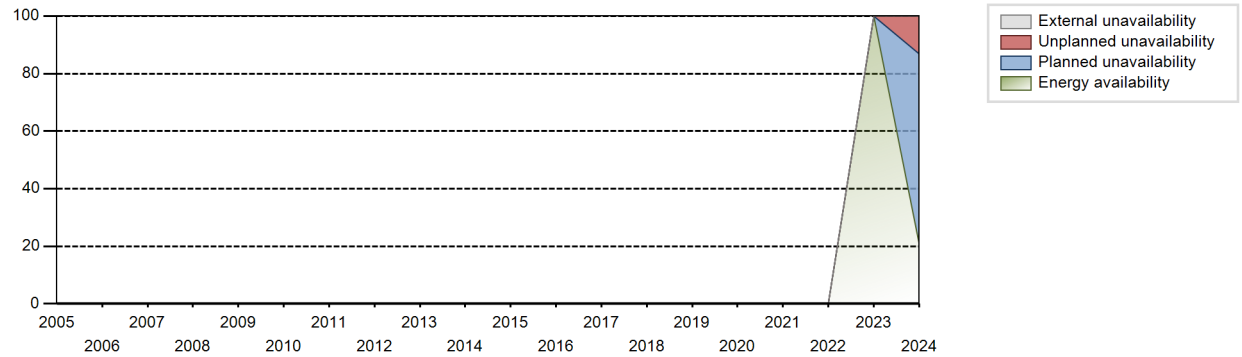
Lifetime energy generation	:	384.29 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6 %
Cumulative Energy Availability Factor (EAF)	:	26.85 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.18 %
Cumulative Unit Capability Factor (UCF)	:	26.85 %	Cumulative Planned Unavailability Factor (PUF)	:	60.97 %
Cumulative Load Factor (LF)	:	26.89 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	74.23 %			

Electricity Production (net) [GWh]

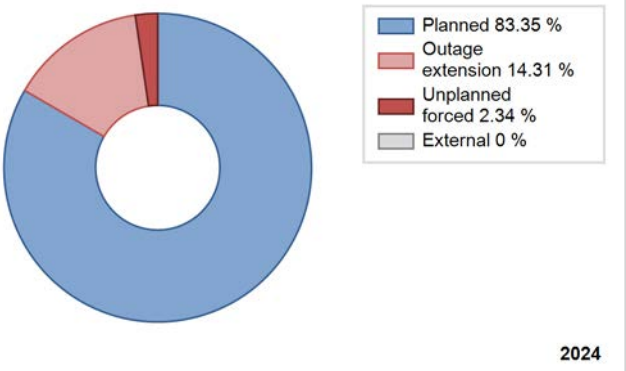


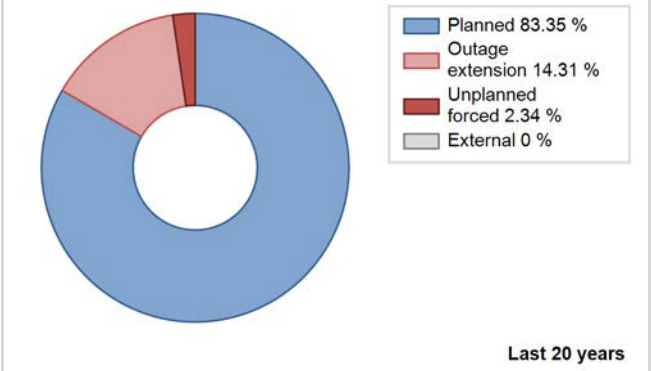
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2023	112.09	744	150	100.00	100.00	100.44	100.00	0.00	0.00	0.00	0.00
2024	272.20	6329	150	20.66	20.66	20.66	72.05	8.25	13.21	66.13	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2023 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
D. Inspection, maintenance or repair without refuelling	2452			2452		
Subtotal	2452			2452		
Total	**2452**			**2452**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2023 to 2024
	Hours Lost	Average hours lost per reactor-year
Total		

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2024 Operating Experience

CN-32 TAISHAN-1 CHINA

Status at end of year	:	**Operational**
Operator	:	TNPJVC (Taishan Nuclear Power Joint Venture Company Limited)
Owner	:	TNPJVC (Taishan Nuclear Power Joint Venture Company Limited)
Reactor Supplier	:	ORANO (ORANO)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / EPR-1750
Thermal power	:	4590 MWth
Gross electrical power	:	1750 MWe
Reference unit power (net)	:	1660 MWe

Key Dates

Construction Date	:	2009-11-18
Grid Date	:	2018-06-29
Commercial Date	:	2018-12-13
Age at end of year	:	6 years

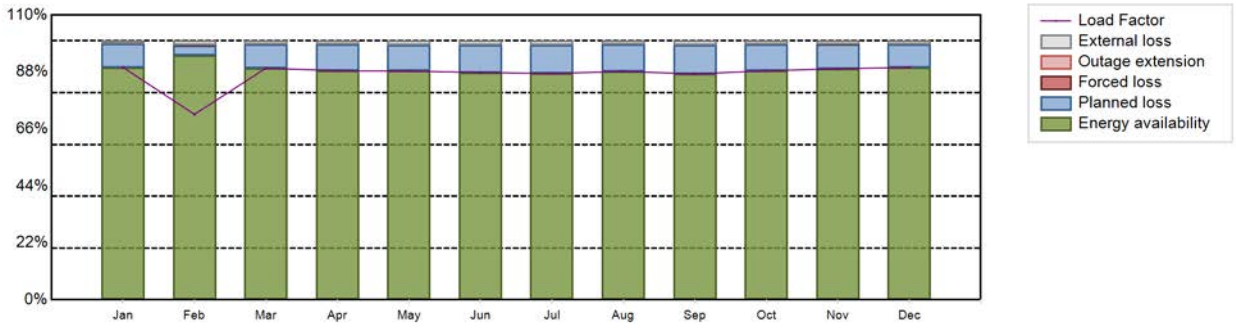
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	329.9
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.55
Average fuel enrichment [% of U235]	:	2.98	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	29.88	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	59000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.657	HP cylinder inlet steam pressure [MPa]	:	NA
Active core height/length [m]	:	4.2	Output voltage [kV]	:	27
Number of fissile fuel assemblies/bundles	:	241	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	89	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	6
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	12720.29 GW(e).h	Forced Loss Rate (FLR)	:	0.01 %
Energy Availability Factor (EAF)	:	89.04 %	Unplanned Capability Loss Factor (UCL)	:	0.01 %
Unit Capability Factor (UCF)	:	90.5 %	Planned Unavailability Factor (PUF)	:	9.5 %
Load Factor (LF)	:	87.24 %	Externally cause unavailability (XUF)	:	1.45 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



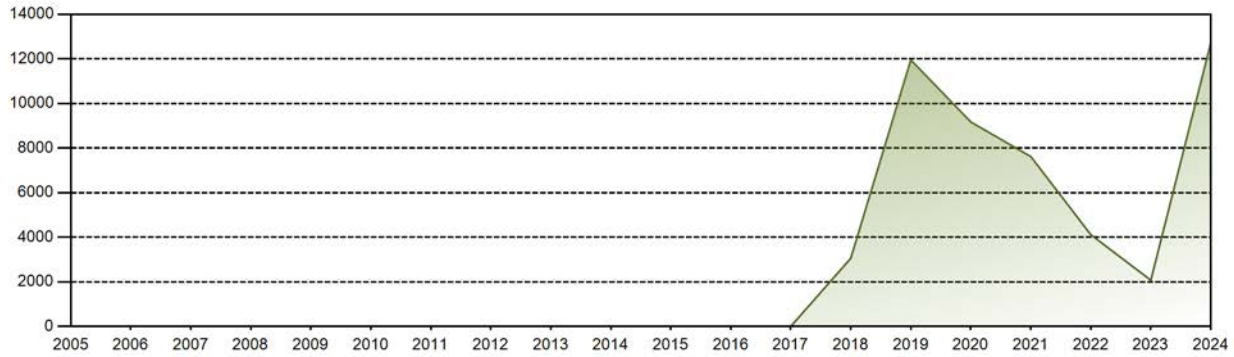
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1109.01	827.80	1105.14	1057.64	1091.03	1049.53	1079.58	1089.41	1043.09	1092.45	1066.71	1108.91	12720.29
EAF [%]	89.80	94.45	89.48	88.49	88.34	87.81	87.41	88.21	87.27	88.45	89.25	89.79	89.04
UCF [%]	90.98	96.20	90.79	89.96	89.86	89.37	88.98	89.69	88.83	89.90	90.60	91.05	90.50
LF [%]	89.80	71.65	89.48	88.49	88.34	87.81	87.41	88.21	87.27	88.45	89.25	89.79	87.24
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
UCL [%]	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
PUF [%]	9.02	3.69	9.21	10.04	10.14	10.63	11.02	10.31	11.17	10.10	9.40	8.95	9.50
XUF [%]	1.19	1.75	1.31	1.47	1.52	1.55	1.57	1.48	1.55	1.44	1.35	1.27	1.45

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Historical Summary

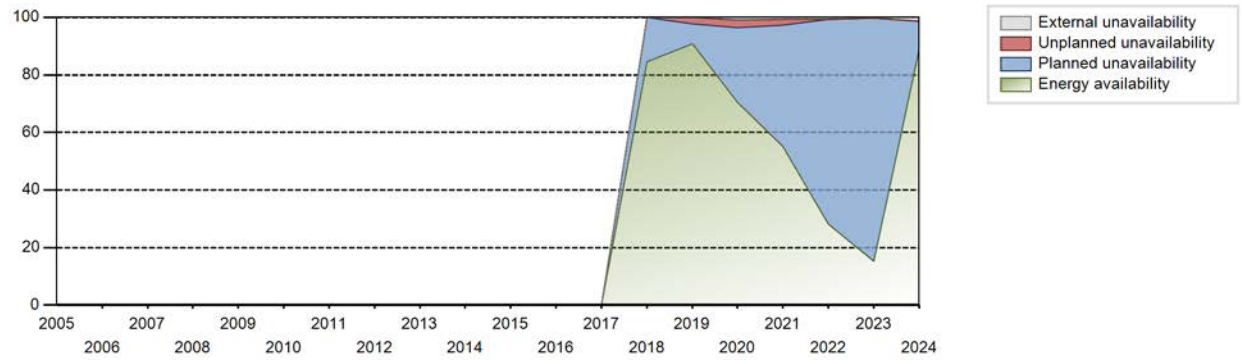
Lifetime energy generation	:	50644.95 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.88 %
Cumulative Energy Availability Factor (EAF)	:	58.53 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.13 %
Cumulative Unit Capability Factor (UCF)	:	59.22 %	Cumulative Planned Unavailability Factor (PUF)	:	39.65 %
Cumulative Load Factor (LF)	:	54.96 %	Cumulative Externally cause unavailability (XUF)	:	0.68 %
Cumulative Operating Factor (OF)	:	62.87 %			

Electricity Production (net) [GWh]

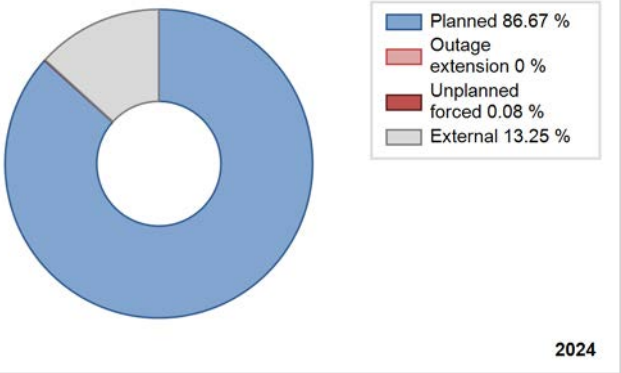


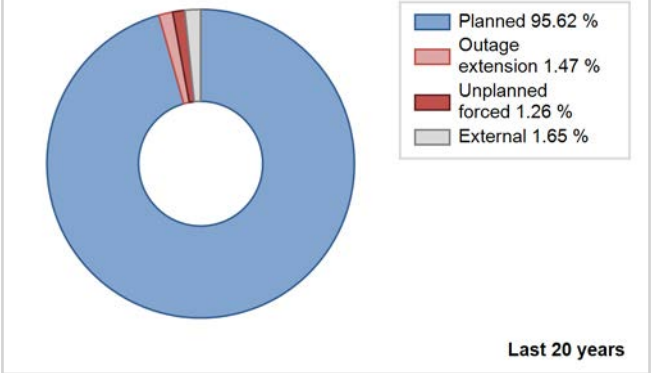
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2018	3056.09	3958	1660	84.52	84.52	83.51	100.00	0.00	0.00	15.48	0.00
2019	11952.73	7836	1660	90.77	90.77	82.20	89.45	0.73	2.26	6.97	0.00
2020	9169.83	6377	1660	70.53	71.56	62.89	72.60	0.53	2.49	25.95	1.03
2021	7616.68	4933	1660	55.07	55.79	52.38	56.31	3.56	2.06	42.15	0.72
2022	4113.09	3322	1660	28.28	28.97	28.28	37.92	0.23	0.07	70.96	0.69
2023	2068.28	1545	1660	15.18	15.45	14.22	17.64	0.00	0.00	84.54	0.27
2024	12720.29	8784	1660	89.04	90.50	87.24	100.00	0.01	0.01	9.50	1.45

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2018 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					37	
C. Inspection, maintenance or repair combined with refuelling				1502		
D. Inspection, maintenance or repair without refuelling				1614		
E. Testing of plant systems or components				5		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						56
L. Human factor related					95	
Z. Other					31	
Subtotal				3121	163	56
Total		**0**			**3340**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2018 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		1
15. Reactor Cooling Systems		12
16. Steam generation systems		12
31. Turbine and auxiliaries		13
32. Feedwater and Main Steam System		47
33. Circulating Water System		14
34. Miscellaneous Systems		76
Total		**175**

Highlights (2024)

There wasn't unplanned scram in CN32 in 2024.

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2024 Operating Experience

CN-33 TAISHAN-2 CHINA

Status at end of year	:	**Operational**
Operator	:	TNPJVC (Taishan Nuclear Power Joint Venture Company Limited)
Owner	:	TNPJVC (Taishan Nuclear Power Joint Venture Company Limited)
Reactor Supplier	:	ORANO (ORANO)
Turbine Supplier	:	ALSTOM (ALSTOM)



Reactor Unit Details

Reactor type and model	:	PWR / EPR-1750
Thermal power	:	4590 MWth
Gross electrical power	:	1750 MWe
Reference unit power (net)	:	1660 MWe

Key Dates

Construction Date	:	2010-04-15
Grid Date	:	2019-06-23
Commercial Date	:	2019-09-07
Age at end of year	:	5 years

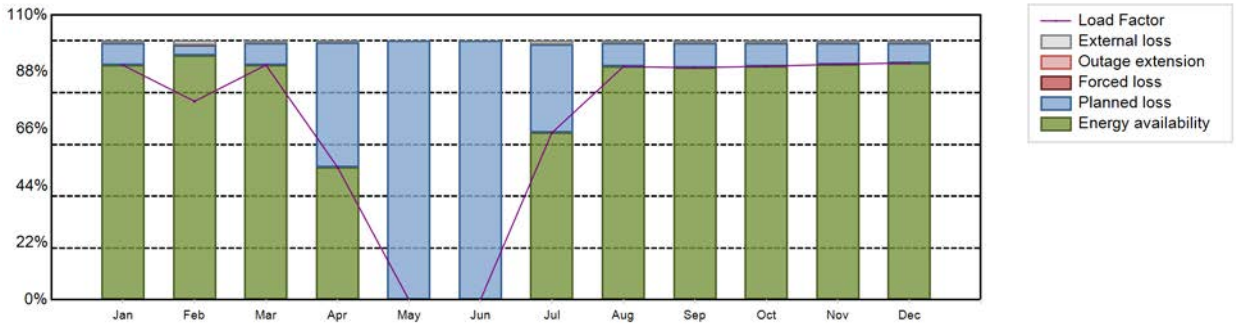
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	329.9
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.55
Average fuel enrichment [% of U235]	:	2.98	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	29.8755	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	59000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.657	HP cylinder inlet steam pressure [MPa]	:	NA
Active core height/length [m]	:	4.2	Output voltage [kV]	:	27
Number of fissile fuel assemblies/bundles	:	241	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	89	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	6
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10049.65 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	70.33 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	71.13 %	Planned Unavailability Factor (PUF)	:	28.87 %
Load Factor (LF)	:	68.92 %	Externally cause unavailability (XUF)	:	0.8 %
Operating Factor (OF)	:	78.56 %	Total off-line time	:	1883 hours

Annual Summary



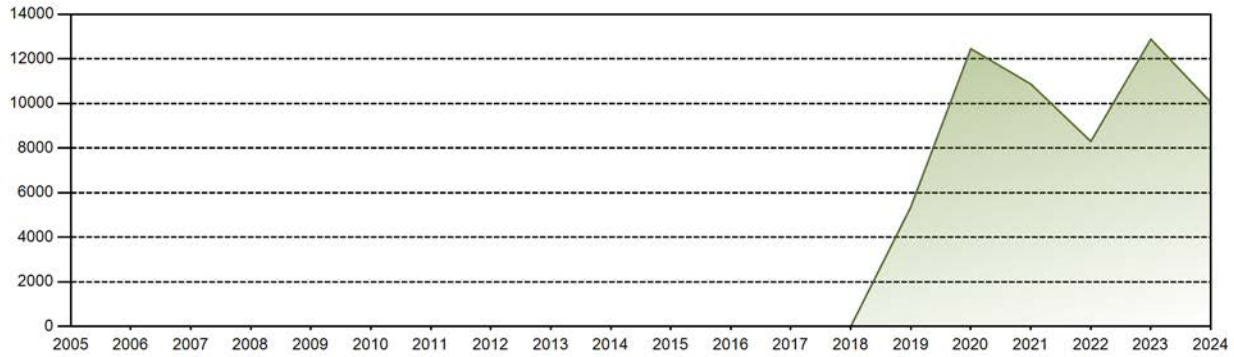
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1119.00	885.86	1119.65	612.95	0.00	0.00	797.16	1112.30	1071.42	1114.14	1087.24	1129.92	10049.65
EAF [%]	90.60	94.40	90.66	51.28	0.00	0.00	64.55	90.06	89.64	90.21	90.97	91.49	70.33
UCF [%]	91.55	96.12	91.50	51.83	0.00	0.00	65.86	90.98	90.57	91.11	91.74	92.27	71.13
LF [%]	90.60	76.67	90.66	51.28	0.00	0.00	64.55	90.06	89.64	90.21	90.97	91.49	68.92
OF [%]	100.00	100.00	100.00	57.50	0.00	0.00	84.81	100.00	100.00	100.00	100.00	100.00	78.56
FLR [%]	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	8.45	3.86	8.50	48.17	100.00	100.00	34.14	9.02	9.43	8.89	8.26	7.73	28.87
XUF [%]	0.94	1.72	0.85	0.54	0.00	0.00	1.31	0.91	0.93	0.90	0.77	0.78	0.80

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Historical Summary

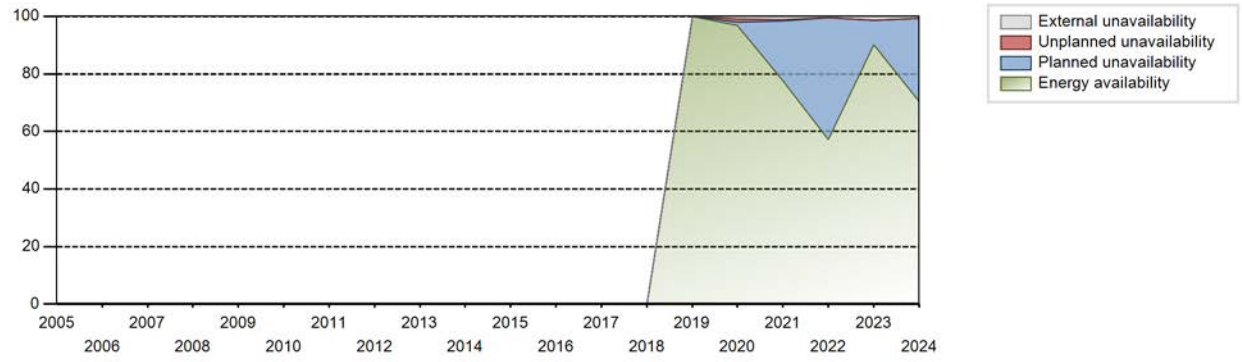
Lifetime energy generation	:	59913.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.31 %
Cumulative Energy Availability Factor (EAF)	:	79.76 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.25 %
Cumulative Unit Capability Factor (UCF)	:	80.7 %	Cumulative Planned Unavailability Factor (PUF)	:	19.05 %
Cumulative Load Factor (LF)	:	76.04 %	Cumulative Externally cause unavailability (XUF)	:	0.93 %
Cumulative Operating Factor (OF)	:	85.51 %			

Electricity Production (net) [GWh]

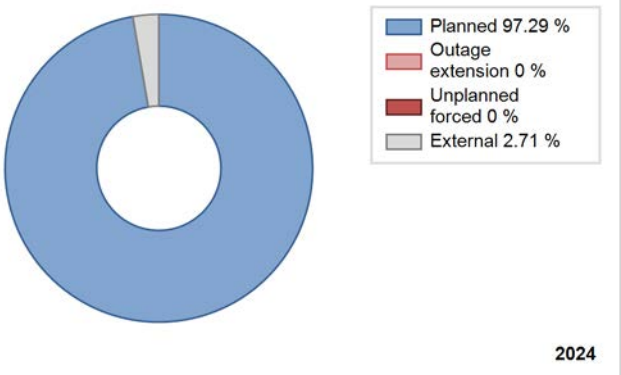


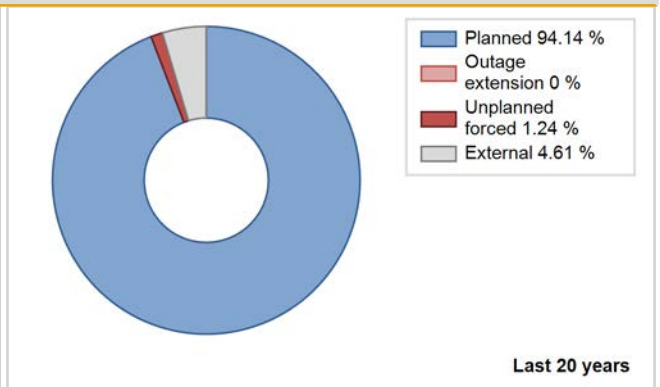
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2019	5356.14	3817	1660	100.00	100.00	92.33	100.00	0.00	0.00	0.00	0.00
2020	12454.80	8667	1660	96.77	97.71	85.42	98.67	1.03	1.02	1.27	0.95
2021	10870.50	7089	1660	77.70	78.97	74.75	80.92	0.40	0.32	20.72	1.27
2022	8297.85	5654	1660	57.06	57.65	57.06	64.54	0.00	0.00	42.35	0.58
2023	12884.09	8760	1660	90.17	91.55	88.60	100.00	0.00	0.00	8.45	1.38
2024	10049.65	6901	1660	70.33	71.13	68.92	78.56	0.00	0.00	28.87	0.80

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2019 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					17	
C. Inspection, maintenance or repair combined with refuelling	1770			1224		
D. Inspection, maintenance or repair without refuelling				12		
E. Testing of plant systems or components				132		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						10
Z. Other	113			21		
Subtotal	1883			1389	17	10
Total	**1883**			**1416**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2019 to 2024
	Hours Lost	Average hours lost per reactor-year
34. Miscellaneous Systems		22
41. Main Generator Systems		3
Total		**25**

Highlights (2024)

There wasn't unplanned scram in CN33 in 2024.

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2024 Operating Experience

CN-10 TIANWAN-1 CHINA

Status at end of year	:	**Operational**
Operator	:	JNPC (Jiangsu Nuclear Power Corporation)
Owner	:	JNPC (Jiangsu Nuclear Power Corporation)
Reactor Supplier	:	IZ (Izhorskiye Zavody)
Turbine Supplier	:	LMZ (JOINT-STOCK COMPANY "LENINGRADSKIY METALLICHESKIY ZAVOD")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-428
Thermal power	:	3000 MWth
Gross electrical power	:	1060 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	1999-10-20
Grid Date	:	2006-05-12
Commercial Date	:	2007-05-17
Age at end of year	:	18 years

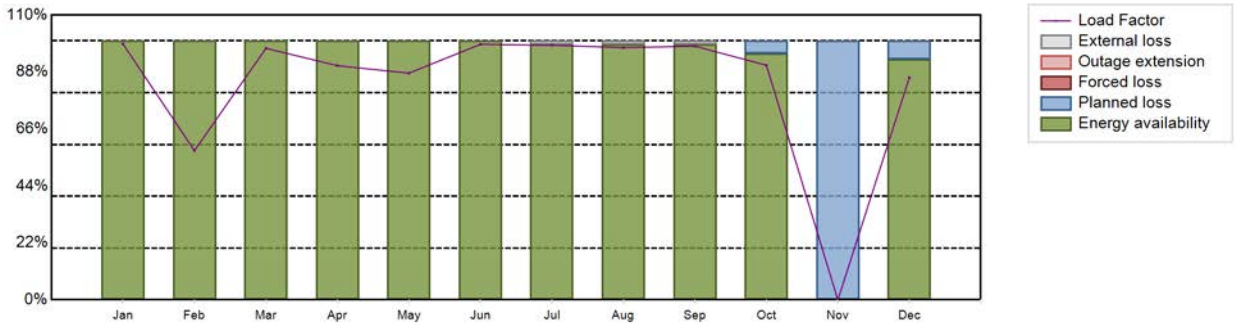
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	NA
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	NA
Average discharge burnup [MWd/t]	:	NA
Active core diameter [m]	:	3.16
Active core height/length [m]	:	NA
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	NA
Number of control rod assemblies	:	103
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	321
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	NA
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	4
HP cylinder inlet steam pressure [MPa]	:	5.78
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7346.29 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	90.45 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	90.79 %	Planned Unavailability Factor (PUF)	:	9.21 %
Load Factor (LF)	:	83.63 %	Externally cause unavailability (XUF)	:	0.34 %
Operating Factor (OF)	:	88.76 %	Total off-line time	:	987 hours

Annual Summary



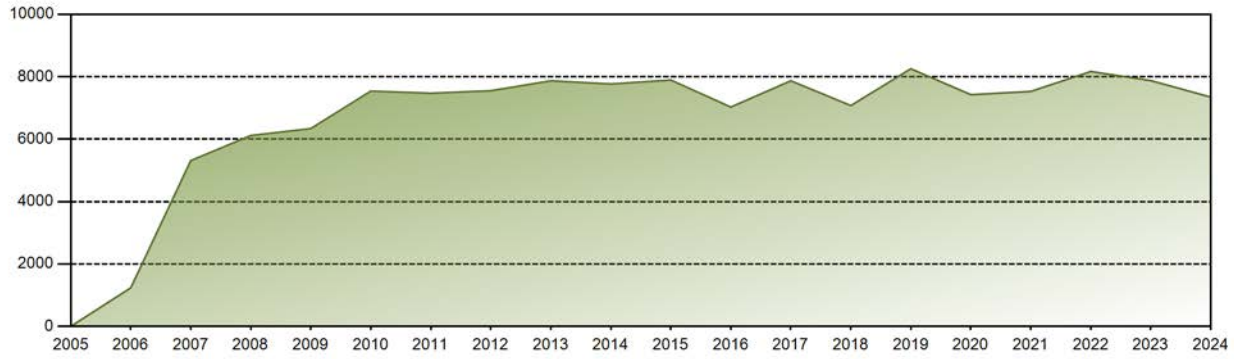
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	735.36	401.13	722.75	651.11	651.44	710.45	731.51	724.69	705.21	674.09	0.00	638.55	7346.29
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	98.66	98.66	98.61	95.13	0.00	92.96	90.45
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	95.13	0.00	92.96	90.79
LF [%]	98.84	57.63	97.14	90.43	87.56	98.67	98.32	97.40	97.95	90.60	0.00	85.83	83.63
OF [%]	100.00	74.28	100.00	100.00	100.00	100.00	100.00	100.00	100.00	95.16	0.00	93.01	88.76
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.87	100.00	7.04	9.21
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	1.34	1.34	1.39	0.00	0.00	0.00	0.34

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Historical Summary

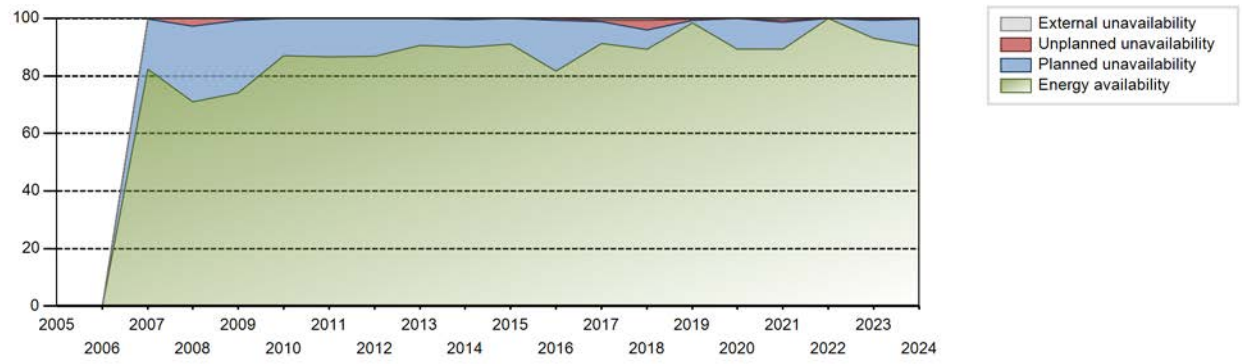
Lifetime energy generation	:	133682.12 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.64 %
Cumulative Energy Availability Factor (EAF)	:	88.16 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.59 %
Cumulative Unit Capability Factor (UCF)	:	88.32 %	Cumulative Planned Unavailability Factor (PUF)	:	11.1 %
Cumulative Load Factor (LF)	:	86.76 %	Cumulative Externally cause unavailability (XUF)	:	0.16 %
Cumulative Operating Factor (OF)	:	87.74 %			

Electricity Production (net) [GWh]



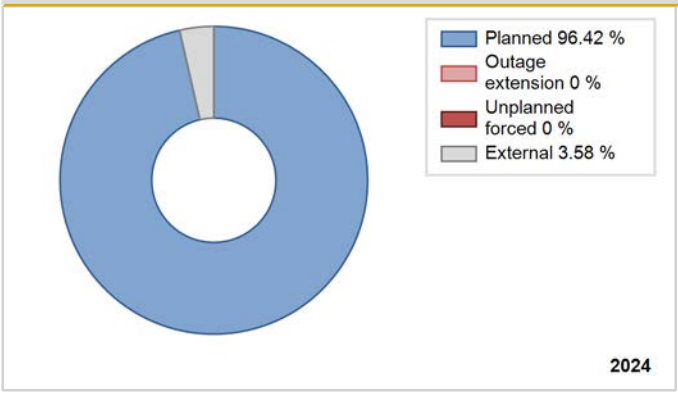
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2007	5311.00	5688	933	82.44	82.44	84.77	82.71	0.44	0.36	17.20	0.00
2008	6116.16	6270	933	70.97	70.97	74.63	71.38	3.60	2.65	26.38	0.00
2009	6337.71	6553	933	74.12	74.12	77.54	74.81	0.97	0.73	25.16	0.00
2010	7539.59	7643	933	87.02	87.02	92.25	87.25	0.00	0.00	12.98	0.00
2011	7470.08	7606	990	86.55	86.55	86.14	86.83	0.07	0.06	13.39	0.00
2012	7550.16	7635	990	86.78	86.78	86.82	86.92	0.00	0.00	13.22	0.00
2013	7869.05	7959	990	90.71	90.71	90.74	90.86	0.00	0.00	9.29	0.00
2014	7766.80	7888	990	89.83	89.83	89.56	90.05	0.09	0.44	9.73	0.00
2015	7894.21	7996	990	91.07	91.07	91.03	91.28	0.00	0.00	8.92	0.00
2016	7027.54	7295	990	81.71	81.71	80.81	83.05	0.90	0.74	17.54	0.00
2017	7869.01	8081	990	91.25	92.05	90.74	92.25	0.40	0.37	7.58	0.80
2018	7074.55	7450	990	89.28	89.91	81.58	85.05	3.66	3.42	6.67	0.64
2019	8254.54	8501	990	98.43	98.68	95.18	97.04	0.52	0.52	0.80	0.25
2020	7424.97	7854	990	89.31	89.31	85.38	89.41	0.00	0.00	10.69	0.00
2021	7528.83	7686	1000	89.35	89.96	85.95	87.74	0.87	0.78	9.26	0.61
2022	8167.00	8630	1000	100.00	100.00	93.23	98.52	0.00	0.00	0.00	0.00
2023	7875.04	8185	1000	92.97	93.15	89.90	93.44	0.50	0.47	6.38	0.18
2024	7346.29	7797	1000	90.45	90.79	83.63	88.76	0.00	0.00	9.21	0.34

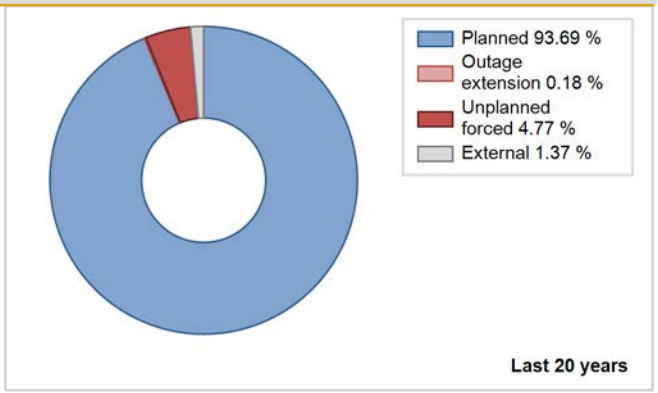
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2007 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					42	
C. Inspection, maintenance or repair combined with refuelling	809			887		
D. Inspection, maintenance or repair without refuelling				79		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						55
L. Human factor related					2	
O. Load dispatching, prioritization			179			10
Subtotal	809		179	966	44	65
Total	**988**			**1075**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2007 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		6
17. Safety I&C Systems (excluding reactor I&C)		2
32. Feedwater and Main Steam System		4
34. Miscellaneous Systems	179	30
41. Main Generator Systems		16
42. Electrical Power Supply Systems		14
Total	**179**	**72**

Highlights (2024)

This year, Unit 1 underwent a unit overhaul, and cooperated with the power grid to reduce power many times, and maintained power operation at other times. At 07:57 on October 30, the turbine generator of No. 1 engine was disconnected and OT115 refueling overhaul began. At 10:31 on December 4, Unit 1 was reconnected to the grid after completing the overhaul. At 16:17 on December 10, the unit was upgraded to full power operation.

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2024 Operating Experience

CN-11 TIANWAN-2 CHINA

Status at end of year	:	**Operational**
Operator	:	JNPC (Jiangsu Nuclear Power Corporation)
Owner	:	JNPC (Jiangsu Nuclear Power Corporation)
Reactor Supplier	:	IZ (Izhorskiye Zavody)
Turbine Supplier	:	LMZ (JOINT-STOCK COMPANY "LENINGRADSKIY METALLICHESKIY ZAVOD")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-428
Thermal power	:	3000 MWth
Gross electrical power	:	1060 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2000-09-20
Grid Date	:	2007-05-14
Commercial Date	:	2007-08-16
Age at end of year	:	17 years

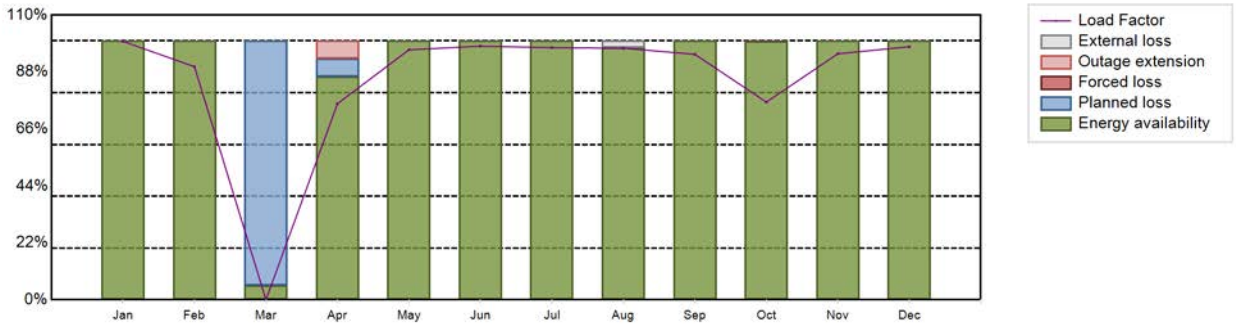
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	40.49
Average discharge burnup [MWd/t]	:	47500
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.68
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	-
Number of control rod assemblies	:	103
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	321
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.46
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	4
HP cylinder inlet steam pressure [MPa]	:	5.78
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7448.9 GW(e).h	Forced Loss Rate (FLR)	:	0.01 %
Energy Availability Factor (EAF)	:	90.65 %	Unplanned Capability Loss Factor (UCL)	:	0.57 %
Unit Capability Factor (UCF)	:	90.88 %	Planned Unavailability Factor (PUF)	:	8.56 %
Load Factor (LF)	:	84.8 %	Externally cause unavailability (XUF)	:	0.23 %
Operating Factor (OF)	:	91.04 %	Total off-line time	:	787 hours

Annual Summary



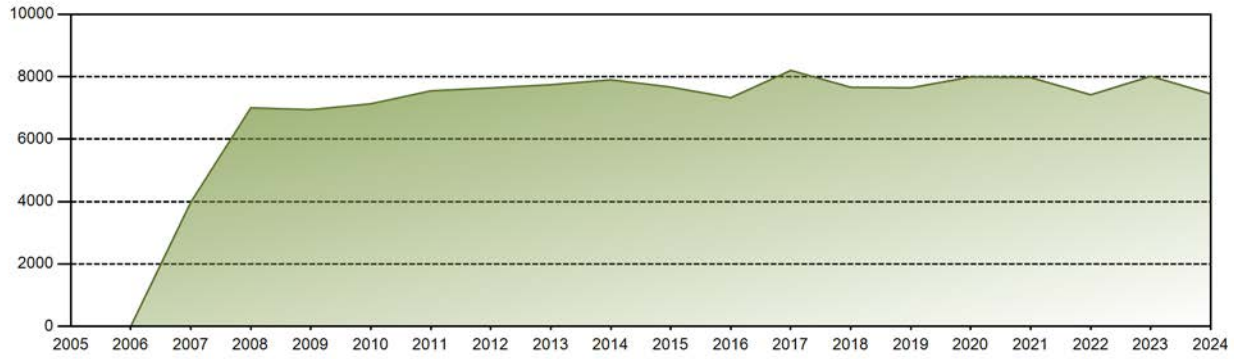
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	742.83	626.63	0.17	545.41	718.47	705.39	724.59	722.92	682.80	568.21	684.23	727.24	7448.90
EAF [%]	100.00	100.00	5.67	86.26	100.00	100.00	100.00	97.31	100.00	99.91	100.00	100.00	90.65
UCF [%]	100.00	100.00	5.67	86.26	100.00	100.00	100.00	100.00	100.00	99.91	100.00	100.00	90.88
LF [%]	99.84	90.03	0.02	75.75	96.57	97.97	97.39	97.17	94.83	76.37	95.03	97.75	84.80
OF [%]	100.00	100.00	5.65	88.19	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.04
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.01
UCL [%]	0.00	0.00	0.00	6.83	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.57
PUF [%]	0.00	0.00	94.33	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.56
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.69	0.00	0.00	0.00	0.00	0.23

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Historical Summary

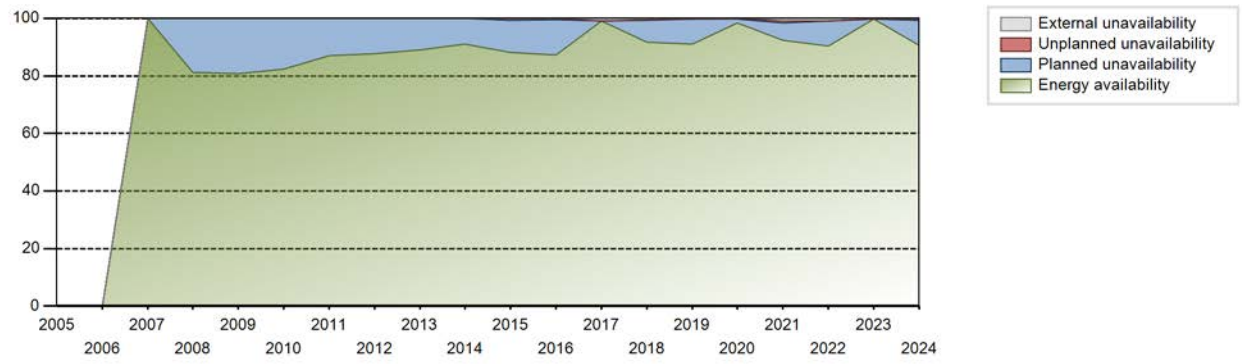
Lifetime energy generation	:	133227.62 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.16 %
Cumulative Energy Availability Factor (EAF)	:	90.16 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.18 %
Cumulative Unit Capability Factor (UCF)	:	90.39 %	Cumulative Planned Unavailability Factor (PUF)	:	9.43 %
Cumulative Load Factor (LF)	:	88.6 %	Cumulative Externally cause unavailability (XUF)	:	0.23 %
Cumulative Operating Factor (OF)	:	90.1 %			

Electricity Production (net) [GWh]



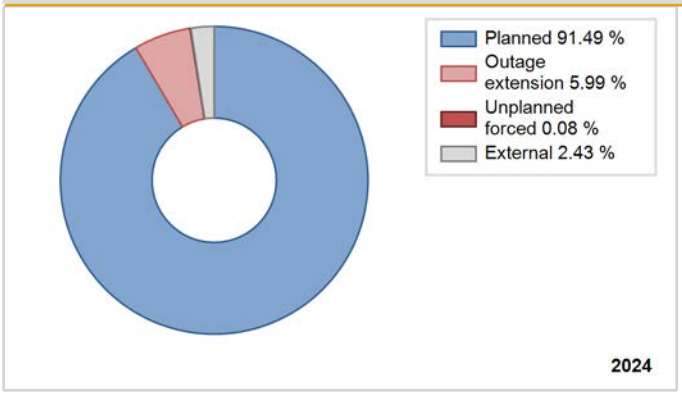
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2007	3974.00	4471	958	100.00	100.00	105.13	100.00	0.00	0.00	0.00	0.00
2008	7003.03	7193	933	81.20	81.20	85.45	81.89	0.03	0.03	18.77	0.00
2009	6943.40	7054	933	80.69	80.69	84.95	80.53	0.02	0.02	19.29	0.00
2010	7131.13	7260	933	82.28	82.28	87.25	82.88	0.09	0.08	17.65	0.00
2011	7546.20	7658	990	87.05	87.05	87.01	87.42	0.00	0.00	12.95	0.00
2012	7640.12	7722	990	87.77	87.77	87.86	87.91	0.00	0.00	12.23	0.00
2013	7741.45	7837	990	89.14	89.14	89.27	89.46	0.00	0.00	10.86	0.00
2014	7901.45	7950	990	91.10	91.10	91.11	90.75	0.00	0.00	8.90	0.00
2015	7666.57	7790	990	88.22	88.22	88.40	88.93	0.87	0.77	11.01	0.00
2016	7326.45	7705	990	87.36	87.36	84.25	87.72	0.50	0.44	12.20	0.00
2017	8201.96	8430	990	98.97	99.90	94.58	96.23	0.03	0.03	0.07	0.93
2018	7661.18	8007	990	91.64	92.22	88.34	91.40	0.07	0.07	7.72	0.58
2019	7644.10	7833	990	91.13	91.30	88.14	89.42	0.09	0.09	8.62	0.17
2020	7991.08	8683	990	98.32	98.32	91.89	98.85	0.25	0.25	1.43	0.00
2021	7972.07	8253	1000	92.34	93.24	91.01	94.21	0.77	0.72	6.03	0.90
2022	7420.49	7861	1000	90.46	91.32	84.71	89.74	0.00	0.00	8.68	0.86
2023	8015.09	8760	1000	99.70	100.00	91.50	100.00	0.00	0.00	0.00	0.30
2024	7448.90	7997	1000	90.65	90.88	84.80	91.04	0.01	0.57	8.56	0.23

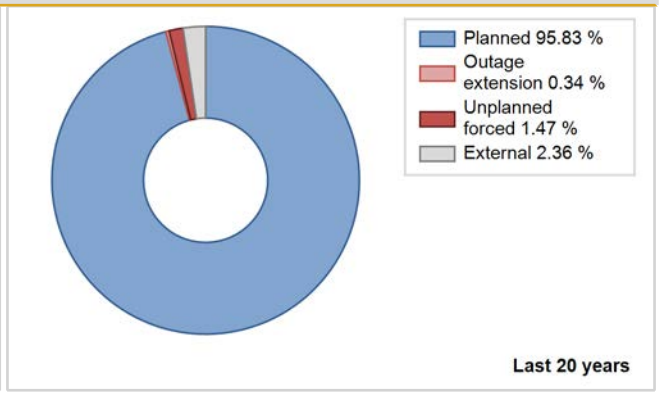
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2007 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		49			6	
C. Inspection, maintenance or repair combined with refuelling	752			732		
D. Inspection, maintenance or repair without refuelling				99		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						47
L. Human factor related					2	
Subtotal	752	49		831	8	47
Total		**801**			**886**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2007 to 2024
	Hours Lost	Average hours lost per reactor-year
31. Turbine and auxiliaries	49	5
32. Feedwater and Main Steam System		1
34. Miscellaneous Systems		9
35. All other I&C Systems		2
Total	**49**	**17**

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2024 Operating Experience

CN-45 TIANWAN-3 CHINA

Status at end of year	:	**Operational**
Operator	:	JNPC (Jiangsu Nuclear Power Corporation)
Owner	:	JNPC (Jiangsu Nuclear Power Corporation)
Reactor Supplier	:	IZ (Izhorskiye Zavody)
Turbine Supplier	:	HTC (HARBIN TURBINE COMPANY LIMITED)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-428M
Thermal power	:	3000 MWth
Gross electrical power	:	1126 MWe
Reference unit power (net)	:	1060 MWe

Key Dates

Construction Date	:	2012-12-27
Grid Date	:	2017-12-30
Commercial Date	:	2018-02-14
Age at end of year	:	7 years

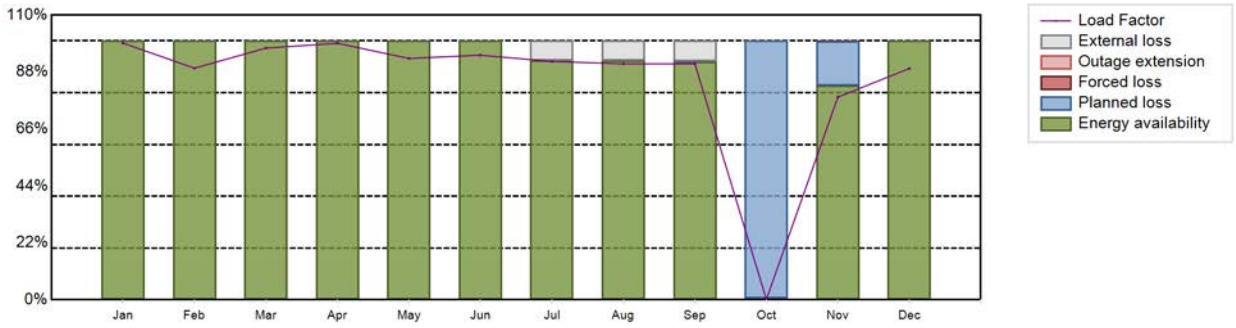
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	NA
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	NA
Average discharge burnup [MWd/t]	:	NA
Active core diameter [m]	:	3.16
Active core height/length [m]	:	NA
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	NA
Number of control rod assemblies	:	103
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	321
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	0.49
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.88
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	NA
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7865.12 GW(e).h	Forced Loss Rate (FLR)	:	0.02 %
Energy Availability Factor (EAF)	:	88.23 %	Unplanned Capability Loss Factor (UCL)	:	0.02 %
Unit Capability Factor (UCF)	:	90.16 %	Planned Unavailability Factor (PUF)	:	9.82 %
Load Factor (LF)	:	84.47 %	Externally cause unavailability (XUF)	:	1.93 %
Operating Factor (OF)	:	90.33 %	Total off-line time	:	849 hours

Annual Summary



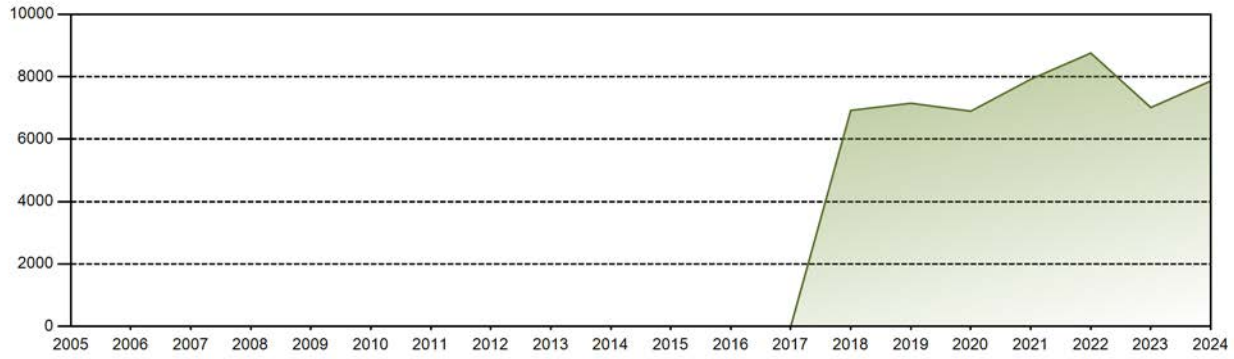
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	782.03	660.05	766.73	756.05	735.28	721.15	726.06	719.00	695.45	1.20	597.53	704.60	7865.12
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	92.39	92.39	91.96	0.64	82.84	100.00	88.23
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.82	0.64	82.84	100.00	90.16
LF [%]	99.16	89.47	97.22	99.06	93.23	94.49	92.06	91.17	91.12	0.15	78.29	89.34	84.47
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	1.21	84.17	100.00	90.33
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.02
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.02
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	99.36	16.90	0.00	9.82
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	7.61	7.61	7.86	0.00	0.00	0.00	1.93

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Historical Summary

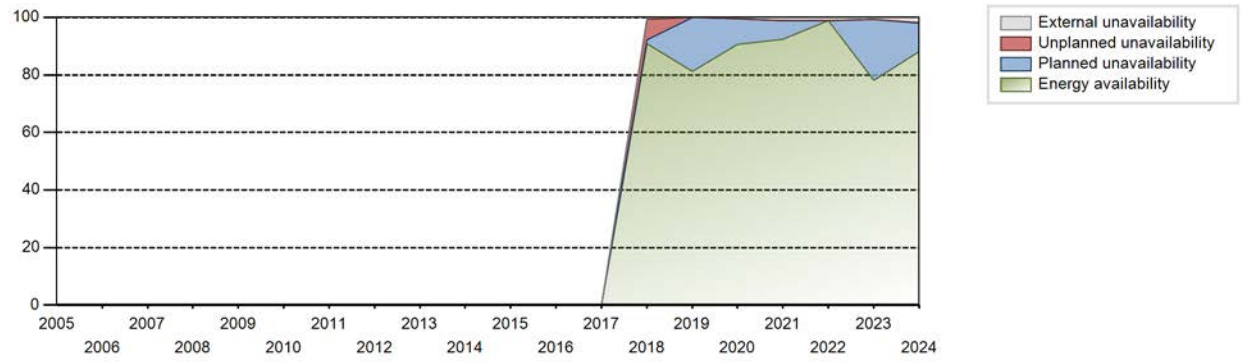
Lifetime energy generation	:	52525.13 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.04 %
Cumulative Energy Availability Factor (EAF)	:	88.59 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.94 %
Cumulative Unit Capability Factor (UCF)	:	89.46 %	Cumulative Planned Unavailability Factor (PUF)	:	9.6 %
Cumulative Load Factor (LF)	:	81.72 %	Cumulative Externally cause unavailability (XUF)	:	0.87 %
Cumulative Operating Factor (OF)	:	87.39 %			

Electricity Production (net) [GWh]

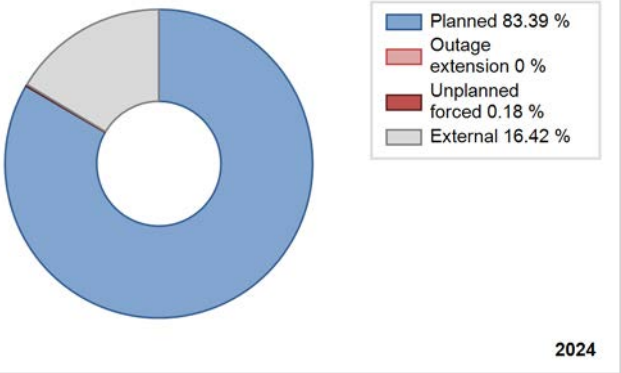


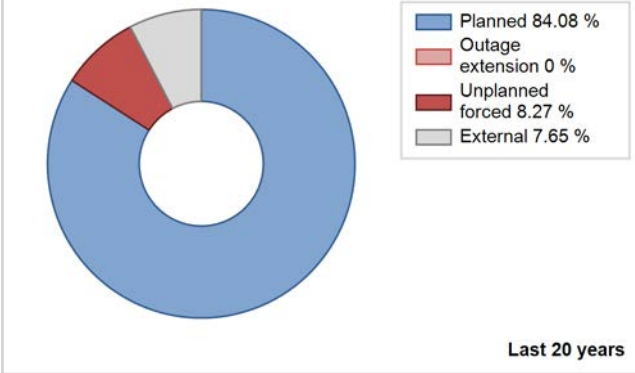
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2018	6922.47	7704	1045	90.85	91.48	78.83	86.83	7.27	7.18	1.34	0.63
2019	7149.36	7055	1045	81.24	81.29	78.10	80.54	0.00	0.00	18.71	0.05
2020	6896.21	7611	1045	90.70	91.29	75.13	86.65	0.00	0.00	8.71	0.58
2021	7919.12	7790	1060	92.29	93.41	85.28	88.93	0.00	0.00	6.59	1.11
2022	8757.42	8709	1060	98.89	100.00	94.31	99.42	0.00	0.00	0.00	1.11
2023	7013.26	6922	1060	78.06	78.70	75.53	79.02	0.00	0.00	21.30	0.64
2024	7865.12	7935	1060	88.23	90.16	84.47	90.33	0.02	0.02	9.82	1.93

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2018 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					72	
C. Inspection, maintenance or repair combined with refuelling	861			627		
D. Inspection, maintenance or repair without refuelling				182		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						227
Subtotal	861			809	72	227
Total	**861**			**1108**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2018 to 2024
	Hours Lost	Average hours lost per reactor-year
13. Reactor Auxiliary Systems		52
16. Steam generation systems		19
34. Miscellaneous Systems		136
Total		**207**

Highlights (2024)

This year, Unit 3 underwent a major overhaul and frequently coordinated with the power grid to reduce output, with one instance of reduced output operation, while maintaining power operation at other times. On September 30 at 18:54, the steam turbine generator of Unit 3 was disconnected, and the OT305 material replacement major overhaul commenced. On November 5 at 04:29, Unit 3 was reconnected to the grid after completing the overhaul. On November 6 at 21:00, the unit reached full power operation. On November 11, 2024, a high pressure differential in the 30PBB32AT101 filter caused the local control panel to trigger a backwash rotor fault, resulting in a reduction of power output for the unit.

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2024 Operating Experience

CN-46 TIANWAN-4 CHINA

Status at end of year	:	**Operational**
Operator	:	JNPC (Jiangsu Nuclear Power Corporation)
Owner	:	JNPC (Jiangsu Nuclear Power Corporation)
Reactor Supplier	:	IZ (Izhorskiye Zavody)
Turbine Supplier	:	HTC (HARBIN TURBINE COMPANY LIMITED)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-428M
Thermal power	:	3000 MWth
Gross electrical power	:	1126 MWe
Reference unit power (net)	:	1060 MWe

Key Dates

Construction Date	:	2013-09-27
Grid Date	:	2018-10-27
Commercial Date	:	2018-12-22
Age at end of year	:	6 years

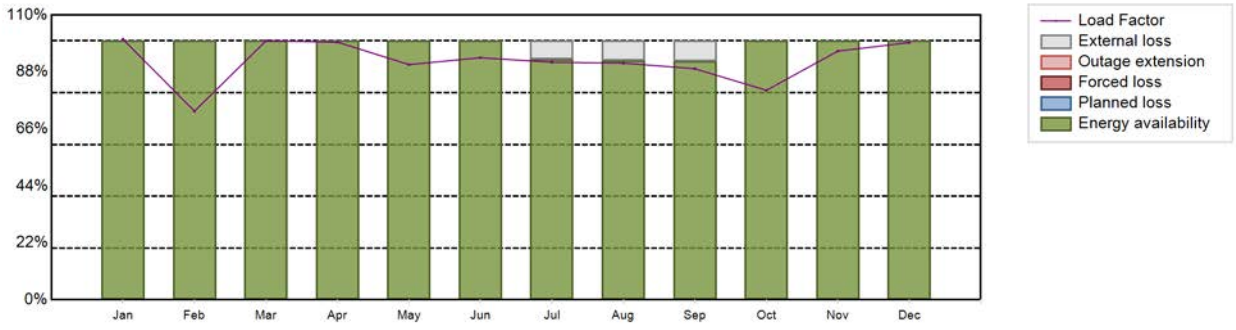
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	NA
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	NA
Average discharge burnup [MWd/t]	:	NA
Active core diameter [m]	:	3.16
Active core height/length [m]	:	NA
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	NA
Number of control rod assemblies	:	103
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	321
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	0.49
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.88
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	NA
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8590.22 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	98.11 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	92.26 %	Externally cause unavailability (XUF)	:	1.89 %
Operating Factor (OF)	:	98.51 %	Total off-line time	:	131 hours

Annual Summary



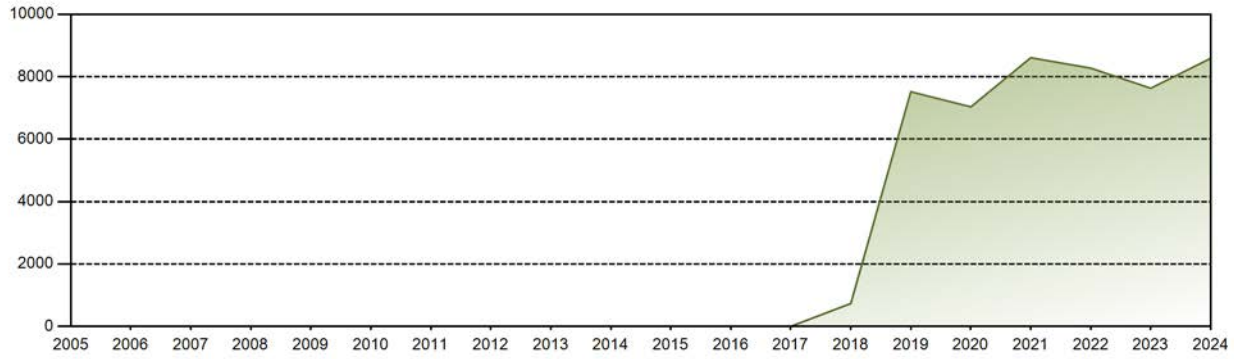
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	793.62	537.59	788.78	759.52	716.59	713.58	723.66	720.89	681.22	638.17	733.23	783.39	8590.22
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	92.90	92.39	92.14	100.00	100.00	100.00	98.11
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	100.63	72.87	100.02	99.52	90.86	93.50	91.76	91.41	89.26	80.92	96.07	99.33	92.26
OF [%]	100.00	81.18	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.51
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	7.10	7.61	7.86	0.00	0.00	0.00	1.89

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Historical Summary

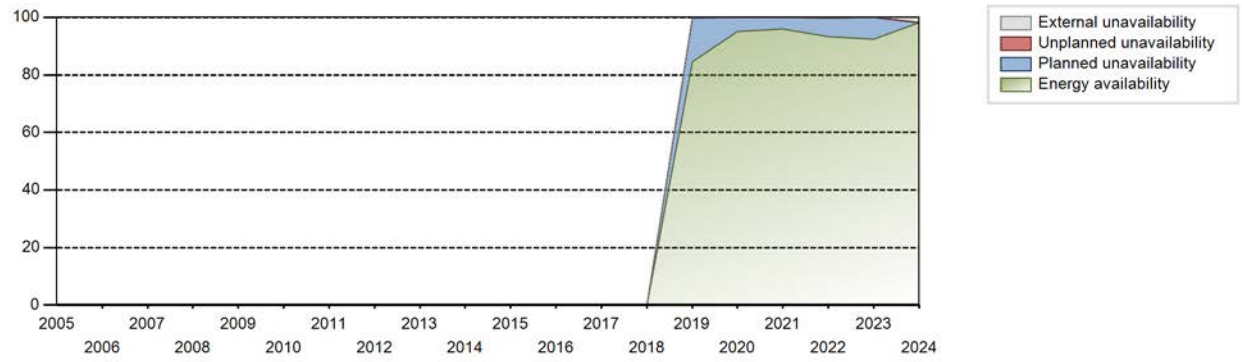
Lifetime energy generation	:	48390.04 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.04 %
Cumulative Energy Availability Factor (EAF)	:	93.24 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.04 %
Cumulative Unit Capability Factor (UCF)	:	93.6 %	Cumulative Planned Unavailability Factor (PUF)	:	6.37 %
Cumulative Load Factor (LF)	:	85.87 %	Cumulative Externally cause unavailability (XUF)	:	0.36 %
Cumulative Operating Factor (OF)	:	90.7 %			

Electricity Production (net) [GWh]

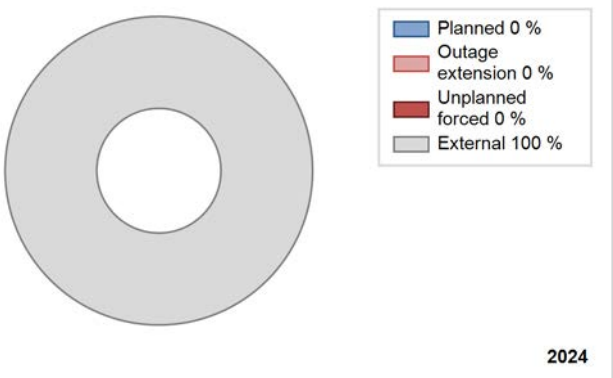


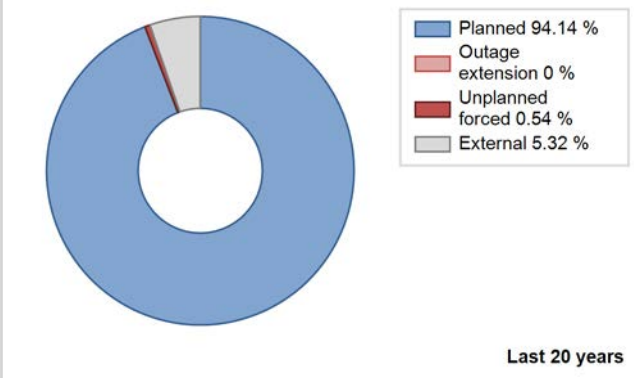
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2018	732.62	1035	1045	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	7519.47	7462	1045	84.63	84.71	82.14	85.18	0.19	0.16	15.13	0.09
2020	7033.68	7003	1045	95.17	95.17	76.63	79.72	0.03	0.02	4.80	0.00
2021	8610.04	8422	1060	95.87	95.87	92.72	96.14	0.00	0.00	4.13	0.00
2022	8273.71	8244	1060	93.18	93.35	89.10	94.11	0.00	0.00	6.65	0.17
2023	7630.39	7932	1060	92.35	92.35	82.17	90.55	0.04	0.04	7.61	0.00
2024	8590.22	8653	1060	98.11	100.00	92.26	98.51	0.00	0.00	0.00	1.89

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2018 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					1	
C. Inspection, maintenance or repair combined with refuelling				531		
E. Testing of plant systems or components				88		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						263
O. Load dispatching, prioritization			131			22
Subtotal			131	619	1	285
Total		**131**			**905**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2018 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		1
34. Miscellaneous Systems	131	273
Total	**131**	**274**

Highlights (2024)

This year, Unit 4 cooperated with the power grid to reduce power many times, and maintained power operation at other times, and there was no emergency shutdown incident.

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2024 Operating Experience

CN-53 TIANWAN-5 CHINA

Status at end of year	:	**Operational**
Operator	:	JNPC (Jiangsu Nuclear Power Corporation)
Owner	:	JNPC (Jiangsu Nuclear Power Corporation)
Reactor Supplier	:	SHE (Shanghai Electric)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1118 MWe
Reference unit power (net)	:	1060 MWe

Key Dates

Construction Date	:	2015-12-27
Grid Date	:	2020-08-08
Commercial Date	:	2020-09-08
Age at end of year	:	4 years

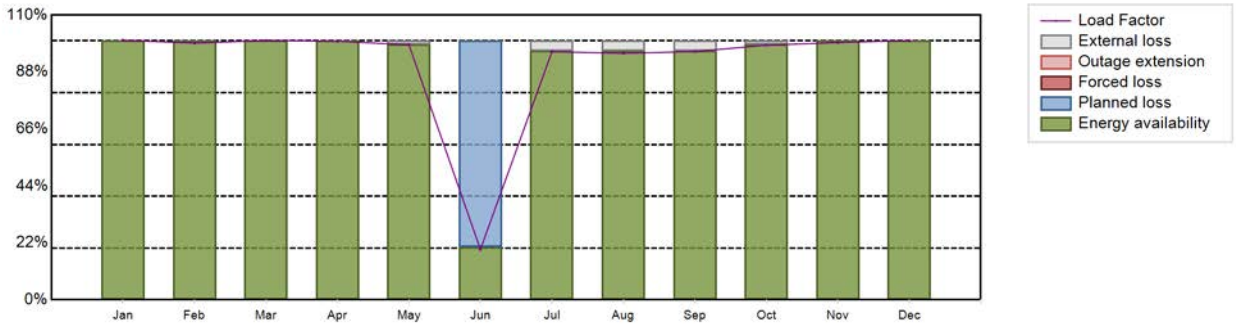
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	329.8
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	3.2	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	3.2	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8562.19 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	92.29 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	93.47 %	Planned Unavailability Factor (PUF)	:	6.53 %
Load Factor (LF)	:	91.96 %	Externally cause unavailability (XUF)	:	1.18 %
Operating Factor (OF)	:	94.01 %	Total off-line time	:	526 hours

Annual Summary



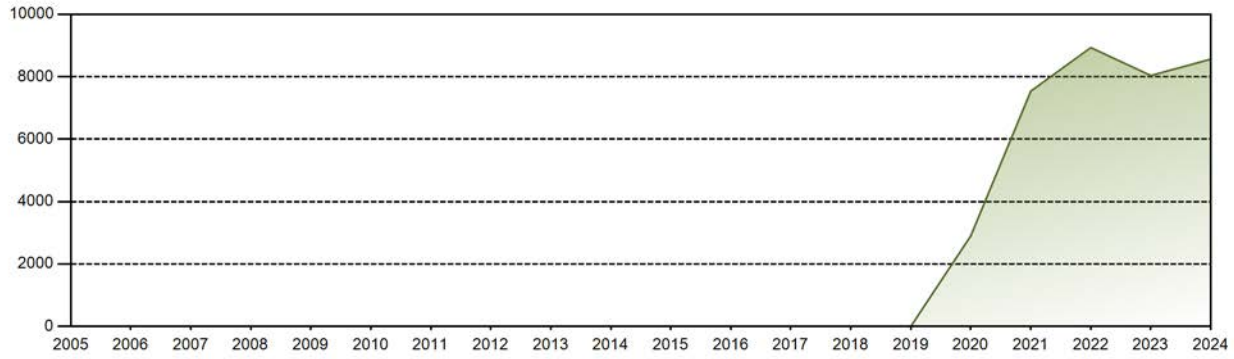
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	790.70	731.55	789.88	762.08	776.98	148.66	755.65	750.97	731.78	775.62	758.42	789.90	8562.19
EAF [%]	100.00	100.00	100.00	100.00	98.73	20.34	96.20	96.20	96.07	98.73	100.00	100.00	92.29
UCF [%]	100.00	100.00	100.00	100.00	100.00	20.34	100.00	100.00	100.00	100.00	100.00	100.00	93.47
LF [%]	100.26	99.16	100.16	99.85	98.52	19.48	95.82	95.22	95.88	98.35	99.37	100.16	91.96
OF [%]	100.00	100.00	100.00	100.00	100.00	26.94	100.00	100.00	100.00	100.00	100.00	100.00	94.01
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	79.66	0.00	0.00	0.00	0.00	0.00	0.00	6.53
XUF [%]	0.00	0.00	0.00	0.00	1.27	0.00	3.80	3.80	3.93	1.27	0.00	0.00	1.18

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Historical Summary

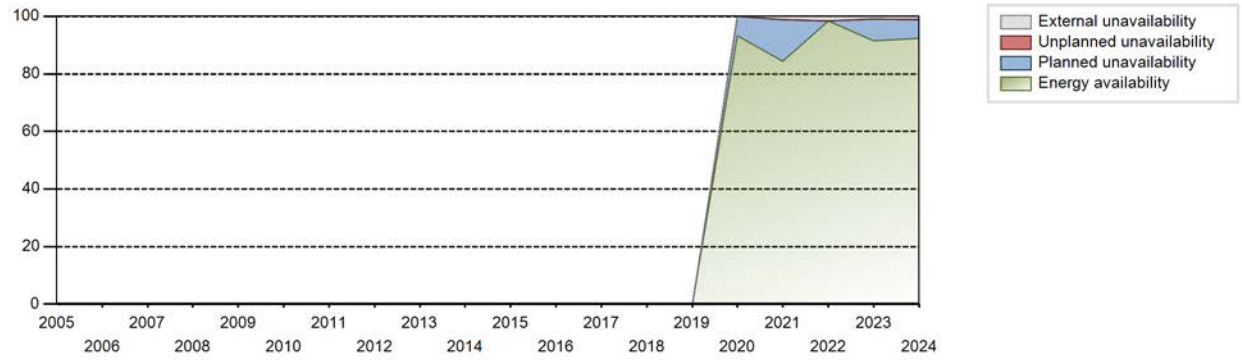
Lifetime energy generation	:	35973.73 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0 %
Cumulative Energy Availability Factor (EAF)	:	91.75 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0 %
Cumulative Unit Capability Factor (UCF)	:	92.85 %	Cumulative Planned Unavailability Factor (PUF)	:	7.15 %
Cumulative Load Factor (LF)	:	89.15 %	Cumulative Externally cause unavailability (XUF)	:	1.1 %
Cumulative Operating Factor (OF)	:	92.36 %			

Electricity Production (net) [GWh]

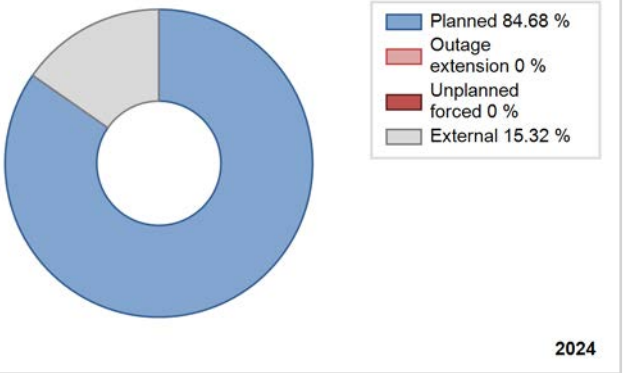


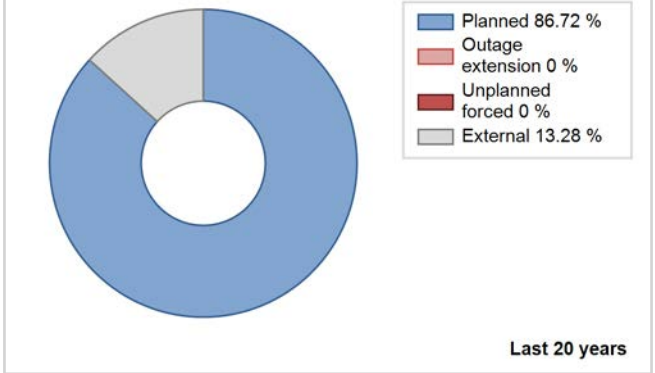
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2020	2901.91	3383	1000	93.34	93.34	91.31	95.87	0.00	0.00	6.66	0.00
2021	7538.34	7400	1060	84.35	85.46	81.18	84.47	0.00	0.00	14.54	1.11
2022	8933.22	8760	1060	98.41	99.97	96.21	100.00	0.00	0.00	0.03	1.56
2023	8038.07	7864	1060	91.46	92.34	86.56	89.77	0.00	0.00	7.66	0.88
2024	8562.19	8258	1060	92.29	93.47	91.96	94.01	0.00	0.00	6.53	1.18

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2020 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
C. Inspection, maintenance or repair combined with refuelling	526			531		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						144
Subtotal	526			531		144
Total	**526**			**675**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2020 to 2024
	Hours Lost	Average hours lost per reactor-year
34. Miscellaneous Systems		141
Total		**141**

Highlights (2024)

This year, Unit 5 underwent a unit overhaul and cooperated with the power grid to reduce power many times. At 06:00 on June 2, the turbine generator of No. 5 engine was disconnected and OT503 refueling overhaul began. At 22:19 on June 24, Unit 5 was reconnected to the grid after completing the overhaul. At 19:45 on June 26, the unit was upgraded to full power operation.

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2024 Operating Experience

CN-54 TIANWAN-6 CHINA

Status at end of year	:	**Operational**
Operator	:	JNPC (Jiangsu Nuclear Power Corporation)
Owner	:	JNPC (Jiangsu Nuclear Power Corporation)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	DEC (Dongfang Electric Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1118 MWe
Reference unit power (net)	:	1060 MWe

Key Dates

Construction Date	:	2016-09-07
Grid Date	:	2021-05-11
Commercial Date	:	2021-06-02
Age at end of year	:	3 years

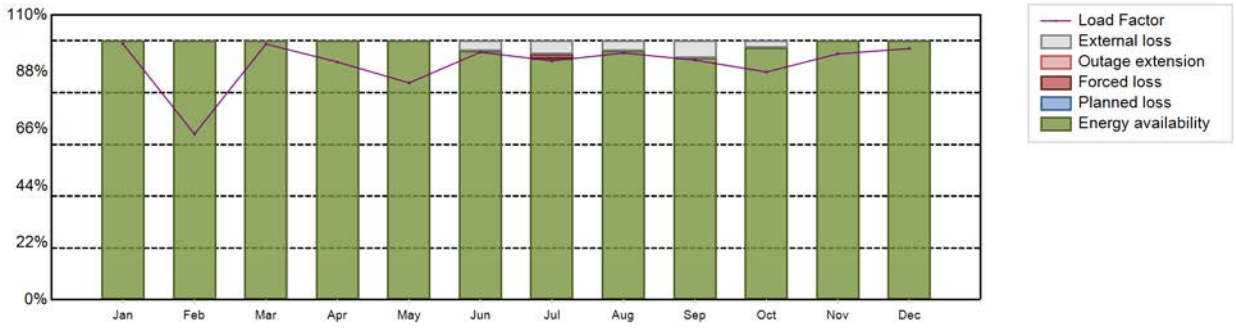
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	329.8
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	3.2	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	3.2	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8493.35 GW(e).h	Forced Loss Rate (FLR)	:	0.15 %
Energy Availability Factor (EAF)	:	98.03 %	Unplanned Capability Loss Factor (UCL)	:	0.15 %
Unit Capability Factor (UCF)	:	99.85 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	91.22 %	Externally cause unavailability (XUF)	:	1.83 %
Operating Factor (OF)	:	99.85 %	Total off-line time	:	13 hours

Annual Summary



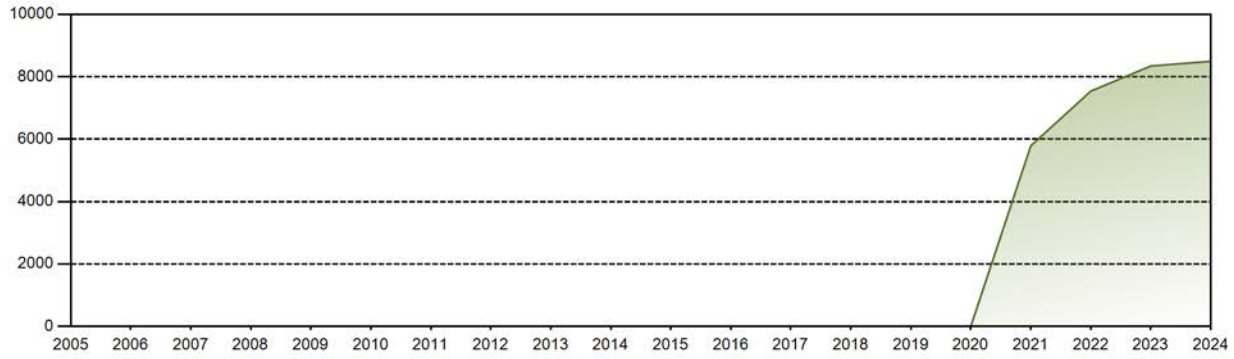
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	779.82	472.13	779.16	701.05	660.67	729.96	727.79	751.91	706.66	694.01	724.97	765.23	8493.35
EAF [%]	100.00	100.00	100.00	100.00	100.00	96.07	93.20	96.20	93.45	97.46	100.00	100.00	98.03
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	98.28	100.00	100.00	100.00	100.00	100.00	99.85
LF [%]	98.88	63.99	98.80	91.86	83.77	95.64	92.28	95.34	92.59	88.00	94.99	97.03	91.22
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	98.25	100.00	100.00	100.00	100.00	100.00	99.85
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	1.72	0.00	0.00	0.00	0.00	0.00	0.15
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	1.72	0.00	0.00	0.00	0.00	0.00	0.15
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	3.93	5.07	3.80	6.55	2.54	0.00	0.00	1.83

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Historical Summary

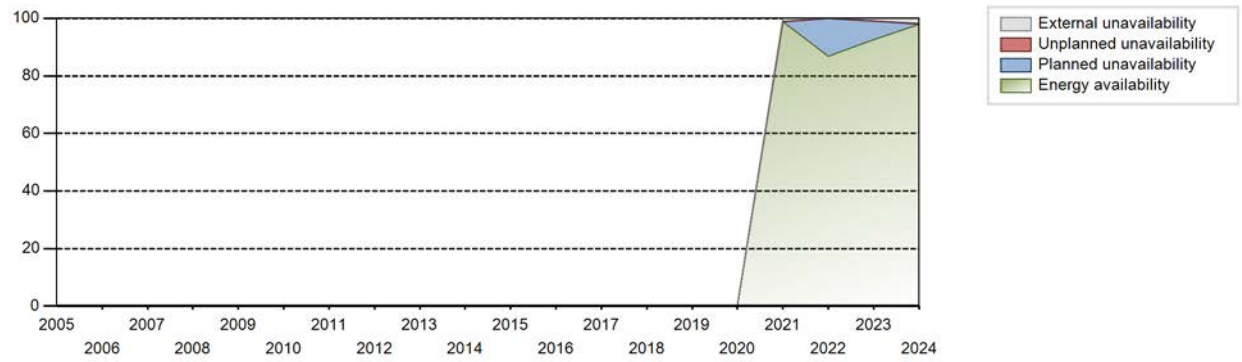
Lifetime energy generation	:	30161.99 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.07 %
Cumulative Energy Availability Factor (EAF)	:	93.53 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.06 %
Cumulative Unit Capability Factor (UCF)	:	94.47 %	Cumulative Planned Unavailability Factor (PUF)	:	5.47 %
Cumulative Load Factor (LF)	:	88.9 %	Cumulative Externally cause unavailability (XUF)	:	0.94 %
Cumulative Operating Factor (OF)	:	94.8 %			

Electricity Production (net) [GWh]

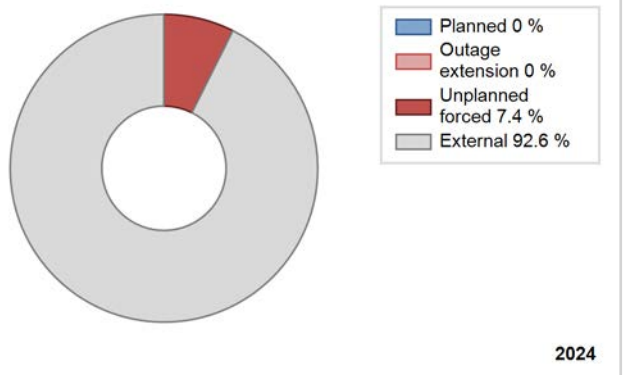


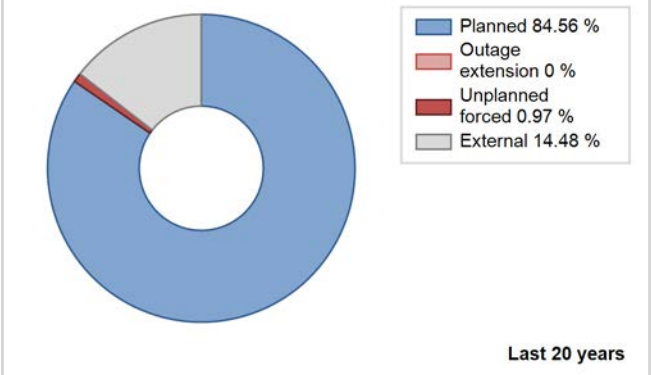
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2021	5786.59	5636	1060	98.89	99.98	96.48	100.00	0.02	0.02	0.00	1.09
2022	7538.05	7643	1060	86.81	86.81	81.18	87.25	0.07	0.06	13.12	0.00
2023	8344.00	8254	1060	92.60	93.49	89.86	94.22	0.00	0.00	6.51	0.89
2024	8493.35	8771	1060	98.03	99.85	91.22	99.85	0.15	0.15	0.00	1.83

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2021 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		13			4	
C. Inspection, maintenance or repair combined with refuelling				445		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						2
Subtotal		13		445	4	2
Total		**13**			**451**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2021 to 2024
	Hours Lost	Average hours lost per reactor-year
31. Turbine and auxiliaries	13	3
34. Miscellaneous Systems		2
Total	**13**	**5**

Highlights (2024)

This year, Unit 6 cooperated with the power grid to reduce power many times, and maintained power operation at other times, and an automatic emergency shutdown event occurred. On July 22, 2024, Unit 6 was reconnected to the grid on July 23, 2024 due to the high vibration of the steam turbine bearing and the superimposed condenser fault signal, resulting in an unplanned shutdown.

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2024 Operating Experience

CN-22 YANGJIANG-1 CHINA

Status at end of year	:	**Operational**
Operator	:	YJNPC (Yangjiang Nuclear Power Company)
Owner	:	YJNPC (Yangjiang Nuclear Power Company)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	SEG (Shanghai Electric Group)



Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1086 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2008-12-16
Grid Date	:	2013-12-31
Commercial Date	:	2014-03-25
Age at end of year	:	11 years

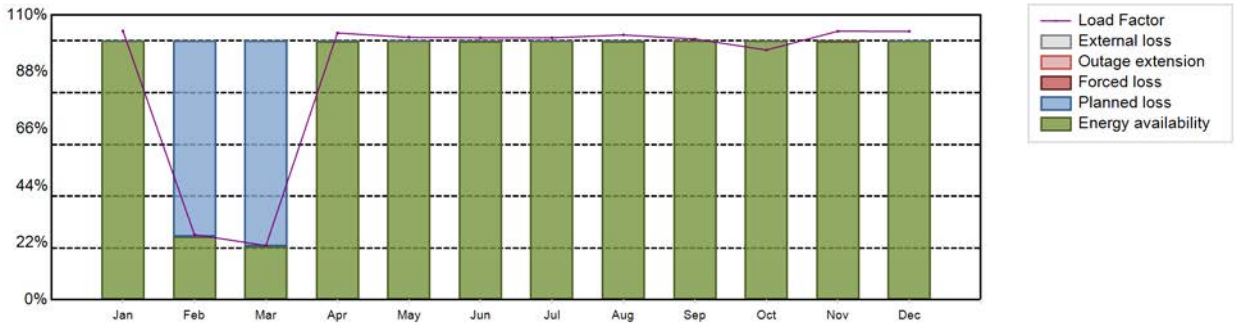
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.4
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	4.45	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	4.45	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7803.91 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	87.28 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	87.28 %	Planned Unavailability Factor (PUF)	:	12.72 %
Load Factor (LF)	:	88.84 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	87.7 %	Total off-line time	:	1080 hours

Annual Summary



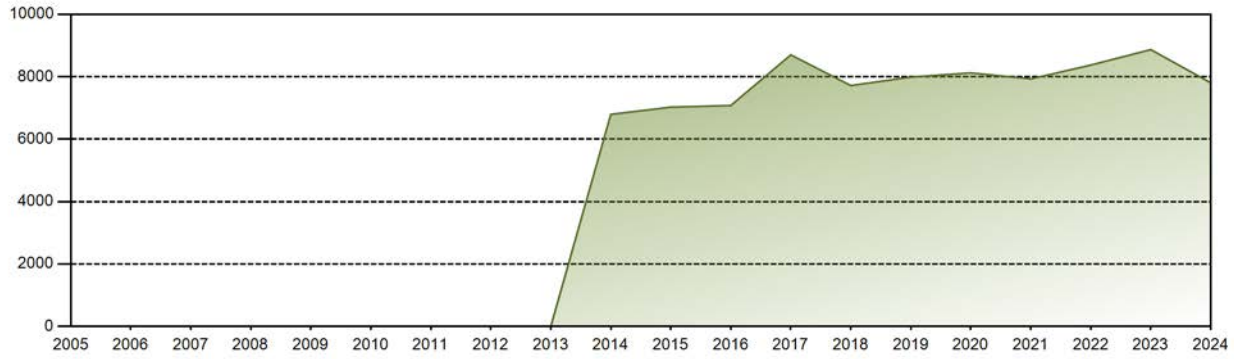
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	772.31	175.38	156.04	741.97	754.21	728.76	752.94	761.04	725.19	717.81	746.98	771.28	7803.91
EAF [%]	100.00	24.40	20.60	99.97	100.00	99.98	100.00	99.98	100.00	100.00	99.98	100.00	87.28
UCF [%]	100.00	24.40	20.60	99.97	100.00	99.98	100.00	99.98	100.00	100.00	99.98	100.00	87.28
LF [%]	103.81	25.20	20.97	103.05	101.37	101.22	101.20	102.29	100.72	96.48	103.75	103.67	88.84
OF [%]	100.00	24.71	25.27	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	87.70
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	75.60	79.40	0.03	0.00	0.02	0.00	0.02	0.00	0.00	0.02	0.00	12.72
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

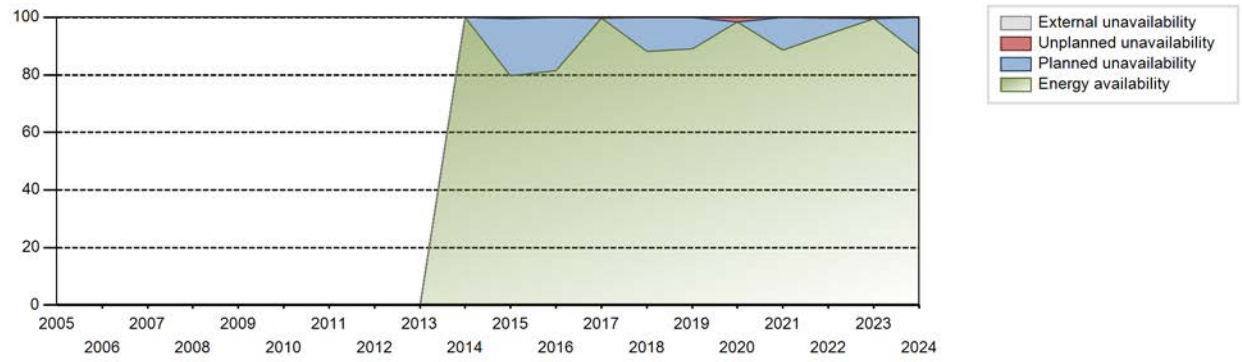
Lifetime energy generation	:	87022.09 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.25 %
Cumulative Energy Availability Factor (EAF)	:	91.29 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.23 %
Cumulative Unit Capability Factor (UCF)	:	91.36 %	Cumulative Planned Unavailability Factor (PUF)	:	8.41 %
Cumulative Load Factor (LF)	:	91.48 %	Cumulative Externally cause unavailability (XUF)	:	0.06 %
Cumulative Operating Factor (OF)	:	91.42 %			

Electricity Production (net) [GWh]



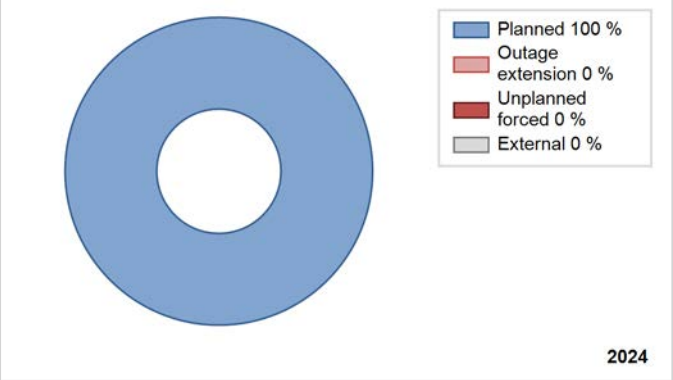
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2014	6793.37	6753	1000	99.93	99.93	100.54	100.00	0.05	0.05	0.02	0.00
2015	7025.37	7021	1000	79.73	79.73	80.20	80.15	0.74	0.59	19.68	0.00
2016	7077.81	6989	1000	81.52	81.56	80.58	79.57	0.00	0.00	18.44	0.04
2017	8699.83	8677	1000	99.75	99.99	99.31	99.05	0.00	0.00	0.01	0.24
2018	7715.76	7789	1000	88.20	88.24	88.08	88.92	0.00	0.00	11.76	0.03
2019	7988.46	7861	1000	89.09	89.09	91.19	89.74	0.00	0.00	10.91	0.00
2020	8122.92	8665	1000	98.42	98.51	92.47	98.65	1.49	1.49	0.00	0.09
2021	7930.66	7834	1000	88.69	88.72	90.53	89.43	0.00	0.00	11.28	0.03
2022	8373.86	8312	1000	94.17	94.41	95.59	94.89	0.00	0.00	5.58	0.25
2023	8868.11	8731	1000	99.61	99.61	101.23	99.67	0.38	0.38	0.01	0.00
2024	7803.91	7704	1000	87.28	87.28	88.84	87.70	0.00	0.00	12.72	0.00

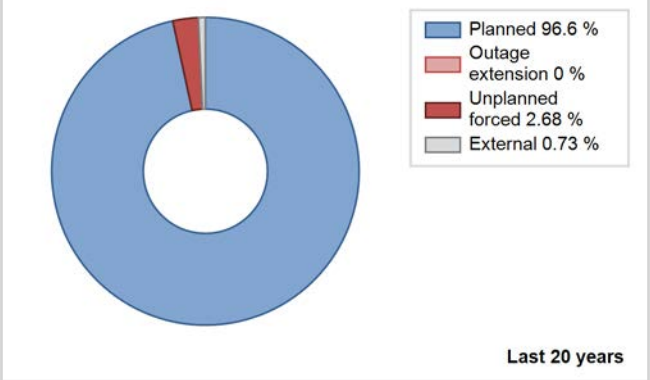
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2014 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					20	
C. Inspection, maintenance or repair combined with refuelling	1079			759		
E. Testing of plant systems or components				0		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						30
Subtotal	1079			759	20	30
Total	**1079**			**809**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2014 to 2024 Average hours lost per reactor-year
31. Turbine and auxiliaries		8
33. Circulating Water System		12
Total		**20**

Highlights (2024)

Unit 1 of Yangjiang Nuclear Power Plant was disconnected from the grid for Y107 outage on February 8, 2024, and re-connected to the grid on March 24. The unit operated at full power at all times except during holidays and grid line maintenance in which it operated at reduced power in order to cooperate with peak shaving of the grid. No scrams has occurred throughout the year.

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2024 Operating Experience

CN-23 YANGJIANG-2 CHINA



Status at end of year	:	**Operational**
Operator	:	YJNPC (Yangjiang Nuclear Power Company)
Owner	:	YJNPC (Yangjiang Nuclear Power Company)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	SEG (Shanghai Electric Group)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1086 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2009-06-04
Grid Date	:	2015-03-10
Commercial Date	:	2015-06-05
Age at end of year	:	9 years

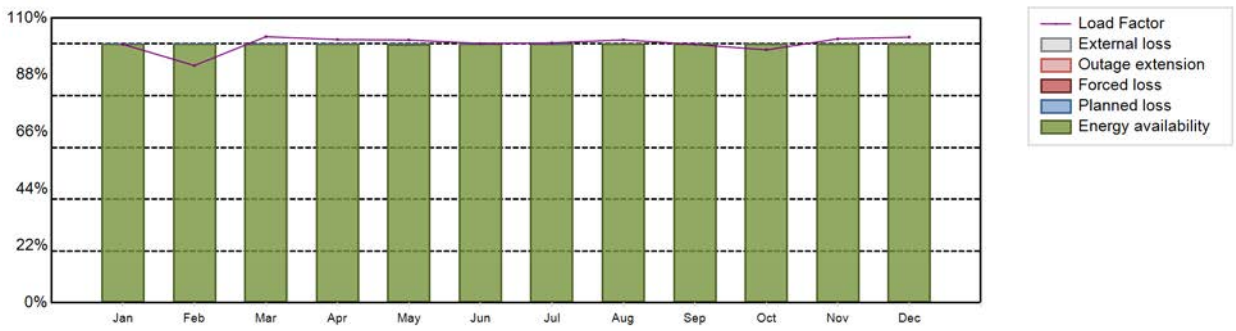
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.4
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	4.45	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	4.45	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8799.14 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	100.17 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



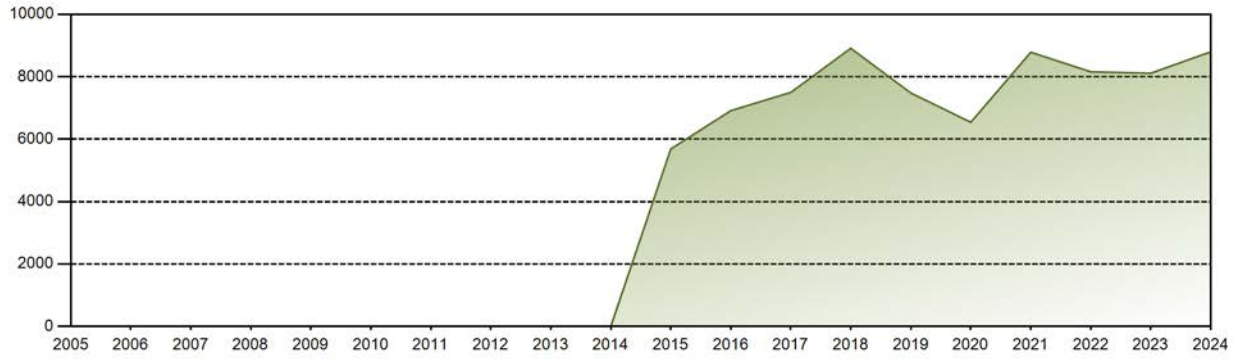
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	742.84	637.82	764.73	731.98	755.30	721.19	746.85	755.64	718.58	726.88	734.02	763.31	8799.14
EAF [%]	100.00	100.00	100.00	100.00	99.97	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	99.97	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	99.84	91.64	102.79	101.66	101.52	100.17	100.38	101.56	99.80	97.70	101.95	102.60	100.17
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

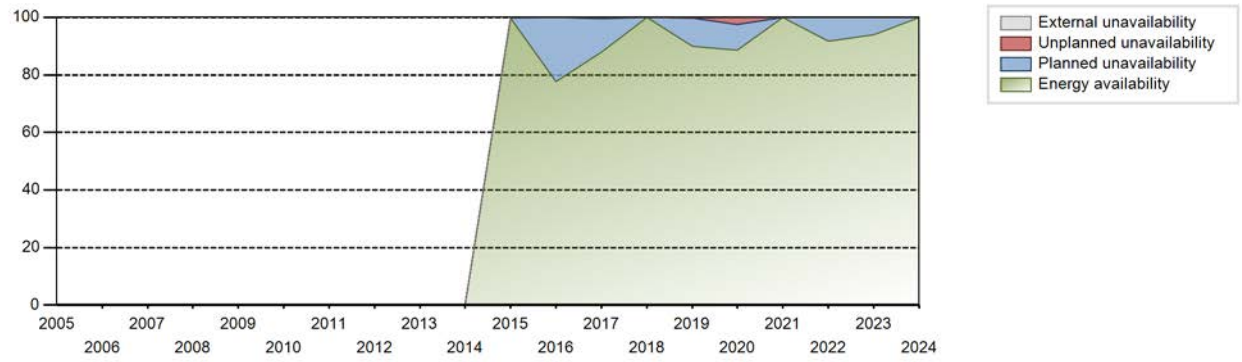
Lifetime energy generation	:	76872.24 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.36 %
Cumulative Energy Availability Factor (EAF)	:	92.65 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.33 %
Cumulative Unit Capability Factor (UCF)	:	92.71 %	Cumulative Planned Unavailability Factor (PUF)	:	6.96 %
Cumulative Load Factor (LF)	:	90.95 %	Cumulative Externally cause unavailability (XUF)	:	0.06 %
Cumulative Operating Factor (OF)	:	91.48 %			

Electricity Production (net) [GWh]



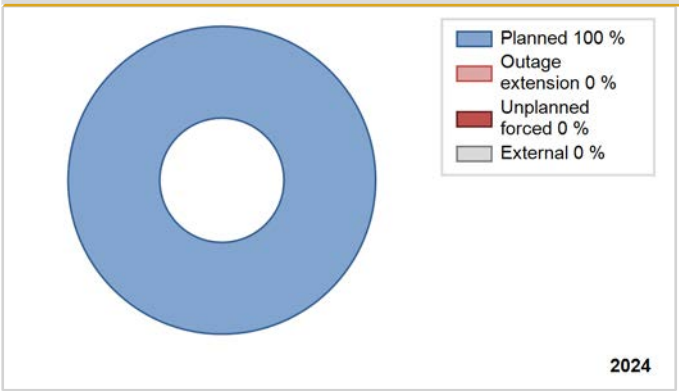
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2015	5683.72	6017	1000	99.79	99.79	102.21	100.00	0.20	0.20	0.01	0.00
2016	6911.71	6874	1000	77.59	77.69	78.69	78.26	0.00	0.00	22.31	0.10
2017	7497.38	7476	1000	87.99	87.99	85.59	85.34	0.52	0.46	11.55	0.00
2018	8910.12	8760	1000	99.95	99.98	101.71	100.00	0.00	0.00	0.02	0.04
2019	7478.07	7943	1000	89.97	90.27	85.37	90.67	0.00	0.00	9.73	0.30
2020	6539.67	6854	1000	88.49	88.49	74.45	78.03	2.84	2.59	8.92	0.00
2021	8783.89	8760	1000	99.99	99.99	100.27	100.00	0.00	0.00	0.01	0.00
2022	8156.58	8077	1000	91.78	91.78	93.11	92.20	0.00	0.00	8.21	0.00
2023	8111.96	8225	1000	93.94	94.04	92.60	93.89	0.00	0.00	5.95	0.11
2024	8799.14	8784	1000	100.00	100.00	100.17	100.00	0.00	0.00	0.00	0.00

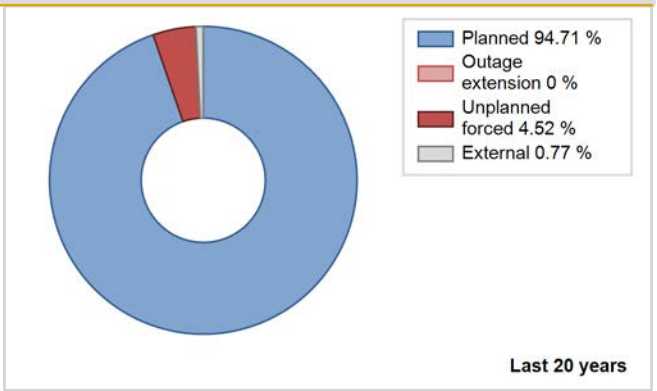
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2015 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					4	
C. Inspection, maintenance or repair combined with refuelling				578		
D. Inspection, maintenance or repair without refuelling				3		
I. Grid capacity limitation						107
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						30
Z. Other				1	23	
Subtotal				582	27	137
Total		**0**			**746**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2015 to 2024 Average hours lost per reactor-year
32. Feedwater and Main Steam System		4
33. Circulating Water System		23
42. Electrical Power Supply Systems		105
Total		**132**

Highlights (2024)

Unit 2 of Yangjiang Nuclear Power operated at full power at all times except during holidays and grid line maintenance in which it operated at reduced power in order to cooperate with peak shaving of the grid. No scrams has occurred throughout the year.

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2024 Operating Experience

CN-40 YANGJIANG-3 CHINA

Status at end of year	:	**Operational**
Operator	:	YJNPC (Yangjiang Nuclear Power Company)
Owner	:	YJNPC (Yangjiang Nuclear Power Company)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	SEG (Shanghai Electric Group)



Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1086 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2010-11-15
Grid Date	:	2015-10-18
Commercial Date	:	2016-01-01
Age at end of year	:	9 years

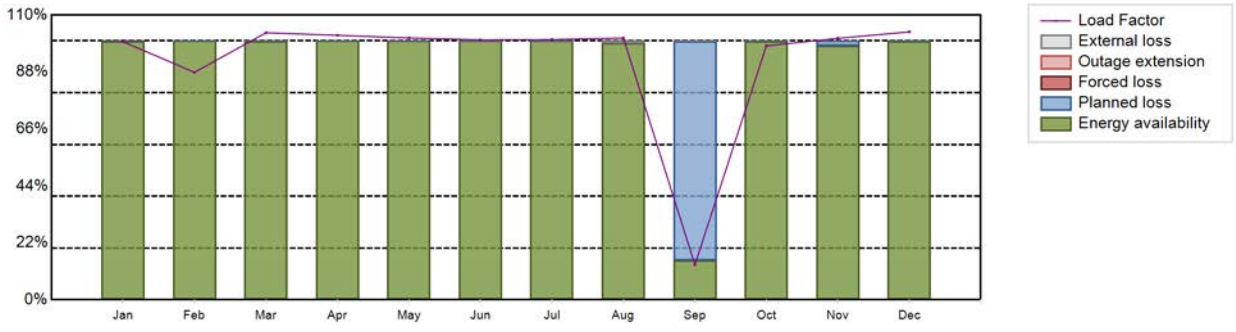
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.4
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	4.45	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	4.45	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8156.23 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	92.81 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	92.9 %	Planned Unavailability Factor (PUF)	:	7.1 %
Load Factor (LF)	:	92.85 %	Externally cause unavailability (XUF)	:	0.09 %
Operating Factor (OF)	:	93.23 %	Total off-line time	:	595 hours

Annual Summary



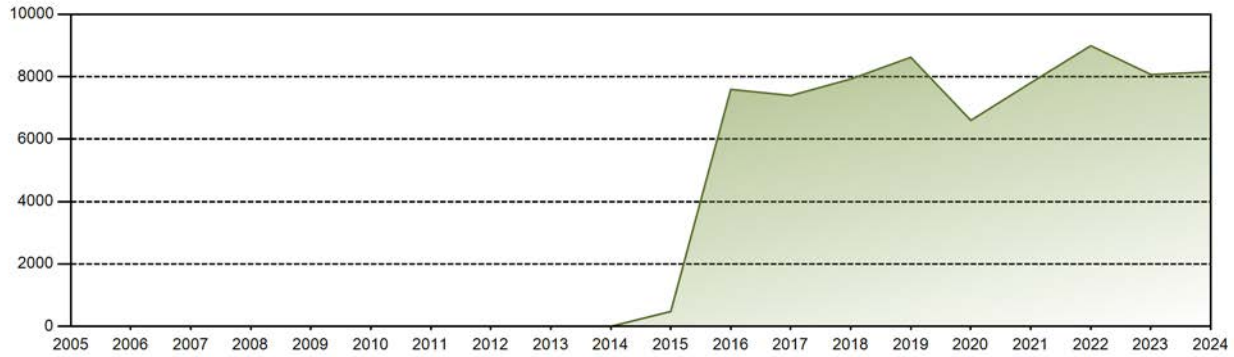
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	741.77	611.60	767.37	735.54	752.49	722.92	747.77	752.35	97.51	729.80	727.15	769.96	8156.23
EAF [%]	99.97	100.00	99.98	100.00	100.00	100.00	100.00	99.23	15.26	99.76	98.18	99.98	92.81
UCF [%]	99.97	100.00	99.98	100.00	100.00	100.00	100.00	100.00	15.51	99.76	98.18	99.98	92.90
LF [%]	99.70	87.87	103.14	102.16	101.14	100.41	100.51	101.12	13.54	98.09	100.99	103.49	92.85
OF [%]	100.00	97.13	100.00	100.00	100.00	100.00	100.00	100.00	20.14	100.00	100.00	100.00	93.23
FLR [%]	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	84.49	0.24	1.82	0.02	7.10
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.77	0.25	0.00	0.00	0.00	0.09

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Historical Summary

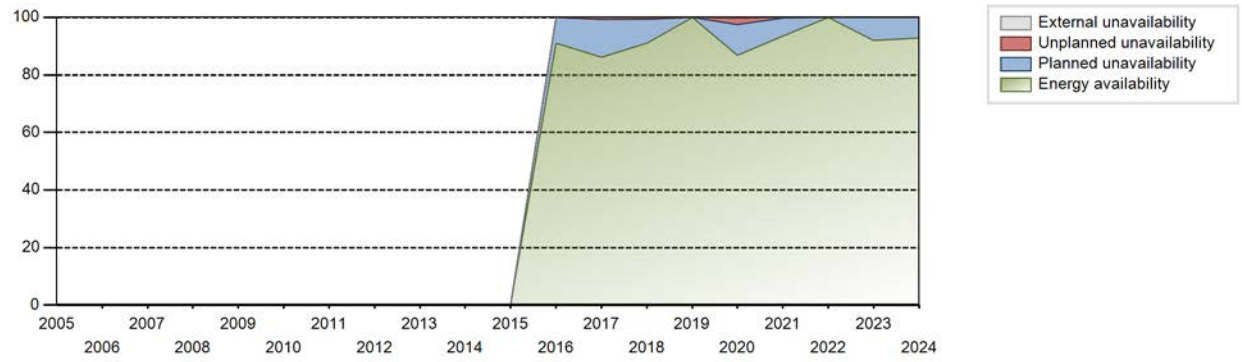
Lifetime energy generation	:	71641.45 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.34 %
Cumulative Energy Availability Factor (EAF)	:	92.58 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.32 %
Cumulative Unit Capability Factor (UCF)	:	92.75 %	Cumulative Planned Unavailability Factor (PUF)	:	6.93 %
Cumulative Load Factor (LF)	:	90.18 %	Cumulative Externally cause unavailability (XUF)	:	0.17 %
Cumulative Operating Factor (OF)	:	91.03 %			

Electricity Production (net) [GWh]

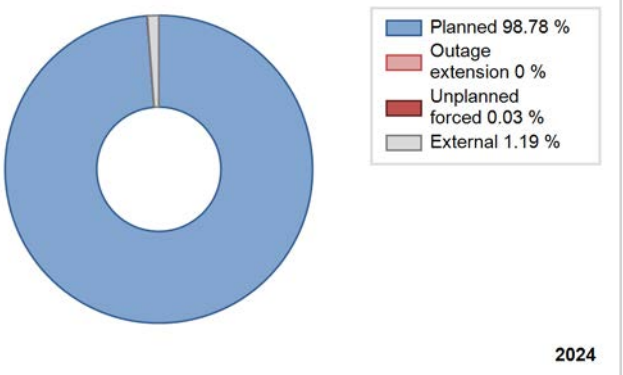


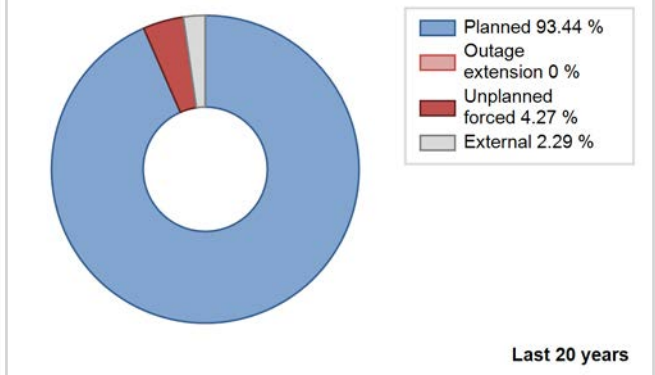
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	7593.85	7559	1000	91.12	91.24	86.45	86.05	0.01	0.01	8.75	0.12
2017	7396.07	7435	1000	86.14	86.87	84.43	84.87	0.00	0.00	13.13	0.72
2018	7926.66	8028	1000	91.09	91.51	90.49	91.64	0.22	0.20	8.30	0.41
2019	8621.67	8760	1000	99.96	99.99	98.42	100.00	0.00	0.00	0.01	0.04
2020	6600.21	7039	1000	86.76	86.91	75.14	80.13	2.70	2.41	10.68	0.15
2021	7804.98	7978	1000	93.41	93.41	89.10	91.07	0.24	0.23	6.36	0.00
2022	8991.99	8760	1000	100.00	100.00	102.65	100.00	0.00	0.00	0.00	0.00
2023	8071.11	8087	1000	91.93	91.93	92.14	92.32	0.00	0.00	8.06	0.00
2024	8156.23	8189	1000	92.81	92.90	92.85	93.23	0.00	0.00	7.10	0.09

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					2	
C. Inspection, maintenance or repair combined with refuelling	575			576		
D. Inspection, maintenance or repair without refuelling				3		
I. Grid capacity limitation			20			103
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						76
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
Z. Other					23	
Subtotal	575		20	579	25	183
Total	**595**			**787**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
31. Turbine and auxiliaries		2
33. Circulating Water System		23
42. Electrical Power Supply Systems	20	103
Total	**20**	**128**

Highlights (2024)

Unit 3 of Yangjiang Nuclear Power Plant was disconnected from the grid for Y306 outage on September 3, 2024, and re-connected to the grid on September 27. The unit operated at full power at all times except during holidays and grid line maintenance in which it operated at reduced power in order to cooperate with peak shaving of the grid (including 1 shutdown for standby to cooperate with the grid). No scrams has occurred throughout the year.

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2024 Operating Experience

CN-41 YANGJIANG-4 CHINA



Status at end of year	:	**Operational**
Operator	:	YJNPC (Yangjiang Nuclear Power Company)
Owner	:	YJNPC (Yangjiang Nuclear Power Company)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	SEG (Shanghai Electric Group)

Reactor Unit Details

Reactor type and model	:	PWR / CPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1086 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2012-11-17
Grid Date	:	2017-01-08
Commercial Date	:	2017-03-15
Age at end of year	:	7 years

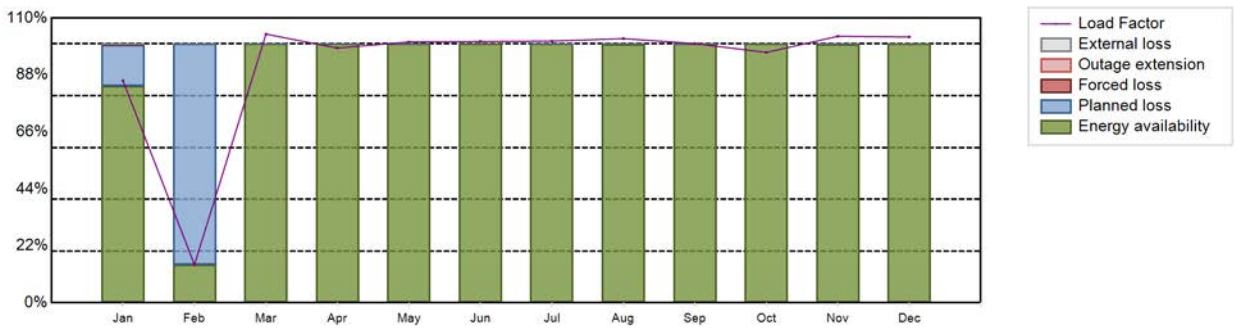
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.4
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	4.45	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	4.45	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8154.38 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	91.86 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	91.88 %	Planned Unavailability Factor (PUF)	:	8.12 %
Load Factor (LF)	:	92.83 %	Externally cause unavailability (XUF)	:	0.02 %
Operating Factor (OF)	:	92.02 %	Total off-line time	:	701 hours

Annual Summary



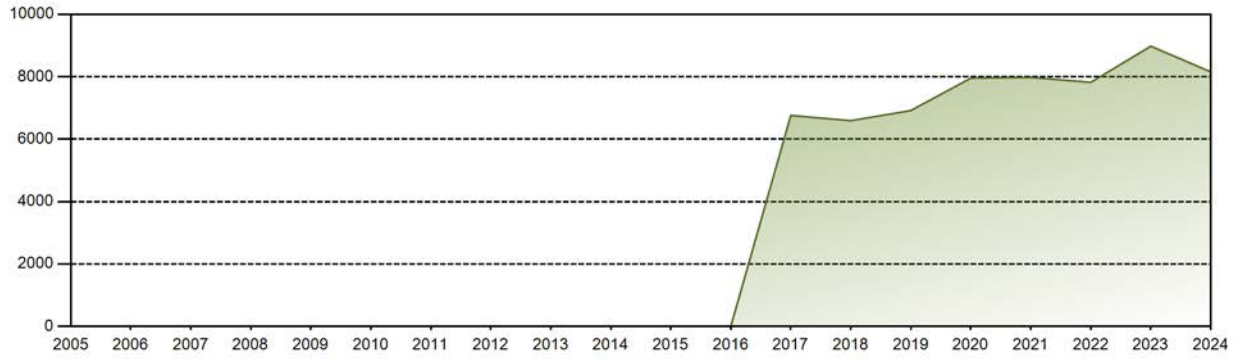
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	637.97	102.67	772.18	708.39	749.58	726.74	752.18	759.19	720.94	719.51	741.27	763.76	8154.38
EAF [%]	83.81	14.64	100.00	100.00	100.00	100.00	100.00	99.98	100.00	100.00	99.98	100.00	91.86
UCF [%]	84.08	14.64	100.00	100.00	100.00	100.00	100.00	99.98	100.00	100.00	99.98	100.00	91.88
LF [%]	85.75	14.75	103.79	98.39	100.75	100.94	101.10	102.04	100.13	96.71	102.95	102.66	92.83
OF [%]	84.41	19.68	100.00	96.39	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.02
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	15.92	85.36	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	8.12
XUF [%]	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02

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Historical Summary

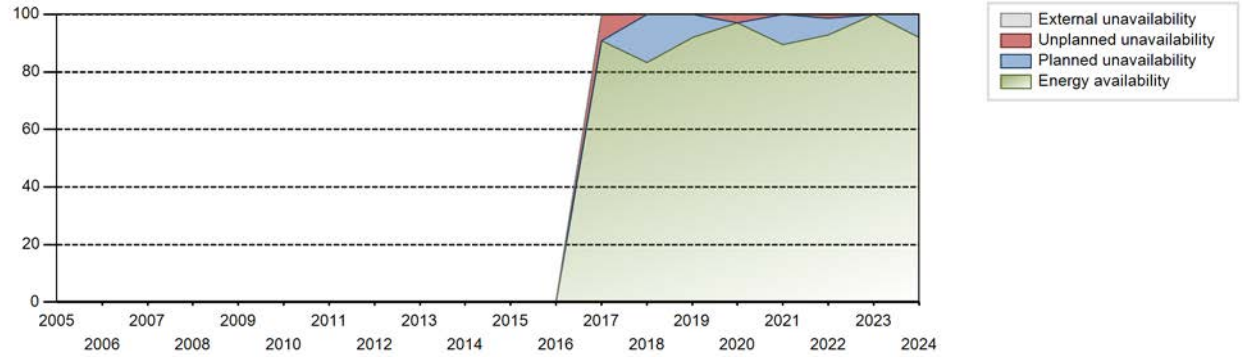
Lifetime energy generation	:	61156.05 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.58 %
Cumulative Energy Availability Factor (EAF)	:	92.17 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.48 %
Cumulative Unit Capability Factor (UCF)	:	92.26 %	Cumulative Planned Unavailability Factor (PUF)	:	6.26 %
Cumulative Load Factor (LF)	:	88.81 %	Cumulative Externally cause unavailability (XUF)	:	0.08 %
Cumulative Operating Factor (OF)	:	88.89 %			

Electricity Production (net) [GWh]

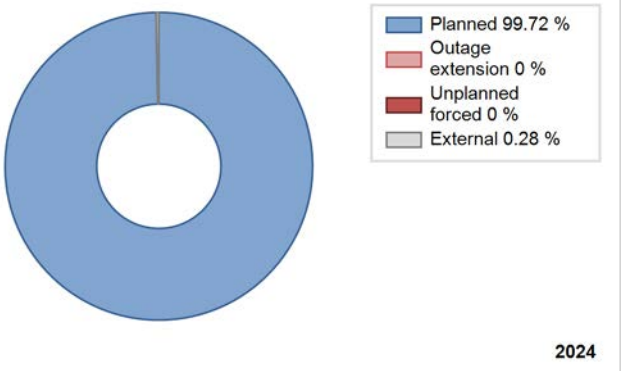


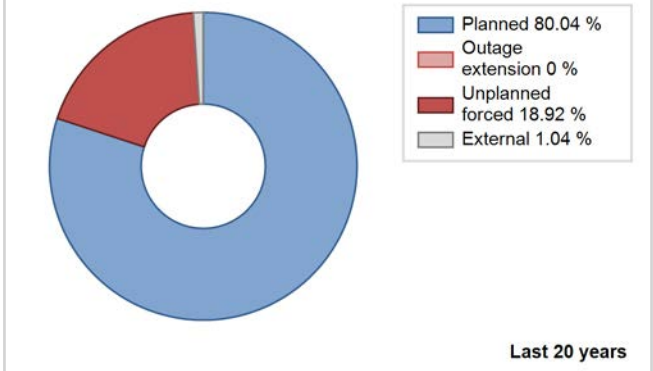
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2017	6759.71	6353	1000	90.72	91.02	90.26	86.51	8.98	8.98	0.01	0.30
2018	6591.93	6695	1000	83.35	83.43	75.25	76.43	0.01	0.01	16.57	0.07
2019	6915.91	7164	1000	91.88	91.88	78.95	81.78	0.01	0.01	8.11	0.00
2020	7954.62	8216	1000	97.02	97.11	90.56	93.53	2.88	2.88	0.00	0.09
2021	7977.13	7880	1000	89.45	89.45	91.06	89.95	0.08	0.08	10.48	0.00
2022	7820.95	7927	1000	92.87	93.08	89.28	90.49	1.18	1.11	5.81	0.21
2023	8978.18	8760	1000	99.99	99.99	102.49	100.00	0.00	0.00	0.01	0.00
2024	8154.38	8083	1000	91.86	91.88	92.83	92.02	0.00	0.00	8.12	0.02

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2017 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					84	
C. Inspection, maintenance or repair combined with refuelling	675			523		
I. Grid capacity limitation			26			91
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						201
Z. Other					32	
Subtotal	675		26	523	116	292
Total		**701**			**931**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2017 to 2024
	Hours Lost	Average hours lost per reactor-year
33. Circulating Water System		31
42. Electrical Power Supply Systems	26	171
Total	**26**	**202**

Highlights (2024)

Unit 4 of Yangjiang Nuclear Power Plant was disconnected from the grid for Y405 outage on January 27, 2024, and re-connected to the grid on February 24. The unit operated at full power at all times except during holidays and grid line maintenance in which it operated at reduced power in order to cooperate with peak shaving of the grid (including 1 shutdown for standby to cooperate with the grid). No scrams has occurred throughout the year.

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2024 Operating Experience

CN-47 YANGJIANG-5 CHINA



Status at end of year	:	**Operational**
Operator	:	YJNPC (Yangjiang Nuclear Power Company)
Owner	:	YJNPC (Yangjiang Nuclear Power Company)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	SEG (Shanghai Electric Group)

Reactor Unit Details

Reactor type and model	:	PWR / ACPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1086 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2013-09-18
Grid Date	:	2018-05-23
Commercial Date	:	2018-07-12
Age at end of year	:	6 years

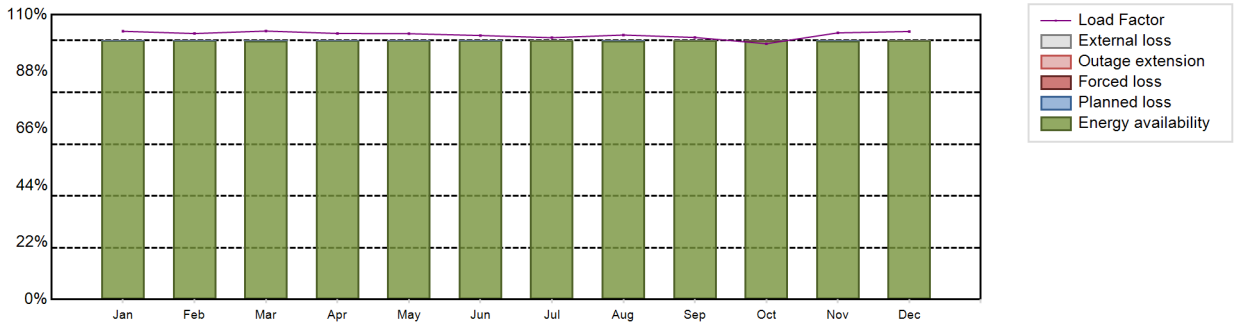
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	-
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8982.32 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	99.99 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	99.99 %	Planned Unavailability Factor (PUF)	:	0.01 %
Load Factor (LF)	:	102.26 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



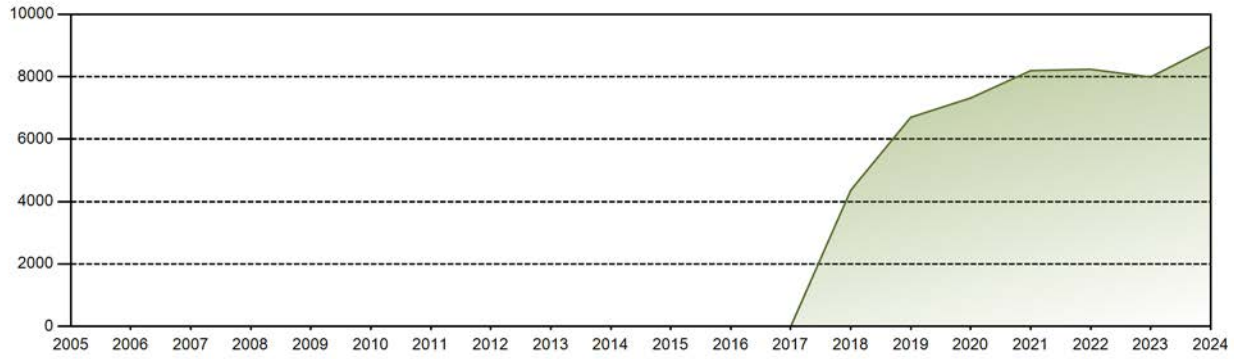
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	770.75	714.99	771.41	739.84	763.76	734.08	752.24	759.94	728.64	735.04	741.51	770.12	8982.32
EAF [%]	100.00	100.00	99.98	100.00	100.00	99.99	100.00	99.98	100.00	100.00	99.98	100.00	99.99
UCF [%]	100.00	100.00	99.98	100.00	100.00	99.99	100.00	99.98	100.00	100.00	99.98	100.00	99.99
LF [%]	103.60	102.73	103.68	102.76	102.66	101.96	101.11	102.14	101.20	98.80	102.99	103.51	102.26
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.02	0.00	0.01
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

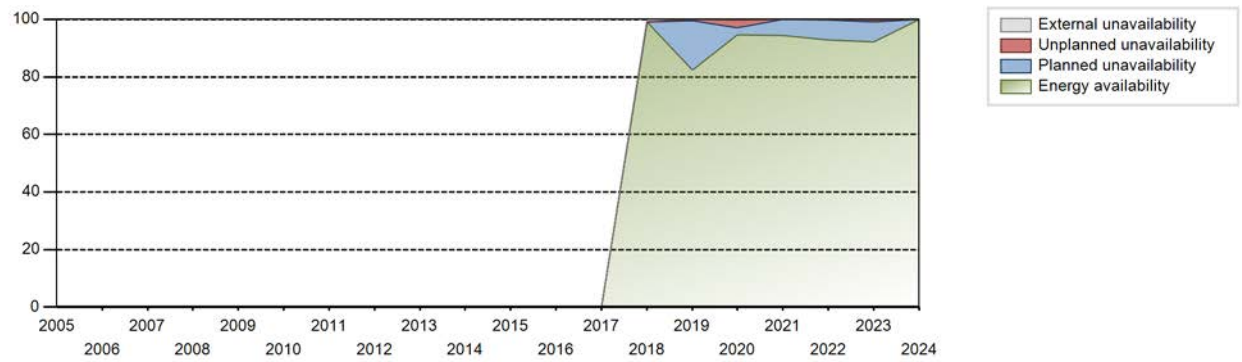
Lifetime energy generation	:	51786 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.59 %
Cumulative Energy Availability Factor (EAF)	:	93.22 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.65 %
Cumulative Unit Capability Factor (UCF)	:	93.33 %	Cumulative Planned Unavailability Factor (PUF)	:	6.02 %
Cumulative Load Factor (LF)	:	90.47 %	Cumulative Externally cause unavailability (XUF)	:	0.11 %
Cumulative Operating Factor (OF)	:	91.7 %			

Electricity Production (net) [GWh]

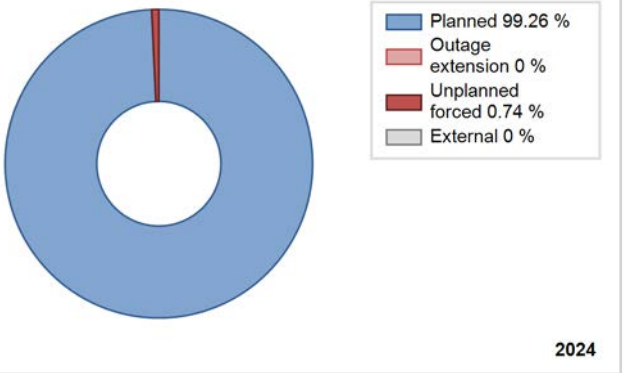


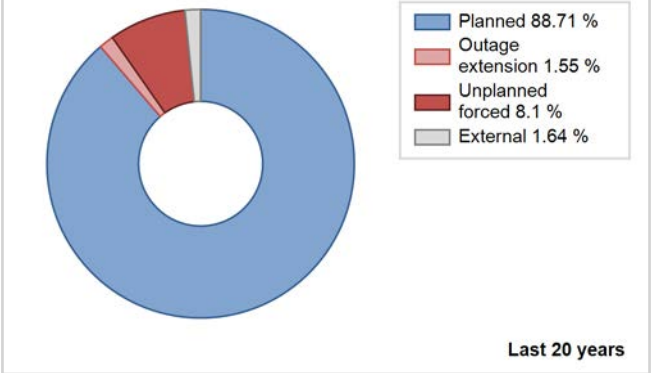
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2018	4365.35	4847	1000	99.11	99.94	94.36	97.26	0.06	0.06	0.00	0.83
2019	6699.42	6927	1000	82.36	82.36	76.48	79.08	0.68	0.56	17.08	0.00
2020	7318.68	7706	1000	94.64	94.79	83.32	87.73	2.83	2.76	2.45	0.15
2021	8195.95	8314	1000	94.39	94.40	93.56	94.91	0.00	0.00	5.60	0.01
2022	8236.09	8177	1000	92.72	92.72	94.02	93.34	0.24	0.22	7.06	0.00
2023	7988.19	8088	1000	92.19	92.34	91.19	92.33	0.00	0.68	6.98	0.15
2024	8982.32	8784	1000	99.99	99.99	102.26	100.00	0.00	0.00	0.01	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2018 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					19	
C. Inspection, maintenance or repair combined with refuelling				502		
I. Grid capacity limitation						102
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						52
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						5
Z. Other					36	
Subtotal				502	55	159
Total		**0**			**716**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2018 to 2024
	Hours Lost	Average hours lost per reactor-year
14. Safety Systems		7
31. Turbine and auxiliaries		2
33. Circulating Water System		35
34. Miscellaneous Systems		9
42. Electrical Power Supply Systems		99
Total		**152**

Highlights (2024)

Unit 5 of Yangjiang Nuclear Power operated at full power at all times except during holidays and grid line maintenance in which it operated at reduced power in order to cooperate with peak shaving of the grid. No scrams has occurred throughout the year.

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2024 Operating Experience

CN-48 YANGJIANG-6 CHINA



Status at end of year	:	**Operational**
Operator	:	YJNPC (Yangjiang Nuclear Power Company)
Owner	:	YJNPC (Yangjiang Nuclear Power Company)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	SEG (Shanghai Electric Group)

Reactor Unit Details

Reactor type and model	:	PWR / ACPR-1000
Thermal power	:	2905 MWth
Gross electrical power	:	1086 MWe
Reference unit power (net)	:	1000 MWe

Key Dates

Construction Date	:	2013-12-23
Grid Date	:	2019-06-29
Commercial Date	:	2019-07-24
Age at end of year	:	5 years

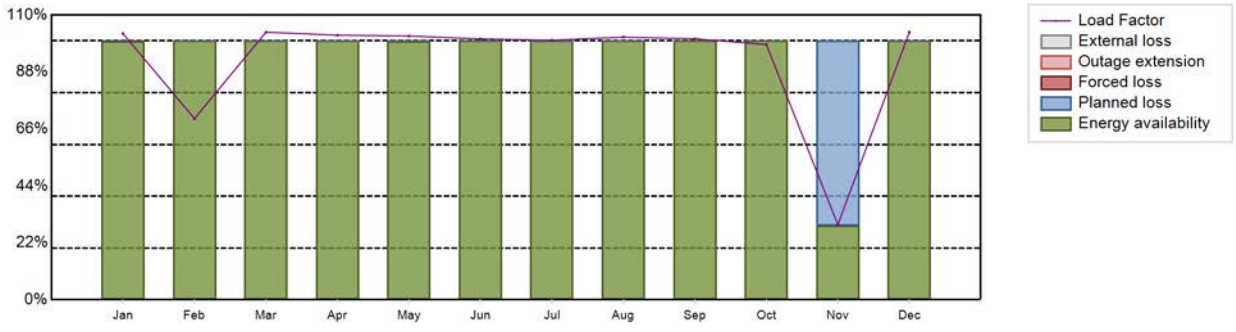
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.4
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.52
Average fuel enrichment [% of U235]	:	4.45	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	4.45	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.43
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8179.48 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	94.14 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	94.14 %	Planned Unavailability Factor (PUF)	:	5.85 %
Load Factor (LF)	:	93.12 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	92.33 %	Total off-line time	:	674 hours

Annual Summary



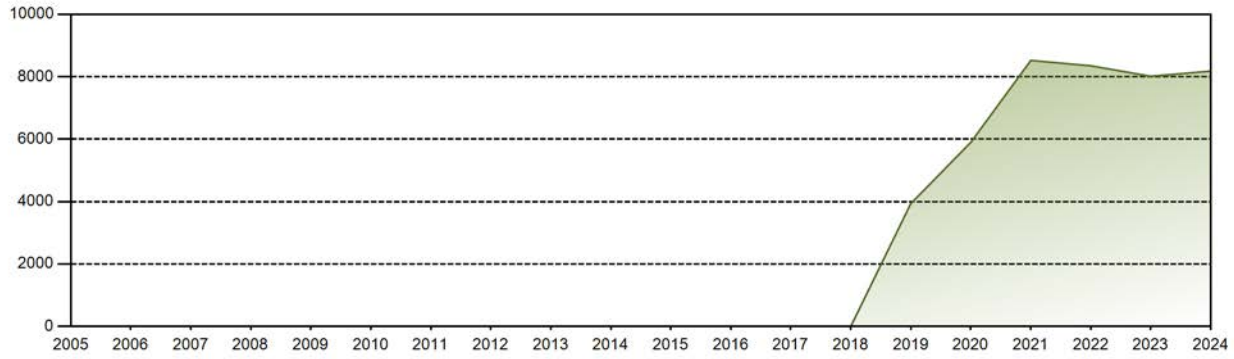
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	764.97	487.34	769.00	736.01	758.15	725.51	745.98	754.84	725.87	733.57	209.22	769.02	8179.48
EAF [%]	99.97	100.00	100.00	100.00	99.97	100.00	99.99	100.00	100.00	100.00	28.64	100.00	94.14
UCF [%]	99.97	100.00	100.00	100.00	99.97	100.00	99.99	100.00	100.00	100.00	28.64	100.00	94.14
LF [%]	102.82	70.02	103.36	102.22	101.90	100.77	100.27	101.46	100.82	98.60	29.06	103.36	93.12
OF [%]	100.00	71.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	33.47	100.00	92.33
FLR [%]	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.00	0.00	71.36	0.00	5.85
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

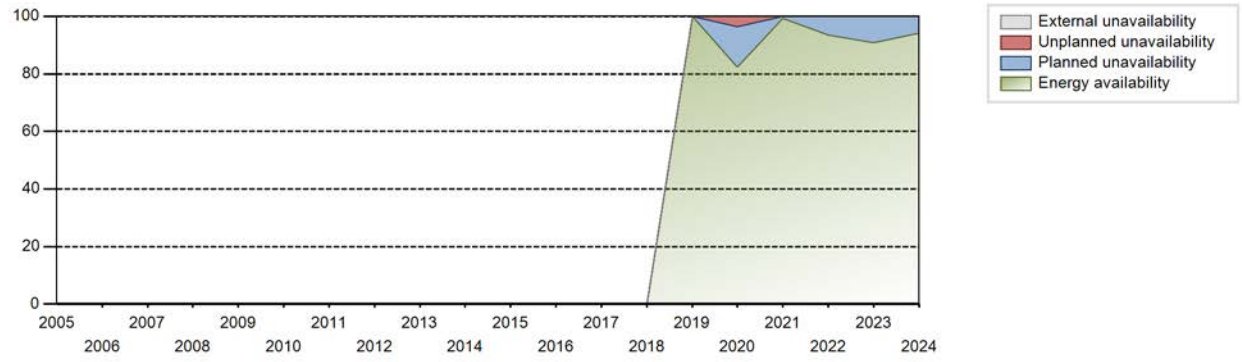
Lifetime energy generation	:	42957.63 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.71 %
Cumulative Energy Availability Factor (EAF)	:	92.68 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.66 %
Cumulative Unit Capability Factor (UCF)	:	92.68 %	Cumulative Planned Unavailability Factor (PUF)	:	6.66 %
Cumulative Load Factor (LF)	:	89.17 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	90.18 %			

Electricity Production (net) [GWh]

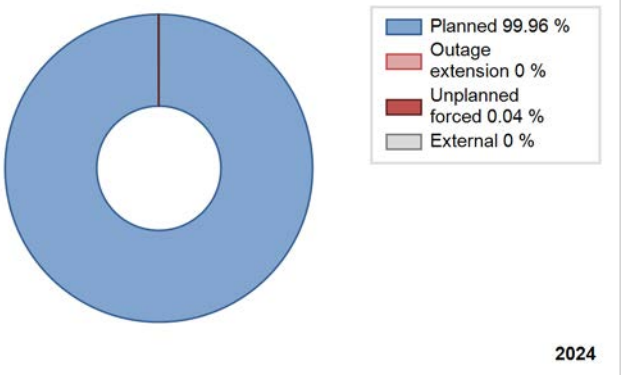


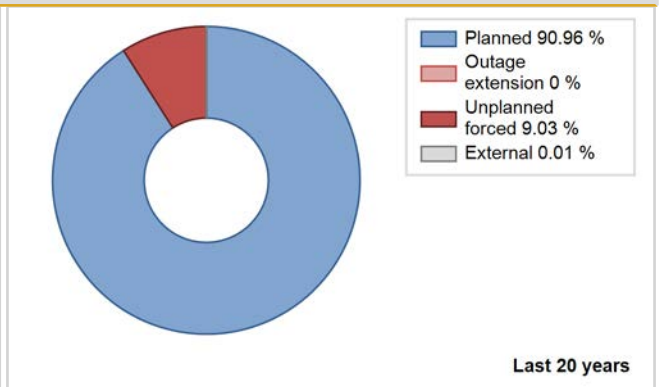
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2019	3934.18	3915	1000	100.00	100.00	92.83	93.25	0.00	0.00	0.00	0.00
2020	5896.66	6526	1000	82.41	82.41	67.13	74.29	4.15	3.57	14.02	0.00
2021	8522.45	8571	1000	99.31	99.31	97.29	97.84	0.00	0.00	0.69	0.00
2022	8349.54	8234	1000	93.56	93.56	95.31	94.00	0.00	0.00	6.44	0.00
2023	8015.33	7990	1000	90.92	90.92	91.50	91.21	0.00	0.00	9.08	0.00
2024	8179.48	8110	1000	94.14	94.14	93.12	92.33	0.00	0.00	5.85	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2019 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
C. Inspection, maintenance or repair combined with refuelling	480			512		
D. Inspection, maintenance or repair without refuelling				44		
I. Grid capacity limitation			195			218
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						46
Z. Other					40	
Subtotal	480		195	556	40	264
Total		**675**			**860**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2019 to 2024
	Hours Lost	Average hours lost per reactor-year
33. Circulating Water System		39
42. Electrical Power Supply Systems	195	211
Total	**195**	**250**

Highlights (2024)

Unit 6 of Yangjiang Nuclear Power Plant was disconnected from the grid for Y604 outage on November 4, 2024, and re-connected to the grid on November 24. The unit operated at full power at all times except during holidays and grid line maintenance in which it operated at reduced power in order to cooperate with peak shaving of the grid (including 1 shutdown for standby to cooperate with the grid). No scrams has occurred throughout the year.

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2024 Operating Experience

CN-57 ZHANGZHOU-1 CHINA

Status at end of year	:	**Operational**
Operator	:	ZGZEC (CNNP Guodian Zhangzhou Energy Co.,Ltd)
Owner	:	ZGZEC (CNNP Guodian Zhangzhou Energy Co.,Ltd)
Reactor Supplier	:	CFHI (China First Heavy Industries)
Turbine Supplier	:	SEPG (SHANGHAI ELECTRIC)

Reactor Unit Details

Reactor type and model	:	PWR / HPR1000
Thermal power	:	3190 MWth
Gross electrical power	:	1212 MWe
Reference unit power (net)	:	1126 MWe

Key Dates

Construction Date	:	2019-10-16
Grid Date	:	2024-11-28
Commercial Date	:	2025-01-01
Age at end of year	:	0 years

Design Characteristics

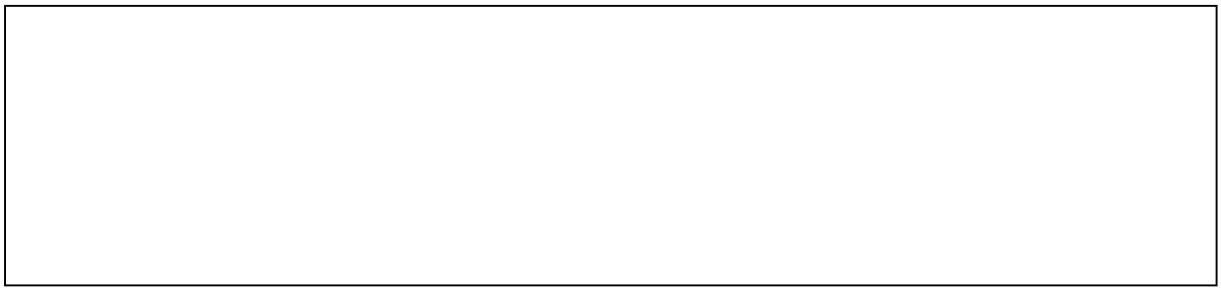
Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	0 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0 %	Total off-line time	:	hours

Annual Summary

No data found



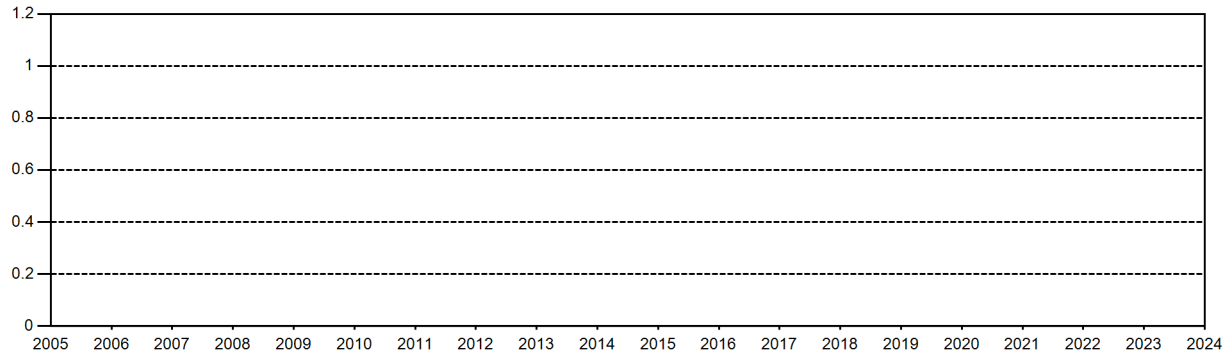
	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

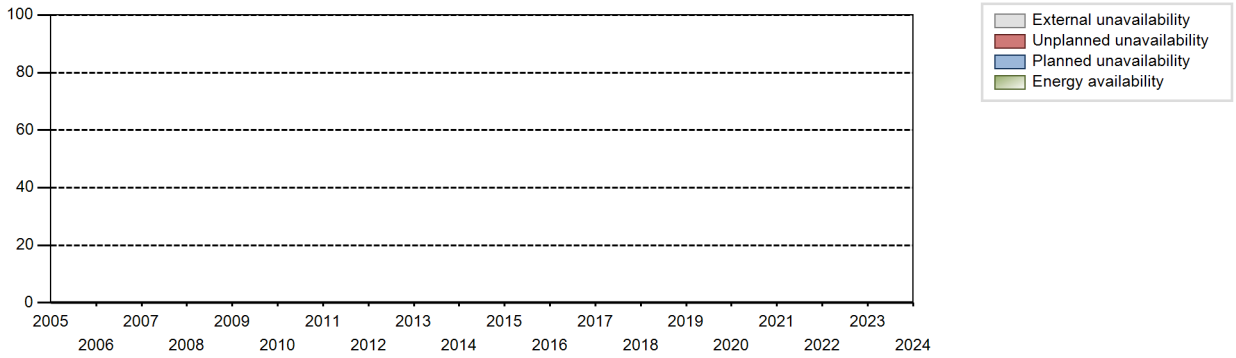
Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0 %
Cumulative Energy Availability Factor (EAF)	:	0 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0 %
Cumulative Unit Capability Factor (UCF)	:	0 %	Cumulative Planned Unavailability Factor (PUF)	:	0 %
Cumulative Load Factor (LF)	:	0 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	0 %			

Electricity Production (net) [GWh]

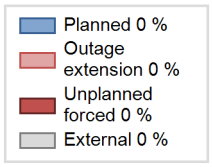


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]

Key Factors in Last 20 Years [%]



Energy Losses by Type



2024

No Data Available

Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024			2025 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
Subtotal						
Total	0			0		

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	2025 to 2024
	Hours Lost	Average hours lost per reactor-year
Total		

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2024 Operating Experience

CZ-4 DUKOVANY-1 CZECH REPUBLIC



Status at end of year	:	**Operational**
Operator	:	CEZ (CZECH POWER Co., CEZ a.s.)
Owner	:	CEZ (CZECH POWER Co., CEZ a.s.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1444 MWth
Gross electrical power	:	500 MWe
Reference unit power (net)	:	479 MWe

Key Dates

Construction Date	:	1979-01-01
Grid Date	:	1985-02-24
Commercial Date	:	1985-05-03
Age at end of year	:	39 years

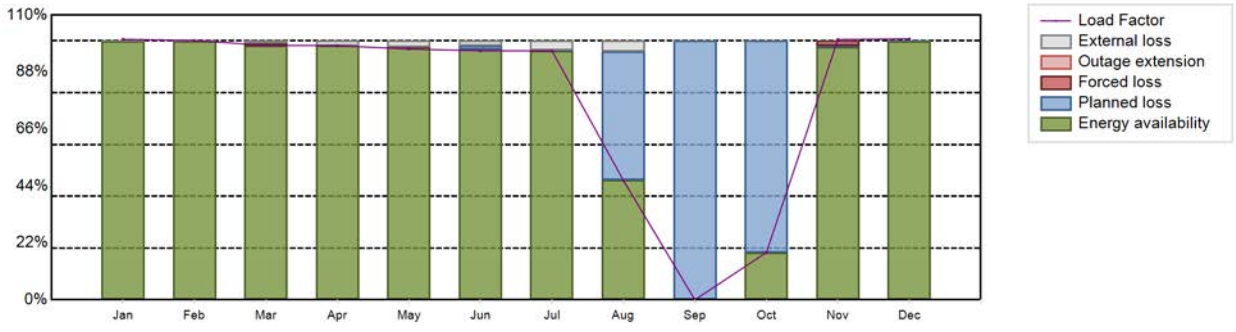
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.3
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	20
Average discharge burnup [MWd/t]	:	44000
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.1
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.26
Reactor outlet temperature [°C]	:	297
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.15
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.3
Output voltage [kV]	:	15.75
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3268.13 GW(e).h	Forced Loss Rate (FLR)	:	0.31 %
Energy Availability Factor (EAF)	:	79.01 %	Unplanned Capability Loss Factor (UCL)	:	0.25 %
Unit Capability Factor (UCF)	:	80.25 %	Planned Unavailability Factor (PUF)	:	19.5 %
Load Factor (LF)	:	79.34 %	Externally cause unavailability (XUF)	:	1.24 %
Operating Factor (OF)	:	81.1 %	Total off-line time	:	1660 hours

Annual Summary



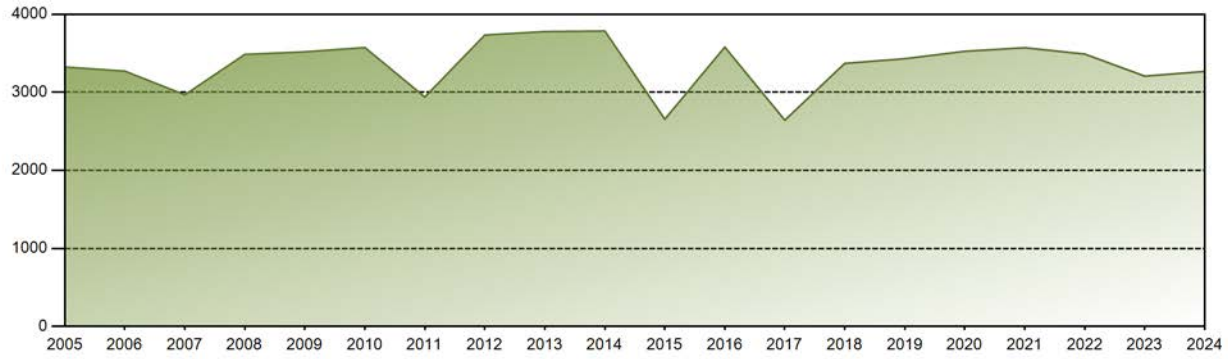
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	350.40	326.27	342.20	330.80	337.20	324.11	334.87	160.63	0.00	63.72	338.75	359.19	3268.13
EAF [%]	99.95	99.78	98.15	98.15	97.61	96.55	96.16	46.27	0.00	18.13	97.57	99.85	79.01
UCF [%]	100.00	100.00	98.93	100.00	99.94	98.53	99.76	50.30	0.00	18.13	97.57	99.85	80.25
LF [%]	100.63	100.17	98.28	98.17	96.84	96.19	96.17	46.13	0.00	18.30	100.53	100.79	79.34
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	50.81	0.00	22.85	100.00	100.00	81.10
FLR [%]	0.00	0.00	1.07	0.00	0.03	0.00	0.00	0.00	0.00	0.00	1.89	0.00	0.31
UCL [%]	0.00	0.00	1.07	0.00	0.03	0.00	0.00	0.00	0.00	0.00	1.88	0.00	0.25
PUF [%]	0.00	0.00	0.00	0.00	0.03	1.47	0.24	49.70	100.00	81.87	0.55	0.15	19.50
XUF [%]	0.05	0.22	0.78	1.85	2.33	1.97	3.60	4.03	0.00	0.00	0.00	0.00	1.24

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Historical Summary

Lifetime energy generation	:	125497.69 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.23 %
Cumulative Energy Availability Factor (EAF)	:	82.94 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.22 %
Cumulative Unit Capability Factor (UCF)	:	83.88 %	Cumulative Planned Unavailability Factor (PUF)	:	13.9 %
Cumulative Load Factor (LF)	:	83.73 %	Cumulative Externally cause unavailability (XUF)	:	0.94 %
Cumulative Operating Factor (OF)	:	85.27 %			

Electricity Production (net) [GWh]

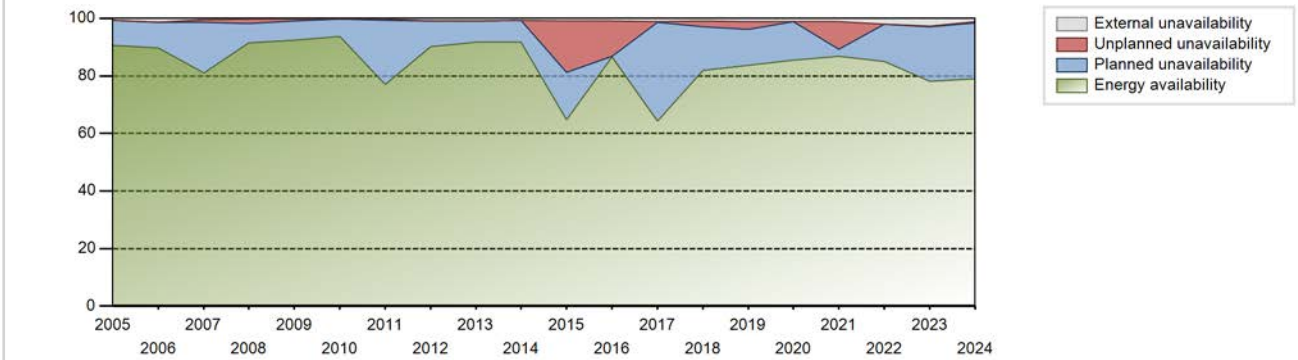


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	1993.92	5418	396	88.11	88.11	86.73	88.06	2.36	2.13	9.77	0.00
1986	2658.35	7094	403	76.12	76.15	75.30	80.98	1.22	0.94	22.91	0.03
1987	2575.95	6867	408	70.74	74.73	72.07	78.39	0.79	0.60	24.68	3.99
1988	2523.99	6996	408	71.53	74.17	70.43	79.64	1.48	1.11	24.72	2.64
1989	2940.57	7579	408	82.01	82.60	82.27	86.52	2.05	1.72	15.68	0.59
1990	2965.55	7658	408	82.49	84.34	82.97	87.42	3.02	2.62	13.04	1.85
1991	2581.09	6751	408	70.50	70.68	72.22	77.07	9.25	7.20	22.12	0.18
1992	3172.77	7537	408	80.45	80.90	88.53	85.80	3.16	2.64	16.46	0.44
1993	3239.65	7649	442	83.67	83.67	83.67	87.32	2.87	2.47	13.86	0.00
1994	3278.54	7656	442	84.64	84.64	84.67	87.40	3.15	2.76	12.60	0.00
1995	2966.06	7022	442	76.78	76.78	76.60	80.16	4.40	3.53	19.69	0.00
1996	3144.62	7592	412	85.36	86.01	86.89	86.43	2.73	2.42	11.57	0.65
1997	3295.57	7678	440	85.26	86.76	85.50	87.65	1.01	0.88	12.36	1.50
1998	2973.35	7518	412	82.62	85.44	82.38	85.82	3.29	2.91	11.65	2.82
1999	2901.08	7034	412	79.23	79.75	80.38	80.30	0.46	0.37	19.88	0.52
2000	3327.93	7934	412	89.73	89.84	91.96	90.32	0.48	0.44	9.72	0.11
2001	3328.90	7996	412	90.16	90.57	92.24	91.28	0.77	0.70	8.73	0.42
2002	3267.45	7926	412	88.92	89.63	90.53	90.48	1.03	0.94	9.43	0.71
2003	3032.00	7261	412	82.63	82.89	84.01	82.89	0.06	0.05	17.06	0.25
2004	3035.50	7349	412	82.91	83.65	83.88	83.66	0.01	1.17	15.18	0.73
2005	3324.55	8015	412	90.62	91.26	92.12	91.50	0.00	0.00	8.74	0.64
2006	3271.63	8014	412	89.73	91.20	90.65	91.48	0.01	0.01	8.79	1.46
2007	2967.32	7198	427	80.92	81.36	81.72	82.17	1.23	1.01	17.63	0.45
2008	3485.30	8090	427	91.59	91.80	92.92	92.10	1.66	1.55	6.65	0.21
2009	3518.64	8186	427	92.48	92.68	94.07	93.45	0.49	0.68	6.65	0.20
2010	3573.83	8256	427	93.76	93.98	95.54	94.25	0.06	0.06	5.96	0.21
2011	2939.01	6877	468	76.93	77.28	77.94	78.50	0.43	0.33	22.39	0.35
2012	3733.44	8049	468	90.24	91.13	90.82	91.63	0.06	0.06	8.82	0.89
2013	3778.58	8142	468	91.72	92.63	92.17	92.95	0.12	0.11	7.27	0.91
2014	3785.47	8141	468	91.74	92.55	92.34	92.93	0.00	0.00	7.45	0.80
2015	2655.64	5753	468	64.66	65.63	64.78	65.67	0.00	17.81	16.56	0.97
2016	3579.05	7721	468	86.69	87.58	87.07	87.91	0.00	12.35	0.07	0.89
2017	2642.46	5780	468	64.32	65.46	64.46	65.98	0.30	0.19	34.35	1.13
2018	3370.83	7305	468	81.91	82.82	82.22	83.39	2.36	2.00	15.18	0.91
2019	3430.94	7462	468	83.62	84.83	83.69	85.18	0.18	2.68	12.50	1.21
2020	3526.21	7620	468	85.48	86.67	85.78	86.75	0.00	0.00	13.33	1.19
2021	3571.79	7761	468	86.90	88.15	87.12	88.60	0.10	9.57	2.28	1.25

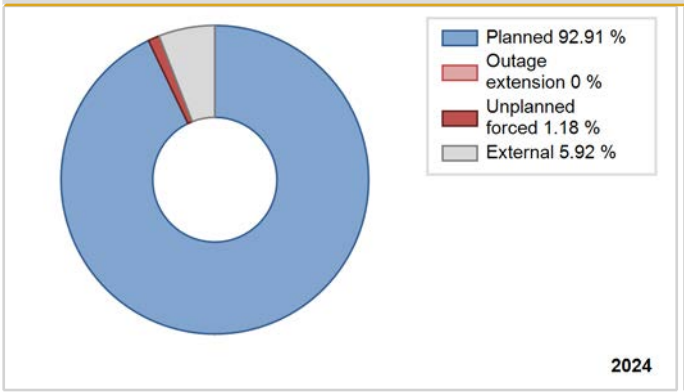
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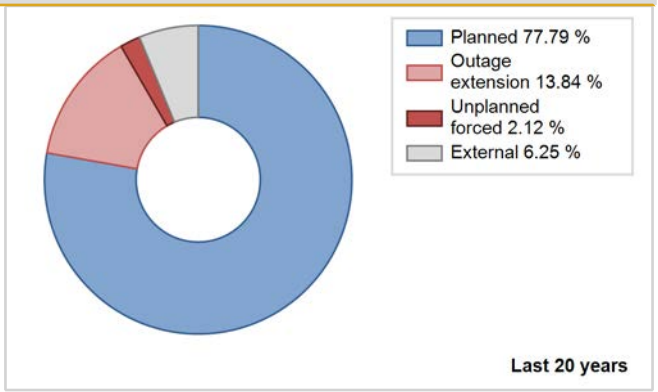
2022	3490.34	7673	468	85.11	87.12	85.14	87.59	0.15	0.13	12.75	2.01
2023	3207.28	7105	468	78.03	80.64	78.23	81.11	0.52	0.42	18.94	2.62
2024	3268.13	7124	479	79.01	80.25	79.34	81.10	0.31	0.25	19.50	1.24

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					70	
C. Inspection, maintenance or repair combined with refuelling	1660			1117		
D. Inspection, maintenance or repair without refuelling				69		
J. Grid limitation, failure or grid unavailability						4
L. Human factor related					66	
Subtotal	1660			1186	136	4
Total	**1660**			**1326**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1985 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		0
12. Reactor I&C Systems		3
13. Reactor Auxiliary Systems		1
14. Safety Systems		5
15. Reactor Cooling Systems		12
16. Steam generation systems		33
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		0
41. Main Generator Systems		0
42. Electrical Power Supply Systems		12
Total		**68**

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RUP revision during the year (2024) due to power uprate

RUP at the end of previous year : 468 [MWe]

Month	Capacity [MWe]	Power Uprate	Main modifications	Description
December	479	Extended power uprate (>7%)	Fuel or core Primary systems Balance of plant I&C and monitoring systems	use of project reserves

Highlights (2024)

the four units are now capable of supplying 2048 MWe to the grid under nominal conditions "almost 300 MWe more than when the last Dukovany unit was first started, 38 years ago"

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2024 Operating Experience

CZ-5 DUKOVANY-2 CZECH REPUBLIC



Status at end of year	:	**Operational**
Operator	:	CEZ (CZECH POWER Co., CEZ a.s.)
Owner	:	CEZ (CZECH POWER Co., CEZ a.s.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1444 MWth
Gross electrical power	:	500 MWe
Reference unit power (net)	:	482 MWe

Key Dates

Construction Date	:	1979-01-01
Grid Date	:	1986-01-30
Commercial Date	:	1986-03-21
Age at end of year	:	38 years

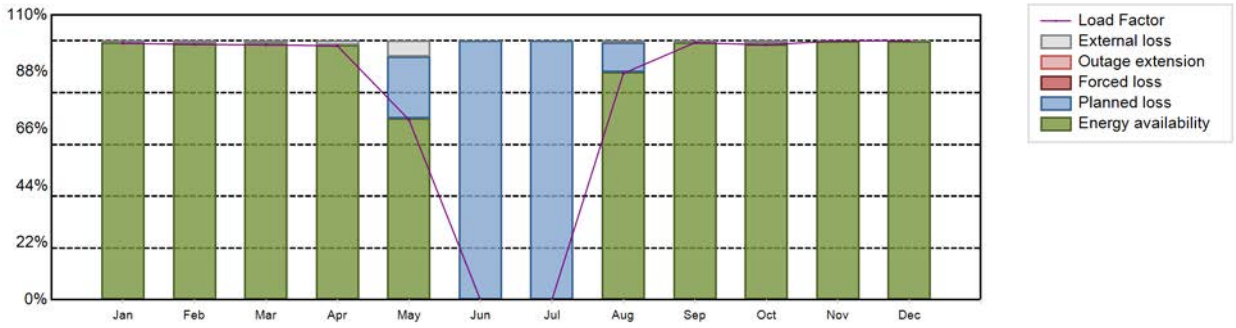
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.3
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	20
Average discharge burnup [MWd/t]	:	44000
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.1
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.26
Reactor outlet temperature [°C]	:	297
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.15
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.3
Output voltage [kV]	:	15.75
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3299.15 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	79.38 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	80.48 %	Planned Unavailability Factor (PUF)	:	19.52 %
Load Factor (LF)	:	79.18 %	Externally cause unavailability (XUF)	:	1.09 %
Operating Factor (OF)	:	80.83 %	Total off-line time	:	1684 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	347.12	323.44	345.02	332.65	243.70	0.00	0.00	306.47	341.77	353.18	347.21	358.59	3299.15
EAF [%]	99.35	98.93	98.86	98.30	70.12	0.00	0.00	88.01	99.41	98.72	99.88	99.94	79.38
UCF [%]	100.00	100.00	100.00	100.00	76.20	0.00	0.00	88.69	100.00	99.74	100.00	100.00	80.48
LF [%]	99.06	98.66	98.46	98.09	69.54	0.00	0.00	87.46	99.31	98.49	100.05	99.99	79.18
OF [%]	100.00	100.00	100.00	100.00	76.75	0.00	0.00	93.68	100.00	100.00	100.00	100.00	80.83
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	23.80	100.00	100.00	11.31	0.00	0.26	0.00	0.00	19.52
XUF [%]	0.65	1.07	1.14	1.70	6.08	0.00	0.00	0.68	0.59	1.02	0.12	0.06	1.09

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Historical Summary

Lifetime energy generation	:	120720.37 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.45 %
Cumulative Energy Availability Factor (EAF)	:	81.51 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.11 %
Cumulative Unit Capability Factor (UCF)	:	82.51 %	Cumulative Planned Unavailability Factor (PUF)	:	14.38 %
Cumulative Load Factor (LF)	:	82.15 %	Cumulative Externally cause unavailability (XUF)	:	1 %
Cumulative Operating Factor (OF)	:	84 %			

Electricity Production (net) [GWh]

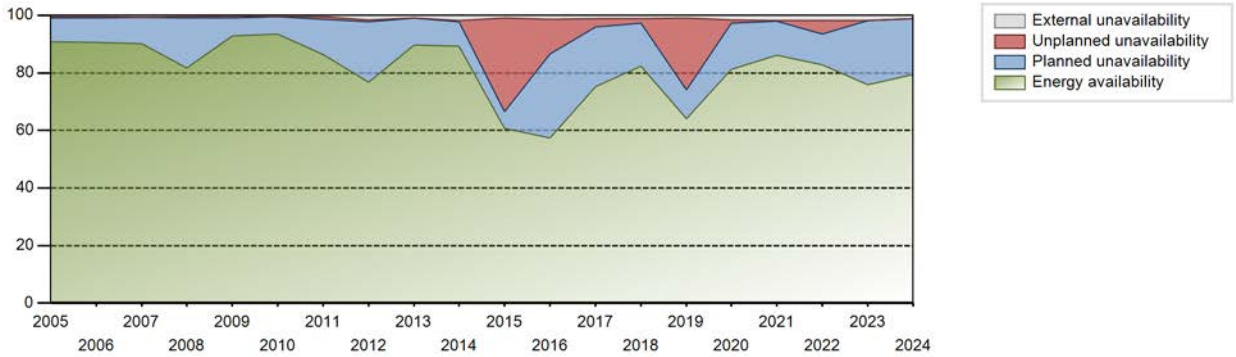


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	2792.72	7615	408	93.71	93.71	93.32	96.65	0.83	0.78	5.50	0.00
1987	2668.61	6997	408	71.57	76.57	74.67	79.87	0.21	0.16	23.28	5.00
1988	2771.27	6963	408	74.59	74.89	77.33	79.27	5.14	4.06	21.06	0.30
1989	3011.03	7713	408	82.23	82.68	84.25	88.05	1.71	1.43	15.89	0.45
1990	2822.65	7566	408	76.46	80.06	78.98	86.37	5.38	4.55	15.39	3.60
1991	2901.44	7600	408	81.18	81.60	81.18	86.76	3.41	2.88	15.52	0.42
1992	2830.61	6551	408	71.42	71.59	78.98	74.58	0.74	0.53	27.88	0.16
1993	3256.93	7496	440	84.16	84.16	84.50	85.57	1.34	1.14	14.70	0.00
1994	3094.32	7315	440	79.64	80.75	80.28	83.50	6.29	5.42	13.82	1.11
1995	3263.35	7720	440	84.35	85.52	84.67	88.13	3.54	3.13	11.34	1.17
1996	2831.01	6917	412	77.31	78.32	78.23	78.75	1.82	1.45	20.22	1.02
1997	3144.83	7179	440	81.11	81.11	81.59	81.95	0.89	0.73	18.16	0.00
1998	3209.23	7803	412	87.73	88.24	88.92	89.08	0.63	0.56	11.20	0.51
1999	3198.15	7812	412	87.81	88.44	88.61	89.18	2.04	1.84	9.71	0.63
2000	2954.10	7223	412	81.18	81.80	81.63	82.23	0.78	0.64	17.56	0.62
2001	3121.12	7646	412	86.35	86.92	86.48	87.28	0.71	0.62	12.46	0.56
2002	3159.64	7716	412	87.83	88.30	87.55	88.08	0.40	0.35	11.35	0.47
2003	3252.55	7939	412	89.20	89.85	90.12	90.63	1.01	0.92	9.23	0.65
2004	3087.75	7439	412	84.19	84.36	85.31	84.68	0.19	0.16	15.48	0.16
2005	3313.22	8048	412	90.75	91.25	91.80	91.87	0.49	0.45	8.30	0.50
2006	3294.69	8017	412	90.59	91.15	91.29	91.52	0.29	0.27	8.58	0.56
2007	3274.74	7983	412	90.12	90.88	90.74	91.13	0.06	0.05	9.07	0.77
2008	3040.36	7228	427	81.60	82.08	82.01	82.29	0.49	0.40	17.52	0.48
2009	3507.86	8209	427	92.78	93.15	93.78	93.71	0.41	0.61	6.24	0.38
2010	3535.93	8250	427	93.39	93.81	94.53	94.18	0.00	0.06	6.14	0.42
2011	3254.83	7676	427	86.33	86.73	87.04	87.65	0.66	1.04	12.23	0.40
2012	3047.28	6918	471	76.80	78.31	76.63	78.76	0.82	0.65	21.04	1.51
2013	3690.57	7984	471	89.75	90.61	89.45	91.14	0.12	0.11	9.28	0.85
2014	3672.64	8033	471	89.25	91.15	89.01	91.70	0.34	0.32	8.54	1.90
2015	2495.87	5426	471	60.74	61.63	60.49	61.94	31.80	32.58	5.79	0.89
2016	2361.31	5194	471	57.39	58.80	57.07	59.13	17.04	12.08	29.12	1.41
2017	3089.36	6782	471	75.20	76.32	74.88	77.42	3.04	2.90	20.78	1.12
2018	3384.99	7359	471	82.35	83.55	82.04	84.01	1.80	1.53	14.92	1.20
2019	2636.32	5751	471	64.14	65.15	63.90	65.65	27.32	24.94	9.91	1.01
2020	3346.78	7359	471	81.25	82.83	80.89	83.78	0.80	1.21	15.95	1.58
2021	3546.52	7744	471	86.20	88.05	85.96	88.40	0.15	0.14	11.81	1.85
2022	3401.12	7448	471	82.83	84.55	82.43	85.02	5.28	4.71	10.74	1.73

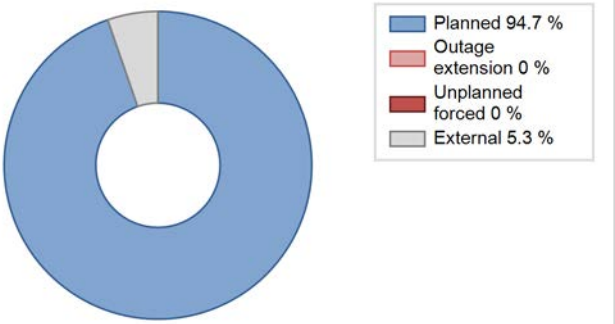
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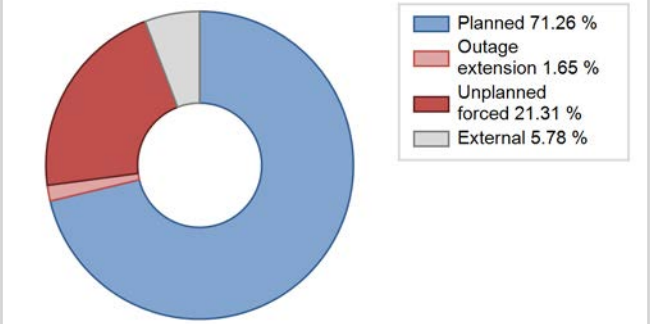
2023	3115.80	6864	471	75.91	77.75	75.52	78.36	0.01	0.01	22.24	1.84
2024	3299.15	7100	482	79.38	80.48	79.18	80.83	0.00	0.00	19.52	1.09

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					89	
C. Inspection, maintenance or repair combined with refuelling	1684			1024		
D. Inspection, maintenance or repair without refuelling				74		
E. Testing of plant systems or components					2	
F. Major backfitting, refurbishment or upgrading activities with refuelling				112		
J. Grid limitation, failure or grid unavailability						4
L. Human factor related					119	
Subtotal	1684			1210	210	4
Total	**1684**			**1424**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1986 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		0
12. Reactor I&C Systems		9
13. Reactor Auxiliary Systems		2
15. Reactor Cooling Systems		17
16. Steam generation systems		60
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		1
32. Feedwater and Main Steam System		10
33. Circulating Water System		1
34. Miscellaneous Systems		1
42. Electrical Power Supply Systems		5
Total		**108**

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RUP revision during the year (2024) due to power uprate

RUP at the end of previous year : 471 [MWe]

Month	Capacity [MWe]	Power Uprate	Main modifications	Description
September	478	Stretch power uprate (2-7%)	Fuel or core Primary systems Balance of plant I&C and monitoring systems	use of project reserves
October	482	Improved measurement (<2%)	Fuel or core Primary systems Balance of plant I&C and monitoring systems	use of project reserves

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2024 Operating Experience

CZ-8 DUKOVANY-3 CZECH REPUBLIC

Status at end of year	:	**Operational**
Operator	:	CEZ (CZECH POWER Co., CEZ a.s.)
Owner	:	CEZ (CZECH POWER Co., CEZ a.s.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)



Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1444 MWth
Gross electrical power	:	500 MWe
Reference unit power (net)	:	475 MWe

Key Dates

Construction Date	:	1979-03-01
Grid Date	:	1986-11-14
Commercial Date	:	1986-12-20
Age at end of year	:	38 years

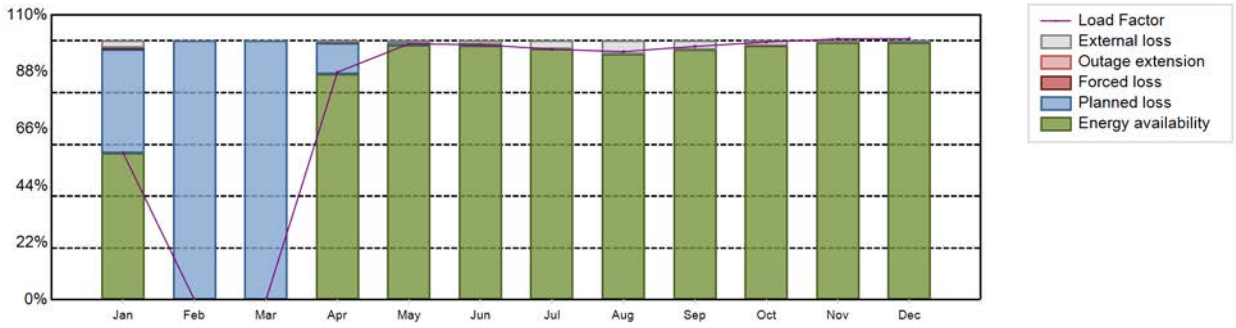
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	12.26
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	297
Fuel material	:	UO2	Number of SG	:	6
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.15
Average fuel enrichment [% of U235]	:	4.3	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	20	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	2.88	HP cylinder inlet steam pressure [MPa]	:	4.3
Active core height/length [m]	:	2.5	Output voltage [kV]	:	15.75
Number of fissile fuel assemblies/bundles	:	349	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	13.1	Number of main condensate pumps	:	3
Number of control rod assemblies	:	37	Number of FW pumps for full power operation	:	4
Number of external reactor coolant loops	:	6	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	3238.93 GW(e).h	Forced Loss Rate (FLR)	:	0.1 %
Energy Availability Factor (EAF)	:	77.55 %	Unplanned Capability Loss Factor (UCL)	:	0.08 %
Unit Capability Factor (UCF)	:	79.27 %	Planned Unavailability Factor (PUF)	:	20.65 %
Load Factor (LF)	:	78.2 %	Externally cause unavailability (XUF)	:	1.72 %
Operating Factor (OF)	:	79.68 %	Total off-line time	:	1785 hours

Annual Summary



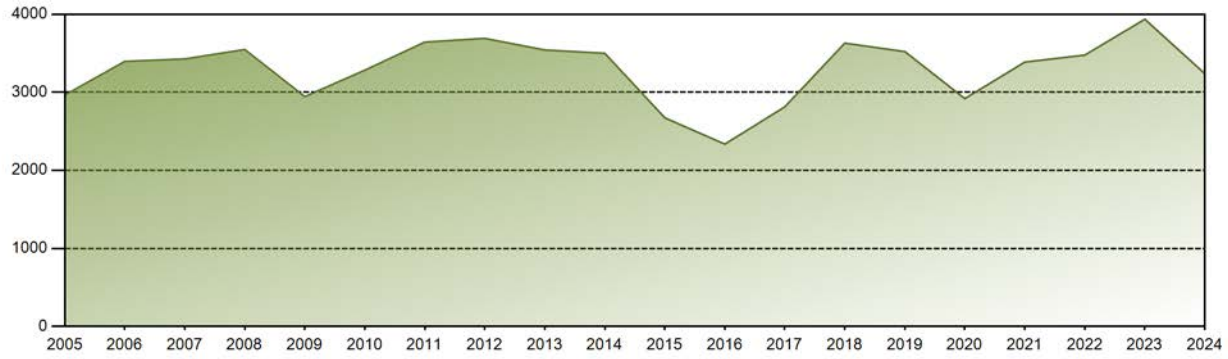
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	197.92	0.00	0.00	296.30	344.21	332.14	341.94	338.77	334.76	351.83	344.62	356.43	3238.93
EAF [%]	56.73	0.00	0.00	87.32	98.47	98.15	96.89	94.91	96.70	98.18	99.33	99.47	77.55
UCF [%]	59.42	0.00	0.00	87.97	99.63	99.59	100.00	100.00	100.00	100.00	100.00	99.96	79.27
LF [%]	56.84	0.00	0.00	87.93	98.86	98.57	96.76	95.86	97.88	99.56	100.77	100.86	78.20
OF [%]	60.62	0.00	0.00	92.78	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	79.68
FLR [%]	1.12	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
UCL [%]	0.67	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
PUF [%]	39.91	100.00	100.00	11.73	0.37	0.41	0.00	0.00	0.00	0.00	0.00	0.04	20.65
XUF [%]	2.69	0.00	0.00	0.65	1.17	1.44	3.11	5.09	3.30	1.82	0.67	0.49	1.72

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Historical Summary

Lifetime energy generation	:	120238 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.91 %
Cumulative Energy Availability Factor (EAF)	:	81.6 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.13 %
Cumulative Unit Capability Factor (UCF)	:	83.14 %	Cumulative Planned Unavailability Factor (PUF)	:	13.73 %
Cumulative Load Factor (LF)	:	82.5 %	Cumulative Externally cause unavailability (XUF)	:	1.53 %
Cumulative Operating Factor (OF)	:	84.53 %			

Electricity Production (net) [GWh]

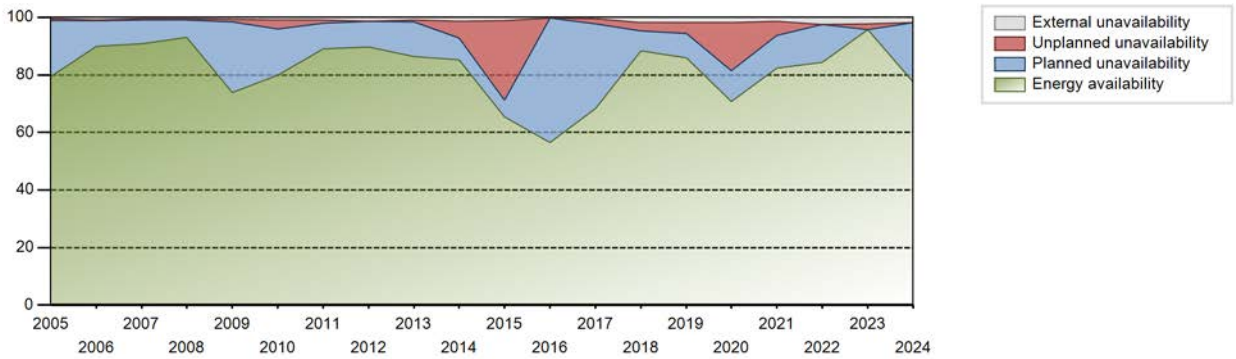


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	280.19	1356	408	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	3109.91	7644	408	84.32	86.35	87.01	87.26	0.46	0.40	13.25	2.03
1988	2988.88	7672	408	79.96	81.44	83.40	87.34	0.40	0.33	18.22	1.48
1989	2685.66	6678	408	71.04	71.39	75.14	76.23	1.53	1.11	27.50	0.35
1990	2981.97	7763	408	80.32	84.97	83.43	88.62	2.80	2.44	12.58	4.65
1991	2987.03	7784	408	81.28	81.59	83.57	88.86	6.94	6.09	12.33	0.31
1992	2917.94	6678	408	72.27	72.59	81.42	76.02	8.86	7.06	20.36	0.32
1993	3190.49	7259	452	80.51	80.51	80.58	82.87	3.63	3.03	16.46	0.00
1994	3343.93	7870	452	84.45	84.45	84.45	89.84	13.39	13.05	2.49	0.00
1995	2689.63	7788	452	70.02	87.40	67.93	88.90	1.70	1.51	11.08	17.38
1996	2871.23	7114	412	78.29	80.39	79.34	80.99	2.57	2.12	17.48	2.10
1997	2904.58	6774	440	74.88	75.46	75.36	77.33	2.29	1.77	22.77	0.57
1998	3090.14	7564	412	85.02	85.70	85.62	86.35	3.01	2.66	11.64	0.67
1999	3246.18	7849	412	89.28	89.86	89.94	89.60	0.39	0.35	9.79	0.58
2000	3187.89	7776	412	87.40	88.75	88.09	88.52	0.42	0.37	10.88	1.35
2001	3005.99	7309	412	82.67	83.78	83.29	83.44	0.06	0.05	16.16	1.12
2002	3259.39	7880	412	89.56	89.89	90.31	89.95	0.00	0.00	10.11	0.33
2003	3280.09	7934	412	89.83	90.50	90.88	90.57	0.03	0.02	9.47	0.68
2004	3302.47	7957	412	90.17	90.27	91.24	90.57	0.10	0.09	9.64	0.10
2005	2964.87	7034	427	79.55	80.00	80.19	80.30	0.85	0.68	19.32	0.45
2006	3396.20	8004	427	90.01	90.83	90.79	91.37	0.41	0.38	8.79	0.82
2007	3427.86	8068	427	90.90	91.41	91.64	92.10	0.49	0.45	8.13	0.51
2008	3548.84	8273	427	93.15	93.66	94.62	94.18	0.02	0.37	5.97	0.50
2009	2944.75	6688	468	73.96	74.69	73.96	76.35	0.99	0.80	24.51	0.74
2010	3283.52	7146	468	79.93	80.87	80.09	81.58	1.99	3.01	16.13	0.94
2011	3643.88	7940	468	89.03	89.93	88.88	90.64	0.60	1.10	8.97	0.90
2012	3691.31	8040	468	89.82	91.09	89.79	91.53	0.07	0.06	8.84	1.28
2013	3542.84	7714	468	86.36	87.37	86.42	88.06	0.31	0.68	11.95	1.01
2014	3500.03	7639	468	85.15	86.61	85.37	87.20	5.52	5.81	7.59	1.46
2015	2673.32	5870	468	65.48	66.71	65.21	67.01	29.23	27.65	5.64	1.23
2016	2336.18	5021	468	56.57	56.75	56.83	57.16	0.01	0.01	43.24	0.18
2017	2813.49	6072	468	68.37	68.86	68.63	69.32	0.07	1.68	29.47	0.48
2018	3630.68	7947	468	88.45	90.37	88.56	90.72	3.09	2.88	6.75	1.92
2019	3521.99	7691	468	85.94	87.65	85.91	87.80	0.04	3.86	8.49	1.71
2020	2919.55	6452	468	70.76	72.50	71.02	73.45	5.75	16.72	10.78	1.74
2021	3387.51	7412	468	82.32	83.75	82.63	84.61	3.91	4.76	11.49	1.43
2022	3477.43	7638	468	84.35	86.76	84.83	87.20	0.00	0.00	13.24	2.41

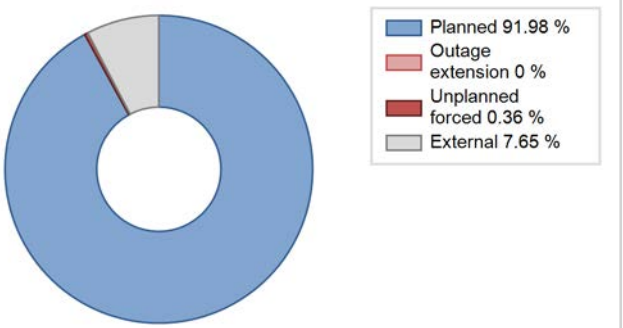
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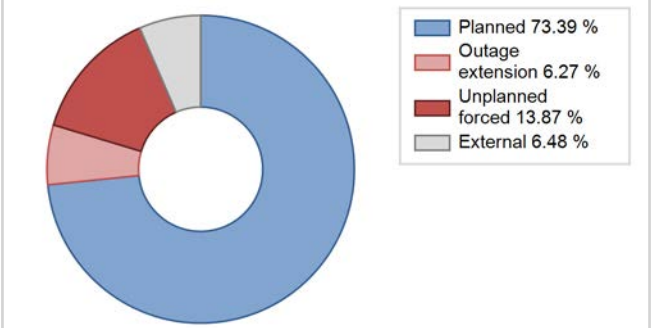
2023	3936.58	8637	468	95.62	97.85	96.02	98.60	2.09	2.09	0.06	2.23
2024	3238.93	6999	475	77.55	79.27	78.20	79.68	0.10	0.08	20.65	1.72

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					111	
C. Inspection, maintenance or repair combined with refuelling	1785			1027		
D. Inspection, maintenance or repair without refuelling				32		
F. Major backfitting, refurbishment or upgrading activities with refuelling				99		
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					95	
Z. Other					5	
Subtotal	1785			1158	211	3
Total	**1785**			**1372**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1986 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		1
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		1
14. Safety Systems		10
15. Reactor Cooling Systems		43
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		14
33. Circulating Water System		8
35. All other I&C Systems		0
41. Main Generator Systems		25
42. Electrical Power Supply Systems		2
Total		**113**

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RUP revision during the year (2024) due to power uprate

RUP at the end of previous year : 468 [MWe]

Month	Capacity [MWe]	Power Uprate	Main modifications	Description
July	475	Extended power uprate (>7%)	Fuel or core Primary systems Balance of plant I&C and monitoring systems	use of project reserves

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2024 Operating Experience

CZ-9 DUKOVANY-4 CZECH REPUBLIC



Status at end of year	:	**Operational**
Operator	:	CEZ (CZECH POWER Co., CEZ a.s.)
Owner	:	CEZ (CZECH POWER Co., CEZ a.s.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1444 MWth
Gross electrical power	:	500 MWe
Reference unit power (net)	:	471 MWe

Key Dates

Construction Date	:	1979-03-01
Grid Date	:	1987-06-11
Commercial Date	:	1987-07-19
Age at end of year	:	37 years

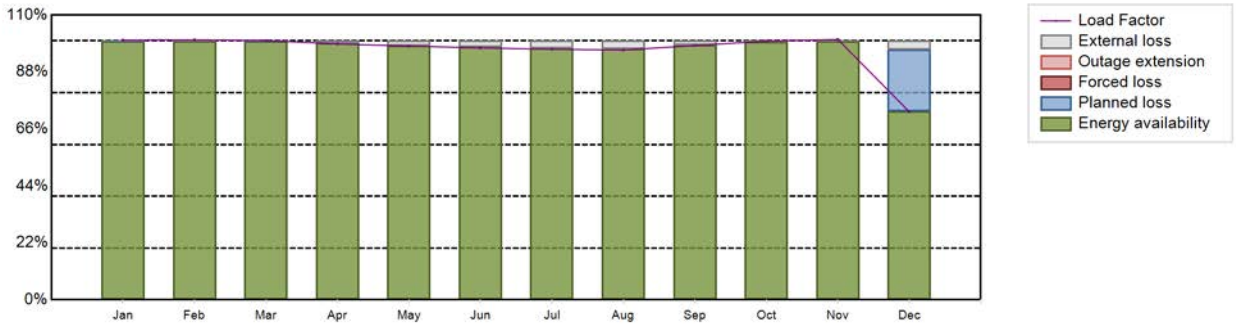
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	12.26
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	297
Fuel material	:	UO2	Number of SG	:	6
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.15
Average fuel enrichment [% of U235]	:	4.3	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	20	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	44000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	2.88	HP cylinder inlet steam pressure [MPa]	:	4.3
Active core height/length [m]	:	2.5	Output voltage [kV]	:	15.75
Number of fissile fuel assemblies/bundles	:	349	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	13.1	Number of main condensate pumps	:	3
Number of control rod assemblies	:	37	Number of FW pumps for full power operation	:	4
Number of external reactor coolant loops	:	6	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	3996.18 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	96.53 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	97.98 %	Planned Unavailability Factor (PUF)	:	2.02 %
Load Factor (LF)	:	96.59 %	Externally cause unavailability (XUF)	:	1.45 %
Operating Factor (OF)	:	98.02 %	Total off-line time	:	174 hours

Annual Summary



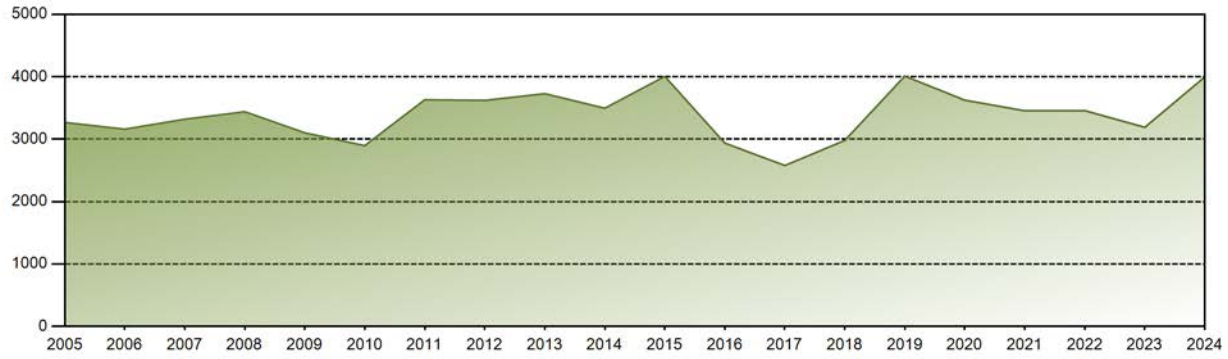
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	351.61	329.21	350.96	335.09	343.37	330.00	339.10	338.11	333.04	350.12	341.02	254.54	3996.17
EAF [%]	99.86	99.99	99.83	99.02	98.15	97.55	97.03	96.78	98.32	99.57	99.91	72.83	96.53
UCF [%]	99.98	100.00	99.94	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00	76.21	97.98
LF [%]	100.34	100.42	100.15	98.81	97.99	97.31	96.77	96.49	98.21	99.91	100.56	72.64	96.59
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	76.61	98.02
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.02	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.79	2.02
XUF [%]	0.12	0.01	0.12	0.96	1.85	2.45	2.97	3.22	1.68	0.43	0.09	3.37	1.45

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Historical Summary

Lifetime energy generation	:	121495.5 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.94 %
Cumulative Energy Availability Factor (EAF)	:	83.75 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.86 %
Cumulative Unit Capability Factor (UCF)	:	84.69 %	Cumulative Planned Unavailability Factor (PUF)	:	13.45 %
Cumulative Load Factor (LF)	:	84.76 %	Cumulative Externally cause unavailability (XUF)	:	0.94 %
Cumulative Operating Factor (OF)	:	86.18 %			

Electricity Production (net) [GWh]

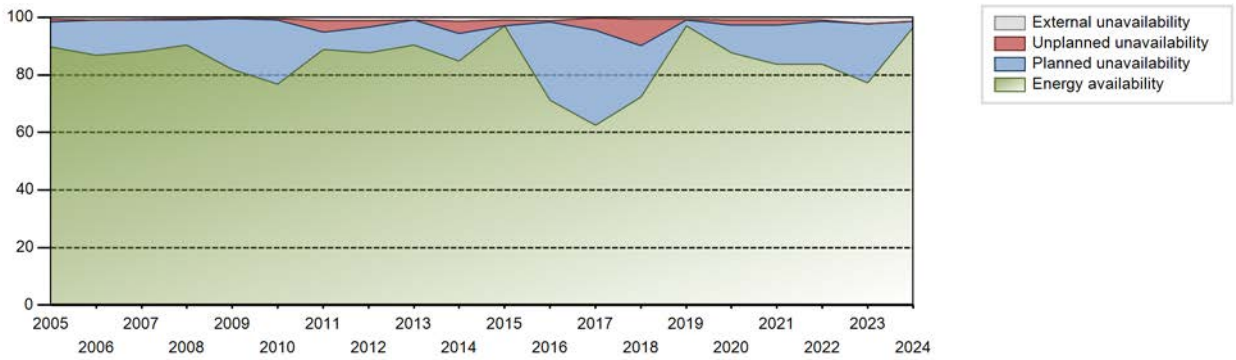


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	1624.94	4643	408	97.85	99.92	90.09	94.34	0.08	0.08	0.00	2.08
1988	2764.01	7092	408	73.78	74.45	77.12	80.74	3.05	2.34	23.20	0.67
1989	2984.55	7314	408	80.41	80.81	83.51	83.49	0.54	0.44	18.74	0.41
1990	2995.30	7836	408	79.96	82.75	83.81	89.45	2.21	1.87	15.38	2.79
1991	2671.99	7301	408	77.93	78.03	74.76	83.34	4.57	3.74	18.23	0.10
1992	3328.41	7614	408	83.66	84.48	92.87	86.68	2.81	2.45	13.07	0.82
1993	2939.81	6859	448	62.05	62.05	74.91	78.30	21.40	16.90	21.05	0.00
1994	3259.81	7538	448	83.06	84.51	83.06	86.05	2.85	2.48	13.01	1.45
1995	3311.14	7712	448	85.35	85.46	84.37	88.04	3.74	3.32	11.23	0.11
1996	3202.13	7762	412	87.13	88.19	88.48	88.37	0.18	0.16	11.64	1.06
1997	3149.15	7202	440	80.89	80.89	81.70	82.21	0.50	0.41	18.70	0.00
1998	3078.56	7536	412	83.85	85.66	85.30	86.03	0.28	0.24	14.09	1.81
1999	3179.42	7792	412	86.60	88.64	88.09	88.95	0.18	0.16	11.20	2.04
2000	3234.52	7839	412	88.12	89.46	89.38	89.24	0.10	0.09	10.45	1.34
2001	3258.06	7946	412	89.25	90.40	90.27	90.71	0.24	0.21	9.39	1.15
2002	2748.24	6745	412	75.57	77.29	76.15	77.00	0.04	0.03	22.68	1.72
2003	3309.80	8009	412	90.66	91.35	91.71	91.43	0.02	0.02	8.63	0.70
2004	3335.38	8029	412	90.87	91.09	92.16	91.40	0.06	0.06	8.85	0.23
2005	3267.00	8008	412	89.62	90.27	90.52	91.42	0.98	0.89	8.83	0.66
2006	3159.49	7704	412	86.92	87.79	87.54	87.95	0.16	0.14	12.07	0.88
2007	3318.99	7854	427	88.05	88.70	88.73	89.66	0.37	0.33	10.96	0.65
2008	3438.67	8010	427	90.35	90.74	91.68	91.19	0.62	0.56	8.70	0.39
2009	3100.50	7247	427	81.82	81.99	82.89	82.73	0.31	0.25	17.75	0.18
2010	2895.11	6846	427	76.74	77.31	77.40	78.15	0.32	0.24	22.44	0.57
2011	3630.71	8001	471	88.78	89.87	88.00	91.34	4.28	4.02	6.11	1.09
2012	3620.96	7850	471	87.65	88.75	87.52	89.37	0.14	2.37	8.87	1.11
2013	3727.91	8009	471	90.45	91.36	90.35	91.43	0.00	0.00	8.63	0.91
2014	3494.80	7591	471	84.79	86.06	84.70	86.66	4.68	4.23	9.71	1.27
2015	4004.79	8623	471	97.05	98.00	97.06	98.44	1.89	1.89	0.11	0.96
2016	2936.27	6423	471	71.26	72.43	70.97	73.12	0.44	0.32	27.25	1.17
2017	2576.88	5542	471	62.47	62.75	62.46	63.26	6.37	4.27	32.98	0.28
2018	2979.28	6498	471	72.22	72.99	72.22	74.19	10.97	8.99	18.01	0.77
2019	4009.33	8576	471	96.97	97.73	97.17	97.90	0.21	0.20	2.07	0.76
2020	3624.27	7800	471	87.66	88.53	87.60	88.80	0.00	1.73	9.73	0.88
2021	3454.30	7452	471	83.80	84.65	83.72	85.07	0.02	1.93	13.42	0.85
2022	3456.36	7454	471	83.78	84.76	83.77	85.09	0.00	0.32	14.92	0.99
2023	3189.39	7000	471	77.31	79.59	77.30	79.91	0.01	0.01	20.40	2.28

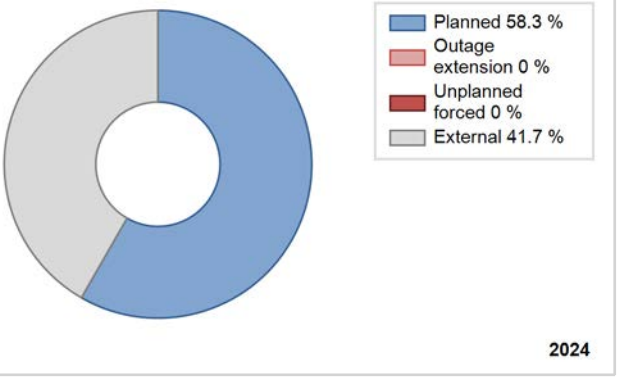
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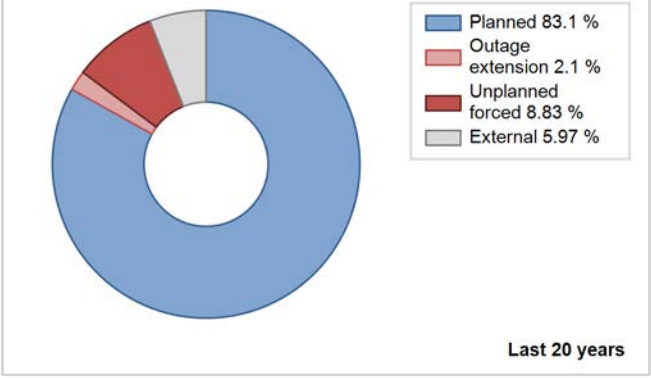
2024	3996.18	8610	471	96.53	97.98	96.59	98.02	0.00	0.00	2.02	1.45

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					69	
C. Inspection, maintenance or repair combined with refuelling	174			984		
D. Inspection, maintenance or repair without refuelling				50		
E. Testing of plant systems or components					4	
F. Major backfitting, refurbishment or upgrading activities with refuelling				63		
J. Grid limitation, failure or grid unavailability						3
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						3
L. Human factor related					7	
Subtotal	174			1097	80	6
Total	**174**			**1183**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1987 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		4
14. Safety Systems		5
15. Reactor Cooling Systems		10
16. Steam generation systems		17
17. Safety I&C Systems (excluding reactor I&C)		10
32. Feedwater and Main Steam System		16
33. Circulating Water System		9
35. All other I&C Systems		1
42. Electrical Power Supply Systems		1
Total		**73**

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2024 Operating Experience

CZ-23 TEMELIN-1 CZECH REPUBLIC



Status at end of year	:	**Operational**
Operator	:	CEZ (CZECH POWER Co., CEZ a.s.)
Owner	:	CEZ (CZECH POWER Co., CEZ a.s.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3120 MWth
Gross electrical power	:	1082 MWe
Reference unit power (net)	:	1027 MWe

Key Dates

Construction Date	:	1987-02-01
Grid Date	:	2000-12-21
Commercial Date	:	2002-06-10
Age at end of year	:	24 years

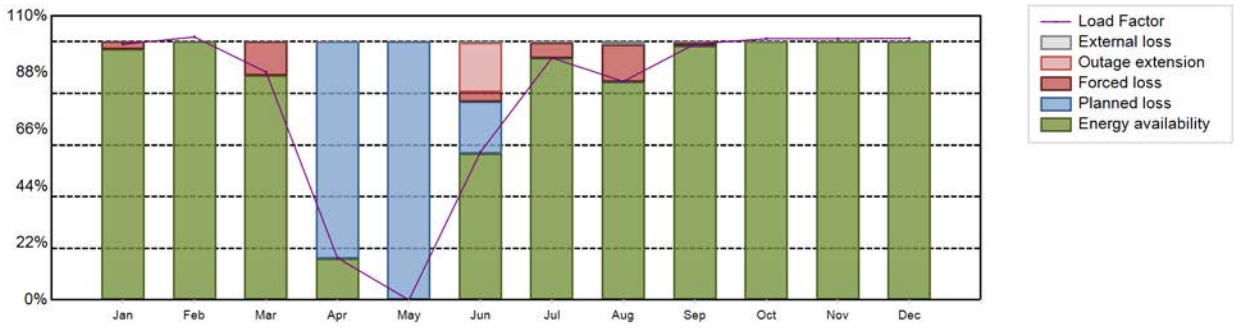
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.6
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	25.7
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.63
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	16.3
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	318
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.46
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.2
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	7094.55 GW(e).h
Energy Availability Factor (EAF)	:	77.75 %
Unit Capability Factor (UCF)	:	77.93 %
Load Factor (LF)	:	78.64 %
Operating Factor (OF)	:	78.88 %
Equivalent non-electrical energy generated (NEG)	:	39.94 GW(e).h
Forced Loss Rate (FLR)	:	4.26 %
Unplanned Capability Loss Factor (UCL)	:	5.04 %
Planned Unavailability Factor (PUF)	:	17.03 %
Externally cause unavailability (XUF)	:	0.18 %
Total off-line time	:	1855 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	756.55	728.03	674.66	120.49	0.00	423.56	716.15	646.74	733.01	773.11	748.09	774.16	7094.55
EAF [%]	97.09	100.00	86.99	15.88	0.00	56.66	93.69	84.54	98.35	99.99	100.00	100.00	77.75
UCF [%]	97.09	100.00	86.99	15.88	0.00	56.94	94.14	85.66	98.64	99.99	100.00	100.00	77.93
LF [%]	99.01	101.85	88.30	16.29	0.00	57.28	93.73	84.64	99.13	101.18	101.17	101.32	78.64
OF [%]	97.18	100.00	87.50	16.25	0.00	63.19	95.83	87.50	99.31	100.00	100.00	100.00	78.88
FLR [%]	2.91	0.00	13.01	0.00	0.00	6.04	5.86	14.32	1.34	0.00	0.00	0.00	4.26
UCL [%]	2.91	0.00	13.01	0.00	0.00	22.83	5.86	14.32	1.34	0.00	0.00	0.00	5.04
PUF [%]	0.00	0.00	0.00	84.12	100.00	20.24	0.00	0.02	0.02	0.01	0.00	0.00	17.03
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.28	0.46	1.12	0.28	0.00	0.00	0.00	0.18

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Historical Summary

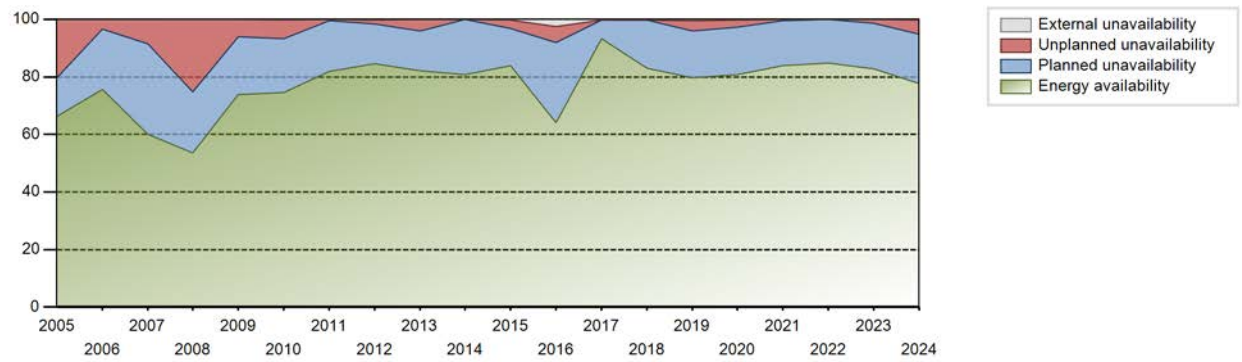
Lifetime energy generation	:	153225.71 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.11 %
Cumulative Energy Availability Factor (EAF)	:	76.6 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.78 %
Cumulative Unit Capability Factor (UCF)	:	76.86 %	Cumulative Planned Unavailability Factor (PUF)	:	18.36 %
Cumulative Load Factor (LF)	:	76.99 %	Cumulative Externally cause unavailability (XUF)	:	0.25 %
Cumulative Operating Factor (OF)	:	77.3 %			

Electricity Production (net) [GWh]



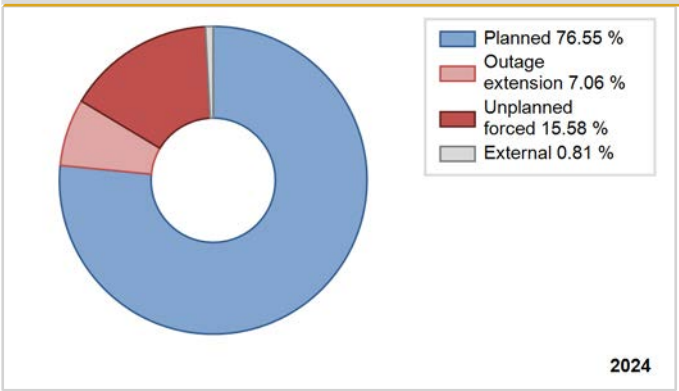
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2002	5147.87	5961	930	76.06	76.06	76.96	82.42	5.17	4.15	19.80	0.00
2003	5455.32	5861	912	65.30	65.30	68.28	66.91	4.15	4.71	29.99	0.00
2004	5715.82	6029	950	68.01	68.09	68.50	68.64	7.98	6.07	25.84	0.08
2005	5443.97	5846	950	66.30	66.33	66.35	66.74	16.34	20.25	13.42	0.03
2006	6124.86	6731	930	75.68	75.69	75.18	76.84	4.39	3.48	20.83	0.01
2007	4901.35	5282	963	60.02	60.02	59.63	60.30	4.05	8.54	31.44	0.01
2008	4526.45	4745	963	53.50	53.57	53.51	54.02	11.75	25.06	21.36	0.07
2009	6229.78	6527	963	73.81	73.88	73.85	74.51	4.22	6.00	20.12	0.07
2010	6305.63	6594	963	74.50	74.83	74.75	75.27	0.65	6.49	18.68	0.33
2011	6915.59	7205	963	81.80	81.82	81.98	82.25	0.53	0.44	17.75	0.02
2012	7159.77	7515	963	84.68	84.99	84.64	85.55	1.59	1.38	13.63	0.31
2013	7018.65	7252	1003	82.22	82.26	82.06	82.79	1.18	4.07	13.68	0.04
2014	7194.59	7092	1023	80.85	80.85	81.34	80.96	0.02	0.10	19.04	0.01
2015	7581.24	7400	1026	83.88	84.22	84.35	84.47	3.28	2.86	12.92	0.34
2016	5786.94	5868	1026	64.07	66.48	64.21	66.80	0.59	5.72	27.79	2.42
2017	8410.14	8205	1026	93.27	93.60	93.57	93.66	0.03	0.02	6.37	0.33
2018	7487.60	7321	1027	83.11	83.34	83.24	83.57	0.11	0.09	16.57	0.23
2019	7169.40	7088	1027	79.65	80.21	79.69	80.91	4.17	3.49	16.30	0.56
2020	7294.10	7178	1027	80.89	81.08	80.86	81.72	3.08	2.58	16.34	0.19
2021	7605.99	7403	1027	83.92	84.02	84.54	84.51	0.25	0.33	15.65	0.10
2022	7733.58	7459	1027	84.84	84.93	85.96	85.15	0.04	0.04	15.03	0.10
2023	7542.49	7283	1027	82.71	82.82	83.84	83.14	0.02	1.18	16.00	0.11
2024	7094.55	6929	1027	77.75	77.93	78.64	78.88	4.26	5.04	17.03	0.18

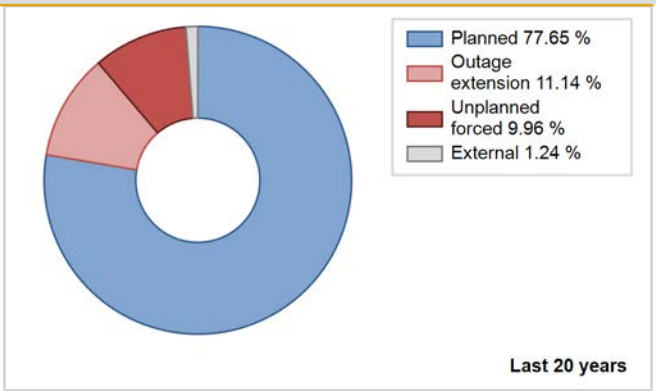
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2002 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		357			399	
C. Inspection, maintenance or repair combined with refuelling	1467			1382		
D. Inspection, maintenance or repair without refuelling				47		
E. Testing of plant systems or components		31		28	3	
F. Major backfitting, refurbishment or upgrading activities with refuelling				108		
L. Human factor related					68	
M. Governmental requirements or court decisions					30	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				59		
Subtotal	1467	388		1624	500	
Total	**1855**			**2124**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2002 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		57
12. Reactor I&C Systems		14
15. Reactor Cooling Systems		69
16. Steam generation systems		10
31. Turbine and auxiliaries	105	163
32. Feedwater and Main Steam System	138	33
33. Circulating Water System	124	7
41. Main Generator Systems		47
42. Electrical Power Supply Systems	21	2
Total	**388**	**402**

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2024 Operating Experience

CZ-24 TEMELIN-2 CZECH REPUBLIC



Status at end of year	:	**Operational**
Operator	:	CEZ (CZECH POWER Co., CEZ a.s.)
Owner	:	CEZ (CZECH POWER Co., CEZ a.s.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3120 MWth
Gross electrical power	:	1082 MWe
Reference unit power (net)	:	1029 MWe

Key Dates

Construction Date	:	1987-02-01
Grid Date	:	2002-12-29
Commercial Date	:	2003-04-18
Age at end of year	:	22 years

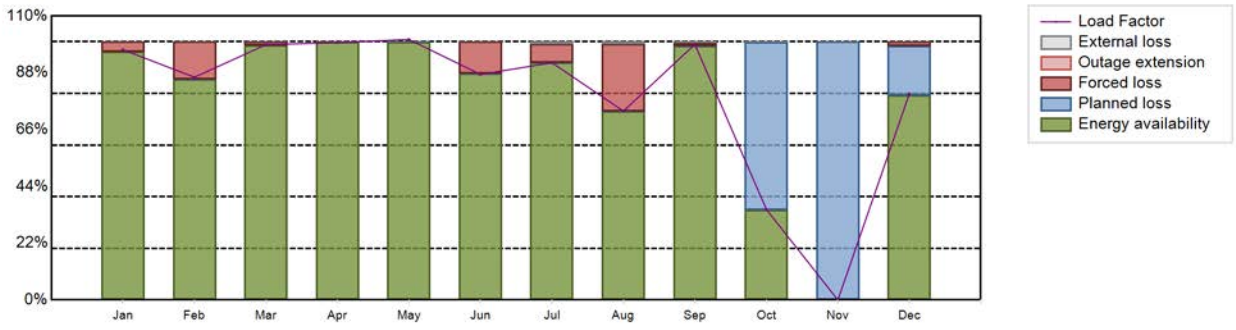
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.7
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	318
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.46
Average fuel enrichment [% of U235]	:	3.6	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25.7	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	45000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6.2
Active core height/length [m]	:	3.63	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	16.3	Number of main condensate pumps	:	4
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH

Annual Production Results (2024)

Net Energy Production	:	7151.82 GW(e).h	Forced Loss Rate (FLR)	:	6.67 %
Energy Availability Factor (EAF)	:	78.82 %	Unplanned Capability Loss Factor (UCL)	:	5.64 %
Unit Capability Factor (UCF)	:	79 %	Planned Unavailability Factor (PUF)	:	15.35 %
Load Factor (LF)	:	79.12 %	Externally cause unavailability (XUF)	:	0.18 %
Operating Factor (OF)	:	79.68 %	Total off-line time	:	1785 hours
Equivalent non-electrical energy generated (NEG)	:	60.54 GW(e).h			

Annual Summary



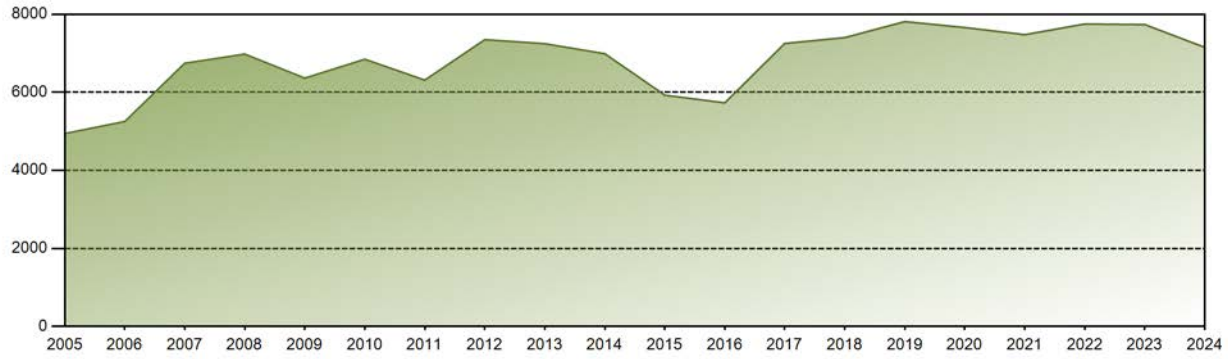
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	741.97	617.86	756.83	738.70	772.46	647.22	703.34	560.16	733.42	268.53	0.00	611.33	7151.82
EAF [%]	96.06	85.47	98.62	99.90	99.97	87.72	91.98	73.14	98.40	34.73	0.00	79.29	78.82
UCF [%]	96.06	85.47	98.62	99.90	99.97	87.72	92.77	74.08	98.85	34.74	0.00	79.29	79.00
LF [%]	96.92	86.27	98.86	99.71	100.90	87.36	91.87	73.17	98.99	35.08	0.00	79.85	79.12
OF [%]	96.24	85.78	98.92	100.00	100.00	88.61	95.16	75.27	99.03	35.08	0.00	81.45	79.68
FLR [%]	3.94	14.53	1.38	0.09	0.00	12.24	7.19	25.89	1.13	0.00	0.00	2.02	6.67
UCL [%]	3.94	14.53	1.38	0.09	0.00	12.23	7.19	25.88	1.13	0.00	0.00	1.63	5.64
PUF [%]	0.00	0.00	0.00	0.02	0.03	0.05	0.03	0.03	0.01	65.26	100.00	19.08	15.35
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.94	0.45	0.01	0.00	0.00	0.18

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Historical Summary

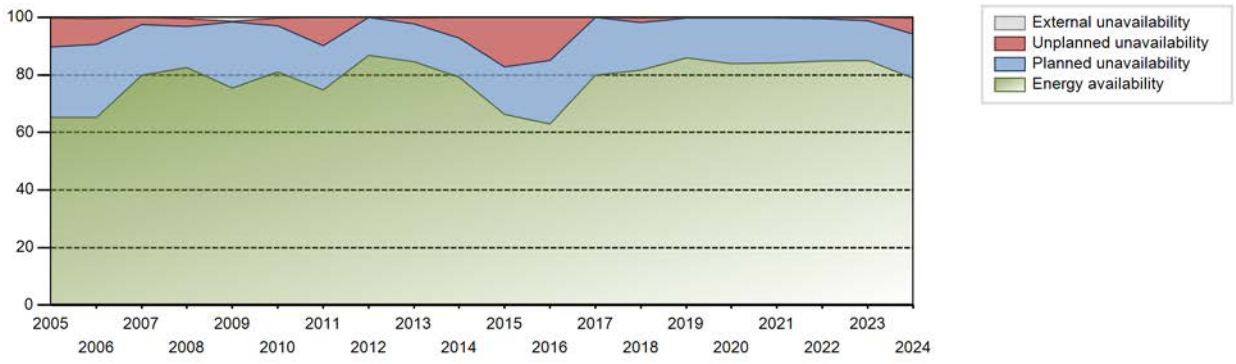
Lifetime energy generation	:	149292.5 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.6 %
Cumulative Energy Availability Factor (EAF)	:	78.56 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.77 %
Cumulative Unit Capability Factor (UCF)	:	78.75 %	Cumulative Planned Unavailability Factor (PUF)	:	16.48 %
Cumulative Load Factor (LF)	:	79 %	Cumulative Externally cause unavailability (XUF)	:	0.19 %
Cumulative Operating Factor (OF)	:	79.19 %			

Electricity Production (net) [GWh]



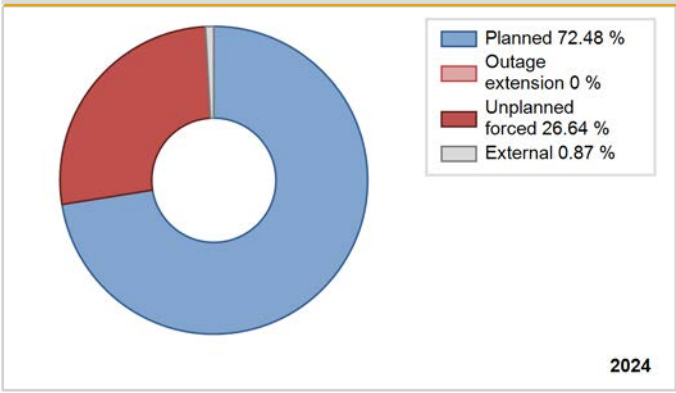
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2003	6033.03	6934	930	84.23	84.23	86.59	86.52	15.60	15.57	0.21	0.00
2004	6340.09	6678	950	75.22	75.22	75.98	76.02	8.49	6.98	17.80	0.00
2005	4941.36	6135	780	65.10	65.25	65.27	70.03	6.34	10.21	24.54	0.15
2006	5251.85	5765	930	65.28	65.82	65.36	65.81	3.01	8.85	25.33	0.54
2007	6745.10	7051	963	79.93	80.05	80.50	80.49	0.85	2.44	17.50	0.12
2008	6978.75	7420	963	82.65	83.23	82.50	84.47	3.05	2.62	14.15	0.58
2009	6363.18	6756	963	75.39	76.80	75.43	77.12	0.25	0.19	23.00	1.41
2010	6847.34	7135	963	80.95	81.10	81.18	81.46	1.55	2.78	16.12	0.15
2011	6311.62	6589	963	74.77	74.85	74.82	75.22	3.32	9.69	15.46	0.08
2012	7349.91	7656	963	86.84	86.91	86.89	87.16	0.05	0.05	13.05	0.06
2013	7246.82	7448	1003	84.48	84.79	84.43	85.02	1.06	1.92	13.29	0.31
2014	6989.25	6980	1003	79.32	79.33	79.55	79.68	8.27	7.15	13.52	0.01
2015	5926.47	5813	1026	66.23	66.24	66.84	66.36	7.35	17.25	16.51	0.00
2016	5730.12	5617	1026	62.87	62.87	63.58	63.95	14.72	14.93	22.20	0.00
2017	7252.35	7024	1026	79.85	79.87	80.69	80.18	0.08	0.06	20.07	0.01
2018	7402.41	7208	1027	81.65	82.00	82.34	82.29	1.30	1.37	16.63	0.35
2019	7813.14	7555	1027	85.98	86.04	86.85	86.24	0.16	0.13	13.82	0.06
2020	7660.96	7398	1029	83.98	84.03	84.89	84.22	0.02	0.19	15.78	0.05
2021	7477.64	7198	1029	84.18	84.19	82.96	82.17	0.34	0.29	15.52	0.02
2022	7751.47	7455	1029	84.84	84.86	85.99	85.10	0.63	0.54	14.60	0.03
2023	7736.61	7474	1029	84.93	84.98	85.83	85.32	1.36	1.17	13.84	0.05
2024	7151.82	6999	1029	78.82	79.00	79.12	79.68	6.67	5.64	15.35	0.18

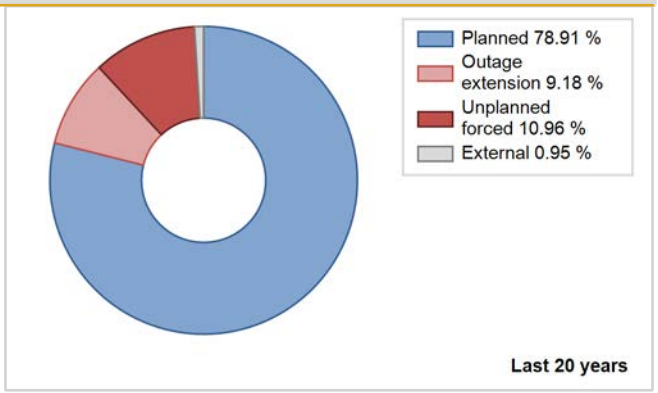
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2003 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		452			382	
C. Inspection, maintenance or repair combined with refuelling	1333			1289		
D. Inspection, maintenance or repair without refuelling				42		
E. Testing of plant systems or components				19	2	
F. Major backfitting, refurbishment or upgrading activities with refuelling				89		
J. Grid limitation, failure or grid unavailability						10
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L. Human factor related					43	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Subtotal	1333	452		1439	427	11
Total		**1785**			**1877**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2003 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		76
12. Reactor I&C Systems		9
13. Reactor Auxiliary Systems		13
15. Reactor Cooling Systems		16
16. Steam generation systems		63
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries	213	104
32. Feedwater and Main Steam System		20
33. Circulating Water System		7
35. All other I&C Systems		27
41. Main Generator Systems	127	35
42. Electrical Power Supply Systems	112	29
Total	**452**	**401**

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2024 Operating Experience

FI-1 LOVIISA-1 FINLAND



Status at end of year	:	**Operational**
Operator	:	FORTUMPH (FORTUM POWER AND HEAT OY (former IVO))
Owner	:	FORTUMPH (FORTUM POWER AND HEAT OY (former IVO))
Reactor Supplier	:	AEE (ATOMENERGOEXPORT)
Turbine Supplier	:	AEE (ATOMENERGOEXPORT)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1500 MWth
Gross electrical power	:	531 MWe
Reference unit power (net)	:	507 MWe

Key Dates

Construction Date	:	1971-05-01
Grid Date	:	1977-02-08
Commercial Date	:	1977-05-09
Age at end of year	:	47 years

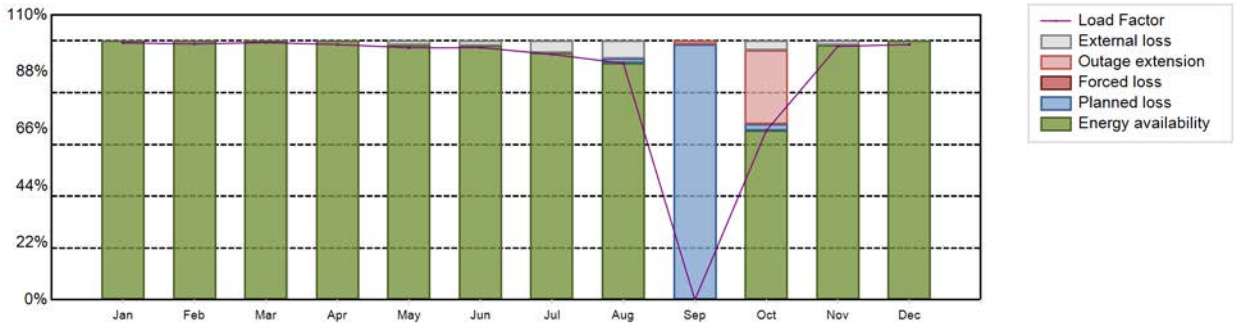
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	12.25
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	301
Fuel material	:	UO2	Number of SG	:	6
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.07
Average fuel enrichment [% of U235]	:	4.3	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	45000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	2.73	HP cylinder inlet steam pressure [MPa]	:	4.4
Active core height/length [m]	:	2.42	Output voltage [kV]	:	15.75
Number of fissile fuel assemblies/bundles	:	313	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	15.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	37	Number of FW pumps for full power operation	:	4
Number of external reactor coolant loops	:	6	Number of on-site safety related diesel generators	:	4
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	3858.78 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	87.3 %	Unplanned Capability Loss Factor (UCL)	:	2.55 %
Unit Capability Factor (UCF)	:	89.02 %	Planned Unavailability Factor (PUF)	:	8.43 %
Load Factor (LF)	:	86.65 %	Externally cause unavailability (XUF)	:	1.72 %
Operating Factor (OF)	:	89.25 %	Total off-line time	:	944 hours

Annual Summary



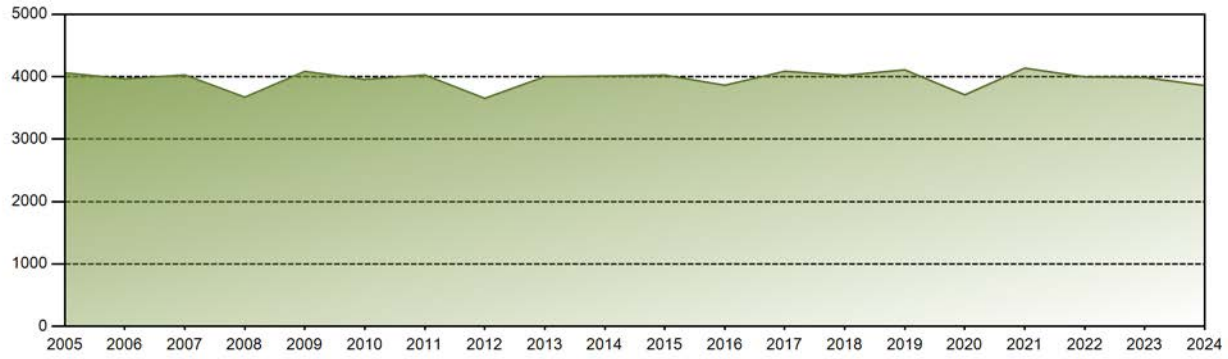
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	374.46	348.82	374.32	359.96	367.22	355.57	357.62	344.56	0.00	246.98	357.40	371.89	3858.78
EAF [%]	100.00	100.00	100.00	100.00	98.31	98.10	95.33	91.34	0.00	65.39	98.34	100.00	87.30
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.21	0.00	68.97	100.00	100.00	89.02
LF [%]	99.27	98.85	99.37	98.61	97.35	97.40	94.81	91.34	0.00	65.39	97.91	98.59	86.65
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.52	0.00	71.41	100.00	100.00	89.25
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	28.59	0.00	0.00	2.55
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79	98.53	2.44	0.00	0.00	8.43
XUF [%]	0.00	0.00	0.00	0.00	1.69	1.90	4.67	6.86	0.00	3.58	1.66	0.00	1.72

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Historical Summary

Lifetime energy generation	:	173479.94 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.33 %
Cumulative Energy Availability Factor (EAF)	:	88.1 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.62 %
Cumulative Unit Capability Factor (UCF)	:	88.76 %	Cumulative Planned Unavailability Factor (PUF)	:	8.62 %
Cumulative Load Factor (LF)	:	87.84 %	Cumulative Externally cause unavailability (XUF)	:	0.66 %
Cumulative Operating Factor (OF)	:	89.9 %			

Electricity Production (net) [GWh]

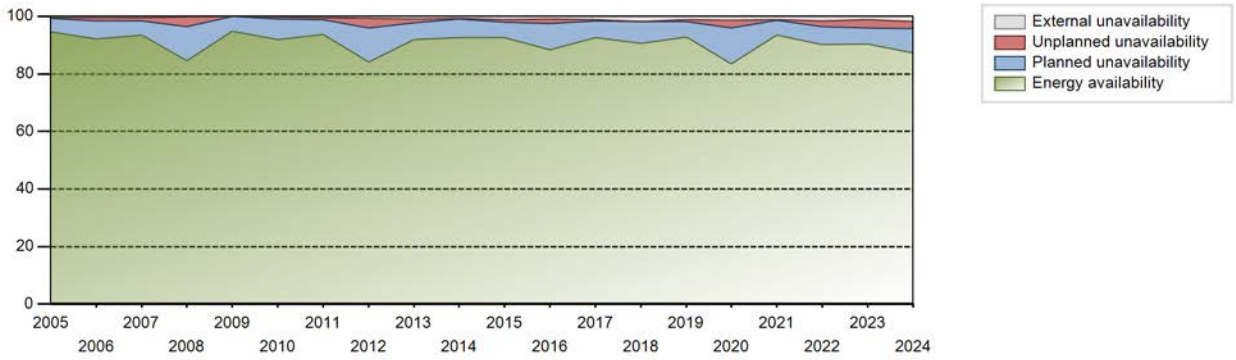


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1977	2505.50	7192	431	83.79	83.79	83.79	95.09	12.65	12.13	4.08	0.00
1978	2975.80	7531	430	78.93	78.93	79.00	85.97	9.27	8.06	13.01	0.00
1979	2901.70	7404	405	81.76	81.76	81.79	84.52	9.09	8.17	10.07	0.00
1980	1407.80	3482	445	36.65	36.65	36.02	39.64	55.36	45.45	17.90	0.00
1981	3105.10	7642	440	81.94	81.94	80.56	87.24	2.74	2.31	15.75	0.00
1982	3245.40	7576	440	84.19	84.19	84.20	86.48	4.46	3.93	11.88	0.00
1983	3337.40	7982	445	86.68	86.68	85.61	91.12	3.01	2.69	10.63	0.00
1984	3343.86	7653	445	85.79	85.79	85.55	87.12	0.31	0.27	13.94	0.00
1985	3599.97	8248	440	92.54	92.54	93.40	94.16	0.45	0.42	7.05	0.00
1986	3522.37	8093	445	91.10	91.10	90.36	92.39	2.67	2.49	6.40	0.00
1987	3600.36	8257	445	94.55	94.55	92.36	94.26	0.00	0.00	5.45	0.00
1988	3354.63	7678	445	87.03	87.03	85.82	87.41	1.21	1.07	11.90	0.00
1989	3575.75	8183	445	92.61	92.80	91.73	93.41	0.00	0.00	7.20	0.19
1990	3271.13	7605	445	85.48	85.50	83.91	86.82	4.46	3.99	10.50	0.03
1991	3360.90	7927	445	88.58	88.84	86.22	90.49	2.52	2.29	8.86	0.26
1992	3108.41	7186	445	80.19	80.30	79.52	81.81	0.44	0.35	19.35	0.11
1993	3443.16	8052	445	89.47	89.49	88.40	91.99	1.77	1.61	8.91	0.02
1994	3497.57	8017	445	90.70	90.76	89.72	91.52	2.31	2.15	7.09	0.06
1995	3389.06	7834	445	87.66	88.50	86.94	89.43	6.50	6.16	5.34	0.84
1996	3203.49	7281	445	82.04	82.51	81.95	82.89	0.00	0.00	17.49	0.47
1997	3794.83	8309	445	93.02	93.87	97.35	94.85	0.02	0.02	6.11	0.86
1998	3852.35	8234	488	91.35	93.39	90.12	94.00	0.05	0.05	6.56	2.04
1999	3883.28	8304	488	91.63	92.37	90.84	94.79	0.00	0.00	7.63	0.74
2000	3618.00	7720	488	84.91	86.50	84.40	87.89	0.06	0.05	13.45	1.59
2001	3920.99	8233	488	92.38	93.41	91.72	93.98	0.67	0.63	5.97	1.02
2002	3790.07	8095	488	89.27	91.40	88.66	92.41	0.72	0.66	7.94	2.13
2003	3938.98	8194	488	92.40	93.22	92.14	93.54	0.16	2.01	4.77	0.83
2004	3715.03	7647	488	86.51	86.91	86.66	87.05	0.24	1.55	11.54	0.40
2005	4062.43	8351	488	94.61	95.02	95.03	95.33	0.28	0.27	4.71	0.41
2006	3964.84	8138	488	92.08	92.63	92.74	92.89	0.18	0.95	6.42	0.55
2007	4028.12	8285	488	93.49	94.00	94.23	94.58	0.32	1.19	4.82	0.50
2008	3671.84	7571	488	84.51	84.87	85.66	86.19	0.09	3.25	11.88	0.36
2009	4084.91	8345	488	94.80	94.83	95.56	95.26	0.03	0.03	5.14	0.03
2010	3955.59	8123	488	91.95	92.33	92.53	92.73	0.53	0.61	7.07	0.38
2011	4026.87	8295	488	93.82	94.32	94.20	94.69	0.80	0.76	4.92	0.51
2012	3653.04	7473	496	84.08	84.86	83.86	85.08	0.00	3.32	11.82	0.78
2013	4000.24	8219	496	92.00	93.02	92.07	93.82	1.33	1.25	5.73	1.02

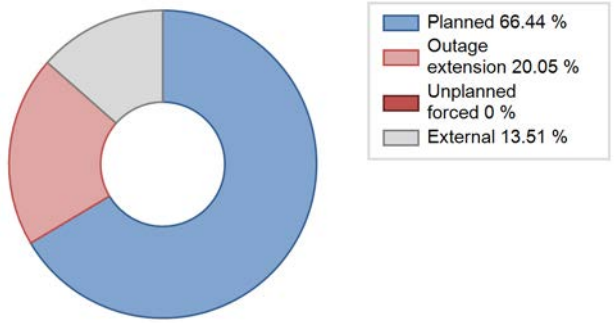
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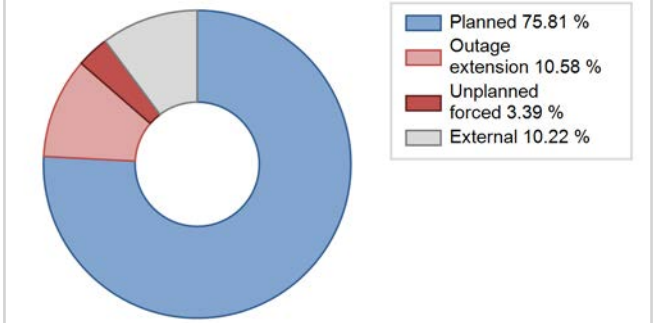
2014	4010.58	8262	496	92.60	93.38	92.30	94.32	0.06	0.06	6.57	0.78
2015	4025.96	8248	496	92.68	93.76	92.66	94.16	0.07	0.99	5.25	1.08
2016	3862.81	7873	502	88.45	89.43	88.48	89.63	0.07	1.58	8.99	0.98
2017	4087.37	8246	507	92.71	93.85	92.71	94.13	0.15	0.55	5.59	1.15
2018	4021.00	8124	507	90.64	92.47	90.54	92.74	0.11	0.10	7.43	1.82
2019	4109.79	8270	507	92.90	94.10	92.54	94.41	0.05	0.71	5.19	1.20
2020	3709.11	7483	507	83.47	84.86	83.29	85.19	0.08	2.57	12.56	1.39
2021	4137.39	8325	507	93.40	94.66	93.16	95.03	0.13	0.17	5.17	1.26
2022	3995.96	8060	507	90.22	91.80	89.98	92.02	0.01	1.96	6.24	1.58
2023	3987.99	8200	507	90.47	91.65	89.79	93.61	2.34	2.79	5.56	1.18
2024	3858.78	7840	507	87.30	89.02	86.65	89.25	0.00	2.55	8.43	1.72

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1977 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					164	
C. Inspection, maintenance or repair combined with refuelling	720			691	7	
D. Inspection, maintenance or repair without refuelling				14		
E. Testing of plant systems or components				2		
L. Human factor related					1	
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						4
Z. Other		224			17	
Subtotal	720	224		707	189	4
Total	**944**			**900**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1977 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		11
14. Safety Systems		3
15. Reactor Cooling Systems		119
16. Steam generation systems		6
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		3
31. Turbine and auxiliaries		12
32. Feedwater and Main Steam System		6
41. Main Generator Systems		2
42. Electrical Power Supply Systems		1
Total		**164**

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2024 Operating Experience

FI-2 LOVIISA-2 FINLAND



Status at end of year	:	**Operational**
Operator	:	FORTUMPH (FORTUM POWER AND HEAT OY (former IVO))
Owner	:	FORTUMPH (FORTUM POWER AND HEAT OY (former IVO))
Reactor Supplier	:	AEE (ATOMENERGOEXPORT)
Turbine Supplier	:	AEE (ATOMENERGOEXPORT)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1500 MWth
Gross electrical power	:	531 MWe
Reference unit power (net)	:	507 MWe

Key Dates

Construction Date	:	1972-08-01
Grid Date	:	1980-11-04
Commercial Date	:	1981-01-05
Age at end of year	:	44 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.3
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	25
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	2.73
Active core height/length [m]	:	2.42
Number of fissile fuel assemblies/bundles	:	313
Fuel linear heat generation rate [kW/m]	:	15.7
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O

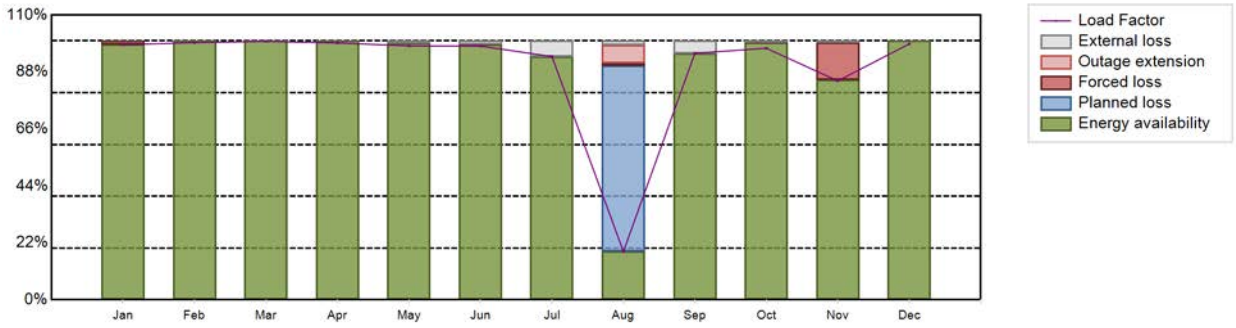
Operating coolant pressure [MPa]	:	12.25
Reactor outlet temperature [°C]	:	300
Number of SG	:	6
Containment type	:	Single
Containment design pressure [MPa]	:	0.07
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.4
Output voltage [kV]	:	15.75
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4009.53 GW(e).h
Energy Availability Factor (EAF)	:	90.61 %
Unit Capability Factor (UCF)	:	91.95 %
Load Factor (LF)	:	90.02 %
Operating Factor (OF)	:	92.53 %

Forced Loss Rate (FLR)	:	1.48 %
Unplanned Capability Loss Factor (UCL)	:	1.97 %
Planned Unavailability Factor (PUF)	:	6.08 %
Externally cause unavailability (XUF)	:	1.34 %
Total off-line time	:	656 hours

Annual Summary



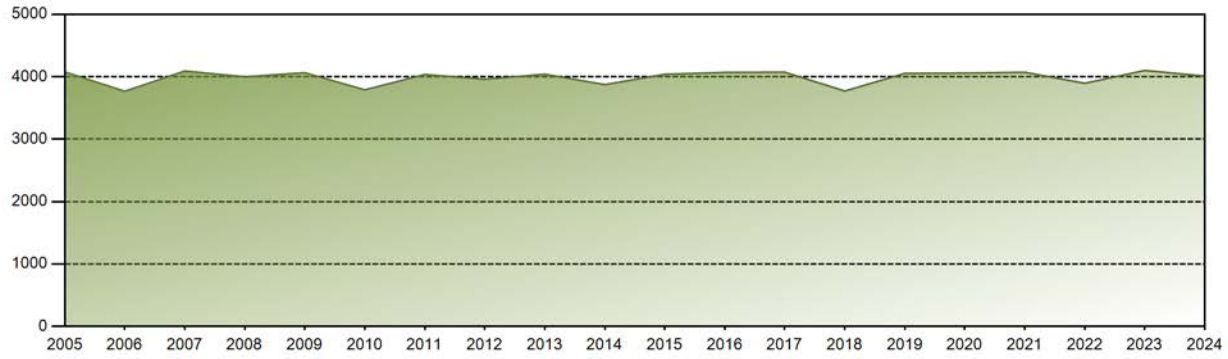
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	371.50	350.63	376.49	362.19	369.96	357.71	354.50	70.34	347.68	366.95	308.67	372.94	4009.53
EAF [%]	98.60	100.00	100.00	100.00	99.00	98.66	93.98	18.65	95.24	99.35	84.98	100.00	90.61
UCF [%]	98.60	100.00	100.00	100.00	100.00	99.93	100.00	20.31	100.00	99.97	85.72	100.00	91.95
LF [%]	98.49	99.36	99.81	99.22	98.08	97.99	93.98	18.65	95.24	97.15	84.56	98.87	90.02
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	24.46	100.00	100.00	86.94	100.00	92.53
FLR [%]	1.40	0.00	0.00	0.00	0.00	0.07	0.00	4.52	0.00	0.03	14.28	0.00	1.48
UCL [%]	1.40	0.00	0.00	0.00	0.00	0.07	0.00	7.92	0.00	0.03	14.28	0.00	1.97
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71.77	0.00	0.00	0.00	0.00	6.08
XUF [%]	0.00	0.00	0.00	0.00	1.00	1.27	6.02	1.66	4.76	0.62	0.74	0.00	1.34

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Historical Summary

Lifetime energy generation	:	164290.98 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.34 %
Cumulative Energy Availability Factor (EAF)	:	89.57 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.53 %
Cumulative Unit Capability Factor (UCF)	:	90.39 %	Cumulative Planned Unavailability Factor (PUF)	:	8.08 %
Cumulative Load Factor (LF)	:	89.46 %	Cumulative Externally cause unavailability (XUF)	:	0.82 %
Cumulative Operating Factor (OF)	:	91.33 %			

Electricity Production (net) [GWh]

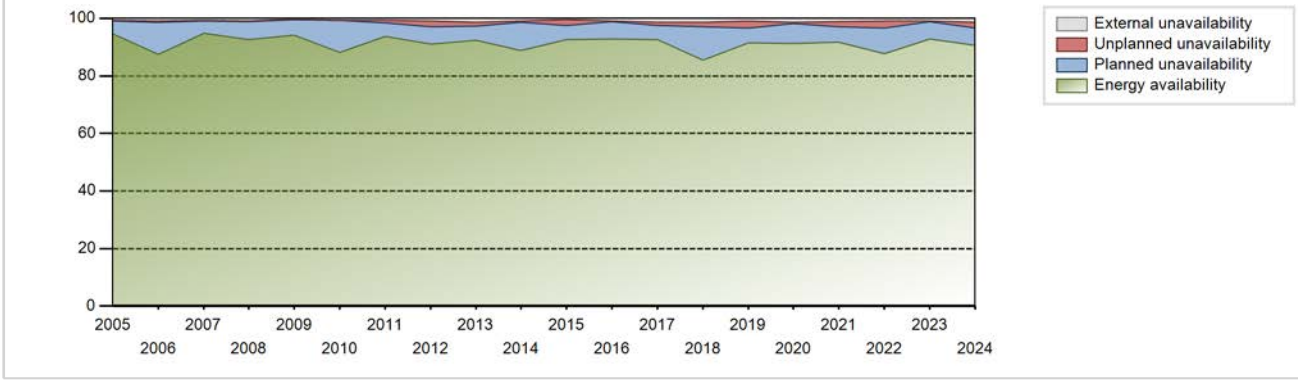


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	2714.20	7062	440	72.18	72.18	70.42	80.62	9.96	7.99	19.83	0.00
1982	2997.40	7046	440	78.00	78.00	77.77	80.43	0.30	0.23	21.76	0.00
1983	3474.50	8063	445	90.09	90.09	89.13	92.04	0.72	0.66	9.25	0.00
1984	3608.63	8251	445	92.57	92.57	92.32	93.93	0.93	0.87	6.56	0.00
1985	3549.84	8162	440	92.15	92.15	92.10	93.17	1.79	1.68	6.17	0.00
1986	3174.87	7273	445	81.46	81.46	81.44	83.03	3.74	3.17	15.37	0.00
1987	3572.08	8242	445	93.37	93.37	91.63	94.09	0.00	0.00	6.63	0.00
1988	3602.27	8305	445	94.69	94.69	92.16	94.55	0.00	0.00	5.31	0.00
1989	3550.96	8128	445	91.69	91.76	91.09	92.79	0.00	0.00	8.24	0.07
1990	3251.05	7584	445	85.28	85.32	83.40	86.58	4.24	3.78	10.90	0.04
1991	3442.19	7941	445	88.98	89.85	88.30	90.65	0.25	0.22	9.93	0.87
1992	3468.45	7931	445	89.10	89.53	88.73	90.29	0.66	0.60	9.88	0.43
1993	3550.79	8050	445	91.25	91.29	91.16	91.97	2.29	2.14	6.57	0.04
1994	3124.71	7170	445	80.50	81.20	80.16	81.85	1.87	1.55	17.25	0.70
1995	3060.25	7064	445	77.57	78.41	78.50	80.64	17.16	16.25	5.34	0.84
1996	3621.33	8227	445	92.73	93.08	92.64	93.66	0.00	0.00	6.92	0.35
1997	3804.70	8267	445	91.96	92.87	97.60	94.37	2.30	2.19	4.94	0.91
1998	3687.90	7892	488	86.41	88.55	86.27	90.09	0.70	0.63	10.82	2.14
1999	3974.34	8281	488	93.53	94.19	92.97	94.53	0.14	0.13	5.69	0.65
2000	3885.10	8314	488	90.90	94.11	90.63	94.65	0.25	0.23	5.66	3.21
2001	3781.06	8149	488	89.58	92.30	88.45	93.03	1.25	1.17	6.53	2.72
2002	3498.66	7463	488	82.56	84.51	81.84	85.19	1.54	4.75	10.74	1.94
2003	3736.65	8358	488	90.00	90.14	87.41	95.41	0.08	0.20	9.66	0.14
2004	4009.18	8231	488	93.11	93.59	93.53	93.70	0.25	0.23	6.18	0.47
2005	4076.12	8376	488	94.55	95.36	95.35	95.62	0.16	0.15	4.49	0.81
2006	3766.55	7863	488	87.47	88.49	88.11	89.76	0.51	0.45	11.06	1.01
2007	4090.87	8403	488	94.85	95.47	95.70	95.92	0.24	0.23	4.30	0.61
2008	3997.95	8240	488	92.52	93.47	93.27	93.81	0.02	0.22	6.32	0.95
2009	4063.83	8318	488	94.26	94.59	95.06	94.95	0.18	0.17	5.24	0.33
2010	3789.14	7797	488	88.09	88.80	88.64	89.01	0.00	0.00	11.20	0.70
2011	4035.30	8290	488	93.70	94.48	94.40	94.63	0.07	0.77	4.75	0.77
2012	3959.19	8141	496	91.02	92.04	90.87	92.68	2.12	1.99	5.97	1.02
2013	4040.04	8250	496	92.40	93.69	92.98	94.18	1.58	1.50	4.81	1.29
2014	3872.75	7912	496	88.91	89.73	89.13	90.32	0.29	0.64	9.63	0.82
2015	4039.11	8276	496	92.60	93.20	92.96	94.47	2.07	1.97	4.84	0.60
2016	4068.96	8304	502	92.94	93.97	93.30	94.54	0.10	0.09	5.94	1.04
2017	4071.92	8255	502	92.51	93.96	92.60	94.24	1.16	1.10	4.94	1.45

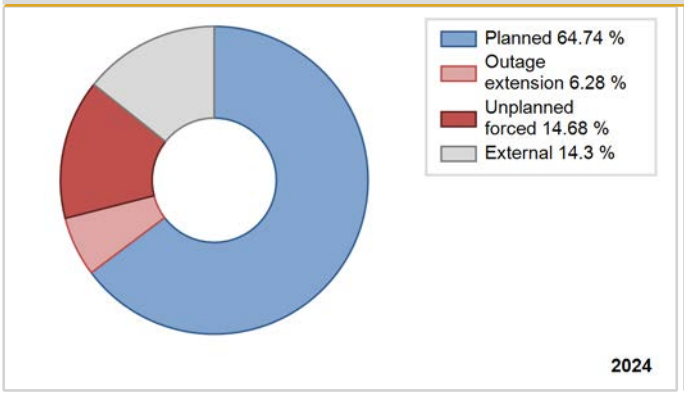
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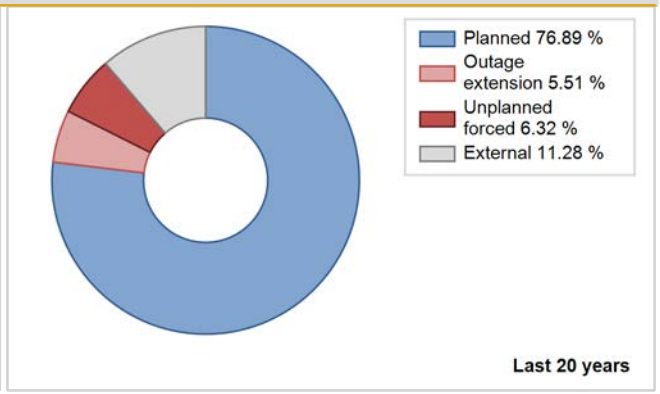
2018	3770.71	7639	507	85.52	86.92	85.60	87.20	0.26	1.44	11.64	1.41
2019	4053.97	8142	507	91.58	92.48	91.28	92.95	0.19	2.56	4.96	0.91
2020	4058.51	8171	507	91.22	92.53	91.13	93.02	0.11	0.52	6.96	1.30
2021	4071.02	8170	507	91.81	93.01	91.66	93.26	0.00	1.80	5.20	1.19
2022	3894.87	7810	507	87.80	88.76	87.69	89.15	1.12	2.46	8.78	0.97
2023	4100.21	8327	507	92.89	93.82	92.32	95.06	0.00	0.28	5.91	0.93
2024	4009.53	8129	507	90.61	91.95	90.02	92.53	1.48	1.97	6.08	1.34

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		173			84	
C. Inspection, maintenance or repair combined with refuelling	504			639	1	
D. Inspection, maintenance or repair without refuelling				27		
Z. Other				1	12	
Subtotal	504	173		667	97	
Total		**677**			**764**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1981 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		9
12. Reactor I&C Systems		8
14. Safety Systems		4
15. Reactor Cooling Systems		42
16. Steam generation systems		2
31. Turbine and auxiliaries		1
32. Feedwater and Main Steam System	58	13
34. Miscellaneous Systems		2
35. All other I&C Systems	115	3
41. Main Generator Systems		1
Total	**173**	**85**

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2024 Operating Experience

FI-3 OLKILUOTO-1 FINLAND



Status at end of year	:	**Operational**
Operator	:	TVO (TEOLLISUUDEN VOIMA OYJ)
Owner	:	TVO (TEOLLISUUDEN VOIMA OYJ)
Reactor Supplier	:	ASEASTAL (ASEA-ATOM / STAL-LAVAL)
Turbine Supplier	:	ASEASTAL (ASEA-ATOM / STAL-LAVAL)

Reactor Unit Details

Reactor type and model	:	BWR / AA-III, BWR-2500
Thermal power	:	2500 MWth
Gross electrical power	:	920 MWe
Reference unit power (net)	:	890 MWe

Key Dates

Construction Date	:	1974-02-01
Grid Date	:	1978-09-02
Commercial Date	:	1979-10-10
Age at end of year	:	46 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.85
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	20
Average discharge burnup [MWd/t]	:	47000
Active core diameter [m]	:	3.88
Active core height/length [m]	:	3.68
Number of fissile fuel assemblies/bundles	:	500
Fuel linear heat generation rate [kW/m]	:	16.3
Number of control rod assemblies	:	121
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

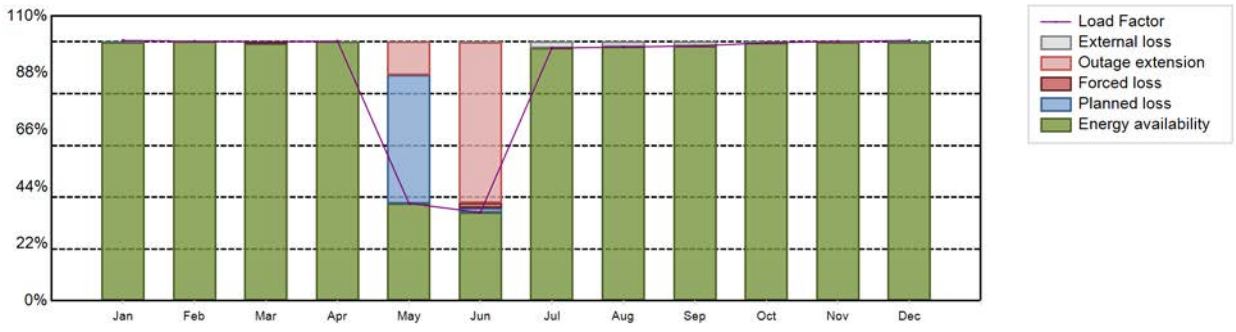
Operating coolant pressure [MPa]	:	7.12
Reactor outlet temperature [°C]	:	286
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	4.8
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	4
HP cylinder inlet steam pressure [MPa]	:	6.7
Output voltage [kV]	:	20
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6953.55 GW(e).h
Energy Availability Factor (EAF)	:	88.7 %
Unit Capability Factor (UCF)	:	89.23 %
Load Factor (LF)	:	88.95 %
Operating Factor (OF)	:	89.65 %

Forced Loss Rate (FLR)	:	0.24 %
Unplanned Capability Loss Factor (UCL)	:	6.39 %
Planned Unavailability Factor (PUF)	:	4.38 %
Externally cause unavailability (XUF)	:	0.53 %
Total off-line time	:	909 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	665.96	621.07	661.01	642.89	249.47	218.44	646.40	649.02	630.74	660.66	642.18	665.68	6953.55
EAF [%]	99.81	100.00	99.38	100.00	37.54	34.09	97.62	98.02	98.43	99.64	99.92	99.93	88.70
UCF [%]	99.81	100.00	99.38	100.00	37.54	34.27	100.00	99.93	99.97	99.89	100.00	99.93	89.23
LF [%]	100.57	100.26	99.96	100.33	37.68	34.09	97.62	98.02	98.43	99.64	100.22	100.53	88.95
OF [%]	100.00	100.00	100.00	100.00	37.90	37.92	100.00	100.00	100.00	100.00	100.00	100.00	89.65
FLR [%]	0.00	0.00	0.62	0.00	0.00	5.31	0.00	0.00	0.03	0.00	0.00	0.00	0.24
UCL [%]	0.00	0.00	0.62	0.00	12.90	63.97	0.00	0.00	0.03	0.00	0.00	0.00	6.39
PUF [%]	0.19	0.00	0.00	0.00	49.55	1.76	0.00	0.07	0.00	0.11	0.00	0.07	4.38
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.18	2.38	1.91	1.54	0.25	0.08	0.00	0.53

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Historical Summary

Lifetime energy generation	:	295816.52 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.36 %
Cumulative Energy Availability Factor (EAF)	:	92.65 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.67 %
Cumulative Unit Capability Factor (UCF)	:	93.11 %	Cumulative Planned Unavailability Factor (PUF)	:	5.23 %
Cumulative Load Factor (LF)	:	92.49 %	Cumulative Externally cause unavailability (XUF)	:	0.46 %
Cumulative Operating Factor (OF)	:	93.68 %			

Electricity Production (net) [GWh]

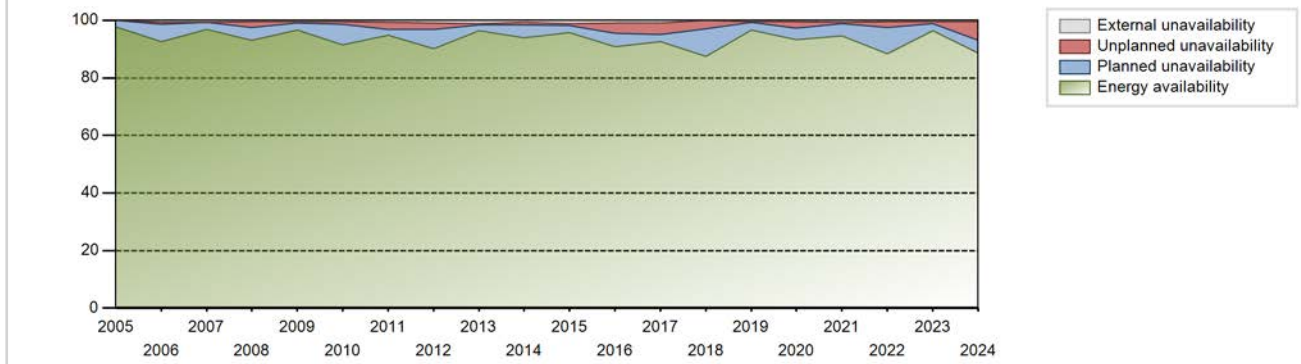


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1979	3465.00	5614	660	86.85	86.85	86.82	90.40	12.45	12.35	0.80	0.00
1980	4280.80	6849	658	76.31	76.31	74.06	77.97	3.12	2.46	21.23	0.00
1981	4549.20	7353	660	80.80	80.80	78.68	83.94	8.82	7.82	11.38	0.00
1982	4997.50	7903	658	86.68	86.68	86.70	90.22	3.90	3.51	9.81	0.00
1983	4808.30	7651	669	81.86	81.86	82.01	87.34	0.96	0.79	17.35	0.00
1984	5505.61	8247	694	91.94	91.94	90.30	93.89	0.33	0.30	7.76	0.00
1985	5414.51	8180	710	88.75	88.75	87.06	93.38	2.58	2.35	8.90	0.00
1986	5463.21	8008	710	90.08	90.08	87.84	91.42	0.72	0.65	9.27	0.00
1987	5636.46	8142	710	92.05	92.05	90.62	92.95	2.64	2.49	5.45	0.00
1988	5778.87	8248	710	94.07	94.29	92.66	93.90	1.20	1.15	4.56	0.22
1989	5056.20	7278	710	83.18	83.18	81.29	83.08	13.17	12.62	4.20	0.00
1990	5857.31	8356	710	95.60	95.60	94.17	95.39	0.57	0.55	3.86	0.00
1991	5873.22	8373	710	94.85	95.72	94.43	95.58	0.13	0.12	4.16	0.87
1992	5803.04	8251	710	93.23	93.72	93.05	93.93	0.44	0.42	5.87	0.49
1993	5944.92	8433	710	95.33	95.78	95.58	96.27	0.28	0.27	3.95	0.45
1994	5978.04	8485	710	96.01	96.50	96.12	96.86	0.05	0.05	3.45	0.49
1995	5931.50	8427	710	95.50	96.11	95.37	96.20	0.84	0.81	3.08	0.61
1996	5938.60	8212	710	92.08	92.19	95.22	93.49	1.22	1.14	6.67	0.11
1997	6374.15	8254	772	93.83	93.86	94.18	94.22	1.24	1.18	4.96	0.03
1998	6807.01	8384	840	94.95	95.57	92.51	95.71	0.22	0.21	4.22	0.62
1999	7111.82	8542	840	96.39	97.24	96.65	97.51	0.26	0.25	2.51	0.84
2000	7043.10	8448	840	95.17	95.81	95.45	96.17	0.13	0.13	4.06	0.65
2001	7163.80	8561	840	97.16	97.64	97.36	97.73	0.01	0.01	2.35	0.48
2002	6997.54	8377	840	95.05	95.51	95.09	95.62	0.65	0.63	3.86	0.46
2003	7127.43	8515	840	96.46	97.08	96.86	97.20	0.18	0.51	2.41	0.61
2004	7009.02	8329	840	94.70	94.70	94.99	94.82	0.80	1.19	4.11	0.00
2005	7221.07	8588	840	97.73	97.85	98.13	98.04	0.03	0.03	2.13	0.12
2006	6973.38	8206	860	92.64	93.34	93.64	93.68	0.35	0.60	6.06	0.71
2007	7334.94	8554	860	96.75	97.37	97.36	97.65	0.04	0.04	2.59	0.63
2008	7066.02	8288	860	93.14	93.59	93.54	94.35	0.78	2.09	4.32	0.44
2009	7295.77	8548	860	96.69	97.22	96.84	97.58	0.30	0.37	2.41	0.53
2010	6976.89	8120	880	91.41	92.00	91.54	92.69	0.65	0.90	7.11	0.59
2011	7289.82	8410	880	94.80	95.55	94.56	96.00	1.91	2.38	2.07	0.76
2012	6973.36	8013	880	90.08	90.91	90.21	91.22	2.52	2.35	6.74	0.83
2013	7470.41	8555	880	96.37	97.41	96.91	97.66	0.36	0.58	2.01	1.04
2014	7266.09	8337	880	94.00	94.81	94.26	95.17	0.38	0.89	4.30	0.81
2015	7396.91	8506	880	95.68	96.75	95.95	97.10	0.24	0.66	2.59	1.07

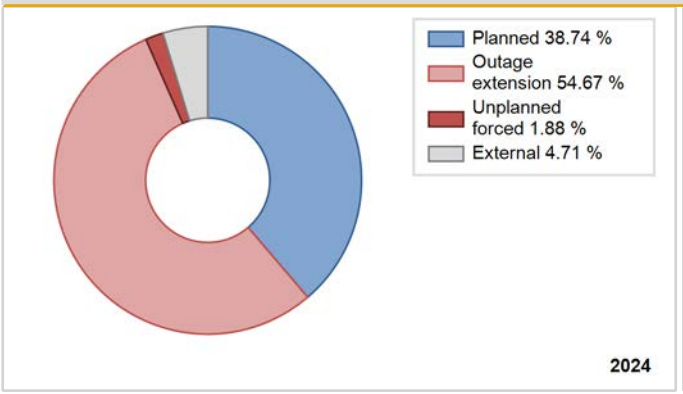
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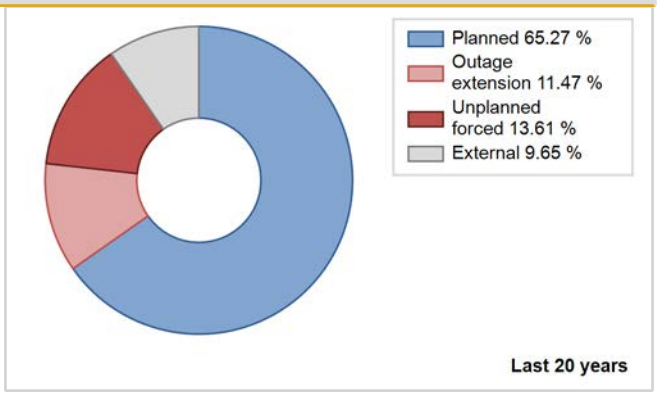
2016	7047.81	8146	880	90.90	91.84	91.18	92.74	2.29	3.46	4.70	0.93
2017	7158.27	8289	880	92.65	93.67	92.86	94.62	3.26	3.82	2.51	1.02
2018	6755.36	7731	880	87.55	87.67	87.63	88.25	0.65	2.73	9.60	0.12
2019	7542.04	8539	890	96.52	96.96	96.74	97.48	0.27	0.32	2.72	0.44
2020	7310.06	8391	890	93.25	93.75	93.51	95.53	2.12	2.30	3.94	0.50
2021	7404.18	8375	890	94.57	95.31	94.97	95.61	0.19	0.34	4.35	0.74
2022	6931.89	7827	890	88.46	88.86	88.91	89.35	2.30	2.09	9.06	0.39
2023	7428.24	8517	890	96.45	96.98	95.28	97.23	0.05	0.57	2.45	0.52
2024	6953.55	7875	890	88.70	89.23	88.95	89.65	0.24	6.39	4.38	0.53

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1979 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		543			107	
B.	Refuelling without maintenance				35		
C.	Inspection, maintenance or repair combined with refuelling	366			377	1	
D.	Inspection, maintenance or repair without refuelling				12		
E.	Testing of plant systems or components				0	4	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				18		
J.	Grid limitation, failure or grid unavailability						1
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						10
L.	Human factor related					1	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
Z.	Other					24	
Subtotal		366	543		442	137	11
Total		**909**			**590**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1979 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		17
12. Reactor I&C Systems		5
13. Reactor Auxiliary Systems		23
14. Safety Systems		3
15. Reactor Cooling Systems		14
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		0
31. Turbine and auxiliaries		15
32. Feedwater and Main Steam System		5
33. Circulating Water System		3
41. Main Generator Systems	543	46
42. Electrical Power Supply Systems		1
Total	**543**	**132**

Highlights (2024)

The electricity production of the Olkiluoto power plant units OL1, OL2 and OL3 during 2024 was 23,260 GWh. The total load factor of OL1, OL2 and OL3 was 79,1 %. The plant units operated safely and in Olkiluoto electricity was produced approximately 28 % of all electricity consumption in Finland.

During the year, the OL1 plant unit had four disruptions that caused production losses. The most significant of these were the repair of the valve of the reheat system in March and high vibrations of the generator stator which led to decrease the power in June.

The annual outages of 2024 at the Olkiluoto´s nuclear power plant was carried out from March 2 to June 19, 2024. OL1 was performed a maintenance outage taking more than 37 days, and OL2 performed a refueling outage that lasted over 10 days. The annual outage period in OL1 extended about 22 days due to main generator stator repairs. The OL2`s annual outage was extended about three days, mainly due to failure of the relief system. It was first annual outage in the OL3 plant unit, and it lasted about 74 days in total. The annual outage in OL3 extended about 37 days, mainly due to the lengthening of the duration of the fuel works. In all other respects annual outages were implemented according to plans.

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2024 Operating Experience

FI-4 OLKILUOTO-2 FINLAND



Status at end of year	:	**Operational**
Operator	:	TVO (TEOLLISUUDEN VOIMA OYJ)
Owner	:	TVO (TEOLLISUUDEN VOIMA OYJ)
Reactor Supplier	:	ASEASTAL (ASEA-ATOM / STAL-LAVAL)
Turbine Supplier	:	ASEASTAL (ASEA-ATOM / STAL-LAVAL)

Reactor Unit Details

Reactor type and model	:	BWR / AA-III, BWR-2500
Thermal power	:	2500 MWth
Gross electrical power	:	920 MWe
Reference unit power (net)	:	890 MWe

Key Dates

Construction Date	:	1975-11-01
Grid Date	:	1980-02-18
Commercial Date	:	1982-07-10
Age at end of year	:	44 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.66
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	21
Average discharge burnup [MWd/t]	:	45500
Active core diameter [m]	:	4.00
Active core height/length [m]	:	3.68
Number of fissile fuel assemblies/bundles	:	500
Fuel linear heat generation rate [kW/m]	:	15.0
Number of control rod assemblies	:	121
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

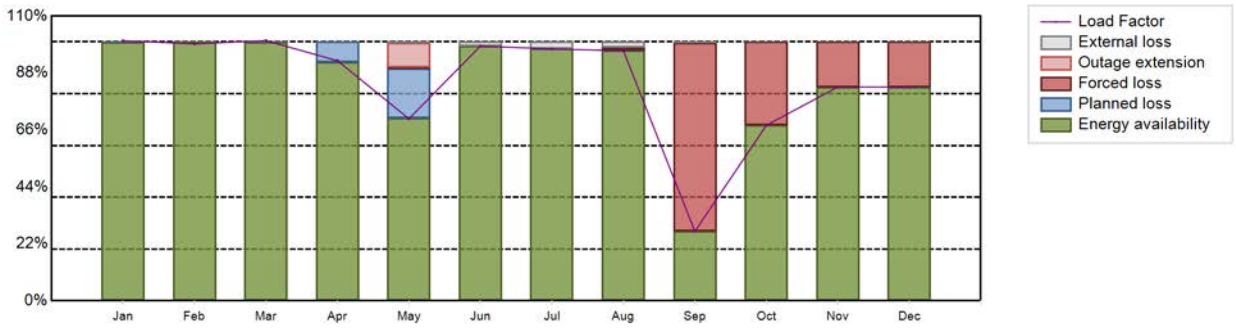
Operating coolant pressure [MPa]	:	7.12
Reactor outlet temperature [°C]	:	286
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	4.8
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	4
HP cylinder inlet steam pressure [MPa]	:	6.7
Output voltage [kV]	:	20
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6615.99 GW(e).h
Energy Availability Factor (EAF)	:	84.57 %
Unit Capability Factor (UCF)	:	85.17 %
Load Factor (LF)	:	84.63 %
Operating Factor (OF)	:	89.78 %

Forced Loss Rate (FLR)	:	12.1 %
Unplanned Capability Loss Factor (UCL)	:	12.53 %
Planned Unavailability Factor (PUF)	:	2.31 %
Externally cause unavailability (XUF)	:	0.59 %
Total off-line time	:	898 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	665.23	614.77	664.62	594.29	465.56	630.50	644.27	639.46	171.90	449.47	529.32	546.60	6615.99
EAF [%]	99.83	100.00	99.91	92.23	70.63	98.39	97.30	96.57	26.86	67.79	82.60	82.55	84.57
UCF [%]	99.83	100.00	99.91	92.23	70.95	100.00	99.88	98.73	27.28	67.79	82.60	82.55	85.17
LF [%]	100.46	99.25	100.51	92.74	70.31	98.39	97.30	96.57	26.83	67.79	82.60	82.55	84.63
OF [%]	100.00	100.00	100.00	92.50	73.12	100.00	100.00	100.00	27.92	83.22	100.00	100.00	89.78
FLR [%]	0.00	0.00	0.00	0.00	0.61	0.00	0.00	1.11	72.72	32.21	17.40	17.42	12.10
UCL [%]	0.00	0.00	0.00	0.00	9.89	0.00	0.00	1.11	72.72	32.21	17.40	17.41	12.53
PUF [%]	0.17	0.00	0.09	7.77	19.17	0.00	0.12	0.16	0.00	0.00	0.00	0.04	2.31
XUF [%]	0.00	0.00	0.00	0.00	0.32	1.61	2.58	2.16	0.42	0.00	0.00	0.00	0.59

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Historical Summary

Lifetime energy generation	:	285576.81 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.62 %
Cumulative Energy Availability Factor (EAF)	:	92.77 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.94 %
Cumulative Unit Capability Factor (UCF)	:	93.32 %	Cumulative Planned Unavailability Factor (PUF)	:	4.74 %
Cumulative Load Factor (LF)	:	92.68 %	Cumulative Externally cause unavailability (XUF)	:	0.55 %
Cumulative Operating Factor (OF)	:	93.98 %			

Electricity Production (net) [GWh]

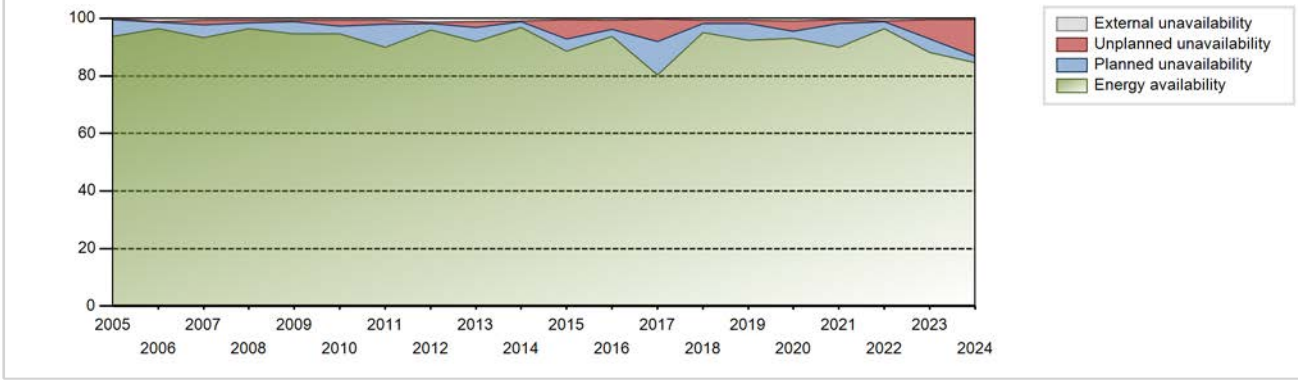


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1982	4587.10	7269	658	77.65	77.65	77.64	79.53	2.38	1.89	20.45	0.00
1983	5087.20	8221	657	86.75	86.75	88.39	93.85	5.00	4.57	8.69	0.00
1984	5341.30	8031	696	89.57	89.57	87.28	91.43	1.96	1.79	8.64	0.00
1985	5415.79	7912	710	88.16	88.16	87.08	90.32	1.98	1.78	10.06	0.00
1986	5840.21	8437	710	95.07	95.07	93.90	96.31	0.32	0.30	4.63	0.00
1987	5725.03	8379	710	93.71	93.71	92.05	95.65	1.41	1.34	4.95	0.00
1988	5713.20	8220	710	92.73	92.73	91.61	93.58	2.89	2.76	4.51	0.00
1989	5827.02	8363	710	94.94	94.94	93.69	95.47	0.39	0.37	4.69	0.00
1990	5749.87	8265	710	93.78	93.78	92.45	94.35	1.20	1.14	5.09	0.00
1991	5730.95	8216	710	92.96	93.67	92.14	93.79	2.10	2.01	4.32	0.71
1992	5790.44	8306	710	93.31	94.54	92.85	94.56	1.63	1.57	3.89	1.23
1993	5861.56	8327	710	94.38	95.14	94.24	95.06	0.16	0.15	4.71	0.76
1994	5732.63	8130	710	92.30	93.15	92.17	92.81	0.10	0.09	6.76	0.85
1995	5747.24	8236	710	92.47	93.71	92.42	94.03	1.88	1.79	4.50	1.24
1996	5915.41	8413	710	94.96	95.29	94.85	95.78	1.49	1.44	3.27	0.33
1997	6077.04	8258	736	93.74	94.56	94.14	94.27	0.22	0.21	5.23	0.82
1998	6628.46	8207	840	93.23	94.29	90.08	93.69	0.51	0.48	5.22	1.06
1999	7091.21	8505	840	96.43	96.86	96.37	97.09	0.17	0.17	2.97	0.43
2000	7028.90	8457	840	95.31	95.93	95.26	96.28	0.15	0.15	3.92	0.61
2001	6988.00	8387	840	95.12	95.12	94.97	95.74	0.52	0.49	4.39	0.00
2002	7108.51	8472	840	96.79	96.96	96.59	96.70	0.47	0.46	2.58	0.16
2003	7026.86	8378	840	95.16	95.48	95.49	95.64	0.39	0.62	3.90	0.33
2004	7080.70	8485	840	95.81	95.81	95.96	96.60	1.23	1.55	2.64	0.00
2005	6996.68	8248	860	93.80	93.82	93.96	94.16	0.05	0.41	5.77	0.01
2006	7294.36	8562	860	96.37	97.43	96.82	97.74	0.21	0.28	2.29	1.06
2007	7051.32	8258	860	93.21	94.01	93.60	94.27	1.01	1.53	4.45	0.81
2008	7313.82	8579	860	96.29	96.94	96.82	97.67	0.80	0.85	2.21	0.65
2009	7156.34	8365	860	94.53	95.20	94.99	95.49	0.14	0.58	4.23	0.66
2010	7167.34	8386	860	94.59	95.29	95.14	95.73	1.45	2.03	2.67	0.70
2011	6913.53	7987	880	89.88	90.69	90.71	91.18	0.39	1.31	8.00	0.81
2012	7477.19	8561	880	95.85	97.30	96.73	97.46	0.00	0.37	2.32	1.46
2013	7162.81	8171	880	92.03	93.11	92.92	93.28	1.98	2.15	4.74	1.09
2014	7496.54	8567	880	96.75	97.61	97.25	97.80	0.15	0.20	2.19	0.86
2015	6863.99	7856	880	88.52	89.08	89.04	89.68	6.32	6.70	4.22	0.56
2016	7300.52	8381	880	93.78	94.58	94.45	95.41	2.81	3.03	2.39	0.80
2017	6256.41	7132	880	80.36	80.53	81.16	81.42	1.89	7.84	11.63	0.17
2018	7333.77	8350	890	95.01	95.65	94.07	95.32	0.45	1.27	3.09	0.64

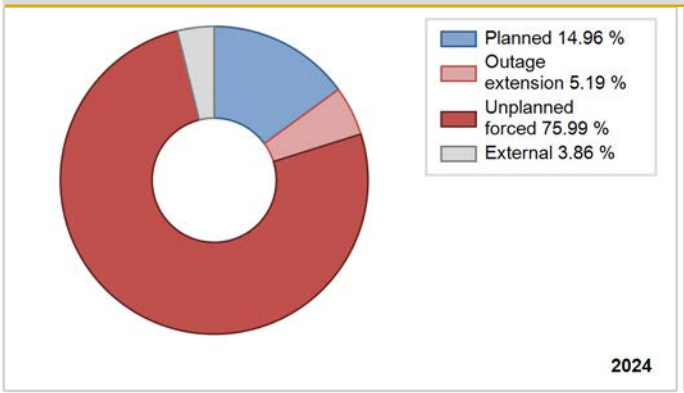
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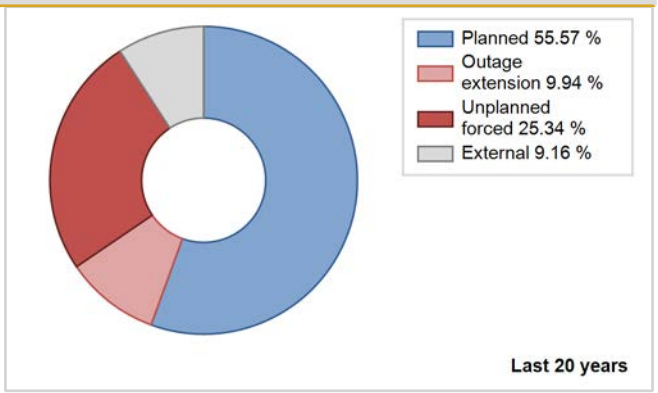
2019	7209.08	8162	890	92.33	92.95	92.47	93.17	1.16	1.16	5.88	0.63
2020	7276.55	8289	890	93.13	93.97	93.08	94.36	2.87	3.58	2.45	0.84
2021	7033.38	7941	890	89.94	90.35	90.21	90.65	0.58	1.41	8.24	0.41
2022	7532.48	8539	890	96.47	97.29	96.61	97.48	0.00	0.42	2.29	0.82
2023	6871.08	7840	890	88.12	88.71	88.13	89.50	6.45	6.59	4.70	0.60
2024	6615.99	7886	890	84.57	85.17	84.63	89.78	12.10	12.53	2.31	0.59

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1982 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		715			315	
B.	Refuelling without maintenance				32		
C.	Inspection, maintenance or repair combined with refuelling	184			355		
D.	Inspection, maintenance or repair without refuelling				7		
E.	Testing of plant systems or components				17	1	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				24		
J.	Grid limitation, failure or grid unavailability						4
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						11
L.	Human factor related					7	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
P.	Fire					0	
Z.	Other					1	0
Subtotal		184	715		435	324	15
Total		**899**			**774**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1982 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		21
12. Reactor I&C Systems		1
13. Reactor Auxiliary Systems		1
14. Safety Systems		4
15. Reactor Cooling Systems	70	22
21. Fuel Handling and Storage Facilities		2
31. Turbine and auxiliaries		7
32. Feedwater and Main Steam System		10
33. Circulating Water System		1
34. Miscellaneous Systems		0
35. All other I&C Systems		1
41. Main Generator Systems	644	228
42. Electrical Power Supply Systems		3
Total	**714**	**301**

Highlights (2024)

The electricity production of the Olkiluoto power plant units OL1, OL2 and OL3 during 2024 was 23,260 GWh. The total load factor of OL1, OL2 and OL3 was 79,1 %. The plant units operated safely and in Olkiluoto electricity was produced approximately 28 % of all electricity consumption in Finland.

During the year, the OL2 plant unit had five disruptions that caused production losses. The most significant of these were turbine bearing vibrations in August and main generator rotor change at cold shutdown in September-Oktober. After cold shutdown OL2 power has been limited to 765 MW gross power.

The annual outages of 2024 at the Olkiluoto´s nuclear power plant was carried out from March 2 to June 19, 2024. OL1 was performed a maintenance outage taking more than 37 days, and OL2 performed a refueling outage that lasted over 10 days. The annual outage period in OL1 extended about 22 days due to main generator stator repairs. The OL2`s annual outage was extended about three days, mainly due to failure of the relief system. It was first annual outage in the OL3 plant unit, and it lasted about 74 days in total. The annual outage in OL3 extended about 37 days, mainly due to the lengthening of the duration of the fuel works. In all other respects annual outages were implemented according to plans.

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2024 Operating Experience

FI-5 OLKILUOTO-3 FINLAND



Status at end of year	:	**Operational**
Operator	:	TVO (TEOLLISUUDEN VOIMA OYJ)
Owner	:	TVO (TEOLLISUUDEN VOIMA OYJ)
Reactor Supplier	:	ORANO (ORANO)
Turbine Supplier	:	SIEMENS (Siemens AG, Power Generation)

Reactor Unit Details

Reactor type and model	:	PWR / EPR
Thermal power	:	4300 MWth
Gross electrical power	:	1660 MWe
Reference unit power (net)	:	1575 MWe

Key Dates

Construction Date	:	2005-08-12
Grid Date	:	2022-03-12
Commercial Date	:	2023-05-01
Age at end of year	:	2 years

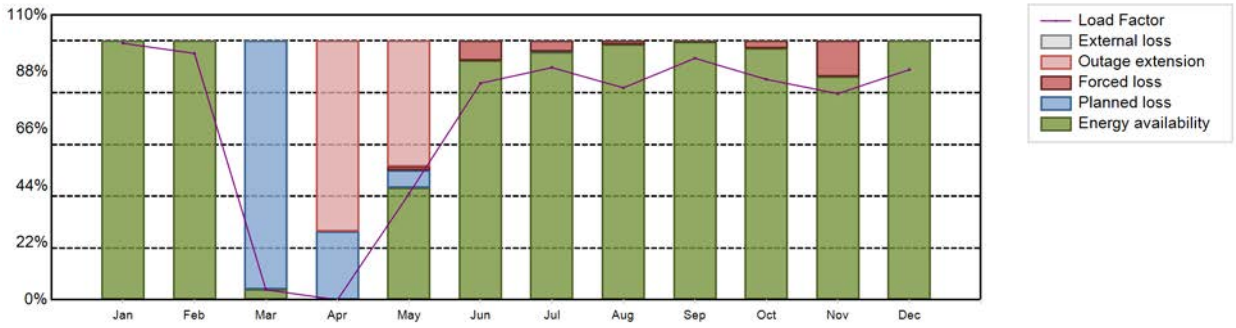
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	312
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.53
Average fuel enrichment [% of U235]	:	2.54	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	47500	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.77	HP cylinder inlet steam pressure [MPa]	:	7
Active core height/length [m]	:	4.2	Output voltage [kV]	:	27
Number of fissile fuel assemblies/bundles	:	241	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	4
Number of control rod assemblies	:	89	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	6
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9690.46 GW(e).h	Forced Loss Rate (FLR)	:	3.31 %
Energy Availability Factor (EAF)	:	76.38 %	Unplanned Capability Loss Factor (UCL)	:	12.75 %
Unit Capability Factor (UCF)	:	76.38 %	Planned Unavailability Factor (PUF)	:	10.87 %
Load Factor (LF)	:	70.04 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	78.45 %	Total off-line time	:	1893 hours

Annual Summary



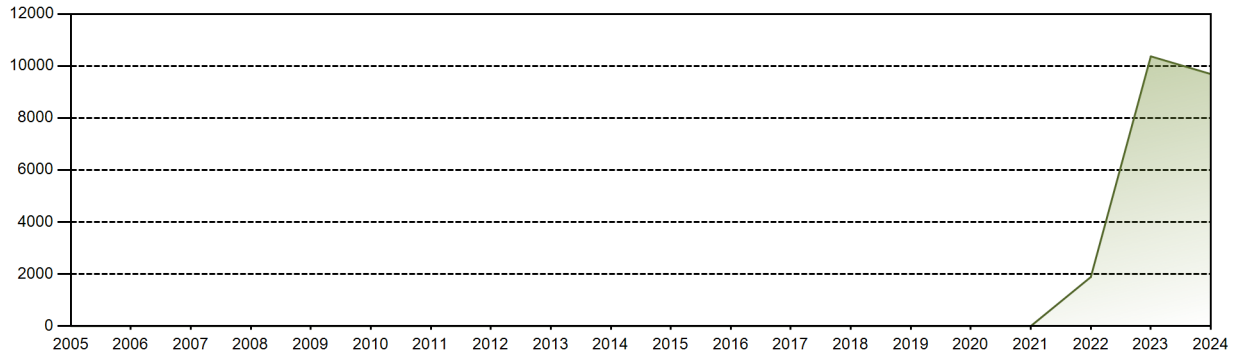
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1161.24	1043.18	45.59	0.00	479.70	948.45	1051.01	959.63	1057.92	999.09	903.01	1041.65	9690.46
EAF [%]	100.00	100.00	4.18	0.00	43.29	92.45	95.67	98.64	99.54	97.25	86.18	100.00	76.38
UCF [%]	100.00	100.00	4.18	0.00	43.29	92.45	95.67	98.64	99.54	97.25	86.18	100.00	76.38
LF [%]	99.10	95.16	3.89	0.00	40.94	83.64	89.69	81.89	93.29	85.15	79.63	88.89	70.04
OF [%]	100.00	100.00	5.38	0.00	51.48	98.19	100.00	100.00	100.00	100.00	86.81	100.00	78.45
FLR [%]	0.00	0.00	0.00	0.00	3.30	7.55	4.21	1.36	0.46	2.75	13.82	0.00	3.31
UCL [%]	0.00	0.00	0.00	73.47	50.03	7.55	4.20	1.36	0.46	2.75	13.82	0.00	12.75
PUF [%]	0.00	0.00	95.82	26.53	6.68	0.00	0.13	0.00	0.00	0.00	0.00	0.00	10.87
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

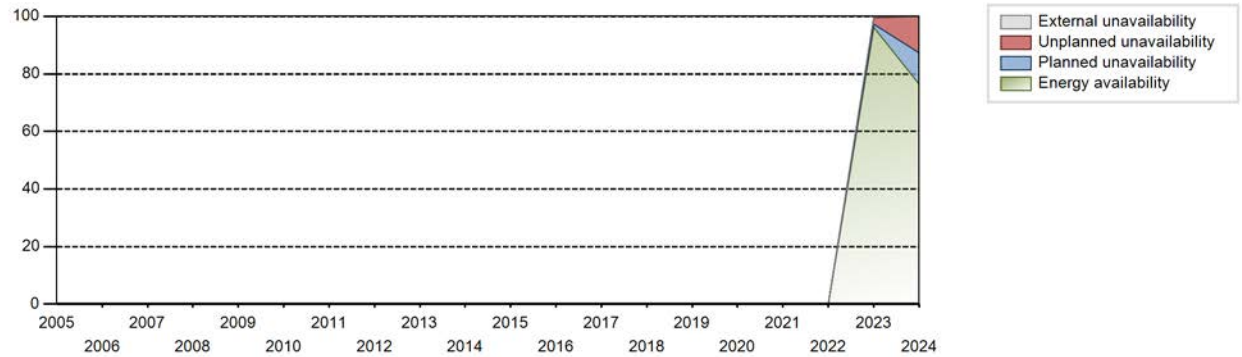
Lifetime energy generation	:	43897.73 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.8 %
Cumulative Energy Availability Factor (EAF)	:	84.44 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.47 %
Cumulative Unit Capability Factor (UCF)	:	84.67 %	Cumulative Planned Unavailability Factor (PUF)	:	6.86 %
Cumulative Load Factor (LF)	:	77.62 %	Cumulative Externally cause unavailability (XUF)	:	0.23 %
Cumulative Operating Factor (OF)	:	86.52 %			

Electricity Production (net) [GWh]

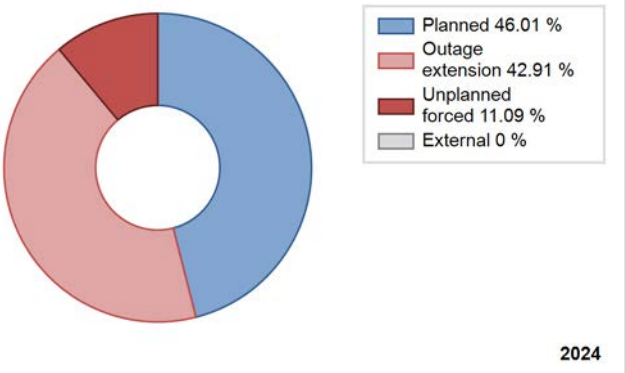


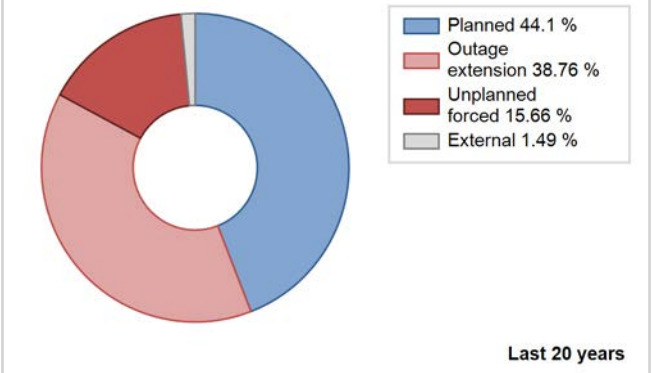
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2023	10371.84	7156	1600	96.28	96.85	88.76	98.57	2.19	2.17	0.98	0.57
2024	9690.46	6892	1575	76.38	76.38	70.04	78.45	3.31	12.75	10.87	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2023 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		998			2938	
C. Inspection, maintenance or repair combined with refuelling	895			537		
E. Testing of plant systems or components					18	
Z. Other					1436	
Subtotal	895	998		537	4392	
Total	**1893**			**4929**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2023 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	361	451
12. Reactor I&C Systems		39
21. Fuel Handling and Storage Facilities	529	187
31. Turbine and auxiliaries		128
32. Feedwater and Main Steam System		856
41. Main Generator Systems	108	68
42. Electrical Power Supply Systems		11
Total	**998**	**1740**

Highlights (2024)

The electricity production of the Olkiluoto power plant units OL1, OL2 and OL3 during 2024 was 23,260 GWh. The total load factor of OL1, OL2 and OL3 was 79,1 %. The plant units operated safely and in Olkiluoto electricity was produced approximately 28 % of all electricity consumption in Finland.

During the year, the OL3 plant unit had seven disruptions that caused production losses. The most significant of these were after outage the reactor core terminal marginal limitations, turbine trip due to low seal oil pressure in June, one of control rods falling into reactor in Oktober and turbine trip in November due to low pressure differential in the generator seal oil system.

The annual outages of 2024 at the Olkiluoto´s nuclear power plant was carried out from March 2 to June 19, 2024. OL1 was performed a maintenance outage taking more than 37 days, and OL2 performed a refueling outage that lasted over 10 days. The annual outage period in OL1 extended about 22 days duet to main generator stator repairs. The OL2`s annual outage was extended about three days, mainly due to failure of the relief system. It was first annual outage in the OL3 plant unit, and it lasted about 74 days in total. The annual outage in OL3 extended about 37 days, mainly due to the lengthening of the duration of the fuel works. In all other respects annual outages were implemented according to plans.

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2024 Operating Experience

FR-54 BELLEVILLE-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)



Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1363 MWe
Reference unit power (net)	:	1310 MWe

Key Dates

Construction Date	:	1980-05-01
Grid Date	:	1987-10-14
Commercial Date	:	1988-06-01
Age at end of year	:	37 years

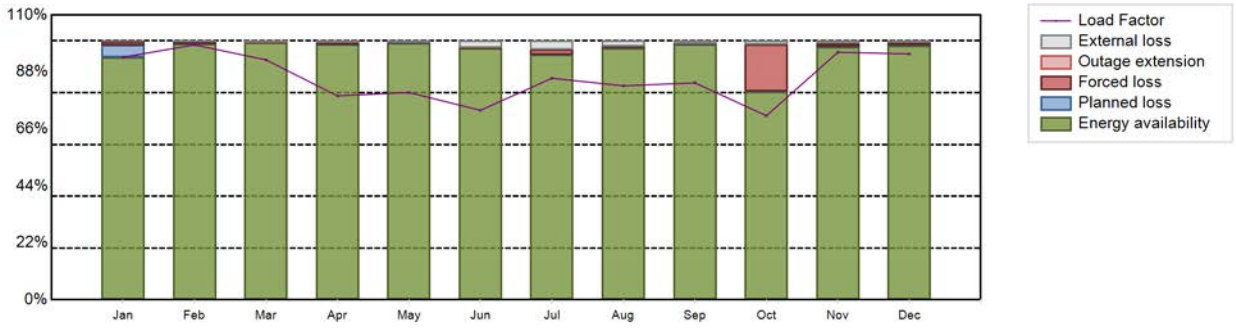
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2/MOX	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.25	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	51	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9878.38 GW(e).h	Forced Loss Rate (FLR)	:	2.24 %
Energy Availability Factor (EAF)	:	96.11 %	Unplanned Capability Loss Factor (UCL)	:	2.23 %
Unit Capability Factor (UCF)	:	97.33 %	Planned Unavailability Factor (PUF)	:	0.44 %
Load Factor (LF)	:	85.85 %	Externally cause unavailability (XUF)	:	1.22 %
Operating Factor (OF)	:	97.42 %	Total off-line time	:	227 hours

Annual Summary



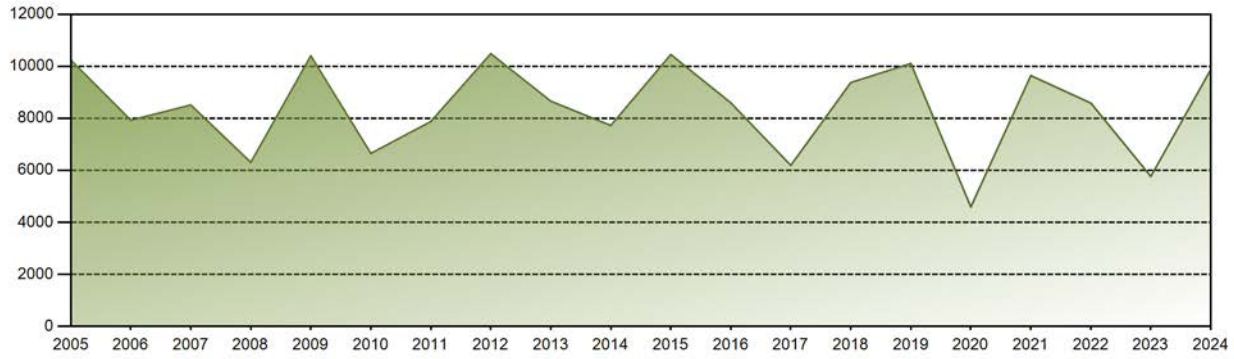
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	913.35	897.77	902.12	742.99	780.38	690.38	834.09	805.54	790.46	693.75	901.82	925.73	9878.38
EAF [%]	93.73	98.90	99.24	98.56	99.05	97.24	94.57	97.25	98.71	80.58	97.71	98.21	96.11
UCF [%]	93.89	99.30	99.84	99.09	99.79	99.87	97.99	99.34	99.95	81.96	98.54	98.79	97.33
LF [%]	93.71	98.47	92.68	78.77	80.07	73.20	85.58	82.65	83.81	71.09	95.61	94.98	85.85
OF [%]	100.00	100.00	100.00	95.42	100.00	94.03	100.00	100.00	100.00	79.73	100.00	100.00	97.42
FLR [%]	1.47	0.68	0.12	0.88	0.14	0.08	1.87	0.63	0.03	18.04	1.41	1.17	2.24
UCL [%]	1.40	0.68	0.12	0.88	0.14	0.08	1.87	0.63	0.03	18.04	1.40	1.17	2.23
PUF [%]	4.71	0.02	0.04	0.03	0.06	0.05	0.14	0.03	0.02	0.00	0.06	0.04	0.44
XUF [%]	0.16	0.40	0.60	0.54	0.75	2.63	3.42	2.08	1.24	1.38	0.83	0.58	1.22

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Historical Summary

Lifetime energy generation	:	301124.85 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.89 %
Cumulative Energy Availability Factor (EAF)	:	75.63 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.31 %
Cumulative Unit Capability Factor (UCF)	:	77.3 %	Cumulative Planned Unavailability Factor (PUF)	:	14.4 %
Cumulative Load Factor (LF)	:	71 %	Cumulative Externally cause unavailability (XUF)	:	1.67 %
Cumulative Operating Factor (OF)	:	77.79 %			

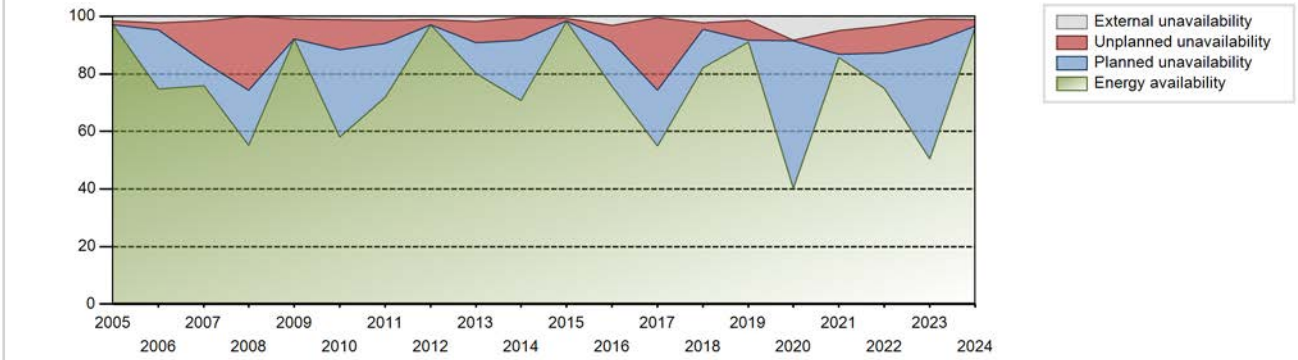
Electricity Production (net) [GWh]



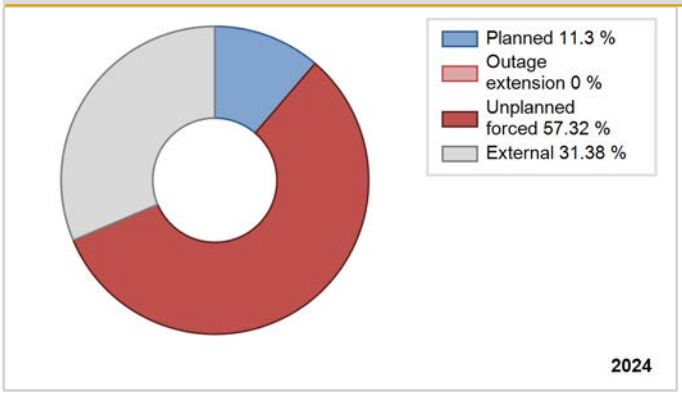
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	6283.00	6478	1310	85.78	86.06	64.40	86.06	13.94	13.94	0.00	0.28
1989	5152.56	4244	1310	45.97	46.53	44.90	48.45	30.63	20.55	32.93	0.55
1990	7914.26	6408	1310	71.15	71.43	68.97	73.15	12.19	9.92	18.66	0.27
1991	8660.21	7092	1310	79.28	80.80	75.47	80.96	5.38	4.59	14.61	1.51
1992	8494.33	7600	1310	91.19	91.82	73.82	86.52	6.07	5.94	2.25	0.63
1993	7921.46	6873	1310	71.25	77.46	69.03	78.46	7.73	6.49	16.05	6.21
1994	6575.76	5848	1310	63.98	65.16	57.30	66.76	24.97	21.69	13.15	1.18
1995	7740.91	6796	1310	73.44	76.23	67.46	77.58	8.01	6.64	17.14	2.79
1996	7365.06	6002	1310	76.49	76.80	64.00	68.33	12.12	10.59	12.61	0.30
1997	9785.27	8294	1310	93.24	93.41	85.27	94.68	5.22	5.14	1.44	0.18
1998	5740.91	4865	1310	51.18	53.72	50.03	55.54	38.57	33.73	12.56	2.54
1999	9580.49	7957	1310	90.43	91.97	83.49	90.83	1.39	1.30	6.73	1.54
2000	4238.57	3459	1310	37.89	37.99	36.83	39.38	9.13	3.82	58.19	0.10
2001	9564.53	7774	1310	86.79	87.31	83.35	88.74	2.17	1.94	10.75	0.52
2002	9567.30	8447	1310	98.94	99.55	83.37	96.43	0.13	0.13	0.32	0.62
2003	8401.73	6871	1310	75.45	77.63	73.21	78.44	8.55	7.26	15.11	2.19
2004	9291.01	7645	1310	88.02	88.59	80.73	87.02	0.00	0.00	11.41	0.57
2005	10236.41	8646	1310	97.11	98.77	89.19	98.69	1.21	1.21	0.02	1.66
2006	7926.72	6870	1310	74.83	77.06	69.07	78.42	2.85	2.54	20.41	2.23
2007	8512.07	7213	1310	75.83	77.52	74.18	82.34	7.36	14.23	8.25	1.69
2008	6304.96	5615	1310	55.20	55.31	54.79	63.92	21.25	25.63	19.05	0.11
2009	10402.30	8350	1310	92.08	93.04	90.65	95.32	6.93	6.92	0.04	0.96
2010	6650.30	5370	1310	58.15	59.20	57.95	61.30	3.94	10.48	30.32	1.04
2011	7876.28	6525	1310	71.77	73.05	68.63	74.49	2.44	8.05	18.90	1.28
2012	10483.62	8691	1310	97.02	98.09	91.11	98.94	1.82	1.82	0.09	1.07
2013	8658.64	7309	1310	80.18	82.02	75.45	83.44	1.60	7.40	10.59	1.84
2014	7723.74	6391	1310	70.68	71.19	67.31	72.96	7.15	7.79	21.01	0.51
2015	10451.61	8660	1310	98.29	99.02	91.08	98.86	0.96	0.96	0.02	0.74
2016	8593.89	7106	1310	75.60	78.78	74.68	80.90	4.70	5.82	15.39	3.19
2017	6191.21	4991	1310	54.88	55.44	53.95	56.97	4.33	25.13	19.43	0.56
2018	9375.77	7412	1310	82.19	84.49	81.70	84.61	1.42	2.29	13.21	2.30
2019	10111.20	8130	1310	91.04	92.33	88.11	92.81	0.30	7.09	0.58	1.29
2020	4590.82	3767	1310	40.13	48.36	39.90	42.88	0.46	0.22	51.42	8.22
2021	9643.04	7845	1310	85.62	90.48	84.03	89.55	2.90	8.32	1.21	4.85
2022	8586.60	6891	1310	75.10	78.53	74.82	78.66	3.40	9.24	12.23	3.43
2023	5765.70	4541	1310	50.43	51.30	50.24	51.84	0.53	8.64	40.06	0.87
2024	9878.38	8557	1310	96.11	97.33	85.85	97.42	2.24	2.23	0.44	1.22

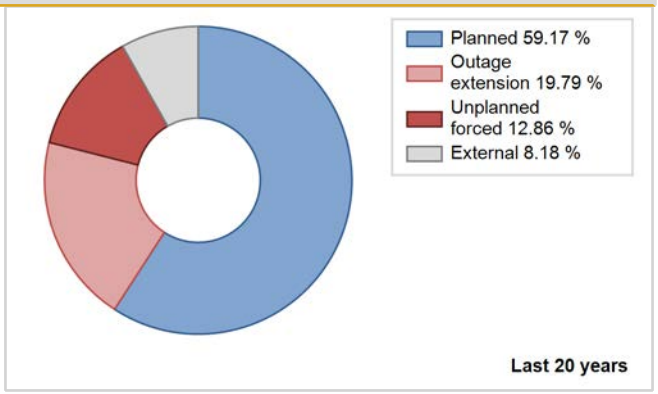
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		129			556	
B.	Refuelling without maintenance				118		
C.	Inspection, maintenance or repair combined with refuelling				1214	6	
D.	Inspection, maintenance or repair without refuelling				5		
E.	Testing of plant systems or components				35	2	0
H.	Nuclear regulatory requirements					64	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			0			0
L.	Human factor related					14	
M.	Governmental requirements or court decisions						3
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						28
O.	Load dispatching, prioritization			95			3
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					2	41
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			2			1
Z.	Other					16	4
Subtotal			129	97	1372	660	80
Total			**226**			**2112**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1988 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		19
12. Reactor I&C Systems		50
13. Reactor Auxiliary Systems		37
14. Safety Systems		25
15. Reactor Cooling Systems		26
16. Steam generation systems		37
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		6
31. Turbine and auxiliaries	22	52
32. Feedwater and Main Steam System		60
33. Circulating Water System		1
34. Miscellaneous Systems		176
35. All other I&C Systems		10
41. Main Generator Systems		29
42. Electrical Power Supply Systems	107	21
Total	**129**	**549**

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2024 Operating Experience

FR-55 BELLEVILLE-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)



Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1363 MWe
Reference unit power (net)	:	1310 MWe

Key Dates

Construction Date	:	1980-08-01
Grid Date	:	1988-07-06
Commercial Date	:	1989-01-01
Age at end of year	:	36 years

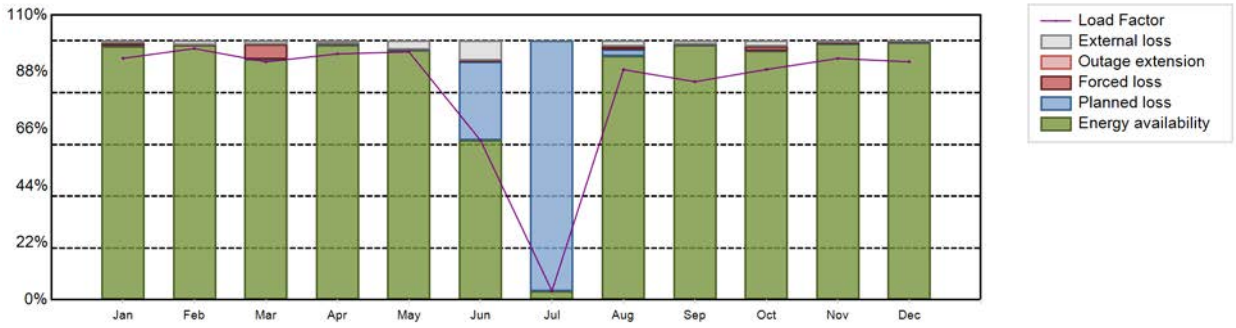
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.25	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9437.18 GW(e).h	Forced Loss Rate (FLR)	:	1.13 %
Energy Availability Factor (EAF)	:	86.22 %	Unplanned Capability Loss Factor (UCL)	:	1.01 %
Unit Capability Factor (UCF)	:	88.08 %	Planned Unavailability Factor (PUF)	:	10.91 %
Load Factor (LF)	:	82.01 %	Externally cause unavailability (XUF)	:	1.86 %
Operating Factor (OF)	:	89.29 %	Total off-line time	:	941 hours

Annual Summary



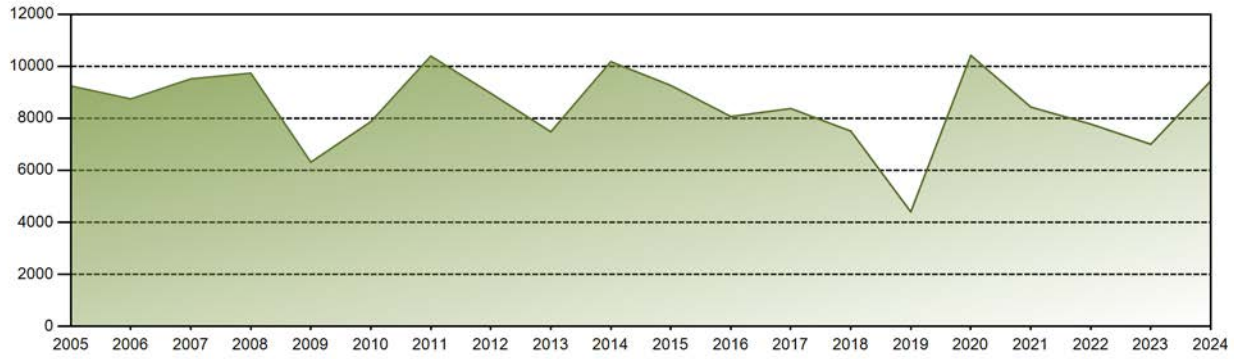
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	909.12	884.78	894.64	895.92	933.40	581.25	33.49	866.61	794.55	868.25	879.22	895.96	9437.18
EAF [%]	97.98	98.36	92.83	98.42	96.38	61.63	3.44	94.12	98.38	96.07	98.89	99.33	86.22
UCF [%]	98.83	99.88	94.09	99.43	99.80	69.24	3.44	96.24	99.76	98.07	99.62	99.79	88.08
LF [%]	93.28	97.04	91.92	94.99	95.77	61.63	3.44	88.92	84.24	88.96	93.22	91.93	82.01
OF [%]	100.00	100.00	94.62	100.00	100.00	70.00	8.06	100.00	100.00	99.87	100.00	100.00	89.29
FLR [%]	1.13	0.08	5.80	0.46	0.18	0.76	0.00	1.23	0.21	1.88	0.31	0.20	1.13
UCL [%]	1.13	0.08	5.79	0.46	0.18	0.53	0.00	1.20	0.21	1.88	0.31	0.20	1.01
PUF [%]	0.04	0.03	0.12	0.12	0.02	30.23	96.56	2.56	0.03	0.05	0.07	0.01	10.91
XUF [%]	0.85	1.53	1.26	1.01	3.42	7.62	0.00	2.12	1.38	2.00	0.72	0.46	1.86

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Historical Summary

Lifetime energy generation	:	299633.85 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.5 %
Cumulative Energy Availability Factor (EAF)	:	76.76 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.16 %
Cumulative Unit Capability Factor (UCF)	:	78.74 %	Cumulative Planned Unavailability Factor (PUF)	:	14.1 %
Cumulative Load Factor (LF)	:	71.94 %	Cumulative Externally cause unavailability (XUF)	:	1.98 %
Cumulative Operating Factor (OF)	:	79.01 %			

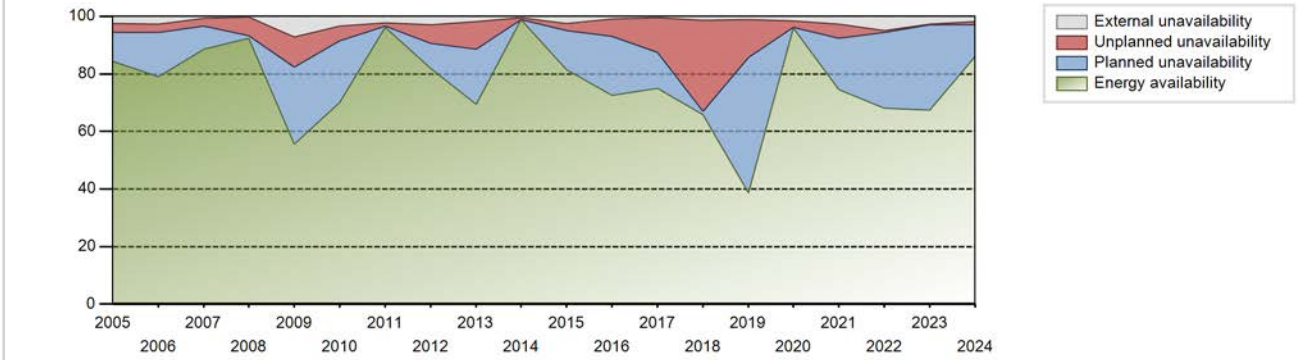
Electricity Production (net) [GWh]



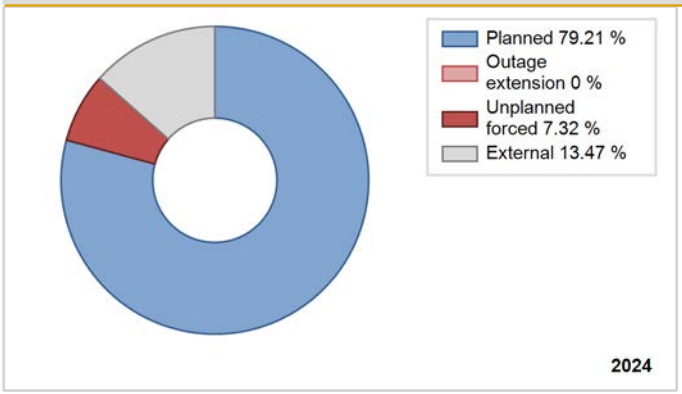
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	8505.66	7419	1310	86.64	86.97	74.12	84.69	12.32	12.23	0.80	0.33
1990	6323.98	5350	1310	56.88	58.44	55.11	61.07	15.85	11.01	30.55	1.56
1991	7876.29	6578	1310	70.27	73.35	68.64	75.09	11.31	9.35	17.30	3.08
1992	8262.05	6904	1310	75.27	75.86	71.80	78.60	8.44	7.00	17.15	0.59
1993	8871.34	7435	1310	80.13	83.38	77.31	84.87	1.52	1.28	15.33	3.25
1994	8241.32	7122	1310	76.93	80.38	71.82	81.30	4.04	3.39	16.23	3.45
1995	7960.50	7438	1310	97.53	99.26	69.37	84.91	0.58	0.58	0.16	1.73
1996	7229.81	6666	1310	71.15	74.45	62.83	75.89	13.79	11.91	13.64	3.30
1997	8508.10	7339	1310	82.04	84.87	74.14	83.78	1.24	1.07	14.07	2.83
1998	5068.01	4239	1310	45.03	45.03	44.16	48.39	54.74	54.45	0.51	0.01
1999	4899.26	4040	1310	43.32	44.82	42.69	46.12	7.10	3.43	51.75	1.50
2000	9882.48	8271	1310	96.68	97.43	85.88	94.16	2.11	2.10	0.47	0.75
2001	8457.97	6935	1310	78.58	79.16	73.70	79.17	8.87	7.71	13.14	0.57
2002	9378.75	7687	1310	84.29	86.15	81.73	87.75	2.17	1.91	11.94	1.86
2003	8624.72	7135	1310	79.44	80.37	75.16	81.45	7.22	6.25	13.37	0.93
2004	10202.59	8621	1310	97.05	98.01	88.66	98.14	1.97	1.97	0.03	0.95
2005	9242.31	7767	1310	84.39	86.90	80.53	88.65	0.73	3.01	10.09	2.51
2006	8743.63	7309	1310	79.06	81.71	76.19	83.44	1.88	2.91	15.38	2.65
2007	9516.03	7895	1310	88.63	89.44	82.92	90.13	2.27	2.63	7.94	0.81
2008	9734.88	8327	1310	92.36	92.61	84.60	94.80	1.98	6.39	1.00	0.25
2009	6310.85	5166	1310	55.55	62.73	54.99	58.97	1.45	10.48	26.79	7.18
2010	7869.74	6361	1310	70.02	73.51	68.58	72.61	2.31	4.98	21.51	3.49
2011	10390.88	8727	1310	96.07	98.36	90.55	99.62	1.07	1.07	0.58	2.28
2012	8959.34	7456	1310	81.86	84.76	77.86	84.88	1.03	6.41	8.83	2.89
2013	7480.48	6273	1310	69.44	71.15	65.19	71.61	3.40	9.79	19.06	1.71
2014	10177.69	8753	1310	98.91	99.44	88.69	99.92	0.53	0.53	0.03	0.54
2015	9264.45	7444	1310	81.50	84.06	80.73	84.98	2.65	2.29	13.65	2.56
2016	8068.56	6779	1310	72.65	73.67	70.12	77.17	2.11	5.83	20.50	1.03
2017	8376.52	6633	1310	75.05	75.51	72.99	75.72	1.17	12.12	12.36	0.47
2018	7508.77	6173	1310	65.77	67.09	65.43	70.47	5.52	31.75	1.16	1.32
2019	4402.58	3481	1310	38.58	39.65	38.36	39.74	5.69	13.16	47.19	1.07
2020	10421.33	8606	1310	95.84	97.41	90.56	97.97	2.34	2.33	0.26	1.57
2021	8432.45	6773	1310	74.48	77.22	73.48	77.32	0.39	4.85	17.93	2.74
2022	7778.25	6194	1310	68.17	73.16	67.78	70.71	0.75	0.56	26.28	4.99
2023	7004.38	6192	1310	67.41	70.09	61.04	70.68	0.22	0.16	29.75	2.68
2024	9437.18	7843	1310	86.22	88.08	82.01	89.29	1.13	1.01	10.91	1.86

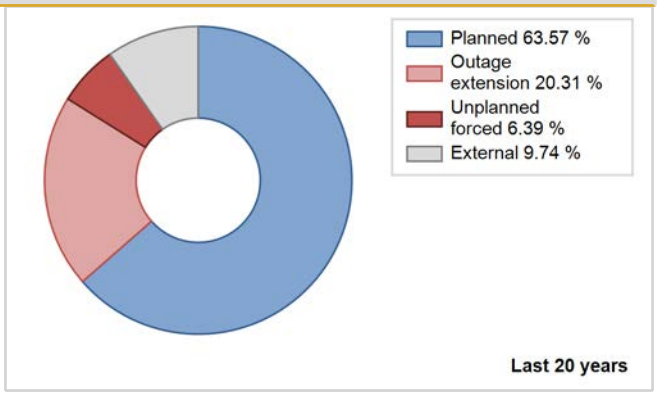
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		40			433	
B. Refuelling without maintenance	900			197		
C. Inspection, maintenance or repair combined with refuelling				962		
E. Testing of plant systems or components				29		
H. Nuclear regulatory requirements					86	
L. Human factor related					15	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
O. Load dispatching, prioritization						1
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					1	37
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						3
Z. Other					33	3
Subtotal	900	40		1188	568	44
Total	**940**			**1800**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1989 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		26
12. Reactor I&C Systems		40
13. Reactor Auxiliary Systems		9
14. Safety Systems		20
15. Reactor Cooling Systems		30
16. Steam generation systems		25
17. Safety I&C Systems (excluding reactor I&C)		7
21. Fuel Handling and Storage Facilities		10
31. Turbine and auxiliaries	40	33
32. Feedwater and Main Steam System		10
33. Circulating Water System		2
34. Miscellaneous Systems		194
35. All other I&C Systems		6
41. Main Generator Systems		4
42. Electrical Power Supply Systems		12
Total	**40**	**428**

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2024 Operating Experience

FR-32 BLAYAIS-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1977-01-01
Grid Date	:	1981-06-12
Commercial Date	:	1981-12-01
Age at end of year	:	43 years

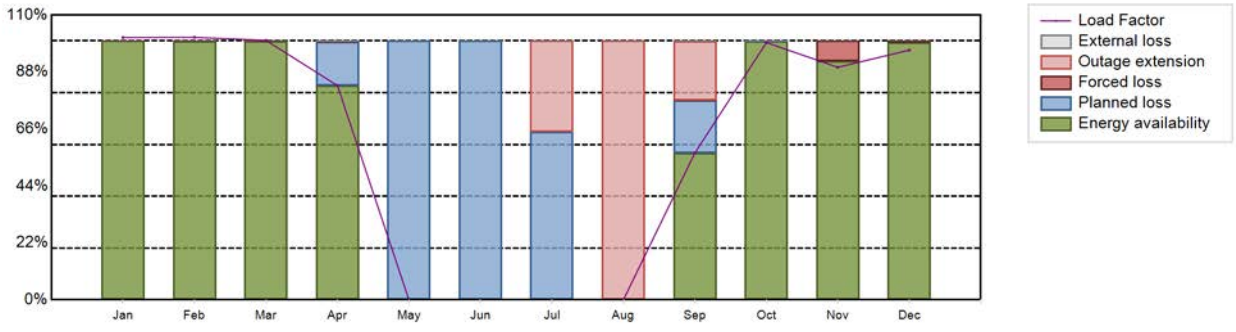
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	323
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4834.7 GW(e).h	Forced Loss Rate (FLR)	:	1.13 %
Energy Availability Factor (EAF)	:	60.71 %	Unplanned Capability Loss Factor (UCL)	:	14.02 %
Unit Capability Factor (UCF)	:	60.76 %	Planned Unavailability Factor (PUF)	:	25.22 %
Load Factor (LF)	:	60.48 %	Externally cause unavailability (XUF)	:	0.04 %
Operating Factor (OF)	:	61.71 %	Total off-line time	:	3363 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	686.15	642.05	677.61	542.23	0.00	0.00	0.00	0.00	371.71	673.56	588.40	653.00	4834.70
EAF [%]	99.99	99.93	99.93	82.66	0.00	0.00	0.00	0.00	56.68	99.79	92.26	99.47	60.71
UCF [%]	99.99	99.93	99.93	83.06	0.00	0.00	0.00	0.00	56.79	99.80	92.26	99.47	60.76
LF [%]	101.35	101.37	100.22	82.76	0.00	0.00	0.00	0.00	56.73	99.35	89.80	96.45	60.48
OF [%]	100.00	100.00	100.00	83.33	0.00	0.00	0.00	0.00	63.61	99.87	96.11	100.00	61.71
FLR [%]	0.01	0.01	0.01	0.07	0.00	0.00	0.00	0.00	0.05	0.10	7.74	0.53	1.13
UCL [%]	0.01	0.01	0.01	0.06	0.00	0.00	35.22	100.00	22.85	0.10	7.74	0.53	14.02
PUF [%]	0.00	0.06	0.06	16.88	100.00	100.00	64.78	0.00	20.36	0.10	0.00	0.00	25.22
XUF [%]	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.11	0.01	0.00	0.00	0.04

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Historical Summary

Lifetime energy generation	:	247301.52 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.16 %
Cumulative Energy Availability Factor (EAF)	:	75.29 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.29 %
Cumulative Unit Capability Factor (UCF)	:	78.33 %	Cumulative Planned Unavailability Factor (PUF)	:	14.38 %
Cumulative Load Factor (LF)	:	71.77 %	Cumulative Externally cause unavailability (XUF)	:	3.04 %
Cumulative Operating Factor (OF)	:	76.63 %			

Electricity Production (net) [GWh]

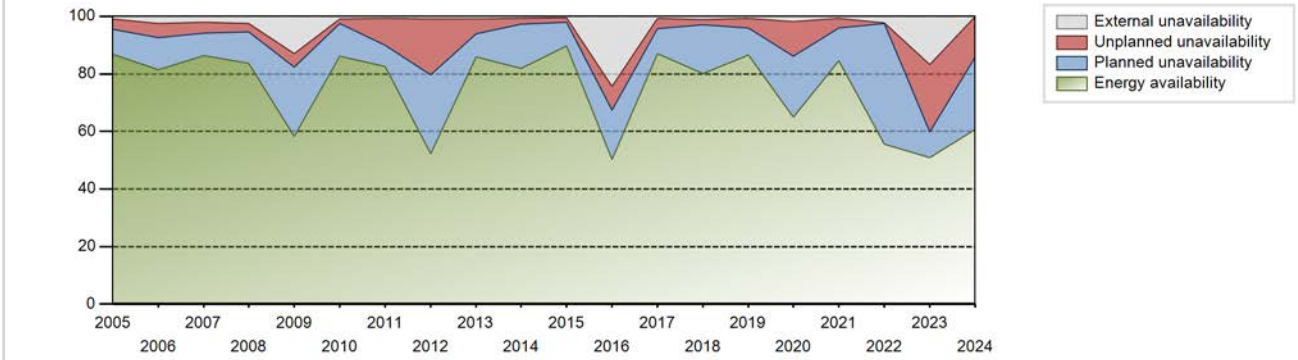


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	1636.20	2584	915	65.60	65.60	65.60	70.16	7.37	5.22	29.18	0.00
1982	6129.80	7588	910	81.46	81.46	76.90	86.62	18.54	18.54	0.00	0.00
1983	3453.00	4285	910	43.92	43.92	43.32	48.92	31.78	20.46	35.62	0.00
1984	6509.00	7536	910	84.55	84.55	81.43	85.79	7.30	6.66	8.79	0.00
1985	6225.20	7348	910	82.83	82.96	78.09	83.88	3.26	2.79	14.24	0.14
1986	6460.60	7754	910	86.95	87.82	81.05	88.52	2.13	1.91	10.26	0.87
1987	5586.60	6793	910	76.23	78.16	70.08	77.55	6.57	5.50	16.35	1.92
1988	5730.00	7069	910	81.27	82.09	71.68	80.48	6.23	5.45	12.46	0.81
1989	6222.43	7419	910	83.31	84.25	78.06	84.69	3.77	3.30	12.46	0.94
1990	5822.59	6834	910	76.90	77.20	73.04	78.01	5.32	4.34	18.47	0.30
1991	6379.04	7400	910	83.31	83.76	80.02	84.47	4.09	3.57	12.67	0.45
1992	4349.17	5079	910	56.60	57.49	54.41	57.82	20.87	15.16	27.35	0.89
1993	5979.16	7253	910	78.32	83.74	75.01	82.80	5.60	4.97	11.29	5.42
1994	3474.92	5119	910	85.78	86.60	43.59	58.44	2.06	1.82	11.58	0.82
1995	6075.80	7206	910	84.28	87.09	76.22	82.26	0.91	0.80	12.11	2.81
1996	6639.15	7798	910	85.56	88.50	83.06	88.78	1.49	1.34	10.17	2.94
1997	6196.60	7621	910	84.56	90.12	77.73	87.00	0.52	0.47	9.41	5.56
1998	5917.56	7078	910	78.22	81.11	74.23	80.80	7.37	6.46	12.43	2.89
1999	6046.81	7082	910	77.91	80.86	75.85	80.84	11.17	10.17	8.97	2.96
2000	2854.09	3602	910	36.56	53.42	35.71	41.01	35.61	29.54	17.04	16.86
2001	4881.50	5768	910	64.02	66.25	61.24	65.84	27.08	24.61	9.15	2.23
2002	6861.10	8251	910	92.98	95.04	86.07	94.19	1.80	1.74	3.22	2.06
2003	4541.69	5321	910	58.11	61.76	56.97	60.74	17.16	12.79	25.45	3.65
2004	6144.26	7217	910	79.22	81.48	76.87	82.16	2.45	2.05	16.47	2.26
2005	6883.56	7841	910	86.82	87.72	86.34	89.50	2.13	3.67	8.60	0.90
2006	6507.99	7440	910	81.57	84.05	81.64	84.93	3.56	4.99	10.96	2.48
2007	6891.00	7791	910	86.39	88.34	86.43	88.93	3.05	3.94	7.72	1.94
2008	6678.68	7651	910	83.66	86.10	83.55	87.10	0.82	2.98	10.93	2.44
2009	4604.59	5461	910	58.38	71.43	57.76	62.34	0.51	4.54	24.02	13.05
2010	6634.72	7679	910	86.10	87.01	83.23	87.66	0.42	1.68	11.31	0.91
2011	6465.19	7370	910	82.66	83.46	81.10	84.13	0.67	9.26	7.28	0.80
2012	4170.62	4690	910	52.22	53.05	52.18	53.39	14.15	19.44	27.52	0.83
2013	6809.65	7659	910	85.90	86.91	85.42	87.43	0.67	5.01	8.08	1.02
2014	6245.02	7214	910	81.80	82.57	78.34	82.35	0.54	2.04	15.39	0.77
2015	6874.30	7961	910	89.68	90.19	86.23	90.88	1.74	1.60	8.21	0.51
2016	3996.76	4637	910	50.28	74.65	50.00	52.79	1.07	8.30	17.04	24.37
2017	6916.74	7783	910	87.06	87.77	86.77	88.85	0.68	3.52	8.70	0.72

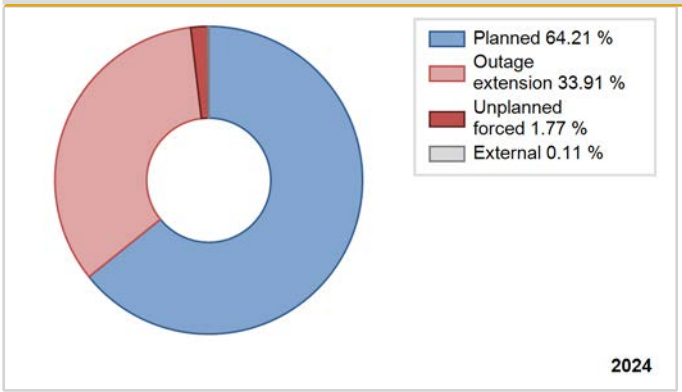
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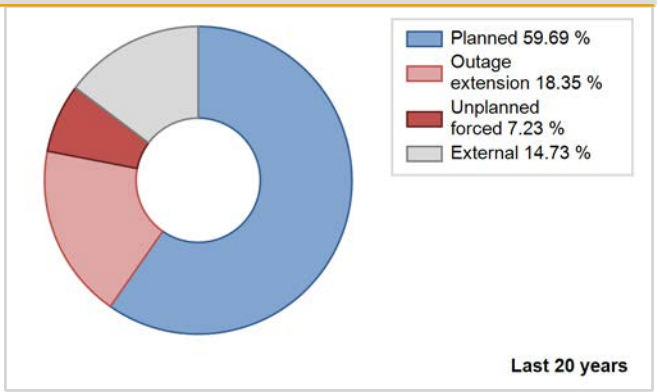
2018	6345.55	7164	910	80.08	81.21	79.60	81.78	0.73	1.73	17.07	1.13
2019	6840.40	7698	910	86.68	87.34	85.81	87.88	1.01	3.51	9.16	0.66
2020	5026.78	5834	910	64.88	66.80	62.89	66.42	11.13	11.84	21.35	1.92
2021	6673.16	7546	910	84.51	85.29	83.71	86.14	1.44	3.20	11.51	0.78
2022	4354.20	5055	910	55.51	57.84	54.62	57.71	0.35	0.21	41.95	2.33
2023	4010.38	4588	910	50.81	67.51	50.31	52.37	2.65	23.47	9.02	16.70
2024	4834.70	5421	910	60.71	60.76	60.48	61.71	1.13	14.02	25.22	0.04

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1981 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		1199			469	0
B.	Refuelling without maintenance				178		
C.	Inspection, maintenance or repair combined with refuelling	2066			1002	4	
D.	Inspection, maintenance or repair without refuelling				28		
E.	Testing of plant systems or components	98			3	1	
H.	Nuclear regulatory requirements					50	
J.	Grid limitation, failure or grid unavailability						1
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L.	Human factor related					10	1
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						43
O.	Load dispatching, prioritization						1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					15	105
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						1
Z.	Other					14	
Subtotal		2164	1199		1211	563	152
Total		**3363**			**1926**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		21
12. Reactor I&C Systems		51
13. Reactor Auxiliary Systems		6
14. Safety Systems		21
15. Reactor Cooling Systems		50
16. Steam generation systems		55
17. Safety I&C Systems (excluding reactor I&C)		4
21. Fuel Handling and Storage Facilities		34
31. Turbine and auxiliaries		26
32. Feedwater and Main Steam System	28	32
33. Circulating Water System		1
34. Miscellaneous Systems	1170	134
35. All other I&C Systems		0
41. Main Generator Systems		61
42. Electrical Power Supply Systems		24
Total	**1198**	**520**

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2024 Operating Experience

FR-33 BLAYAIS-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	FRAM (FRAMATOME)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1977-01-01
Grid Date	:	1982-07-17
Commercial Date	:	1983-02-01
Age at end of year	:	42 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.44
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

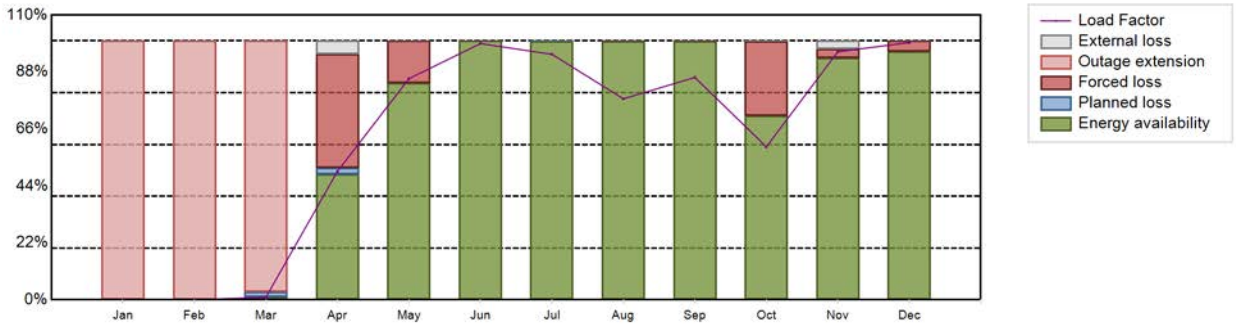
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	323
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4990.59 GW(e).h
Energy Availability Factor (EAF)	:	66.28 %
Unit Capability Factor (UCF)	:	66.97 %
Load Factor (LF)	:	62.43 %
Operating Factor (OF)	:	67.37 %

Forced Loss Rate (FLR)	:	10.74 %
Unplanned Capability Loss Factor (UCL)	:	32.65 %
Planned Unavailability Factor (PUF)	:	0.38 %
Externally cause unavailability (XUF)	:	0.69 %
Total off-line time	:	2866 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	7.05	325.15	578.30	648.36	642.09	525.60	562.87	400.59	627.86	672.72	4990.59
EAF [%]	0.00	0.00	1.05	48.50	83.85	100.00	99.94	99.97	99.92	70.98	93.33	95.87	66.28
UCF [%]	0.00	0.00	1.05	53.51	83.85	100.00	99.94	99.97	99.92	71.17	96.54	95.87	66.97
LF [%]	0.00	0.00	1.04	49.63	85.42	98.96	94.84	77.63	85.91	59.09	95.83	99.36	62.43
OF [%]	0.00	0.00	2.96	55.83	84.14	100.00	100.00	100.00	100.00	70.60	96.81	96.37	67.37
FLR [%]	0.00	0.00	0.00	45.13	16.15	0.00	0.00	0.03	0.00	28.83	3.46	4.13	10.74
UCL [%]	100.00	100.00	96.97	44.02	16.15	0.00	0.00	0.03	0.00	28.83	3.46	4.13	32.65
PUF [%]	0.00	0.00	1.99	2.47	0.00	0.00	0.06	0.00	0.07	0.00	0.00	0.00	0.38
XUF [%]	0.00	0.00	0.00	5.01	0.00	0.00	0.00	0.00	0.00	0.19	3.21	0.00	0.69

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Historical Summary

Lifetime energy generation	:	256098.1 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.86 %
Cumulative Energy Availability Factor (EAF)	:	78.96 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.39 %
Cumulative Unit Capability Factor (UCF)	:	80.96 %	Cumulative Planned Unavailability Factor (PUF)	:	14.65 %
Cumulative Load Factor (LF)	:	76.03 %	Cumulative Externally cause unavailability (XUF)	:	2.01 %
Cumulative Operating Factor (OF)	:	79.65 %			

Electricity Production (net) [GWh]

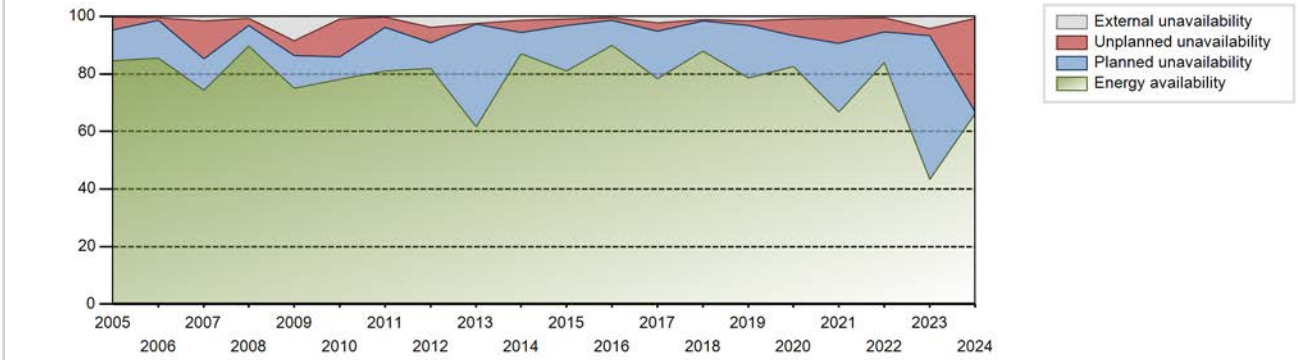


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	5094.00	5817	910	62.33	62.33	61.55	63.87	9.70	6.69	30.98	0.00
1984	6645.00	7716	910	85.54	85.54	83.13	87.84	4.07	3.63	10.83	0.00
1985	6819.70	7937	910	89.90	90.00	85.55	90.61	1.61	1.47	8.53	0.11
1986	6048.40	7142	910	82.86	83.21	75.87	81.53	3.13	2.68	14.10	0.36
1987	5987.10	7218	910	84.20	84.82	75.11	82.40	4.93	4.40	10.78	0.63
1988	4162.00	5718	910	90.75	91.17	52.07	65.10	4.68	4.48	4.35	0.41
1989	5560.97	6720	910	73.44	76.95	69.76	76.71	3.25	2.59	20.46	3.51
1990	5656.42	7381	910	85.73	87.37	70.96	84.26	2.33	2.08	10.54	1.65
1991	5326.54	6789	910	75.13	78.33	66.82	77.50	3.66	2.98	18.69	3.20
1992	5953.25	7505	910	83.74	86.89	74.48	85.44	0.72	0.63	12.48	3.16
1993	5253.21	6203	910	67.00	71.03	65.90	70.81	1.73	1.25	27.72	4.02
1994	6692.60	7658	910	88.12	88.74	83.96	87.42	0.21	0.19	11.07	0.62
1995	6725.49	7775	910	85.61	87.94	84.37	88.76	1.75	1.57	10.49	2.33
1996	6709.81	7587	910	85.04	87.36	83.94	86.37	0.45	0.40	12.24	2.32
1997	6769.92	7681	910	84.77	88.67	84.93	87.68	1.95	1.77	9.56	3.90
1998	6974.32	7883	910	87.20	90.03	87.49	89.99	0.11	0.10	9.87	2.83
1999	5836.20	6544	910	73.05	75.10	73.21	74.70	12.55	10.78	14.12	2.05
2000	4941.11	5592	910	63.00	75.24	61.81	63.66	5.56	4.43	20.33	12.24
2001	6547.95	7358	910	81.93	83.56	82.14	84.00	4.64	4.06	12.38	1.63
2002	5971.95	7357	910	82.72	84.35	74.92	83.98	7.27	6.61	9.05	1.62
2003	5181.16	5784	910	63.69	66.03	65.00	66.03	2.06	1.39	32.58	2.34
2004	6734.56	7346	910	81.47	82.57	84.25	83.63	6.55	5.78	11.65	1.09
2005	6918.75	7513	910	84.65	84.96	86.78	85.76	0.15	4.32	10.71	0.32
2006	6786.69	7599	910	85.44	86.03	85.14	86.75	0.92	0.80	13.17	0.59
2007	6035.60	6686	910	74.27	75.83	75.71	76.32	0.19	13.19	10.99	1.56
2008	7191.21	7977	910	89.67	90.28	89.96	90.81	0.04	2.58	7.15	0.60
2009	6050.55	6736	910	75.02	83.55	75.90	76.89	1.67	5.01	11.44	8.53
2010	6341.07	6919	910	78.18	79.08	79.55	78.98	12.48	13.07	7.85	0.90
2011	6516.19	7156	910	80.96	81.16	81.74	81.69	0.19	3.54	15.30	0.20
2012	6486.49	7345	910	81.81	85.65	81.15	83.62	0.53	5.29	9.06	3.84
2013	4891.24	5591	910	61.69	64.21	61.36	63.82	0.19	0.13	35.67	2.52
2014	6064.42	7030	910	87.12	88.54	76.08	80.25	0.53	4.12	7.34	1.41
2015	6278.21	7227	910	81.02	81.87	78.76	82.50	1.19	2.32	15.81	0.85
2016	6937.64	8106	910	89.90	90.40	86.79	92.28	1.02	0.95	8.65	0.50
2017	6376.49	6972	910	78.39	80.73	79.99	79.59	0.05	2.93	16.34	2.34
2018	7003.89	7825	910	87.94	89.08	87.86	89.33	0.10	0.36	10.55	1.14
2019	6366.21	7008	910	78.57	80.19	79.86	80.00	0.63	1.57	18.23	1.62

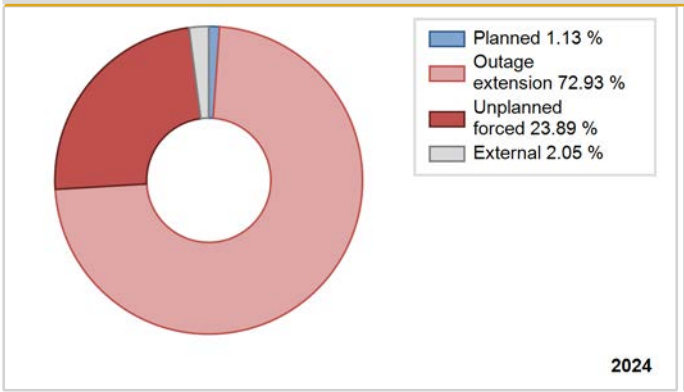
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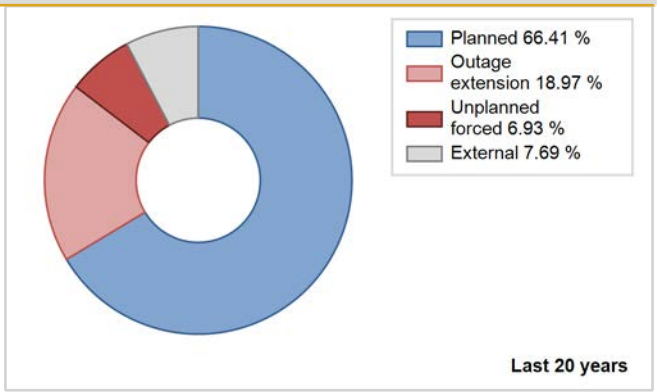
2020	6716.68	7468	910	82.49	83.37	84.03	85.02	2.07	5.81	10.82	0.88
2021	5452.66	6016	910	66.74	67.48	68.40	68.68	2.95	8.62	23.90	0.74
2022	6323.87	7395	910	83.93	84.43	79.33	84.42	1.42	4.84	10.73	0.50
2023	3520.88	4176	910	43.36	47.64	44.17	47.67	0.01	2.47	49.88	4.29
2024	4990.59	5918	910	66.28	66.97	62.43	67.37	10.74	32.65	0.38	0.69

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1983 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		2735			300	
B.	Refuelling without maintenance				156		
C.	Inspection, maintenance or repair combined with refuelling				1081	2	
D.	Inspection, maintenance or repair without refuelling				16		
E.	Testing of plant systems or components	1			49	0	
H.	Nuclear regulatory requirements					12	
J.	Grid limitation, failure or grid unavailability						3
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			46			21
L.	Human factor related					6	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			34			44
O.	Load dispatching, prioritization			26			1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						15
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			23			7
Z.	Other					18	2
Subtotal		1	2735	129	1302	338	93
Total		**2865**			**1733**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		17
12. Reactor I&C Systems		6
13. Reactor Auxiliary Systems		6
14. Safety Systems		10
15. Reactor Cooling Systems		20
16. Steam generation systems		28
21. Fuel Handling and Storage Facilities		2
31. Turbine and auxiliaries	229	32
32. Feedwater and Main Steam System	318	44
33. Circulating Water System		4
34. Miscellaneous Systems	2160	112
35. All other I&C Systems		1
41. Main Generator Systems	27	7
42. Electrical Power Supply Systems		15
Total	**2734**	**304**

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2024 Operating Experience

FR-34 BLAYAIS-3 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1978-04-01
Grid Date	:	1983-08-17
Commercial Date	:	1983-11-14
Age at end of year	:	41 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.44
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

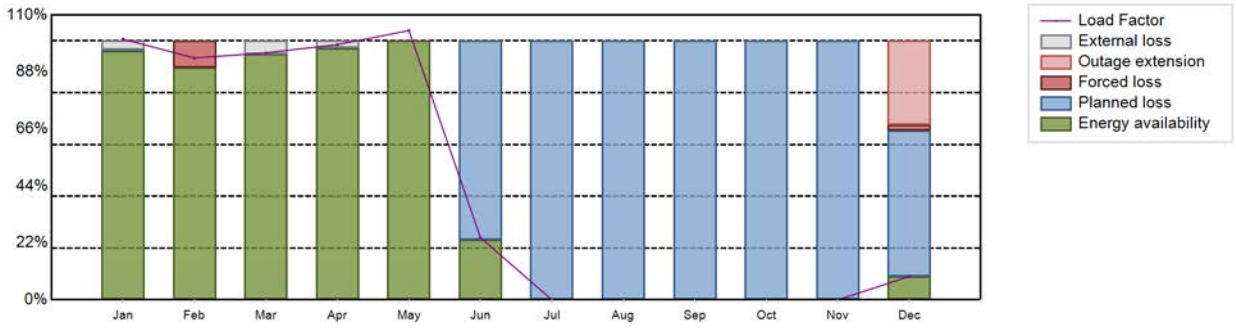
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	323
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3486.86 GW(e).h
Energy Availability Factor (EAF)	:	42.39 %
Unit Capability Factor (UCF)	:	43.34 %
Load Factor (LF)	:	43.62 %
Operating Factor (OF)	:	42.76 %

Forced Loss Rate (FLR)	:	2.25 %
Unplanned Capability Loss Factor (UCL)	:	3.75 %
Planned Unavailability Factor (PUF)	:	52.92 %
Externally cause unavailability (XUF)	:	0.95 %
Total off-line time	:	5028 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	681.64	591.61	644.98	645.89	704.03	157.53	0.00	0.00	0.00	0.00	0.00	61.16	3486.86
EAF [%]	96.10	89.74	94.85	97.25	99.99	23.26	0.00	0.00	0.00	0.00	0.00	9.05	42.39
UCF [%]	99.55	89.74	99.98	99.96	99.99	23.26	0.00	0.00	0.00	0.00	0.00	9.05	43.34
LF [%]	100.68	93.41	95.39	98.58	103.99	24.04	0.00	0.00	0.00	0.00	0.00	9.03	43.62
OF [%]	96.77	89.80	92.46	97.78	100.00	23.47	0.00	0.00	0.00	0.00	0.00	14.38	42.76
FLR [%]	0.00	10.26	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	19.32	2.25
UCL [%]	0.00	10.26	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	34.61	3.75
PUF [%]	0.45	0.00	0.02	0.04	0.00	76.74	100.00	100.00	100.00	100.00	100.00	56.34	52.92
XUF [%]	3.45	0.00	5.14	2.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95

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Historical Summary

Lifetime energy generation	:	249608.84 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.6 %
Cumulative Energy Availability Factor (EAF)	:	77.68 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.42 %
Cumulative Unit Capability Factor (UCF)	:	79.59 %	Cumulative Planned Unavailability Factor (PUF)	:	15.98 %
Cumulative Load Factor (LF)	:	75.73 %	Cumulative Externally cause unavailability (XUF)	:	1.91 %
Cumulative Operating Factor (OF)	:	78.46 %			

Electricity Production (net) [GWh]

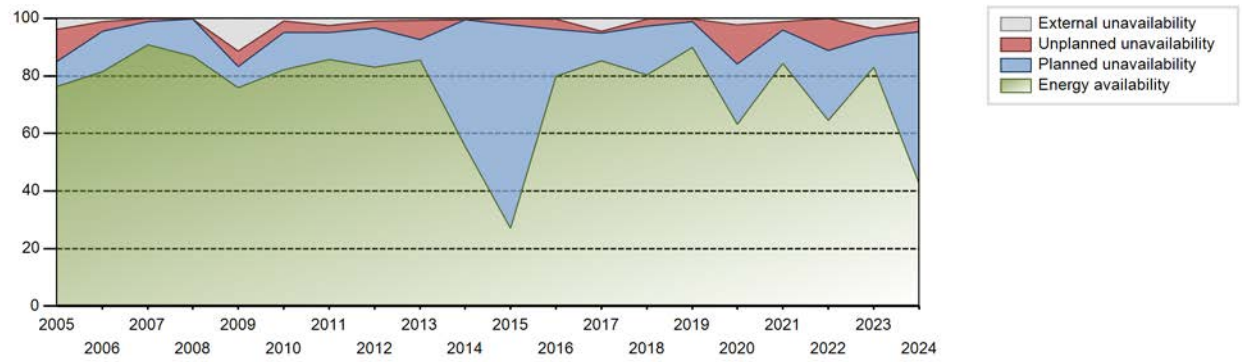


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	1912.00	2739	910	87.37	87.37	87.37	86.95	0.00	0.00	12.63	0.00
1984	5944.00	7055	910	80.35	80.35	74.36	80.32	4.20	3.53	16.13	0.00
1985	6568.90	7729	910	86.57	86.96	82.40	88.23	2.89	2.59	10.45	0.40
1986	6504.90	7759	910	88.15	88.26	81.60	88.57	1.39	1.25	10.50	0.11
1987	4304.70	5473	910	93.47	93.91	54.00	62.48	0.41	0.39	5.70	0.44
1988	5287.00	6708	910	81.56	82.76	66.14	76.37	5.58	4.89	12.35	1.20
1989	6086.42	7292	910	78.54	82.65	76.35	83.24	5.65	4.94	12.40	4.11
1990	4871.16	5673	910	62.81	64.32	61.11	64.76	17.56	13.70	21.98	1.51
1991	6372.29	7448	910	83.97	84.62	79.94	85.02	3.34	2.93	12.45	0.65
1992	5967.94	7220	910	81.80	83.02	74.66	82.19	5.19	4.54	12.44	1.22
1993	6285.26	7728	910	79.77	87.71	78.85	88.22	1.40	1.25	11.04	7.94
1994	4212.82	4979	910	57.74	57.77	52.85	56.84	20.93	15.29	26.93	0.03
1995	6739.57	7525	910	85.38	85.89	84.54	85.90	0.25	0.21	13.89	0.51
1996	6924.05	7744	910	86.76	87.15	86.62	88.16	2.56	2.29	10.57	0.39
1997	6614.05	7659	910	86.41	86.41	82.97	87.43	0.38	0.33	13.26	0.00
1998	6970.16	7954	910	87.77	90.07	87.44	90.80	1.63	1.50	8.44	2.30
1999	5123.02	5861	910	64.20	66.83	64.27	66.91	24.93	22.19	10.98	2.63
2000	6183.61	7143	910	78.19	80.27	77.36	81.32	11.24	10.17	9.56	2.08
2001	6707.06	7540	910	84.22	85.36	84.14	86.07	3.65	3.23	11.40	1.15
2002	6882.02	7682	910	86.44	87.52	86.33	87.69	3.06	2.77	9.71	1.08
2003	5844.86	6725	910	73.57	86.51	73.32	76.77	2.41	2.14	11.36	12.93
2004	5822.81	6699	910	72.46	75.20	72.84	76.26	1.50	1.15	23.65	2.74
2005	5868.13	6875	910	76.42	80.27	73.61	78.48	1.83	11.21	8.52	3.85
2006	6515.66	7340	910	81.51	82.76	81.75	83.80	0.38	3.30	13.95	1.25
2007	7441.68	8035	910	90.86	90.92	93.35	91.72	1.11	1.02	8.06	0.06
2008	7138.33	7676	910	86.85	87.02	89.30	87.39	0.04	0.04	12.94	0.17
2009	6134.50	6949	910	75.79	87.09	76.95	79.33	1.16	5.43	7.48	11.31
2010	6679.72	7390	910	82.23	83.14	83.79	84.36	2.65	4.05	12.82	0.91
2011	6925.35	7769	910	85.73	88.23	86.88	88.69	0.20	2.48	9.29	2.51
2012	6747.82	7436	910	83.03	83.86	84.42	84.65	1.77	2.46	13.68	0.83
2013	6944.29	7535	910	85.41	86.05	87.11	86.02	0.03	6.65	7.30	0.64
2014	4270.69	4677	910	55.53	55.92	53.57	53.39	0.31	0.17	43.91	0.38
2015	2219.74	2748	910	27.06	27.11	27.85	31.37	7.87	2.32	70.58	0.04
2016	6569.71	7181	910	79.82	80.04	82.19	81.75	1.18	3.63	16.32	0.23
2017	6902.06	7507	910	85.20	89.60	86.58	85.70	0.15	0.70	9.70	4.40
2018	6427.78	7110	910	80.36	80.69	80.63	81.16	0.60	2.34	16.97	0.33
2019	7147.00	7935	910	89.85	90.14	89.66	90.58	1.06	0.97	8.89	0.29

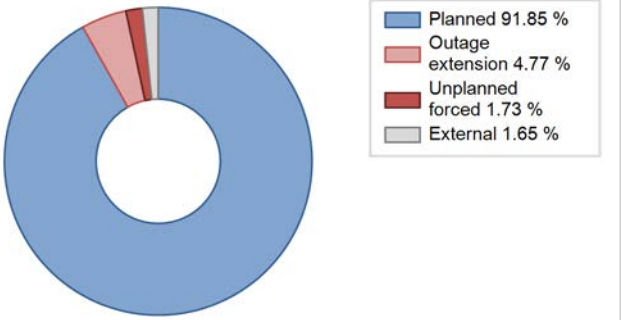
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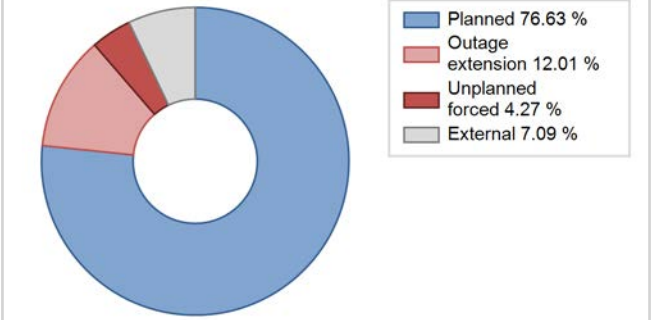
2020	5093.20	5757	910	63.21	65.58	63.72	65.54	2.49	13.45	20.97	2.37
2021	6897.13	7425	910	84.37	85.57	86.52	84.76	2.21	2.87	11.57	1.20
2022	5310.70	5740	910	64.62	64.62	66.62	65.53	1.87	11.29	24.09	0.00
2023	6594.91	7436	910	82.99	86.51	82.73	84.89	2.80	2.76	10.72	3.52
2024	3486.86	3756	910	42.39	43.34	43.62	42.76	2.25	3.75	52.92	0.95

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1983 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		327			294	
B.	Refuelling without maintenance				133		
C.	Inspection, maintenance or repair combined with refuelling	4584			1201	4	
D.	Inspection, maintenance or repair without refuelling				17	0	
E.	Testing of plant systems or components	21			4	0	
H.	Nuclear regulatory requirements					19	
J.	Grid limitation, failure or grid unavailability						6
L.	Human factor related					2	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			36			30
O.	Load dispatching, prioritization			36			1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					1	17
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			24			7
Z.	Other					41	9
Subtotal		4605	327	96	1355	361	70
Total		**5028**			**1786**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		10
12. Reactor I&C Systems		17
13. Reactor Auxiliary Systems		24
14. Safety Systems		7
15. Reactor Cooling Systems		7
16. Steam generation systems		55
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries	71	16
32. Feedwater and Main Steam System	15	10
33. Circulating Water System		1
34. Miscellaneous Systems	241	106
35. All other I&C Systems		3
41. Main Generator Systems		30
42. Electrical Power Supply Systems		15
Total	**327**	**302**

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2024 Operating Experience

FR-35 BLAYAIS-4 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1978-04-01
Grid Date	:	1983-05-16
Commercial Date	:	1983-10-01
Age at end of year	:	41 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.44
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

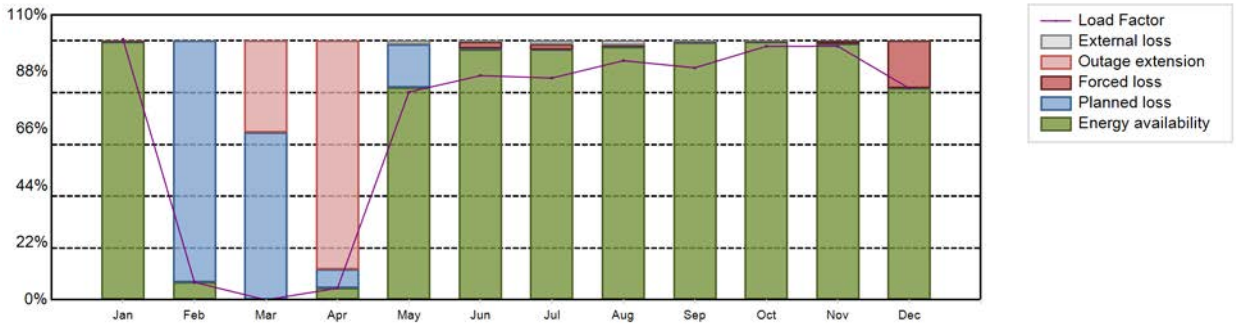
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	323
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5515.43 GW(e).h
Energy Availability Factor (EAF)	:	72.31 %
Unit Capability Factor (UCF)	:	72.76 %
Load Factor (LF)	:	69 %
Operating Factor (OF)	:	75.46 %

Forced Loss Rate (FLR)	:	2.82 %
Unplanned Capability Loss Factor (UCL)	:	12.34 %
Planned Unavailability Factor (PUF)	:	14.9 %
Externally cause unavailability (XUF)	:	0.45 %
Total off-line time	:	2156 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	681.32	42.94	0.00	29.45	543.34	567.32	579.92	625.43	587.20	663.84	641.80	552.88	5515.43
EAF [%]	99.71	6.69	0.00	4.50	82.11	96.69	96.59	97.68	99.39	99.69	98.86	81.76	72.31
UCF [%]	99.71	6.69	0.00	4.50	83.55	96.99	98.07	99.30	99.87	99.70	98.86	81.76	72.76
LF [%]	100.63	6.78	0.00	4.49	80.25	86.59	85.66	92.38	89.62	97.92	97.95	81.66	69.00
OF [%]	100.00	6.90	0.00	11.81	100.00	99.72	100.00	100.00	100.00	99.87	100.00	82.93	75.46
FLR [%]	0.27	0.00	0.00	0.00	0.00	2.67	1.85	0.59	0.13	0.29	1.10	18.20	2.82
UCL [%]	0.27	0.00	35.40	88.20	0.00	2.66	1.85	0.59	0.13	0.29	1.10	18.19	12.34
PUF [%]	0.02	93.31	64.60	7.30	16.45	0.35	0.08	0.10	0.01	0.01	0.04	0.05	14.90
XUF [%]	0.00	0.00	0.00	0.00	1.45	0.30	1.48	1.63	0.48	0.01	0.00	0.00	0.45

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Historical Summary

Lifetime energy generation	:	246429.67 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.5 %
Cumulative Energy Availability Factor (EAF)	:	77.9 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.82 %
Cumulative Unit Capability Factor (UCF)	:	80.82 %	Cumulative Planned Unavailability Factor (PUF)	:	13.36 %
Cumulative Load Factor (LF)	:	74.41 %	Cumulative Externally cause unavailability (XUF)	:	2.92 %
Cumulative Operating Factor (OF)	:	80.06 %			

Electricity Production (net) [GWh]

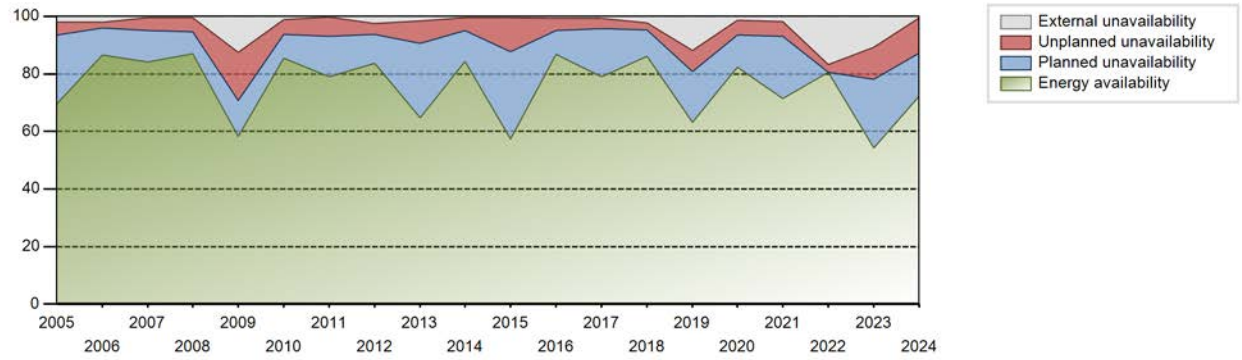


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	3356.00	4418	910	93.49	93.49	94.46	94.75	6.51	6.51	0.00	0.00
1984	6012.00	6780	910	76.00	76.00	75.21	77.19	3.36	2.64	21.36	0.00
1985	5972.60	7024	910	78.72	78.77	74.92	80.18	14.40	13.25	7.98	0.06
1986	6278.10	7412	910	81.87	82.50	78.76	84.61	5.24	4.56	12.94	0.62
1987	6104.60	7437	910	83.87	85.61	76.58	84.90	4.28	3.83	10.56	1.74
1988	4337.00	5662	910	70.16	71.53	54.26	64.46	10.95	8.79	19.68	1.36
1989	5816.26	7250	910	87.48	89.41	72.96	82.76	10.17	10.12	0.47	1.93
1990	5912.31	7347	910	78.18	83.42	74.17	83.87	4.46	3.89	12.69	5.24
1991	5467.70	6496	910	73.14	73.50	68.59	74.16	12.22	10.23	16.27	0.36
1992	6120.58	7430	910	83.48	84.10	76.57	84.59	0.53	0.44	15.45	0.62
1993	5096.35	6854	910	72.90	85.31	63.93	78.24	2.81	2.47	12.22	12.41
1994	5897.06	7308	910	81.85	82.61	73.98	83.42	4.78	4.14	13.25	0.76
1995	5342.37	6198	910	71.47	75.19	67.02	70.75	1.19	0.90	23.91	3.72
1996	6719.61	7761	910	86.92	88.17	84.06	88.35	1.73	1.55	10.27	1.26
1997	6497.20	7705	910	86.56	89.14	81.50	87.96	0.83	0.75	10.12	2.58
1998	6692.57	7930	910	87.93	90.26	83.96	90.53	1.47	1.35	8.39	2.33
1999	6161.15	7369	910	80.20	83.33	77.29	84.12	4.52	3.94	12.73	3.13
2000	5467.51	6559	910	72.53	75.05	68.40	74.67	15.60	13.87	11.08	2.53
2001	6370.03	7297	910	82.09	82.44	79.91	83.30	5.22	4.54	13.01	0.35
2002	6462.24	7623	910	85.09	86.19	81.07	87.02	3.08	2.74	11.07	1.10
2003	5311.06	6292	910	68.45	72.86	66.62	71.83	17.64	15.61	11.53	4.41
2004	6560.31	7749	910	84.57	88.32	82.07	88.22	3.30	3.01	8.66	3.75
2005	5454.68	6357	910	69.58	71.55	68.43	72.57	3.26	4.42	24.03	1.96
2006	6758.43	7827	910	86.48	88.49	84.78	89.35	2.00	1.96	9.55	2.01
2007	6607.83	7484	910	84.23	84.69	82.89	85.43	3.51	4.38	10.94	0.46
2008	6755.66	7760	910	86.97	87.44	84.52	88.34	1.07	4.83	7.73	0.46
2009	4574.28	5295	910	58.35	70.81	57.38	60.45	1.33	16.86	12.33	12.46
2010	6723.73	7718	910	85.49	86.58	84.35	88.11	3.34	5.11	8.31	1.09
2011	6138.08	7079	910	79.11	79.42	77.00	80.81	2.44	6.58	14.00	0.30
2012	6615.11	7653	910	83.71	86.20	82.76	87.12	0.70	3.69	10.11	2.49
2013	5146.77	5924	910	64.78	66.27	64.56	67.63	2.73	7.86	25.87	1.49
2014	6463.78	7566	910	84.41	84.81	81.09	86.37	5.02	4.48	10.70	0.40
2015	4522.44	5124	910	57.32	57.84	56.73	58.49	5.33	11.75	30.42	0.52
2016	6772.22	7859	910	86.75	87.42	84.72	89.47	1.11	4.22	8.36	0.67
2017	6184.82	7044	910	78.98	79.62	77.59	80.41	0.67	3.72	16.65	0.64
2018	6690.11	7744	910	86.13	88.42	83.92	88.40	1.33	2.38	9.20	2.28
2019	4935.56	5685	910	63.09	74.97	61.91	64.90	1.58	7.26	17.77	11.88

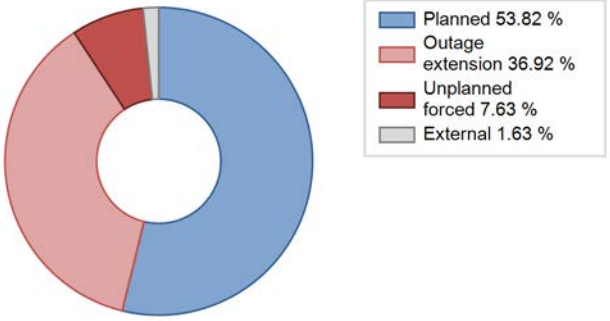
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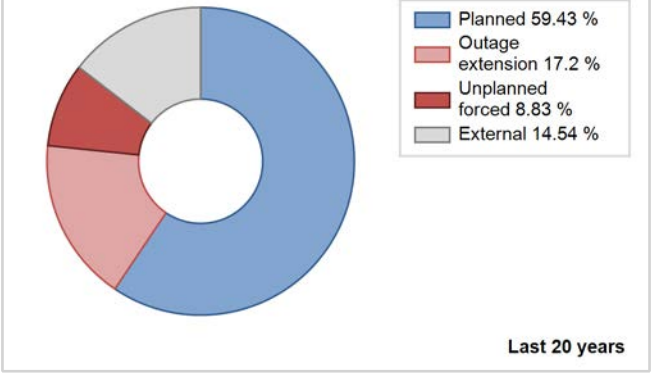
2020	6573.47	7472	910	82.40	83.86	82.24	85.06	0.29	5.06	11.08	1.46
2021	5530.48	6379	910	71.51	73.31	69.38	72.82	1.50	5.05	21.63	1.80
2022	6137.48	8095	910	80.54	97.33	76.99	92.41	2.65	2.65	0.02	16.79
2023	4262.81	5261	910	54.28	65.00	53.47	60.06	11.27	11.24	23.76	10.72
2024	5515.43	6628	910	72.31	72.76	69.00	75.46	2.82	12.34	14.90	0.45

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1983 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		1025			374	
B.	Refuelling without maintenance	1128			159		
C.	Inspection, maintenance or repair combined with refuelling				957	22	
D.	Inspection, maintenance or repair without refuelling				5	6	
E.	Testing of plant systems or components	2			2	0	
H.	Nuclear regulatory requirements					6	
L.	Human factor related					12	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			2			21
O.	Load dispatching, prioritization						2
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						63
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						13
Z.	Other					24	4
Subtotal		1130	1025	2	1123	444	103
Total		**2157**			**1670**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		40
13. Reactor Auxiliary Systems		10
14. Safety Systems		34
15. Reactor Cooling Systems		6
16. Steam generation systems		31
21. Fuel Handling and Storage Facilities		17
31. Turbine and auxiliaries		39
32. Feedwater and Main Steam System	127	8
33. Circulating Water System		7
34. Miscellaneous Systems	898	112
35. All other I&C Systems		2
41. Main Generator Systems		50
42. Electrical Power Supply Systems		17
Total	**1025**	**380**

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2024 Operating Experience

FR-13 BUGEY-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	FRAM (FRAMATOME)

Reactor Unit Details

Reactor type and model	:	PWR / CP0
Thermal power	:	2785 MWth
Gross electrical power	:	945 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1972-11-01
Grid Date	:	1978-05-10
Commercial Date	:	1979-03-01
Age at end of year	:	46 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

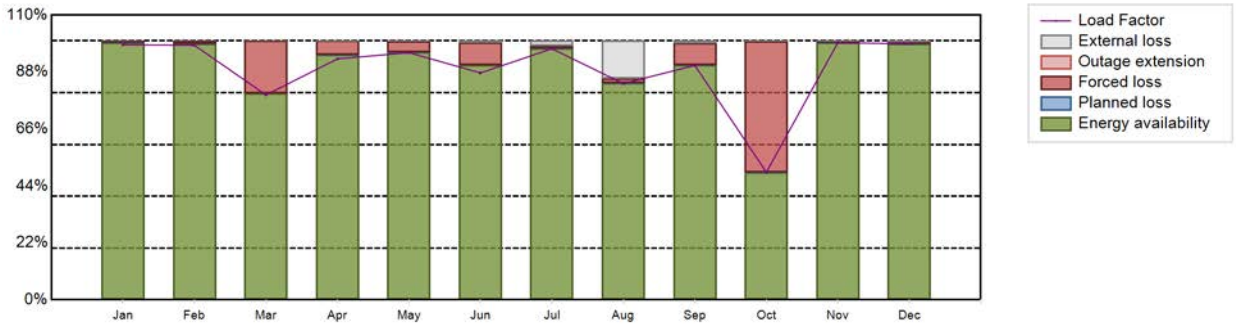
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7124.59 GW(e).h
Energy Availability Factor (EAF)	:	89.72 %
Unit Capability Factor (UCF)	:	91.29 %
Load Factor (LF)	:	89.13 %
Operating Factor (OF)	:	92.26 %

Forced Loss Rate (FLR)	:	8.68 %
Unplanned Capability Loss Factor (UCL)	:	8.68 %
Planned Unavailability Factor (PUF)	:	0.03 %
Externally cause unavailability (XUF)	:	1.57 %
Total off-line time	:	680 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	667.05	622.58	535.09	609.74	646.38	574.17	656.45	565.57	593.18	334.15	650.67	669.56	7124.59
EAF [%]	99.37	98.80	79.87	94.73	95.52	90.60	97.02	83.68	90.61	49.31	99.35	98.93	89.72
UCF [%]	99.37	98.80	79.87	94.73	95.73	91.14	98.88	98.20	91.51	49.39	99.37	99.40	91.29
LF [%]	98.52	98.30	79.14	93.06	95.47	87.63	96.96	83.54	90.53	49.29	99.31	98.90	89.13
OF [%]	100.00	100.00	81.83	95.83	100.00	89.03	100.00	93.68	93.61	53.96	100.00	100.00	92.26
FLR [%]	0.61	1.17	20.13	5.26	4.27	8.86	1.06	1.74	8.46	50.60	0.55	0.56	8.68
UCL [%]	0.61	1.17	20.13	5.26	4.26	8.86	1.06	1.74	8.46	50.59	0.55	0.56	8.68
PUF [%]	0.02	0.03	0.00	0.01	0.01	0.00	0.06	0.06	0.03	0.01	0.09	0.04	0.03
XUF [%]	0.00	0.00	0.00	0.00	0.20	0.54	1.87	14.52	0.90	0.09	0.02	0.47	1.57

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Historical Summary

Lifetime energy generation	:	252597.14 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.48 %
Cumulative Energy Availability Factor (EAF)	:	72.04 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	9.59 %
Cumulative Unit Capability Factor (UCF)	:	74.21 %	Cumulative Planned Unavailability Factor (PUF)	:	16.2 %
Cumulative Load Factor (LF)	:	68.4 %	Cumulative Externally cause unavailability (XUF)	:	2.17 %
Cumulative Operating Factor (OF)	:	73.87 %			

Electricity Production (net) [GWh]

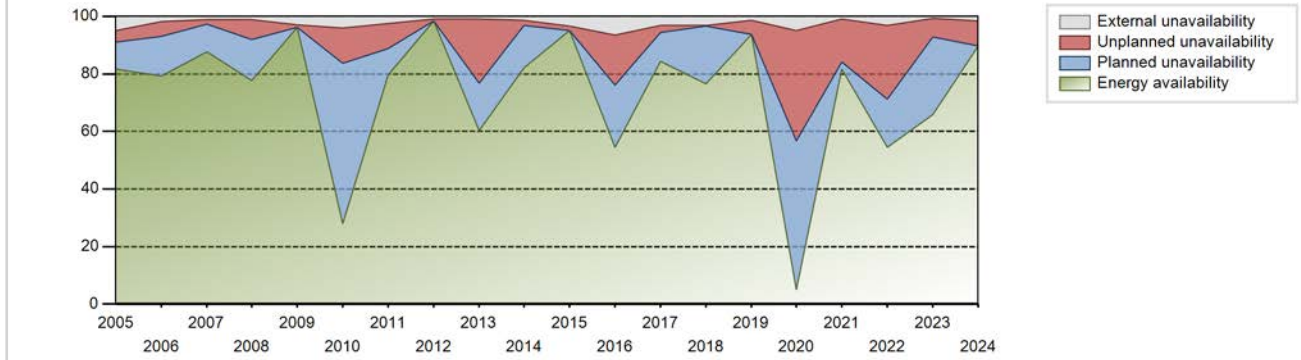


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1979	4379.00	5588	925	53.15	53.15	52.04	60.48	3.85	2.13	44.72	0.00
1980	4460.00	5271	920	55.71	55.71	55.19	60.01	21.66	15.40	28.89	0.00
1981	5209.60	6017	920	65.16	65.16	64.64	68.69	13.23	9.93	24.90	0.00
1982	3341.70	3863	920	41.65	41.65	41.46	44.10	42.64	30.96	27.40	0.00
1983	6725.00	7689	920	85.30	85.30	83.45	87.77	6.98	6.40	8.30	0.00
1984	5748.00	6580	920	87.95	87.95	71.13	74.91	4.49	4.13	7.92	0.00
1985	5948.80	7118	920	76.00	79.74	73.81	81.26	6.30	5.36	14.90	3.74
1986	5945.60	7515	920	84.51	86.37	73.77	85.79	3.30	2.94	10.68	1.86
1987	3581.10	4729	920	51.62	53.37	44.43	53.98	37.63	32.20	14.43	1.75
1988	4495.00	5718	920	63.15	67.02	55.62	65.10	22.17	19.09	13.88	3.87
1989	4700.83	5721	920	61.06	64.74	58.33	65.31	20.60	16.79	18.47	3.68
1990	4878.71	6213	920	69.32	69.66	60.54	70.92	11.42	8.98	21.36	0.34
1991	4927.21	6001	920	64.44	66.70	61.14	68.50	2.73	1.87	31.42	2.26
1992	3918.31	4781	910	50.22	53.86	49.02	54.43	19.55	13.09	33.06	3.64
1993	4509.91	5718	910	94.18	99.21	56.57	65.27	0.79	0.79	0.00	5.03
1994	5782.19	6811	910	76.55	77.70	72.53	77.75	5.88	4.86	17.44	1.15
1995	6045.65	7051	910	78.10	79.65	75.84	80.49	4.74	3.96	16.39	1.55
1996	5533.91	6863	910	75.43	78.74	69.23	78.13	8.62	7.42	13.84	3.30
1997	5477.66	6815	910	81.00	84.40	68.71	77.80	4.70	4.16	11.44	3.40
1998	5379.41	6605	910	72.90	77.60	67.48	75.40	7.39	6.19	16.21	4.70
1999	5960.27	7050	910	77.52	78.94	74.77	80.48	8.83	7.64	13.42	1.42
2000	5183.54	6025	910	66.29	68.50	64.85	68.59	0.55	0.38	31.13	2.20
2001	5685.92	6493	910	72.23	72.27	71.33	74.12	26.61	26.21	1.53	0.03
2002	5542.28	6212	910	69.90	70.17	69.53	70.91	20.40	17.98	11.85	0.26
2003	5521.65	6579	910	71.00	74.83	69.27	75.10	4.82	3.79	21.38	3.83
2004	7593.43	8571	910	95.97	97.12	95.00	97.58	2.17	2.16	0.72	1.14
2005	6373.89	7607	910	81.71	86.74	79.96	86.84	2.19	3.88	9.38	5.03
2006	6125.65	7158	910	79.17	80.93	76.85	81.72	1.63	5.28	13.79	1.76
2007	6925.13	7880	910	87.64	88.72	86.86	89.94	1.48	1.63	9.65	1.07
2008	6130.76	7517	910	77.74	78.90	76.70	85.58	8.03	6.89	14.21	1.16
2009	7285.26	8731	910	96.09	98.97	91.39	99.67	0.98	0.98	0.05	2.88
2010	2218.07	2732	910	27.93	31.94	27.82	31.19	1.30	12.29	55.77	4.01
2011	6127.50	7260	910	79.65	82.06	76.87	82.88	2.28	8.69	9.26	2.41
2012	7658.29	8712	910	98.37	99.27	95.81	99.18	0.72	0.72	0.01	0.90
2013	4679.30	5482	910	60.35	61.21	58.70	62.58	1.56	22.31	16.49	0.85
2014	6386.08	7390	910	82.10	83.54	80.11	84.36	1.95	1.67	14.79	1.44
2015	7307.72	8526	910	95.01	98.48	91.67	97.33	1.50	1.50	0.02	3.47

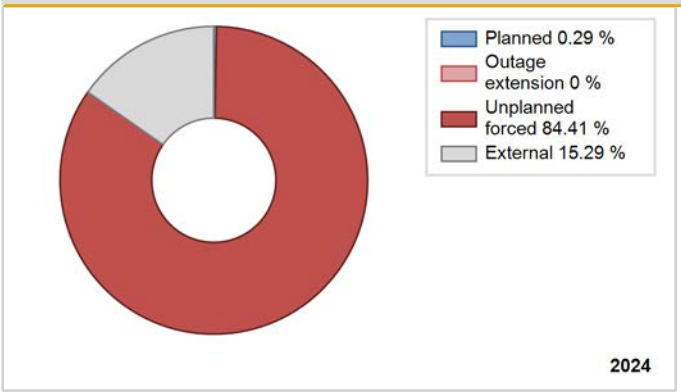
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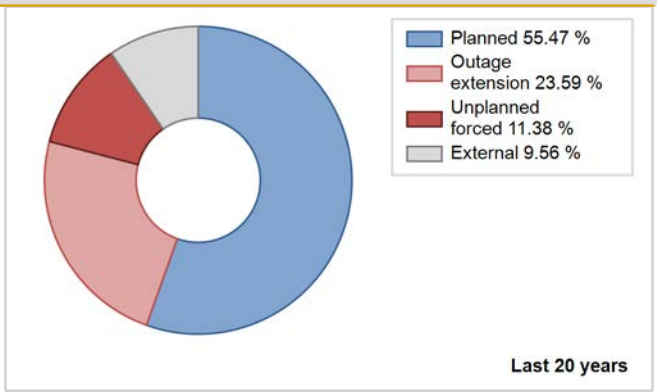
2016	4345.61	5400	910	54.40	60.80	54.36	61.48	3.78	17.55	21.65	6.39
2017	6690.06	7569	910	84.40	87.66	83.92	86.40	2.60	2.34	10.00	3.25
2018	6115.35	6916	910	76.59	79.71	76.71	78.95	0.09	0.19	20.10	3.12
2019	7443.41	8383	910	93.64	95.04	93.37	95.70	4.95	4.95	0.01	1.39
2020	351.50	412	910	5.02	9.95	4.40	4.69	2.79	38.40	51.64	4.93
2021	6445.92	7527	910	81.63	82.65	80.86	85.92	2.64	14.79	2.56	1.03
2022	4317.13	5083	910	54.42	57.50	54.16	58.03	22.94	25.64	16.86	3.09
2023	5226.93	5996	910	65.75	66.52	65.57	68.45	3.49	6.49	26.99	0.77
2024	7124.59	8104	910	89.72	91.29	89.13	92.26	8.68	8.68	0.03	1.57

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1979 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		612			640	
B. Refuelling without maintenance				30		
C. Inspection, maintenance or repair combined with refuelling				1223	29	
D. Inspection, maintenance or repair without refuelling				82		
E. Testing of plant systems or components				8	0	
H. Nuclear regulatory requirements					29	
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L. Human factor related					10	
M. Governmental requirements or court decisions						1
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			47			15
O. Load dispatching, prioritization			21			1
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						32
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						1
Z. Other				2	66	
Subtotal		612	68	1345	774	50
Total		**680**			**2169**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1979 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		160
12. Reactor I&C Systems		19
13. Reactor Auxiliary Systems		10
14. Safety Systems		46
15. Reactor Cooling Systems		23
16. Steam generation systems		24
21. Fuel Handling and Storage Facilities		4
31. Turbine and auxiliaries	58	35
32. Feedwater and Main Steam System		33
33. Circulating Water System		1
34. Miscellaneous Systems	47	206
35. All other I&C Systems		3
41. Main Generator Systems		48
42. Electrical Power Supply Systems	507	37
Total	**612**	**649**

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2024 Operating Experience

FR-14 BUGEY-3 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	FRAM (FRAMATOME)

Reactor Unit Details

Reactor type and model	:	PWR / CP0
Thermal power	:	2785 MWth
Gross electrical power	:	945 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1973-09-01
Grid Date	:	1978-09-21
Commercial Date	:	1979-03-01
Age at end of year	:	46 years

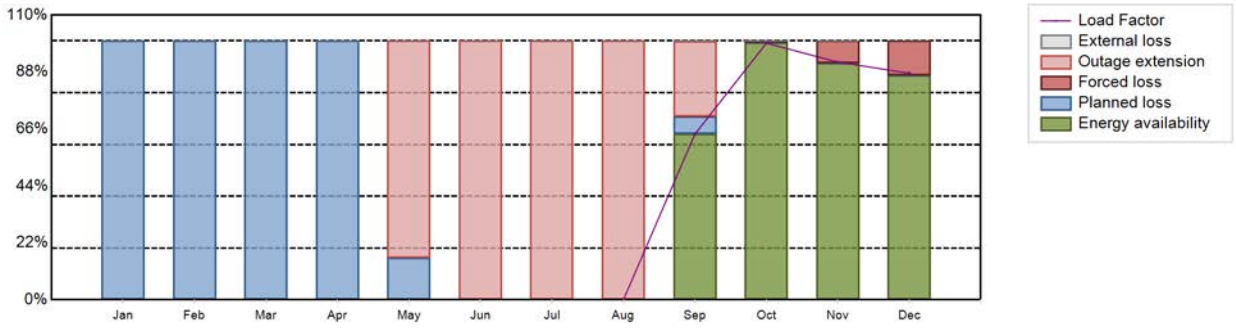
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2285.28 GW(e).h
Energy Availability Factor (EAF)	:	28.52 %
Unit Capability Factor (UCF)	:	28.55 %
Load Factor (LF)	:	28.59 %
Operating Factor (OF)	:	29.52 %
Forced Loss Rate (FLR)	:	6.17 %
Unplanned Capability Loss Factor (UCL)	:	36.48 %
Planned Unavailability Factor (PUF)	:	34.96 %
Externally cause unavailability (XUF)	:	0.04 %
Total off-line time	:	6191 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	419.18	672.03	601.54	592.53	2285.28
EAF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.13	99.39	91.34	86.73	28.52
UCF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.35	99.58	91.35	86.73	28.55
LF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.98	99.13	91.81	87.52	28.59
OF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71.11	99.87	91.94	90.73	29.52
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.39	8.64	13.25	6.17
UCL [%]	0.00	0.00	0.00	0.00	83.87	100.00	100.00	100.00	29.03	0.39	8.64	13.25	36.48
PUF [%]	100.00	100.00	100.00	100.00	16.13	0.00	0.00	0.00	6.63	0.03	0.01	0.02	34.96
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.20	0.01	0.00	0.04

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Historical Summary

Lifetime energy generation	:	242720.92 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	9.31 %
Cumulative Energy Availability Factor (EAF)	:	69.95 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.42 %
Cumulative Unit Capability Factor (UCF)	:	72.36 %	Cumulative Planned Unavailability Factor (PUF)	:	15.22 %
Cumulative Load Factor (LF)	:	65.89 %	Cumulative Externally cause unavailability (XUF)	:	2.41 %
Cumulative Operating Factor (OF)	:	71.24 %			

Electricity Production (net) [GWh]

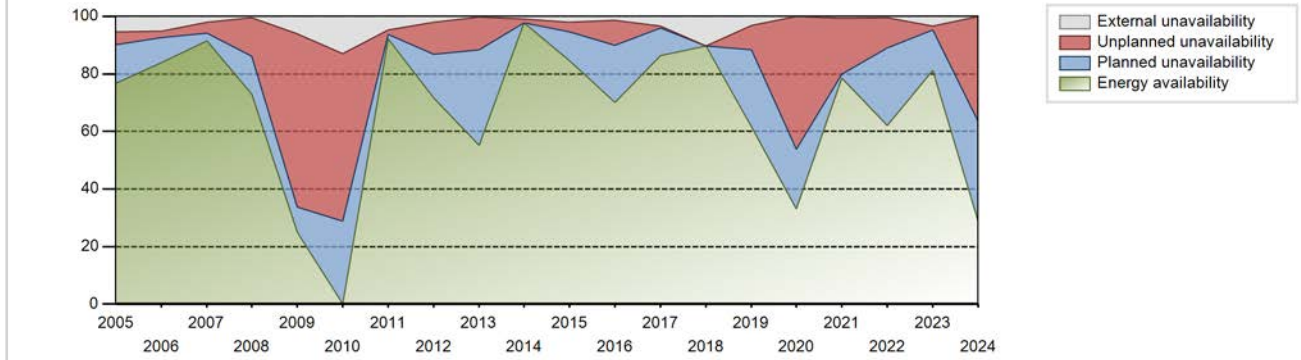


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1979	3504.00	4389	925	39.87	39.87	40.39	45.04	0.00	0.00	60.13	0.00
1980	5960.00	6951	920	74.66	74.66	73.75	79.13	12.90	11.05	14.28	0.00
1981	4849.60	5646	920	61.04	61.04	60.17	64.45	7.91	5.24	33.71	0.00
1982	6002.20	7661	920	78.90	78.90	74.48	87.45	7.28	6.20	14.90	0.00
1983	5525.00	6556	920	74.04	74.04	68.56	74.84	10.03	8.25	17.71	0.00
1984	5793.00	6905	920	77.95	77.95	71.68	78.61	10.85	9.49	12.56	0.00
1985	4571.10	5235	920	57.17	58.70	56.72	59.76	31.91	27.51	13.80	1.53
1986	6558.10	7634	920	87.13	87.65	81.37	87.15	1.89	1.69	10.66	0.52
1987	5482.50	6637	920	76.39	78.36	68.03	75.76	10.45	9.14	12.50	1.97
1988	3812.00	4935	920	62.42	64.68	47.17	56.18	23.14	19.48	15.84	2.26
1989	4914.26	6467	920	87.37	88.72	60.98	73.82	10.86	10.81	0.47	1.35
1990	4538.61	5474	920	62.95	68.02	56.32	62.49	14.73	11.75	20.24	5.07
1991	3442.82	4168	920	51.68	55.68	42.72	47.58	9.48	5.83	38.49	4.00
1992	2489.99	2879	910	32.19	32.50	31.15	32.78	67.39	67.17	0.33	0.31
1993	5954.45	7117	910	76.13	80.20	74.70	81.24	3.88	3.24	16.56	4.07
1994	4717.68	5872	910	65.25	69.97	59.18	67.03	16.89	14.22	15.80	4.72
1995	5535.71	6564	910	95.21	95.93	69.44	74.93	3.60	3.59	0.48	0.72
1996	5652.94	7012	910	76.38	78.72	70.72	79.83	10.63	9.37	11.91	2.34
1997	5596.64	6561	910	74.89	74.98	70.21	74.90	10.44	8.74	16.28	0.08
1998	6680.36	7875	910	89.04	89.13	83.80	89.90	1.44	1.30	9.56	0.09
1999	5786.61	7001	910	77.26	77.60	72.59	79.92	10.96	9.56	12.85	0.33
2000	5745.14	6765	910	74.71	75.70	71.87	77.02	13.70	12.02	12.28	0.99
2001	6230.61	7129	910	81.20	81.80	78.16	81.38	4.21	3.60	14.60	0.60
2002	4634.68	5654	910	63.88	66.43	58.14	64.54	4.18	2.90	30.68	2.54
2003	6646.07	7924	910	85.15	97.22	83.37	90.46	1.42	1.40	1.38	12.06
2004	6447.31	7461	910	87.85	88.23	80.66	84.94	2.89	2.62	9.15	0.37
2005	5805.39	7017	910	76.85	82.31	72.83	80.10	4.37	4.48	13.20	5.46
2006	6563.54	7624	910	83.89	89.14	82.34	87.03	2.00	2.09	8.77	5.25
2007	7277.78	8258	910	91.39	93.44	91.30	94.27	3.85	3.74	2.82	2.05
2008	5807.10	7352	910	72.94	73.49	72.65	83.70	14.37	13.33	13.18	0.54
2009	1984.81	2676	910	24.97	31.00	24.90	30.55	16.68	60.24	8.76	6.04
2010	0.00	0	910	0.00	12.88	0.00	0.00	0.00	58.34	28.78	12.88
2011	7184.55	8370	910	92.08	96.70	90.13	95.55	1.77	1.75	1.55	4.62
2012	5696.79	6487	910	71.64	73.68	71.27	73.85	5.07	11.11	15.21	2.04
2013	4321.81	4929	910	55.12	55.40	54.22	56.27	2.07	11.31	33.30	0.27
2014	7412.21	8563	910	97.69	98.52	92.98	97.75	1.43	1.43	0.06	0.83
2015	6656.93	7664	910	84.60	86.70	83.51	87.49	3.30	3.21	10.09	2.10

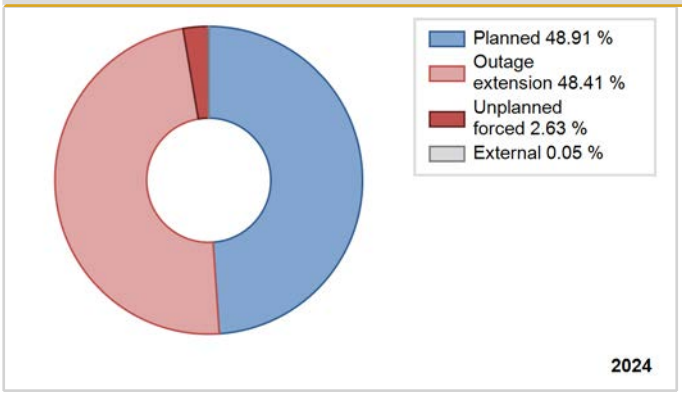
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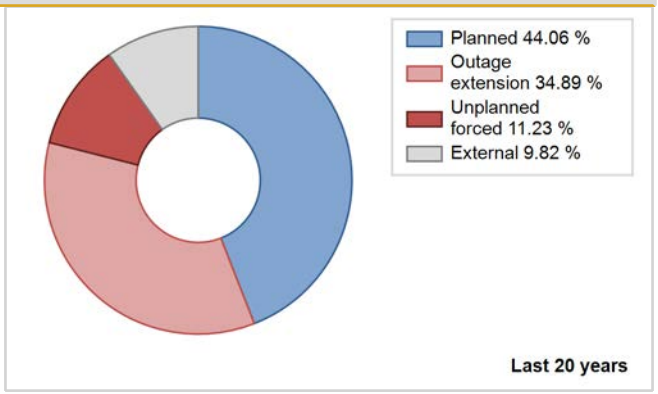
2016	5556.90	6516	910	70.15	71.51	69.52	74.18	6.77	8.61	19.88	1.36
2017	6840.57	7744	910	86.28	89.66	85.81	88.40	0.80	0.72	9.62	3.38
2018	6993.15	8196	910	89.68	99.94	87.73	93.56	0.05	0.05	0.01	10.26
2019	4893.90	5806	910	61.73	64.80	61.39	66.28	10.14	8.55	26.64	3.07
2020	2537.87	2962	910	33.18	33.18	31.75	33.72	28.80	46.21	20.61	0.00
2021	6181.66	7068	910	78.65	79.27	77.55	80.68	0.41	19.49	1.24	0.62
2022	4981.07	5653	910	62.12	62.62	62.49	64.53	6.51	10.51	26.88	0.50
2023	6418.38	7378	910	81.27	84.56	80.52	84.22	1.65	1.42	14.02	3.28
2024	2285.28	2593	910	28.52	28.55	28.59	29.52	6.17	36.48	34.96	0.04

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1979 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		3167			855	
B. Refuelling without maintenance				26		
C. Inspection, maintenance or repair combined with refuelling	3023			1105	28	
D. Inspection, maintenance or repair without refuelling				64		
E. Testing of plant systems or components				32	1	
F. Major backfitting, refurbishment or upgrading activities with refuelling				2		
H. Nuclear regulatory requirements					2	
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						10
L. Human factor related					10	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						28
O. Load dispatching, prioritization						1
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					17	93
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						1
Z. Other					11	
Subtotal	3023	3167		1229	924	133
Total		**6190**			**2286**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1979 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		145
12. Reactor I&C Systems		12
13. Reactor Auxiliary Systems		12
14. Safety Systems		19
15. Reactor Cooling Systems		30
16. Steam generation systems		234
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries	58	63
32. Feedwater and Main Steam System		19
33. Circulating Water System		1
34. Miscellaneous Systems	3040	225
35. All other I&C Systems		0
41. Main Generator Systems	69	79
42. Electrical Power Supply Systems		17
Total	**3167**	**856**

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2024 Operating Experience

FR-15 BUGEY-4 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	FRAM (FRAMATOME)

Reactor Unit Details

Reactor type and model	:	PWR / CP0
Thermal power	:	2785 MWth
Gross electrical power	:	917 MWe
Reference unit power (net)	:	880 MWe

Key Dates

Construction Date	:	1974-06-01
Grid Date	:	1979-03-08
Commercial Date	:	1979-07-01
Age at end of year	:	45 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

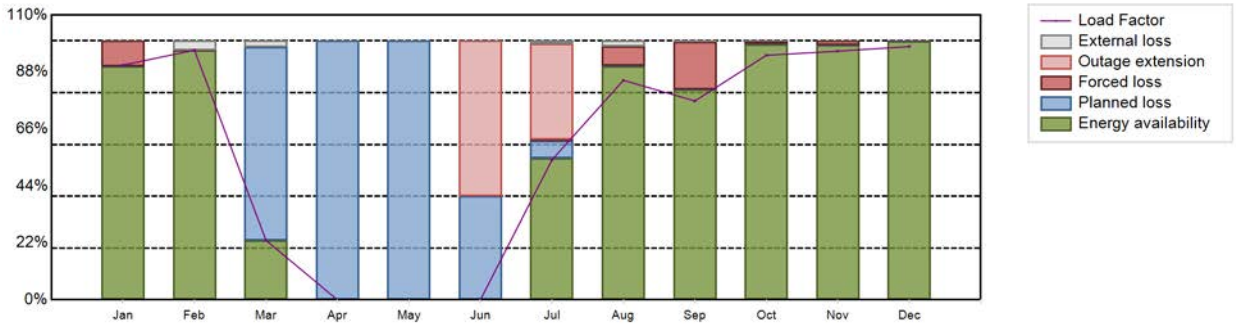
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4598 GW(e).h
Energy Availability Factor (EAF)	:	61.05 %
Unit Capability Factor (UCF)	:	61.87 %
Load Factor (LF)	:	59.48 %
Operating Factor (OF)	:	63.48 %

Forced Loss Rate (FLR)	:	4.99 %
Unplanned Capability Loss Factor (UCL)	:	11.29 %
Planned Unavailability Factor (PUF)	:	26.83 %
Externally cause unavailability (XUF)	:	0.82 %
Total off-line time	:	3208 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	593.61	590.57	150.39	0.00	0.00	0.00	353.58	555.07	486.66	619.18	608.48	640.46	4598.00
EAF [%]	90.17	96.38	23.00	0.00	0.00	0.00	54.67	90.31	81.24	98.73	98.37	99.85	61.05
UCF [%]	90.17	100.00	25.47	0.00	0.00	0.00	55.87	92.47	81.55	98.93	98.37	99.85	61.87
LF [%]	90.67	96.42	23.00	0.00	0.00	0.00	54.01	84.78	76.81	94.44	96.04	97.82	59.48
OF [%]	100.00	100.00	26.11	0.00	0.00	0.00	63.04	90.73	81.94	99.87	100.00	100.00	63.48
FLR [%]	9.82	0.00	0.00	0.00	0.00	0.00	0.83	7.50	18.42	1.05	1.61	0.12	4.99
UCL [%]	9.82	0.00	0.00	0.00	0.00	60.00	37.38	7.50	18.41	1.05	1.61	0.12	11.29
PUF [%]	0.01	0.00	74.53	100.00	100.00	40.00	6.76	0.03	0.04	0.01	0.01	0.02	26.83
XUF [%]	0.00	3.62	2.46	0.00	0.00	0.00	1.20	2.16	0.30	0.20	0.00	0.00	0.82

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Historical Summary

Lifetime energy generation	:	245858.51 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.71 %
Cumulative Energy Availability Factor (EAF)	:	73.5 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	9.09 %
Cumulative Unit Capability Factor (UCF)	:	75.62 %	Cumulative Planned Unavailability Factor (PUF)	:	15.3 %
Cumulative Load Factor (LF)	:	69.39 %	Cumulative Externally cause unavailability (XUF)	:	2.12 %
Cumulative Operating Factor (OF)	:	75 %			

Electricity Production (net) [GWh]

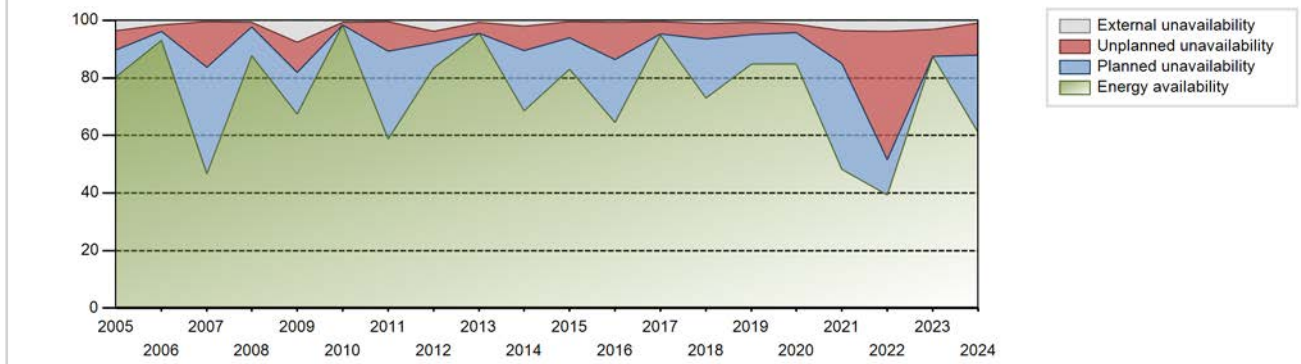


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1979	3528.00	5030	900	64.64	64.64	58.45	64.63	7.03	4.89	30.47	0.00
1980	5063.00	5983	900	65.84	65.84	64.04	68.11	7.76	5.54	28.63	0.00
1981	5671.90	6834	900	75.58	75.58	71.94	78.01	7.43	6.07	18.35	0.00
1982	5474.90	6276	900	69.75	69.75	69.44	71.64	18.88	16.23	14.02	0.00
1983	6329.00	7389	900	83.23	83.28	80.28	84.35	2.40	2.05	14.67	0.05
1984	5882.00	6896	900	75.84	75.84	74.40	78.51	8.57	7.11	17.05	0.00
1985	6224.40	7696	900	86.67	87.22	78.95	87.85	2.08	1.85	10.93	0.55
1986	5312.70	6622	900	76.12	78.72	67.39	75.59	6.46	5.44	15.84	2.60
1987	4670.90	6180	900	78.16	79.80	59.25	70.55	6.45	5.50	14.70	1.63
1988	3323.00	4524	900	51.52	67.31	42.03	51.50	23.06	20.18	12.51	15.80
1989	5541.34	6846	900	76.16	76.69	70.29	78.15	9.60	8.14	15.17	0.53
1990	3186.65	4312	880	53.52	56.66	41.34	49.22	4.28	2.53	40.81	3.13
1991	4984.85	6317	880	69.33	71.78	64.66	72.11	12.15	9.93	18.29	2.45
1992	1649.11	2012	880	22.25	22.25	21.33	22.91	77.11	74.94	2.82	0.00
1993	5748.62	7506	880	74.24	82.16	74.57	85.68	5.37	4.66	13.18	7.92
1994	5209.34	6619	880	82.16	83.47	67.58	75.56	3.58	3.10	13.43	1.31
1995	3989.94	4843	880	59.14	64.32	51.76	55.29	16.92	13.10	22.57	5.19
1996	4188.12	5333	880	62.37	62.57	54.18	60.71	34.28	32.64	4.79	0.20
1997	5652.46	7420	880	80.75	83.58	73.32	84.70	2.58	2.21	14.21	2.83
1998	6304.00	7791	880	86.32	88.31	81.78	88.94	2.09	1.88	9.81	1.99
1999	5591.31	7231	880	77.46	81.55	72.53	82.55	0.39	0.32	18.13	4.09
2000	5987.96	7544	880	82.58	85.08	77.46	85.88	3.07	2.70	12.22	2.50
2001	4746.00	5921	880	63.43	65.82	61.57	67.59	2.47	1.66	32.52	2.39
2002	5590.81	7130	880	83.36	83.51	72.53	81.39	0.90	0.76	15.73	0.15
2003	6645.34	8192	880	94.23	95.56	86.20	93.52	4.43	4.43	0.01	1.33
2004	6098.32	7367	880	81.31	82.97	78.89	83.87	2.42	2.05	14.98	1.66
2005	6073.19	7672	880	80.34	83.97	78.78	87.58	7.39	6.70	9.33	3.63
2006	6846.66	8341	880	93.15	94.65	88.82	95.22	2.50	2.42	2.93	1.50
2007	3586.19	4217	880	46.76	47.20	46.52	48.14	1.14	15.77	37.03	0.44
2008	6790.40	7891	880	87.70	88.48	87.85	89.83	1.46	1.54	9.98	0.78
2009	5094.25	6262	880	67.46	75.16	66.08	71.48	5.81	10.47	14.36	7.70
2010	7374.14	8674	880	98.36	98.95	95.66	99.02	1.03	1.02	0.02	0.59
2011	4458.28	5344	880	58.75	59.29	57.83	61.00	1.87	10.14	30.56	0.54
2012	6365.58	7529	880	83.51	87.26	82.35	85.71	1.52	4.14	8.59	3.75
2013	7125.79	8425	880	95.40	96.19	92.44	96.18	3.79	3.79	0.02	0.79
2014	5022.76	6265	880	68.53	70.60	65.16	71.52	1.36	8.47	20.93	2.06
2015	6335.29	7448	880	82.93	83.43	82.18	85.02	5.88	5.64	10.94	0.50

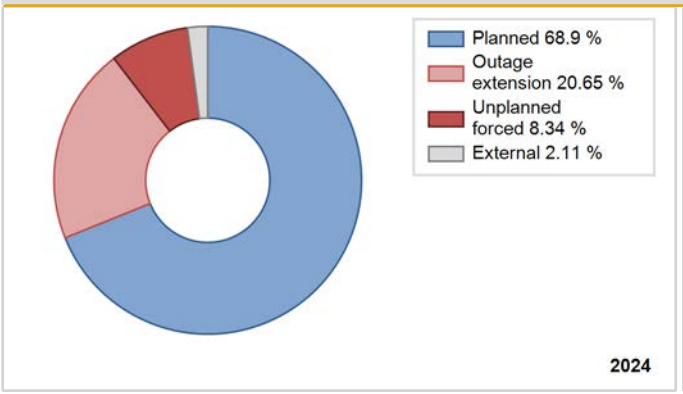
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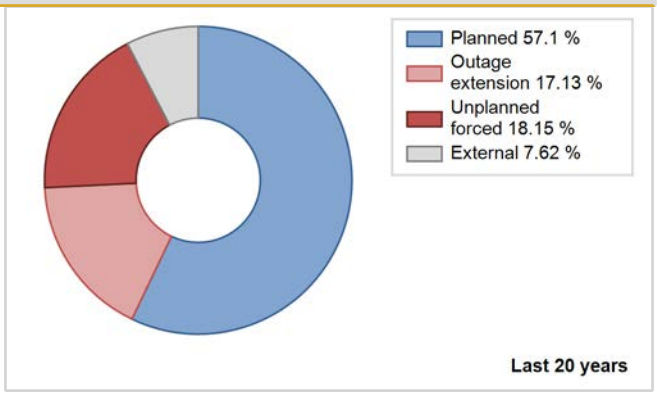
2016	4915.52	5739	880	64.52	65.19	63.59	65.33	0.11	12.89	21.92	0.67
2017	7189.64	8420	880	94.74	95.20	93.27	96.12	0.49	4.19	0.61	0.46
2018	5628.66	6625	880	73.06	74.24	73.02	75.63	5.71	5.27	20.48	1.19
2019	6584.52	7618	880	84.80	85.47	85.42	86.96	3.25	4.26	10.27	0.67
2020	6391.78	7595	880	84.80	86.10	82.69	86.46	3.30	2.94	10.96	1.30
2021	3552.95	4434	880	48.17	51.73	46.09	50.62	3.11	11.39	36.87	3.56
2022	2846.18	3339	880	39.25	43.11	36.92	38.12	45.87	44.54	12.35	3.86
2023	6683.66	8125	880	87.48	90.72	86.70	92.75	9.26	9.25	0.03	3.24
2024	4598.00	5576	880	61.05	61.87	59.48	63.48	4.99	11.29	26.83	0.82

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1979 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		880			634	
B. Refuelling without maintenance				23		
C. Inspection, maintenance or repair combined with refuelling	2301			1164	14	
D. Inspection, maintenance or repair without refuelling				69		
E. Testing of plant systems or components	1			10	0	
H. Nuclear regulatory requirements					25	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			9			0
L. Human factor related					9	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
O. Load dispatching, prioritization			17			6
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						48
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						8
Z. Other					14	0
Subtotal	2302	880	26	1266	696	64
Total	**3208**			**2026**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1979 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		182
12. Reactor I&C Systems		21
13. Reactor Auxiliary Systems	145	6
14. Safety Systems		86
15. Reactor Cooling Systems		16
16. Steam generation systems		64
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		0
31. Turbine and auxiliaries		52
32. Feedwater and Main Steam System		13
33. Circulating Water System		2
34. Miscellaneous Systems	707	87
35. All other I&C Systems		4
41. Main Generator Systems	27	27
42. Electrical Power Supply Systems		92
Total	**879**	**652**

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2024 Operating Experience

FR-16 BUGEY-5 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	FRAM (FRAMATOME)

Reactor Unit Details

Reactor type and model	:	PWR / CP0
Thermal power	:	2785 MWth
Gross electrical power	:	917 MWe
Reference unit power (net)	:	880 MWe

Key Dates

Construction Date	:	1974-07-01
Grid Date	:	1979-07-31
Commercial Date	:	1980-01-03
Age at end of year	:	45 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

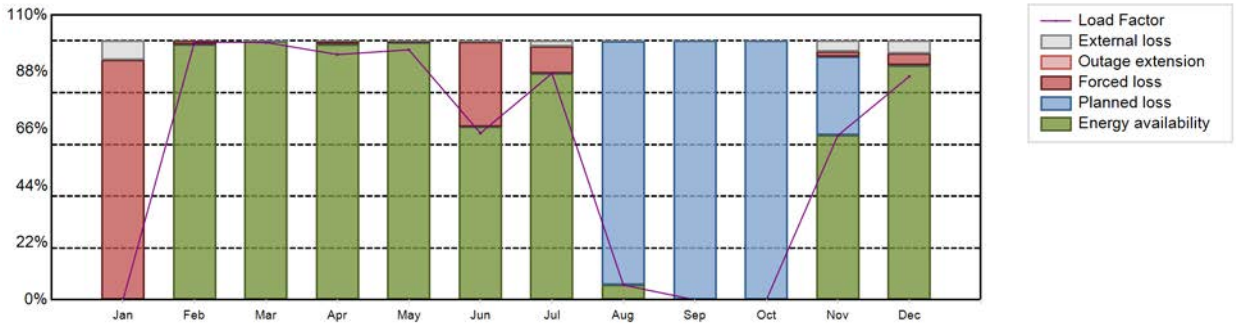
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4477.09 GW(e).h
Energy Availability Factor (EAF)	:	59.02 %
Unit Capability Factor (UCF)	:	60.63 %
Load Factor (LF)	:	57.92 %
Operating Factor (OF)	:	60.43 %

Forced Loss Rate (FLR)	:	16.78 %
Unplanned Capability Loss Factor (UCL)	:	12.23 %
Planned Unavailability Factor (PUF)	:	27.14 %
Externally cause unavailability (XUF)	:	1.61 %
Total off-line time	:	3476 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.01	609.62	650.01	600.26	632.28	407.72	572.40	37.54	0.00	0.00	402.25	565.00	4477.09
EAF [%]	0.00	98.63	99.79	98.69	99.36	66.75	87.48	5.74	0.00	0.00	63.75	90.54	59.02
UCF [%]	7.30	98.63	99.79	98.73	99.50	67.22	89.54	5.96	0.00	0.00	67.74	95.49	60.63
LF [%]	0.00	99.53	99.41	94.74	96.57	64.35	87.43	5.73	0.00	0.00	63.49	86.30	57.92
OF [%]	0.00	100.00	100.00	100.00	100.00	67.78	91.67	6.59	0.00	0.00	70.69	90.99	60.43
FLR [%]	92.70	1.36	0.19	1.13	0.46	32.77	10.46	0.00	0.00	0.00	3.03	4.46	16.78
UCL [%]	92.70	1.36	0.19	1.12	0.46	32.77	10.46	0.00	0.00	0.00	2.12	4.46	12.23
PUF [%]	0.00	0.01	0.02	0.15	0.03	0.01	0.00	94.04	100.00	100.00	30.14	0.05	27.14
XUF [%]	7.30	0.00	0.00	0.03	0.15	0.48	2.05	0.22	0.00	0.00	4.00	4.95	1.61

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Historical Summary

Lifetime energy generation	:	237540.24 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.73 %
Cumulative Energy Availability Factor (EAF)	:	71.9 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	10.43 %
Cumulative Unit Capability Factor (UCF)	:	74.19 %	Cumulative Planned Unavailability Factor (PUF)	:	15.38 %
Cumulative Load Factor (LF)	:	67.67 %	Cumulative Externally cause unavailability (XUF)	:	2.3 %
Cumulative Operating Factor (OF)	:	73.67 %			

Electricity Production (net) [GWh]

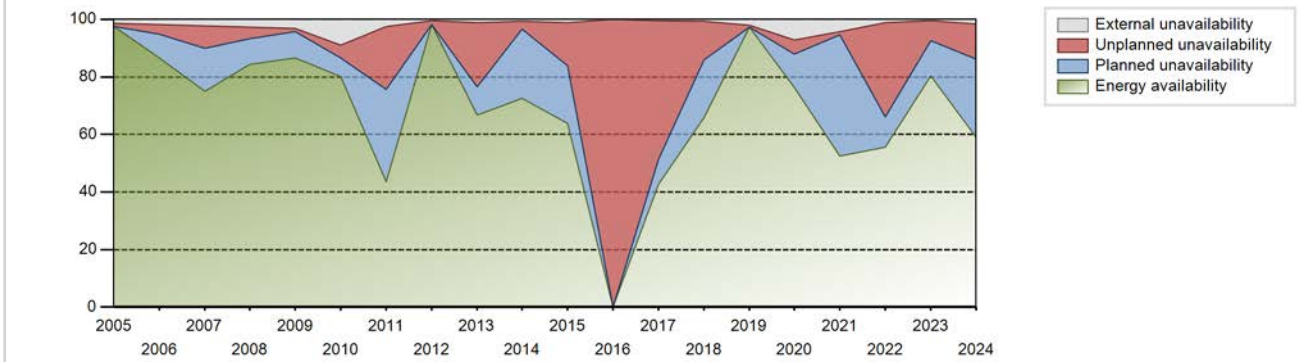


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	6589.00	8050	900	84.50	84.50	83.35	91.64	5.14	4.58	10.92	0.00
1981	4869.30	6061	900	62.75	62.75	61.76	69.19	15.79	11.77	25.49	0.00
1982	5738.50	6956	900	76.38	76.38	72.79	79.41	7.50	6.20	17.43	0.00
1983	5578.00	6649	900	73.90	73.90	70.75	75.90	6.20	4.88	21.21	0.00
1984	5778.00	6884	900	74.10	74.10	73.09	78.37	8.03	6.47	19.43	0.00
1985	6079.70	7314	900	80.50	84.57	77.11	83.49	5.26	4.69	10.74	4.07
1986	5465.50	6493	900	75.53	75.70	69.32	74.12	9.49	7.94	16.36	0.17
1987	5015.90	6044	900	66.65	67.77	63.62	69.00	19.07	15.97	16.26	1.12
1988	5466.00	6465	900	84.64	89.74	69.14	73.60	10.26	10.26	0.00	5.10
1989	4757.98	6185	900	64.71	68.78	60.35	70.61	17.71	14.80	16.42	4.06
1990	5585.97	7156	880	74.85	80.74	72.46	81.69	3.54	2.97	16.29	5.88
1991	3358.36	4258	880	43.96	47.88	43.57	48.61	18.91	11.16	40.95	3.92
1992	4034.99	5003	880	52.52	56.39	52.20	56.96	15.49	10.33	33.28	3.87
1993	4416.61	5329	880	57.37	60.55	57.29	60.83	4.76	3.03	36.42	3.18
1994	4487.33	6311	880	85.68	85.91	58.21	72.04	1.40	1.22	12.87	0.22
1995	5582.80	7060	880	77.97	79.88	72.42	80.59	8.08	7.02	13.11	1.91
1996	5361.36	6844	880	77.53	79.00	69.36	77.91	4.57	3.78	17.22	1.47
1997	5592.90	7302	880	84.27	87.99	72.55	83.36	1.27	1.13	10.89	3.72
1998	5320.37	6844	880	80.46	83.94	69.02	78.13	4.52	3.97	12.08	3.48
1999	6108.75	7679	880	82.66	86.75	79.24	87.66	1.02	0.89	12.35	4.09
2000	5403.24	6889	880	74.63	77.30	69.90	78.43	11.53	10.08	12.63	2.67
2001	4358.59	5604	880	72.09	77.89	56.54	63.97	0.26	0.20	21.91	5.80
2002	6146.94	7925	880	90.98	90.98	79.74	90.47	3.60	3.40	5.62	0.00
2003	5711.09	7220	880	80.03	83.52	74.09	82.42	6.30	5.62	10.86	3.49
2004	5256.10	6438	880	71.42	72.70	68.00	73.29	14.46	12.29	15.01	1.28
2005	7022.84	8573	880	97.55	98.85	91.09	97.85	1.13	1.13	0.02	1.30
2006	6118.12	7765	880	86.64	88.48	79.37	88.64	3.43	3.33	8.20	1.84
2007	5752.87	7051	880	75.07	77.36	74.63	80.49	4.33	7.74	14.90	2.29
2008	6302.49	7822	880	84.34	86.98	81.53	89.05	4.17	4.08	8.94	2.64
2009	6556.83	7935	880	86.60	89.78	85.06	90.58	1.13	1.02	9.20	3.18
2010	5927.46	7457	880	80.13	89.11	76.89	85.13	2.82	4.35	6.54	8.98
2011	3271.68	4079	880	43.46	45.86	42.44	46.56	2.41	22.04	32.10	2.39
2012	7133.76	8569	880	98.27	98.68	92.29	97.55	1.31	1.31	0.01	0.41
2013	5083.50	5997	880	66.73	67.79	65.94	68.46	18.44	22.38	9.83	1.05
2014	5508.01	6492	880	72.44	73.04	71.45	74.11	3.11	2.74	24.22	0.60
2015	4924.48	5693	880	63.94	65.20	63.88	64.99	1.07	14.91	19.89	1.26
2016	0.00	0	880	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00

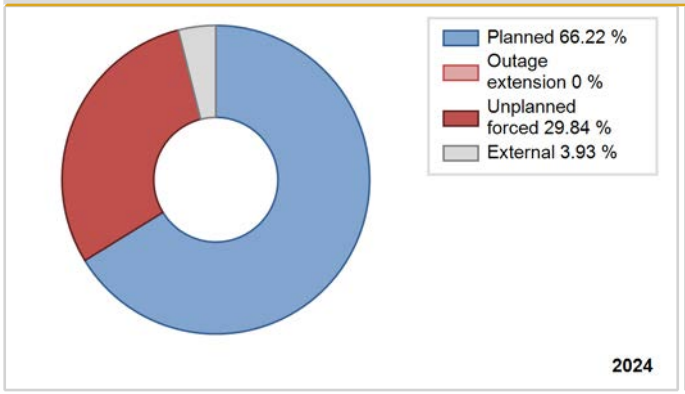
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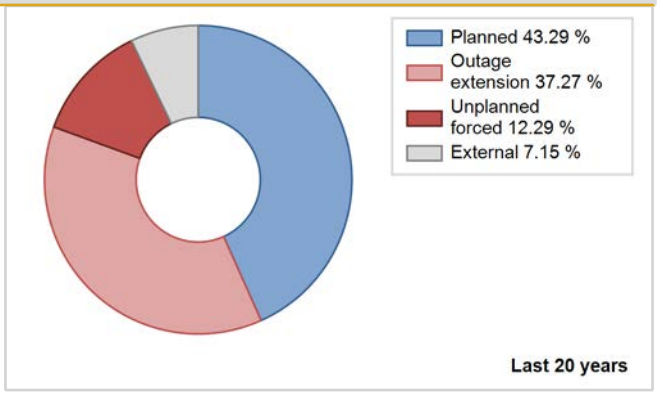
2017	3282.27	3887	880	42.74	43.19	42.58	44.37	0.44	48.14	8.67	0.45
2018	5098.42	5902	880	65.87	66.62	66.14	67.37	9.11	13.37	20.02	0.75
2019	7323.23	8655	880	97.31	99.34	95.00	98.80	0.63	0.63	0.04	2.03
2020	5887.45	6900	880	76.33	83.59	76.16	78.55	1.68	4.88	11.53	7.26
2021	4054.52	4822	880	52.51	56.83	52.60	55.05	1.66	0.96	42.21	4.32
2022	4244.17	5623	880	55.52	56.63	55.06	64.19	17.70	32.73	10.64	1.11
2023	6081.03	7143	880	80.30	80.82	78.88	81.54	6.21	6.87	12.31	0.52
2024	4477.09	5308	880	59.02	60.63	57.92	60.43	16.78	12.23	27.14	1.61

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1980 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		1023			447	
B. Refuelling without maintenance	72			25		
C. Inspection, maintenance or repair combined with refuelling	2264			1238	8	
D. Inspection, maintenance or repair without refuelling				20		
E. Testing of plant systems or components				7	1	
H. Nuclear regulatory requirements					308	
J. Grid limitation, failure or grid unavailability						1
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						10
L. Human factor related					17	0
M. Governmental requirements or court decisions						0
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						14
O. Load dispatching, prioritization						2
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)			55		7	22
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			62			11
Z. Other					37	9
Subtotal	2336	1023	117	1290	825	69
Total		**3476**			**2184**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	678	33
12. Reactor I&C Systems	279	49
13. Reactor Auxiliary Systems		10
14. Safety Systems		8
15. Reactor Cooling Systems		19
16. Steam generation systems		403
17. Safety I&C Systems (excluding reactor I&C)		2
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries	40	78
32. Feedwater and Main Steam System		12
33. Circulating Water System		2
34. Miscellaneous Systems		92
41. Main Generator Systems		43
42. Electrical Power Supply Systems	26	9
Total	**1023**	**761**

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2024 Operating Experience

FR-50 CATTENOM-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1362 MWe
Reference unit power (net)	:	1300 MWe

Key Dates

Construction Date	:	1979-10-29
Grid Date	:	1986-11-13
Commercial Date	:	1987-04-01
Age at end of year	:	38 years

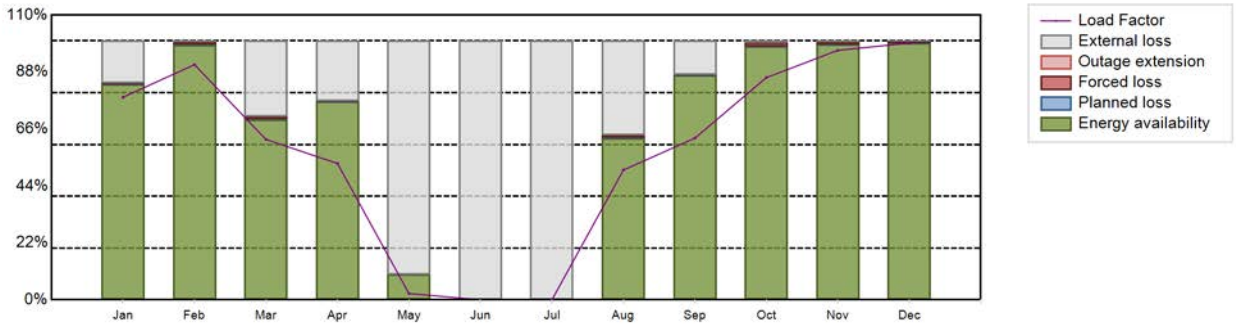
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	323.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6455.59 GW(e).h	Forced Loss Rate (FLR)	:	0.57 %
Energy Availability Factor (EAF)	:	65 %	Unplanned Capability Loss Factor (UCL)	:	0.57 %
Unit Capability Factor (UCF)	:	99.36 %	Planned Unavailability Factor (PUF)	:	0.07 %
Load Factor (LF)	:	56.53 %	Externally cause unavailability (XUF)	:	34.36 %
Operating Factor (OF)	:	64.61 %	Total off-line time	:	3109 hours

Annual Summary



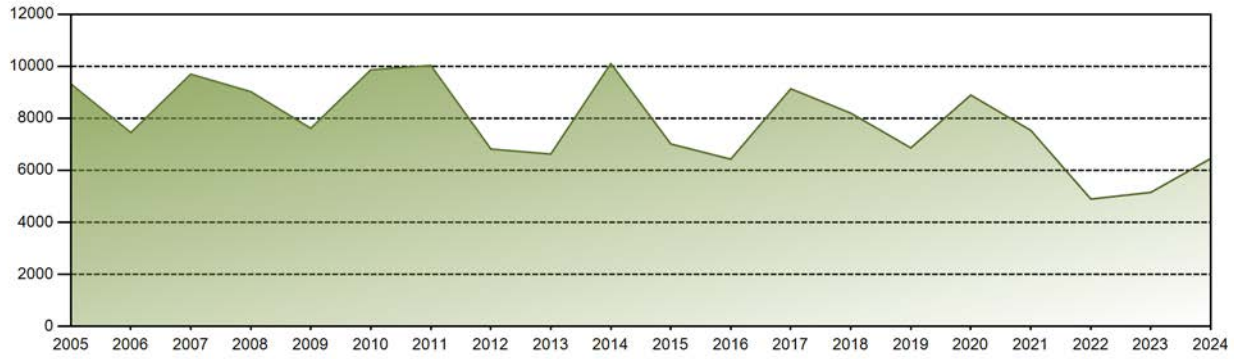
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	756.83	821.86	598.34	493.06	23.63	0.00	0.00	484.90	584.53	831.35	901.92	959.17	6455.59
EAF [%]	83.14	98.35	69.62	76.54	9.69	0.00	0.00	62.44	86.72	97.83	98.67	99.18	65.00
UCF [%]	99.46	98.75	98.90	99.76	100.00	100.00	100.00	98.71	99.80	98.54	99.09	99.35	99.36
LF [%]	78.25	90.83	61.95	52.68	2.44	0.00	0.00	50.13	62.45	85.84	96.36	99.17	56.53
OF [%]	84.01	100.00	71.33	77.36	9.68	0.00	0.00	61.16	73.89	99.87	100.00	100.00	64.61
FLR [%]	0.52	1.03	1.00	0.13	0.00	0.00	0.00	1.21	0.18	1.31	0.88	0.59	0.57
UCL [%]	0.52	1.03	1.00	0.13	0.00	0.00	0.00	1.21	0.18	1.31	0.88	0.59	0.57
PUF [%]	0.03	0.22	0.10	0.12	0.00	0.00	0.00	0.08	0.03	0.15	0.03	0.06	0.07
XUF [%]	16.32	0.40	29.27	23.22	90.31	100.00	100.00	36.27	13.07	0.71	0.42	0.17	34.36

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Historical Summary

Lifetime energy generation	:	293153.09 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	11.44 %
Cumulative Energy Availability Factor (EAF)	:	71.55 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	11.9 %
Cumulative Unit Capability Factor (UCF)	:	74.44 %	Cumulative Planned Unavailability Factor (PUF)	:	13.67 %
Cumulative Load Factor (LF)	:	67.9 %	Cumulative Externally cause unavailability (XUF)	:	2.88 %
Cumulative Operating Factor (OF)	:	74.54 %			

Electricity Production (net) [GWh]

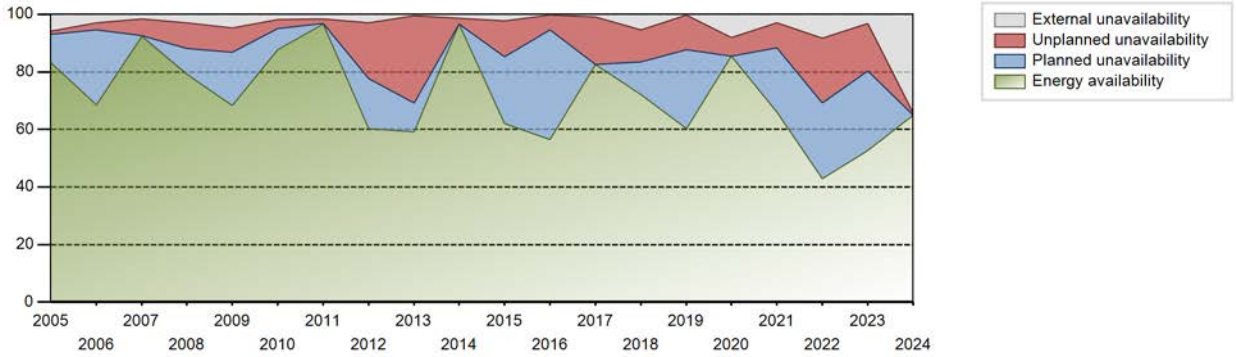


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	7429.80	6393	1265	68.80	69.47	65.53	68.38	30.53	30.53	0.00	0.67
1988	5283.00	4369	1300	47.40	47.80	46.26	49.74	32.01	22.51	29.70	0.39
1989	6802.43	5548	1300	60.28	60.28	59.73	63.33	24.40	19.46	20.26	0.00
1990	7781.88	6710	1300	75.29	75.71	68.33	76.60	11.10	9.46	14.84	0.42
1991	1509.28	1336	1300	13.48	13.48	13.25	15.25	84.22	71.92	14.61	0.00
1992	7933.30	6595	1300	71.02	71.46	69.47	75.08	12.28	10.00	18.54	0.44
1993	6956.55	5608	1300	61.46	63.47	61.09	64.02	25.00	21.15	15.37	2.01
1994	6775.45	6006	1300	64.04	64.06	59.50	68.56	35.14	34.71	1.22	0.02
1995	6634.25	6346	1300	59.54	59.84	58.26	72.44	27.42	22.60	17.55	0.30
1996	9539.24	7783	1300	87.29	87.48	83.54	88.60	0.58	0.51	12.01	0.19
1997	8688.94	7374	1300	81.38	84.07	76.30	84.18	0.75	0.64	15.29	2.69
1998	9365.85	7644	1300	85.65	85.89	82.24	87.26	5.54	5.04	9.07	0.23
1999	8273.01	7028	1300	76.29	79.76	72.65	80.23	1.45	1.17	19.07	3.46
2000	8053.79	6873	1300	78.09	81.03	70.53	78.24	0.87	0.71	18.26	2.94
2001	9220.15	8094	1300	96.42	96.44	80.96	92.40	1.60	1.57	1.99	0.02
2002	8270.16	7011	1300	79.18	79.38	72.62	80.03	8.52	7.39	13.23	0.19
2003	8530.97	7150	1300	78.44	80.35	74.91	81.62	0.89	0.72	18.92	1.91
2004	9764.16	8583	1300	96.38	96.94	85.51	97.71	1.94	1.91	1.15	0.56
2005	9323.78	7919	1300	83.23	89.12	81.86	90.39	0.25	1.05	9.83	5.89
2006	7448.99	6480	1300	68.59	71.55	65.41	73.97	2.32	2.45	26.00	2.96
2007	9696.23	8426	1300	92.42	93.96	85.14	96.19	5.90	5.89	0.15	1.54
2008	9022.88	7881	1300	79.19	82.22	79.02	89.72	7.91	8.73	9.05	3.03
2009	7612.66	6261	1300	68.35	73.14	66.85	71.47	2.20	8.29	18.56	4.79
2010	9864.05	7948	1300	87.65	89.44	86.62	90.73	1.81	3.20	7.36	1.79
2011	10033.88	8538	1300	96.69	98.22	88.11	97.47	1.63	1.63	0.15	1.54
2012	6818.80	5738	1300	60.27	63.12	59.71	65.32	4.83	19.50	17.38	2.85
2013	6624.72	5440	1300	59.23	59.70	58.17	62.10	33.56	30.33	9.97	0.47
2014	10106.20	8421	1300	96.54	97.98	88.74	96.13	1.97	1.97	0.05	1.44
2015	7013.40	5683	1300	61.96	64.19	61.59	64.87	2.94	12.59	23.22	2.23
2016	6428.77	5371	1300	56.57	56.93	56.30	61.15	1.84	5.10	37.97	0.36
2017	9134.86	7393	1300	82.49	83.34	80.21	84.39	16.58	16.56	0.10	0.85
2018	8198.29	6694	1300	72.02	77.35	71.99	76.42	9.64	11.24	11.41	5.33
2019	6861.87	5497	1300	60.39	60.74	60.26	62.75	3.11	11.99	27.26	0.35
2020	8894.78	7835	1300	85.47	93.64	77.89	89.20	6.33	6.33	0.03	8.17
2021	7533.87	6204	1300	66.17	69.10	66.16	70.82	11.09	8.62	22.28	2.93
2022	4896.26	3863	1300	43.00	51.38	42.99	44.10	0.84	22.53	26.09	8.38
2023	5152.34	4861	1300	52.63	55.77	45.24	55.49	12.86	16.57	27.66	3.14

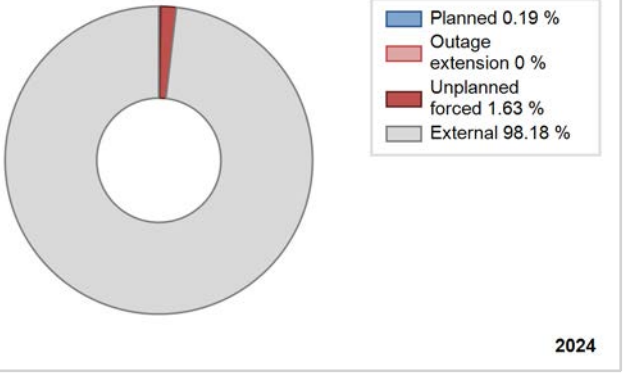
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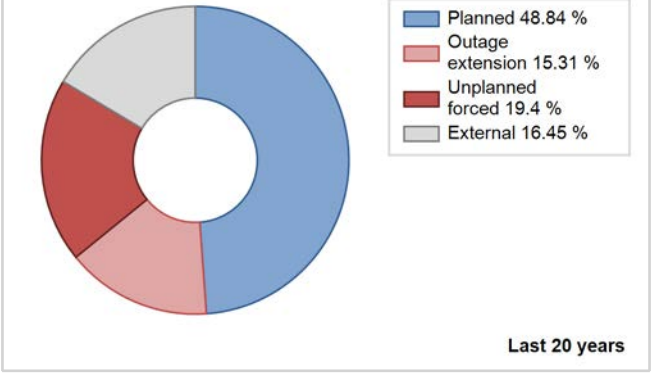
2024	6455.59	5675	1300	65.00	99.36	56.53	64.61	0.57	0.57	0.07	34.36

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					849	
B.	Refuelling without maintenance				184		
C.	Inspection, maintenance or repair combined with refuelling				891	9	
D.	Inspection, maintenance or repair without refuelling				35	5	
E.	Testing of plant systems or components				41		
H.	Nuclear regulatory requirements					5	
J.	Grid limitation, failure or grid unavailability						1
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			0			5
L.	Human factor related					9	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
O.	Load dispatching, prioritization			133			4
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					0	34
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			2976			96
Z.	Other					41	6
Subtotal				3109	1151	918	148
Total			**3109**			**2217**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		22
12. Reactor I&C Systems		55
13. Reactor Auxiliary Systems		30
14. Safety Systems		8
15. Reactor Cooling Systems		57
16. Steam generation systems		27
17. Safety I&C Systems (excluding reactor I&C)		7
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		54
32. Feedwater and Main Steam System		65
33. Circulating Water System		19
34. Miscellaneous Systems		153
35. All other I&C Systems		6
41. Main Generator Systems		227
42. Electrical Power Supply Systems		113
Total		**844**

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2024 Operating Experience

FR-53 CATTENOM-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1362 MWe
Reference unit power (net)	:	1300 MWe

Key Dates

Construction Date	:	1980-07-28
Grid Date	:	1987-09-17
Commercial Date	:	1988-02-01
Age at end of year	:	37 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	16
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	4.267
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.2
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

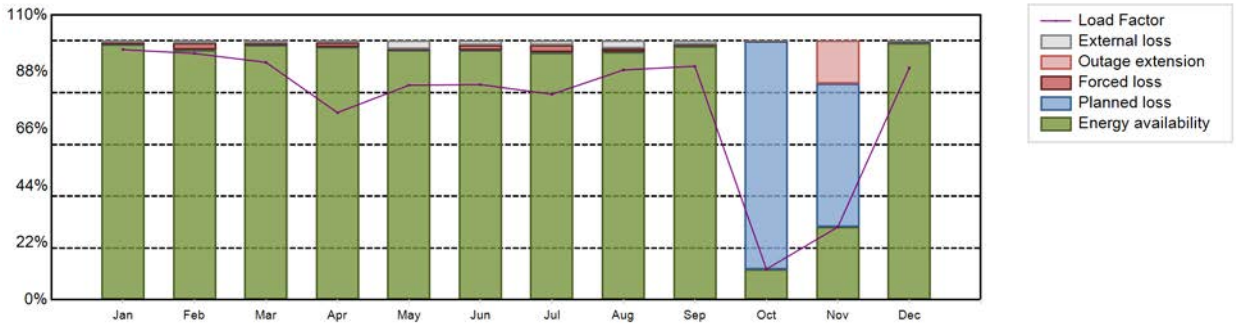
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	328.7
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	4.1
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.95
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8653.18 GW(e).h
Energy Availability Factor (EAF)	:	84.28 %
Unit Capability Factor (UCF)	:	85.44 %
Load Factor (LF)	:	75.78 %
Operating Factor (OF)	:	87.25 %

Forced Loss Rate (FLR)	:	1.28 %
Unplanned Capability Loss Factor (UCL)	:	2.46 %
Planned Unavailability Factor (PUF)	:	12.1 %
Externally cause unavailability (XUF)	:	1.16 %
Total off-line time	:	1120 hours

Annual Summary



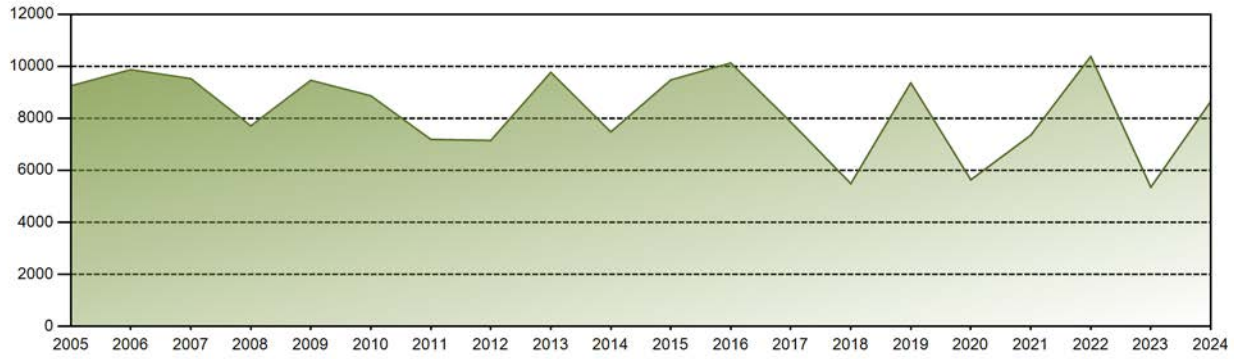
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	934.70	860.89	885.88	676.62	801.51	778.03	767.97	858.50	844.47	114.82	263.28	866.52	8653.18
EAF [%]	98.56	96.42	98.34	97.54	96.27	96.38	95.47	95.61	97.99	11.89	28.13	99.11	84.28
UCF [%]	99.25	97.21	99.14	98.18	99.38	98.08	96.99	98.50	99.30	11.97	28.13	99.46	85.44
LF [%]	96.64	95.15	91.72	72.29	82.87	83.12	79.40	88.76	90.22	11.86	28.13	89.59	75.78
OF [%]	100.00	100.00	100.00	100.00	98.39	99.44	100.00	100.00	100.00	12.89	36.81	100.00	87.25
FLR [%]	0.71	2.64	0.82	1.64	0.55	1.81	2.95	1.21	0.65	0.85	0.00	0.33	1.28
UCL [%]	0.71	2.63	0.81	1.64	0.55	1.81	2.95	1.20	0.65	0.10	16.48	0.33	2.46
PUF [%]	0.04	0.16	0.05	0.18	0.07	0.10	0.06	0.29	0.06	87.93	55.39	0.21	12.10
XUF [%]	0.68	0.79	0.80	0.63	3.11	1.70	1.52	2.89	1.31	0.08	0.00	0.35	1.16

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Historical Summary

Lifetime energy generation	:	304821.75 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.61 %
Cumulative Energy Availability Factor (EAF)	:	76.66 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.65 %
Cumulative Unit Capability Factor (UCF)	:	78.97 %	Cumulative Planned Unavailability Factor (PUF)	:	13.37 %
Cumulative Load Factor (LF)	:	71.91 %	Cumulative Externally cause unavailability (XUF)	:	2.31 %
Cumulative Operating Factor (OF)	:	78.69 %			

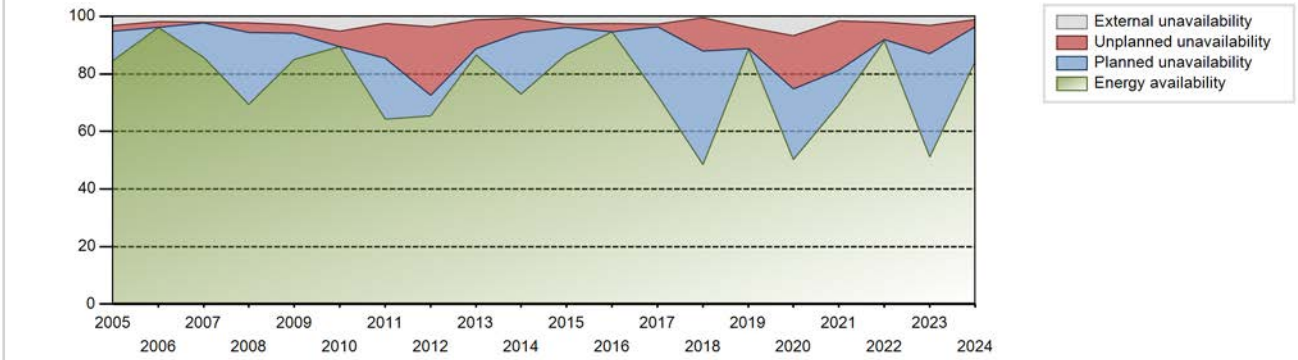
Electricity Production (net) [GWh]



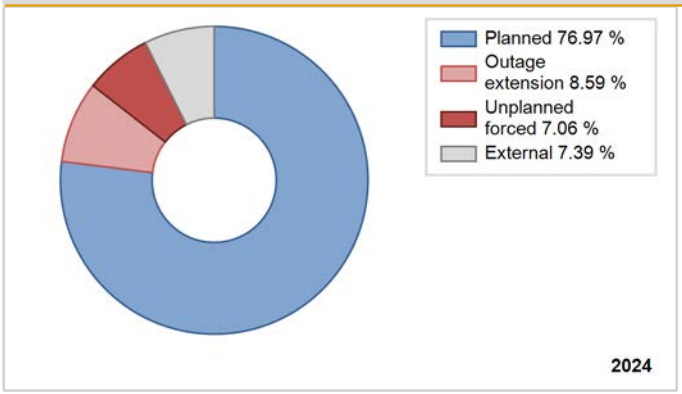
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	8138.00	7156	1300	90.80	91.04	71.35	81.94	5.24	5.03	3.93	0.24
1989	1765.48	1452	1300	15.48	16.51	15.50	16.58	77.27	56.12	27.37	1.03
1990	8137.59	6670	1300	82.70	82.98	71.46	76.14	6.39	5.66	11.36	0.27
1991	7543.13	6472	1300	68.21	71.75	66.24	73.88	11.68	9.49	18.77	3.54
1992	8134.30	6752	1300	72.38	75.63	71.23	76.87	7.25	5.91	18.46	3.26
1993	8626.96	6990	1300	76.22	78.82	75.75	79.79	6.36	5.36	15.83	2.60
1994	8526.27	7158	1300	77.69	80.49	74.87	81.71	3.61	3.01	16.50	2.80
1995	8603.72	7138	1300	78.31	79.93	75.55	81.48	7.42	6.40	13.67	1.62
1996	9018.10	7804	1300	98.09	99.57	78.97	88.84	0.38	0.38	0.04	1.49
1997	8487.38	7503	1300	82.21	84.39	74.53	85.65	4.23	3.73	11.88	2.19
1998	7259.47	6144	1300	67.96	68.96	63.75	70.14	7.64	5.71	25.34	1.00
1999	9367.49	7781	1300	87.28	90.19	82.26	88.82	0.22	0.20	9.61	2.91
2000	9164.30	7868	1300	88.57	88.61	80.25	89.57	7.45	7.14	4.25	0.05
2001	8649.04	7033	1300	77.53	79.41	75.95	80.29	2.80	2.28	18.30	1.88
2002	8288.00	6918	1300	76.87	76.92	72.78	78.97	8.18	6.85	16.23	0.05
2003	10197.46	8217	1300	93.45	99.30	89.55	93.80	0.63	0.63	0.07	5.84
2004	7368.16	6183	1300	66.80	68.70	64.52	70.39	18.24	15.33	15.97	1.90
2005	9247.81	7845	1300	84.65	87.87	81.21	89.55	1.12	2.04	10.09	3.22
2006	9870.28	8626	1300	96.14	97.96	86.67	98.47	1.97	1.97	0.07	1.82
2007	9526.50	7758	1300	85.72	87.82	83.65	88.56	0.07	0.06	12.11	2.10
2008	7707.77	6356	1300	69.45	71.67	67.50	72.36	0.45	3.47	24.86	2.22
2009	9460.92	7845	1300	85.12	88.12	83.08	89.55	1.47	2.88	9.00	3.00
2010	8866.22	8001	1300	89.41	94.65	77.86	91.34	5.32	5.32	0.03	5.24
2011	7188.84	5995	1300	64.26	66.64	63.13	68.44	2.91	12.06	21.30	2.38
2012	7149.60	5981	1300	65.49	69.16	62.61	68.09	10.21	23.70	7.14	3.67
2013	9766.15	7830	1300	86.59	87.79	85.76	89.38	2.78	9.93	2.28	1.20
2014	7475.58	6535	1300	72.92	73.61	65.64	74.60	6.20	4.86	21.52	0.69
2015	9474.83	7870	1300	86.81	89.49	83.20	89.84	1.18	1.07	9.44	2.68
2016	10129.04	8664	1300	94.52	97.10	88.70	98.63	2.87	2.86	0.04	2.58
2017	7853.19	6649	1300	72.48	75.10	68.96	75.90	1.23	0.93	23.96	2.62
2018	5487.63	4386	1300	48.54	49.10	48.19	50.07	18.90	11.44	39.45	0.56
2019	9366.77	8046	1300	88.69	92.57	82.25	91.85	7.39	7.39	0.04	3.88
2020	5634.04	4699	1300	50.31	57.06	49.34	53.49	1.48	18.56	24.38	6.74
2021	7351.90	6220	1300	69.09	70.79	64.56	71.00	0.46	17.04	12.17	1.70
2022	10380.51	8319	1300	91.51	93.46	91.15	94.97	4.84	6.04	0.50	1.95
2023	5348.61	4698	1300	51.09	54.34	46.97	53.63	15.05	9.62	36.03	3.25
2024	8653.18	7664	1300	84.28	85.44	75.78	87.25	1.28	2.46	12.10	1.16

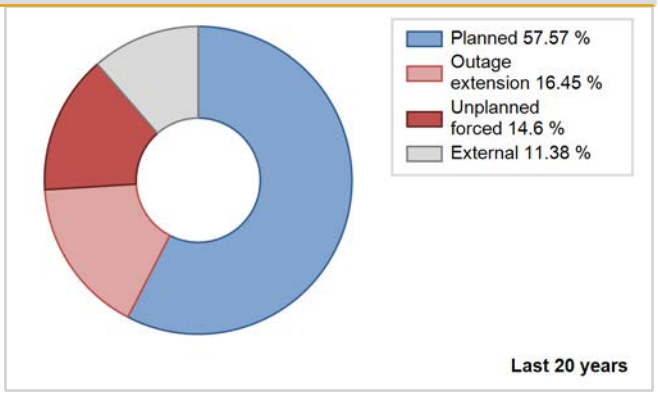
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		119			533	
B.	Refuelling without maintenance	985			113		
C.	Inspection, maintenance or repair combined with refuelling				968	5	
D.	Inspection, maintenance or repair without refuelling				37	12	
E.	Testing of plant systems or components				33	0	1
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						2
L.	Human factor related					21	
M.	Governmental requirements or court decisions						2
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						11
O.	Load dispatching, prioritization			4			2
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						18
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			12			18
Z.	Other					23	18
Subtotal		985	119	16	1151	594	72
Total		**1120**			**1817**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1988 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		16
13. Reactor Auxiliary Systems		4
14. Safety Systems		48
15. Reactor Cooling Systems		111
16. Steam generation systems		53
31. Turbine and auxiliaries		23
32. Feedwater and Main Steam System		12
33. Circulating Water System		1
34. Miscellaneous Systems	119	187
35. All other I&C Systems		2
41. Main Generator Systems		48
42. Electrical Power Supply Systems		18
Total	**119**	**530**

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2024 Operating Experience

FR-60 CATTENOM-3 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1362 MWe
Reference unit power (net)	:	1300 MWe

Key Dates

Construction Date	:	1982-06-15
Grid Date	:	1990-07-06
Commercial Date	:	1991-02-01
Age at end of year	:	34 years

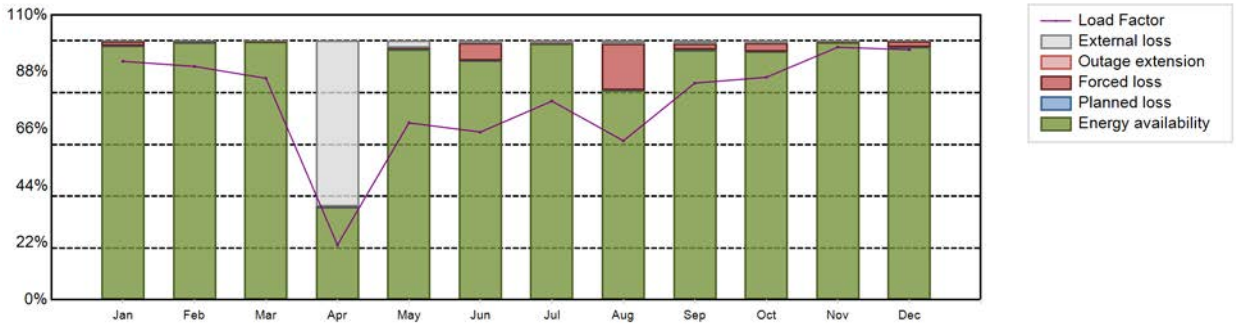
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8799.06 GW(e).h	Forced Loss Rate (FLR)	:	3 %
Energy Availability Factor (EAF)	:	91.03 %	Unplanned Capability Loss Factor (UCL)	:	3 %
Unit Capability Factor (UCF)	:	96.94 %	Planned Unavailability Factor (PUF)	:	0.07 %
Load Factor (LF)	:	77.05 %	Externally cause unavailability (XUF)	:	5.91 %
Operating Factor (OF)	:	90.56 %	Total off-line time	:	829 hours

Annual Summary



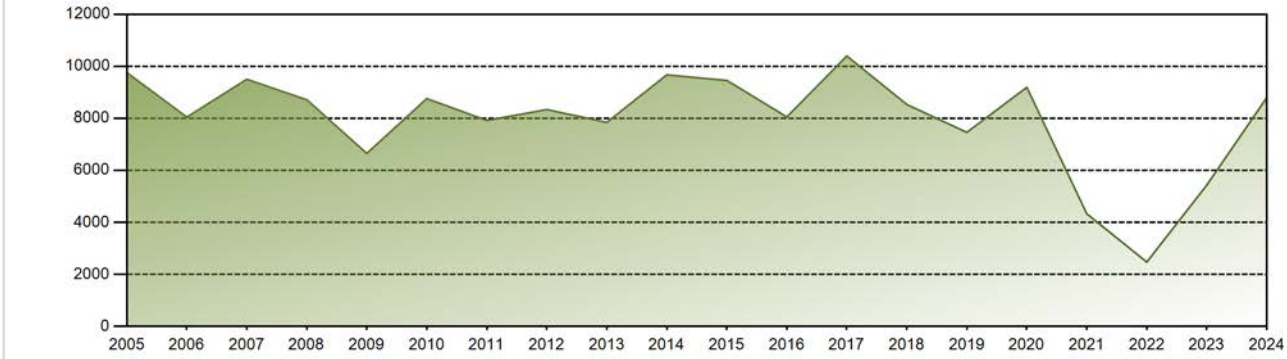
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	890.89	815.61	826.42	198.44	661.20	606.56	742.25	594.15	783.55	832.49	913.33	934.20	8799.06
EAF [%]	98.11	99.46	99.60	35.93	96.76	92.41	98.96	81.02	96.44	95.81	99.42	97.70	91.03
UCF [%]	98.13	99.64	99.69	99.78	99.28	93.19	99.93	82.06	97.62	96.68	99.76	97.77	96.94
LF [%]	92.11	90.14	85.56	21.20	68.36	64.80	76.74	61.43	83.71	85.96	97.58	96.59	77.05
OF [%]	99.19	100.00	100.00	36.67	93.95	78.33	100.00	81.85	98.61	97.18	100.00	100.00	90.56
FLR [%]	1.85	0.24	0.15	0.21	0.52	6.80	0.03	17.93	2.29	3.31	0.15	2.22	3.00
UCL [%]	1.85	0.24	0.15	0.21	0.52	6.80	0.03	17.92	2.28	3.31	0.15	2.22	3.00
PUF [%]	0.02	0.12	0.16	0.01	0.20	0.01	0.05	0.01	0.10	0.01	0.09	0.01	0.07
XUF [%]	0.02	0.18	0.09	63.84	2.52	0.78	0.97	1.04	1.18	0.86	0.34	0.07	5.91

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Historical Summary

Lifetime energy generation	:	278421.04 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.95 %
Cumulative Energy Availability Factor (EAF)	:	75.76 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	9.41 %
Cumulative Unit Capability Factor (UCF)	:	78.13 %	Cumulative Planned Unavailability Factor (PUF)	:	12.46 %
Cumulative Load Factor (LF)	:	71.5 %	Cumulative Externally cause unavailability (XUF)	:	2.37 %
Cumulative Operating Factor (OF)	:	77.7 %			

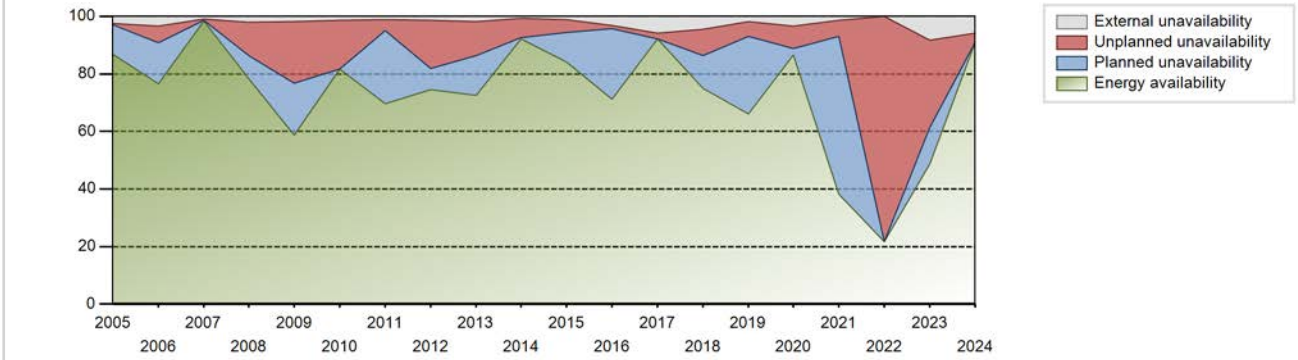
Electricity Production (net) [GWh]



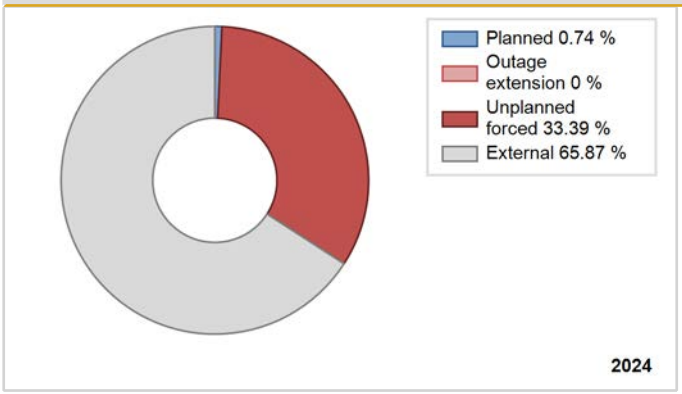
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1991	9683.15	7897	1300	88.20	89.61	85.70	90.51	10.29	10.27	0.12	1.41
1992	7145.04	5903	1300	65.61	67.00	62.57	67.20	3.95	2.76	30.24	1.40
1993	8035.13	6858	1300	75.86	81.16	70.56	78.29	1.87	1.55	17.30	5.29
1994	8613.33	7464	1300	84.36	85.71	75.64	85.21	1.30	1.13	13.16	1.35
1995	8344.31	7269	1300	78.93	82.24	73.27	82.98	5.14	4.46	13.30	3.31
1996	8264.73	7184	1300	77.27	80.56	72.38	81.79	3.75	3.14	16.29	3.29
1997	9504.06	8097	1300	93.25	94.46	83.46	92.43	1.79	1.72	3.82	1.22
1998	8054.93	7175	1300	80.15	83.51	70.73	81.91	2.52	2.16	14.33	3.36
1999	8237.00	7169	1300	79.73	83.51	72.33	81.84	1.57	1.34	15.15	3.78
2000	8933.53	7984	1300	98.71	99.15	78.23	90.89	0.57	0.57	0.29	0.43
2001	3171.47	2739	1300	29.74	29.81	27.85	31.27	58.95	42.80	27.39	0.07
2002	9402.46	7443	1300	82.50	83.63	82.56	84.97	3.03	2.62	13.75	1.13
2003	11254.01	8715	1300	98.37	99.34	98.82	99.49	0.18	0.18	0.47	0.97
2004	9162.73	7274	1300	80.35	81.37	80.24	82.81	3.34	2.81	15.82	1.02
2005	9757.05	7944	1300	86.70	89.23	85.67	90.67	0.52	0.47	10.30	2.53
2006	8045.34	7088	1300	76.49	79.94	70.65	80.91	1.63	5.67	14.39	3.45
2007	9500.56	8559	1300	98.46	99.27	83.43	97.71	0.65	0.65	0.07	0.81
2008	8712.70	7145	1300	78.40	80.48	76.30	81.34	1.04	11.62	7.90	2.08
2009	6649.76	5277	1300	58.66	60.45	58.39	60.24	20.99	21.49	18.06	1.79
2010	8756.81	6966	1300	81.71	82.99	76.90	79.52	17.00	16.99	0.01	1.28
2011	7918.57	6306	1300	69.59	70.83	69.53	71.99	2.78	3.73	25.44	1.24
2012	8337.71	6760	1300	74.49	75.86	73.01	76.96	1.63	16.80	7.34	1.36
2013	7844.56	6552	1300	72.57	74.29	68.88	74.79	1.69	11.91	13.80	1.72
2014	9671.58	8049	1300	92.06	92.80	84.93	91.88	3.56	6.74	0.46	0.74
2015	9456.96	7813	1300	84.04	85.30	83.04	89.19	4.80	4.30	10.41	1.26
2016	8053.88	6821	1300	71.20	74.31	70.53	77.65	1.43	1.08	24.62	3.11
2017	10396.60	8390	1300	92.19	97.96	91.29	95.78	1.97	1.97	0.07	5.78
2018	8531.74	7038	1300	75.07	79.59	74.92	80.34	9.36	9.07	11.34	4.52
2019	7460.81	6029	1300	65.97	67.85	65.51	68.82	0.31	5.06	27.09	1.88
2020	9190.97	7711	1300	86.57	89.88	80.49	87.78	7.95	7.76	2.35	3.31
2021	4325.56	3519	1300	38.12	39.49	37.98	40.17	12.43	5.63	54.88	1.37
2022	2472.54	1942	1300	21.66	21.66	21.71	22.17	78.34	78.33	0.01	0.00
2023	5434.54	4611	1300	48.76	57.01	47.72	52.64	33.87	30.30	12.69	8.25
2024	8799.06	7955	1300	91.03	96.94	77.05	90.56	3.00	3.00	0.07	5.91

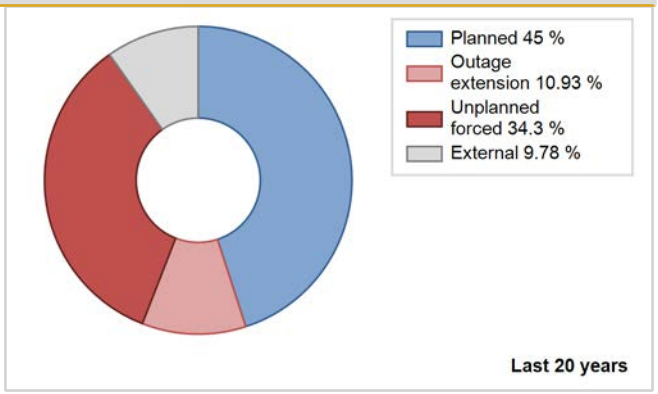
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1991 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		209			676	
B.	Refuelling without maintenance				81		
C.	Inspection, maintenance or repair combined with refuelling				938	12	
D.	Inspection, maintenance or repair without refuelling				42		
E.	Testing of plant systems or components				11		
H.	Nuclear regulatory requirements					68	
J.	Grid limitation, failure or grid unavailability						11
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						13
L.	Human factor related					7	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
O.	Load dispatching, prioritization			148			7
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					1	32
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			472			21
Z.	Other					23	
Subtotal			209	620	1072	787	88
Total			**829**			**1947**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1991 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		71
12. Reactor I&C Systems	11	30
13. Reactor Auxiliary Systems	34	34
14. Safety Systems	20	276
15. Reactor Cooling Systems		15
16. Steam generation systems		23
21. Fuel Handling and Storage Facilities		7
31. Turbine and auxiliaries	114	25
32. Feedwater and Main Steam System		12
33. Circulating Water System	19	9
34. Miscellaneous Systems		70
41. Main Generator Systems		73
42. Electrical Power Supply Systems	10	21
Total	**208**	**666**

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2024 Operating Experience

FR-65 CATTENOM-4 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1362 MWe
Reference unit power (net)	:	1300 MWe

Key Dates

Construction Date	:	1983-09-28
Grid Date	:	1991-05-27
Commercial Date	:	1992-01-01
Age at end of year	:	33 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	16
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	4.267
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.2
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

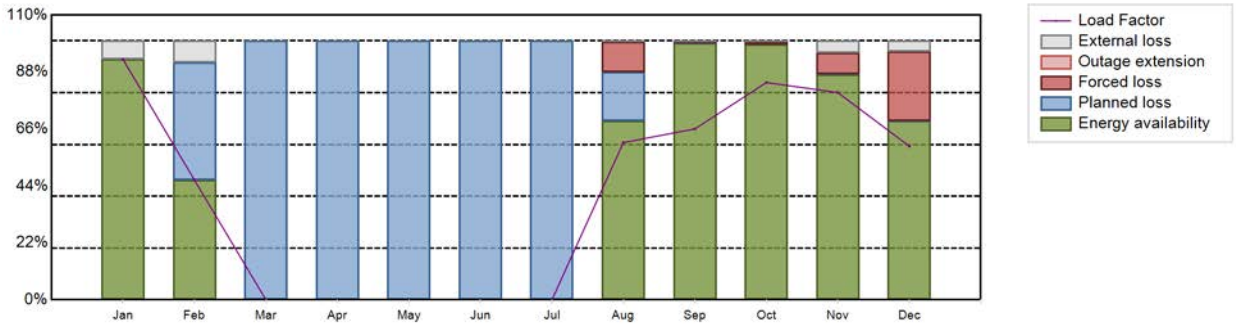
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	328.7
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	4.1
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.95
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4657.99 GW(e).h
Energy Availability Factor (EAF)	:	46.85 %
Unit Capability Factor (UCF)	:	48.95 %
Load Factor (LF)	:	40.79 %
Operating Factor (OF)	:	48.69 %

Forced Loss Rate (FLR)	:	7.6 %
Unplanned Capability Loss Factor (UCL)	:	4.02 %
Planned Unavailability Factor (PUF)	:	47.02 %
Externally cause unavailability (XUF)	:	2.11 %
Total off-line time	:	4507 hours

Annual Summary



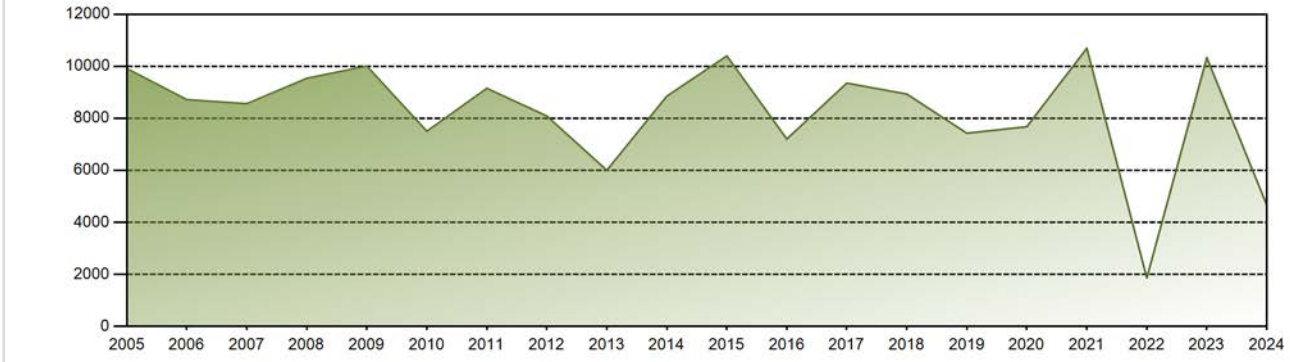
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	898.35	418.35	0.00	0.00	0.00	0.00	0.00	587.37	618.01	812.86	749.21	573.86	4657.99
EAF [%]	92.87	46.23	0.00	0.00	0.00	0.00	0.00	69.06	99.09	98.58	86.97	69.13	46.85
UCF [%]	100.00	54.60	0.00	0.00	0.00	0.00	0.00	69.54	99.45	98.93	91.66	73.33	48.95
LF [%]	92.88	46.24	0.00	0.00	0.00	0.00	0.00	60.73	66.03	83.93	80.04	59.33	40.79
OF [%]	100.00	55.03	0.00	0.00	0.00	0.00	0.00	75.81	87.64	99.87	96.67	69.22	48.69
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.30	0.49	1.07	8.02	26.64	7.60
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.60	0.49	1.07	8.00	26.63	4.02
PUF [%]	0.00	45.40	100.00	100.00	100.00	100.00	100.00	18.85	0.06	0.00	0.35	0.04	47.02
XUF [%]	7.13	8.37	0.00	0.00	0.00	0.00	0.00	0.49	0.36	0.35	4.69	4.20	2.11

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Historical Summary

Lifetime energy generation	:	281887.39 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.21 %
Cumulative Energy Availability Factor (EAF)	:	79.17 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.59 %
Cumulative Unit Capability Factor (UCF)	:	81.65 %	Cumulative Planned Unavailability Factor (PUF)	:	12.77 %
Cumulative Load Factor (LF)	:	74.41 %	Cumulative Externally cause unavailability (XUF)	:	2.47 %
Cumulative Operating Factor (OF)	:	81.25 %			

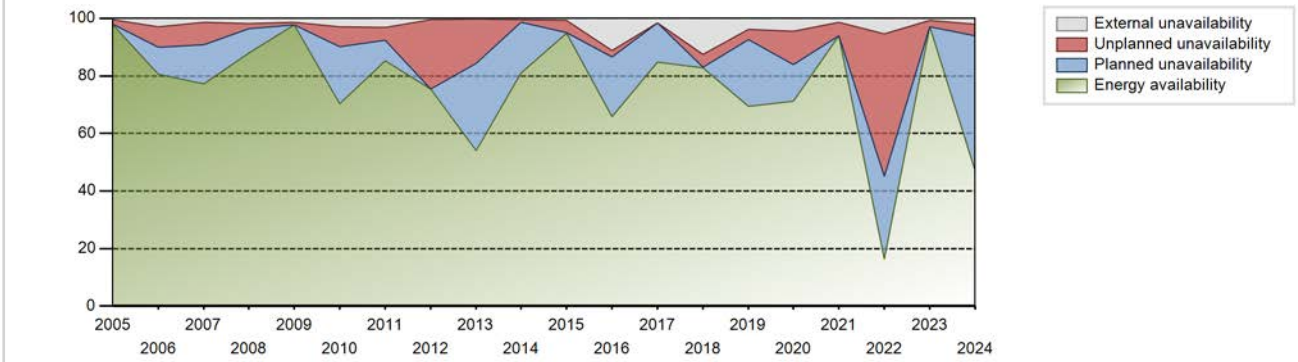
Electricity Production (net) [GWh]



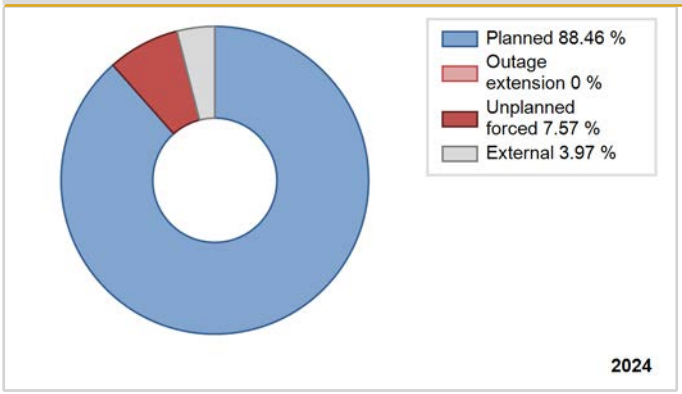
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1992	9355.95	7649	1300	85.83	88.01	81.93	87.08	0.88	0.78	11.21	2.18
1993	7736.44	6251	1300	77.98	79.09	67.94	71.36	6.27	5.29	15.62	1.11
1994	7828.78	6866	1300	80.42	81.90	68.75	78.38	2.35	1.97	16.13	1.48
1995	8942.43	7563	1300	82.80	85.53	78.53	86.34	3.24	2.87	11.60	2.73
1996	8897.57	7399	1300	81.35	82.59	77.92	84.23	5.41	4.73	12.69	1.24
1997	8690.54	7382	1300	79.28	82.61	76.31	84.27	1.84	1.55	15.84	3.33
1998	10000.14	8476	1300	94.49	96.06	87.81	96.76	2.40	2.37	1.58	1.56
1999	8131.93	7164	1300	80.77	82.85	71.41	81.78	5.31	4.65	12.50	2.08
2000	9139.01	7692	1300	85.08	86.59	80.03	87.57	0.18	0.15	13.25	1.51
2001	8593.18	7375	1300	84.84	86.55	75.46	84.19	0.30	0.26	13.19	1.71
2002	10598.80	8467	1300	95.10	95.29	93.07	96.66	0.33	0.31	4.40	0.19
2003	7708.34	6406	1300	69.75	72.09	67.69	73.13	1.34	0.98	26.93	2.34
2004	9311.78	7560	1300	84.51	85.02	81.54	86.07	1.40	1.21	13.77	0.51
2005	9913.85	8520	1300	97.83	98.32	87.06	97.26	1.66	1.66	0.02	0.49
2006	8719.60	7440	1300	80.57	83.51	76.57	84.93	0.60	7.05	9.44	2.95
2007	8562.21	6999	1300	77.13	78.42	75.19	79.90	1.59	7.80	13.78	1.29
2008	9538.78	7975	1300	87.89	89.83	83.53	90.79	0.71	1.70	8.48	1.93
2009	10010.11	8733	1300	97.73	99.13	87.90	99.69	0.85	0.85	0.02	1.39
2010	7502.23	6677	1300	70.36	73.24	65.88	76.22	2.52	7.05	19.71	2.87
2011	9152.84	7786	1300	85.24	88.38	80.37	88.88	0.70	4.37	7.25	3.15
2012	8090.85	6692	1300	75.41	76.00	70.85	76.18	23.98	23.98	0.02	0.59
2013	6000.78	4913	1300	53.96	54.34	52.69	56.08	8.92	15.38	30.29	0.38
2014	8851.37	7240	1300	81.05	81.55	77.73	82.65	0.46	0.82	17.63	0.50
2015	10400.59	8451	1300	94.92	95.61	91.33	96.47	4.36	4.36	0.03	0.69
2016	7204.81	6164	1300	65.79	77.06	63.09	70.17	2.82	2.24	20.70	11.27
2017	9354.28	7629	1300	84.84	86.39	82.14	87.09	0.16	0.14	13.47	1.55
2018	8932.66	7525	1300	82.90	95.41	78.44	85.90	4.52	4.52	0.06	12.51
2019	7428.66	6266	1300	69.53	73.44	65.23	71.53	3.00	3.43	23.13	3.91
2020	7676.68	6751	1300	71.29	75.68	67.23	76.86	11.78	11.70	12.62	4.39
2021	10695.07	8439	1300	93.92	95.33	93.92	96.34	4.58	4.58	0.09	1.41
2022	1865.96	1687	1300	16.38	21.84	16.39	19.26	69.37	49.46	28.70	5.46
2023	10334.09	8645	1300	97.07	97.83	90.75	98.69	2.11	2.11	0.06	0.76
2024	4657.99	4277	1300	46.85	48.95	40.79	48.69	7.60	4.02	47.02	2.11

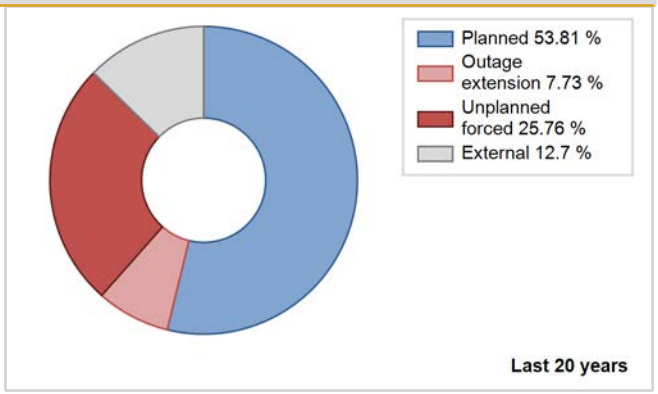
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1992 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		272			416	1
B.	Refuelling without maintenance				106		
C.	Inspection, maintenance or repair combined with refuelling	4057			932	20	
D.	Inspection, maintenance or repair without refuelling				38		
E.	Testing of plant systems or components				39		
I.	Grid capacity limitation						0
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			0			20
L.	Human factor related					13	8
M.	Governmental requirements or court decisions						0
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
O.	Load dispatching, prioritization			121			5
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					2	47
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			55			33
Z.	Other					6	1
Subtotal		4057	272	176	1115	457	116
Total		**4505**			**1688**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1992 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		9
13. Reactor Auxiliary Systems		10
14. Safety Systems		159
15. Reactor Cooling Systems		9
16. Steam generation systems		33
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		8
31. Turbine and auxiliaries		34
32. Feedwater and Main Steam System	196	25
33. Circulating Water System		2
34. Miscellaneous Systems		36
35. All other I&C Systems		4
41. Main Generator Systems	76	86
42. Electrical Power Supply Systems		16
Total	**272**	**434**

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2024 Operating Experience

FR-40 CHINON B-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP2
Thermal power	:	2785 MWth
Gross electrical power	:	954 MWe
Reference unit power (net)	:	905 MWe

Key Dates

Construction Date	:	1977-03-01
Grid Date	:	1982-11-30
Commercial Date	:	1984-02-01
Age at end of year	:	42 years

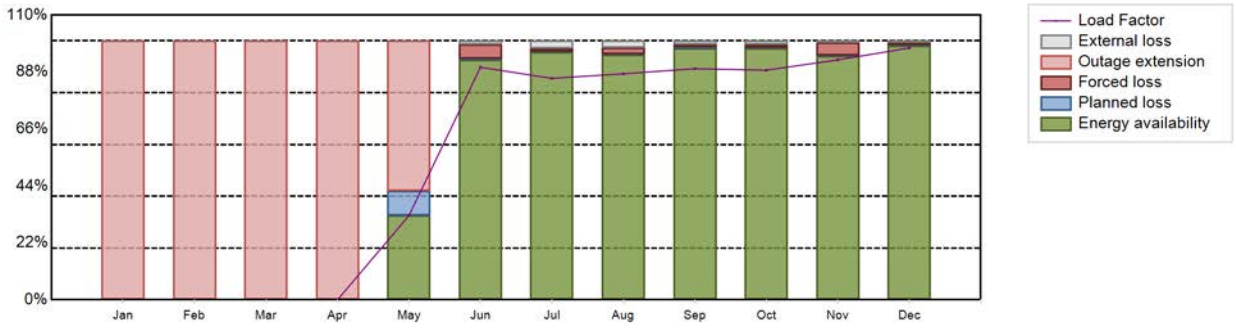
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.4
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	38	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4406.29 GW(e).h	Forced Loss Rate (FLR)	:	2.37 %
Energy Availability Factor (EAF)	:	58.69 %	Unplanned Capability Loss Factor (UCL)	:	39.41 %
Unit Capability Factor (UCF)	:	59.6 %	Planned Unavailability Factor (PUF)	:	0.99 %
Load Factor (LF)	:	55.43 %	Externally cause unavailability (XUF)	:	0.9 %
Operating Factor (OF)	:	61.77 %	Total off-line time	:	3358 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	0.00	0.00	218.80	585.32	575.97	587.94	581.68	597.98	603.89	654.72	4406.29
EAF [%]	0.00	0.00	0.00	0.00	32.50	92.57	95.68	94.55	97.22	97.18	94.15	98.15	58.69
UCF [%]	0.00	0.00	0.00	0.00	32.50	94.03	98.46	97.08	98.66	98.48	94.76	98.80	59.60
LF [%]	0.00	0.00	0.00	0.00	32.50	89.83	85.54	87.32	89.27	88.69	92.68	97.24	55.43
OF [%]	0.00	0.00	0.00	0.00	41.94	100.00	100.00	100.00	100.00	99.87	96.94	100.00	61.77
FLR [%]	0.00	0.00	0.00	0.00	0.00	5.51	1.27	2.55	0.99	1.38	4.90	0.91	2.37
UCL [%]	100.00	100.00	100.00	100.00	58.06	5.48	1.27	2.54	0.99	1.38	4.89	0.91	39.41
PUF [%]	0.00	0.00	0.00	0.00	9.44	0.49	0.26	0.38	0.35	0.14	0.35	0.29	0.99
XUF [%]	0.00	0.00	0.00	0.00	0.00	1.46	2.79	2.53	1.44	1.31	0.61	0.66	0.90

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Historical Summary

Lifetime energy generation	:	234090.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.92 %
Cumulative Energy Availability Factor (EAF)	:	74.39 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.92 %
Cumulative Unit Capability Factor (UCF)	:	76.65 %	Cumulative Planned Unavailability Factor (PUF)	:	15.43 %
Cumulative Load Factor (LF)	:	71.12 %	Cumulative Externally cause unavailability (XUF)	:	2.26 %
Cumulative Operating Factor (OF)	:	76.42 %			

Electricity Production (net) [GWh]

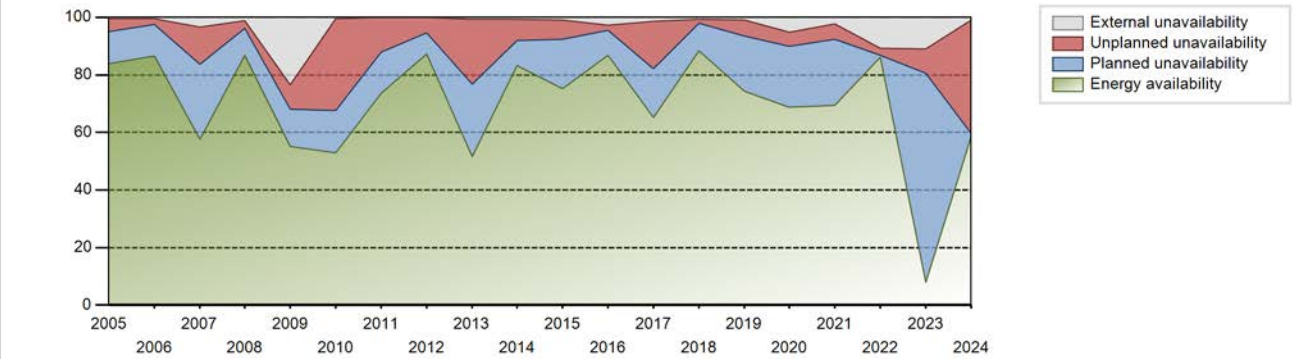


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	4568.00	5570	870	57.57	57.57	56.11	60.14	16.20	11.13	31.30	0.00
1985	5978.20	7402	870	82.12	84.46	78.44	84.50	2.46	2.13	13.41	2.34
1986	6322.20	7609	870	86.06	86.08	82.96	86.86	3.52	3.14	10.77	0.02
1987	4914.10	6438	870	72.92	73.65	64.48	73.49	16.21	14.25	12.10	0.73
1988	5271.00	7195	870	96.18	97.40	68.97	81.91	2.50	2.50	0.10	1.22
1989	4734.28	5724	870	63.62	64.41	62.12	65.34	19.35	15.45	20.14	0.78
1990	5912.97	7043	870	79.14	79.34	77.59	80.40	9.15	7.99	12.67	0.20
1991	5339.25	6033	905	67.66	67.96	67.35	68.87	20.43	17.45	14.60	0.30
1992	5972.02	7133	905	80.59	80.94	75.12	81.20	3.98	3.35	15.70	0.36
1993	5651.68	6914	905	73.26	77.71	71.29	78.93	10.64	9.25	13.05	4.45
1994	5366.30	6347	905	71.36	71.91	67.69	72.45	4.52	3.41	24.68	0.55
1995	6333.93	7573	905	84.39	85.60	79.90	86.45	4.43	3.97	10.44	1.21
1996	6295.23	7476	905	83.36	83.58	79.19	85.11	5.07	4.46	11.96	0.22
1997	6093.31	7268	905	81.84	81.94	76.86	82.97	1.47	1.22	16.84	0.10
1998	6631.27	7759	905	85.68	87.12	83.65	88.57	1.47	1.30	11.59	1.44
1999	6214.03	7483	905	82.06	84.31	78.38	85.42	5.73	5.12	10.57	2.25
2000	6166.79	7416	905	82.68	83.64	77.57	84.43	5.27	4.65	11.71	0.96
2001	5769.00	7260	905	81.16	82.61	72.77	82.88	1.95	1.65	15.75	1.45
2002	6229.34	7671	905	85.55	88.86	78.58	87.57	2.02	1.83	9.30	3.31
2003	5181.70	6357	905	68.36	71.01	65.36	72.57	4.62	3.44	25.55	2.65
2004	6252.57	7536	905	83.66	83.66	78.65	85.79	6.40	5.72	10.63	0.00
2005	6465.82	7611	905	83.93	84.49	81.55	86.87	2.05	4.40	11.11	0.56
2006	6637.84	7873	905	86.67	87.25	83.73	89.87	2.14	1.91	10.84	0.59
2007	4538.82	5559	905	57.66	61.04	57.25	63.46	15.66	12.83	26.13	3.38
2008	6893.10	7862	905	86.87	88.07	86.71	89.50	1.53	2.65	9.28	1.20
2009	4345.75	5003	905	55.12	78.46	54.82	57.11	1.51	8.58	12.95	23.34
2010	4165.79	4893	905	52.82	53.23	52.55	55.86	35.70	31.96	14.81	0.42
2011	5808.26	6601	905	73.65	73.66	73.26	75.35	2.27	12.09	14.26	0.01
2012	6881.62	7766	905	87.31	87.31	86.57	88.41	1.89	5.39	7.30	0.00
2013	4078.88	4634	905	51.55	52.27	51.45	52.90	6.40	22.45	25.29	0.71
2014	6524.18	7473	905	83.17	83.90	82.29	85.31	3.68	7.30	8.80	0.73
2015	5847.76	6812	905	75.28	76.17	73.76	77.76	5.56	6.73	17.10	0.89
2016	6754.06	7846	905	86.81	89.53	84.96	89.32	0.44	1.74	8.73	2.72
2017	5139.16	5867	905	65.25	66.72	64.82	66.97	5.36	16.47	16.81	1.48
2018	6888.18	7949	905	88.47	89.27	86.89	90.74	0.76	1.17	9.56	0.79
2019	5820.16	6750	905	74.38	75.25	73.41	77.05	2.81	5.65	19.11	0.87
2020	5253.27	6335	905	68.67	73.73	66.08	72.12	4.39	5.02	21.25	5.06

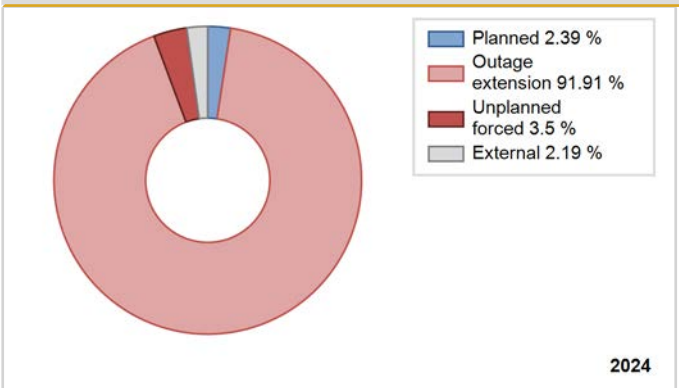
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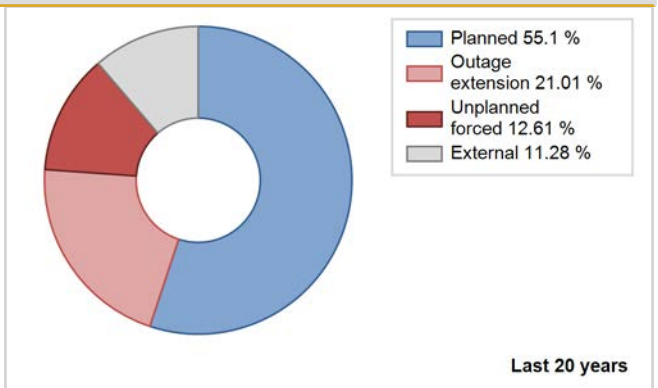
2021	5250.72	6240	905	69.43	71.70	66.23	71.23	0.55	5.25	23.06	2.27
2022	6467.62	8247	905	86.15	96.97	81.58	94.14	1.66	2.27	0.77	10.82
2023	628.22	889	905	7.93	18.88	7.92	10.15	0.00	8.49	72.63	10.96
2024	4406.29	5426	905	58.69	59.60	55.43	61.77	2.37	39.41	0.99	0.90

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		3359			571	
B. Refuelling without maintenance				150		
C. Inspection, maintenance or repair combined with refuelling				1133	42	
E. Testing of plant systems or components				5	1	
H. Nuclear regulatory requirements					3	
I. Grid capacity limitation						0
J. Grid limitation, failure or grid unavailability						4
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L. Human factor related					11	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			2			4
O. Load dispatching, prioritization						1
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					25	83
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					6	14
Z. Other					19	1
Subtotal		3359	2	1288	678	107
Total		**3361**			**2073**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		5
12. Reactor I&C Systems		8
13. Reactor Auxiliary Systems		24
14. Safety Systems		9
15. Reactor Cooling Systems		26
16. Steam generation systems		12
17. Safety I&C Systems (excluding reactor I&C)		2
21. Fuel Handling and Storage Facilities		12
31. Turbine and auxiliaries	22	116
32. Feedwater and Main Steam System		17
33. Circulating Water System	2	2
34. Miscellaneous Systems	3335	199
35. All other I&C Systems		4
41. Main Generator Systems		98
42. Electrical Power Supply Systems		27
Total	**3359**	**561**

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2024 Operating Experience

FR-41 CHINON B-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP2
Thermal power	:	2785 MWth
Gross electrical power	:	954 MWe
Reference unit power (net)	:	905 MWe

Key Dates

Construction Date	:	1977-03-01
Grid Date	:	1983-11-29
Commercial Date	:	1984-08-01
Age at end of year	:	41 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	38
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

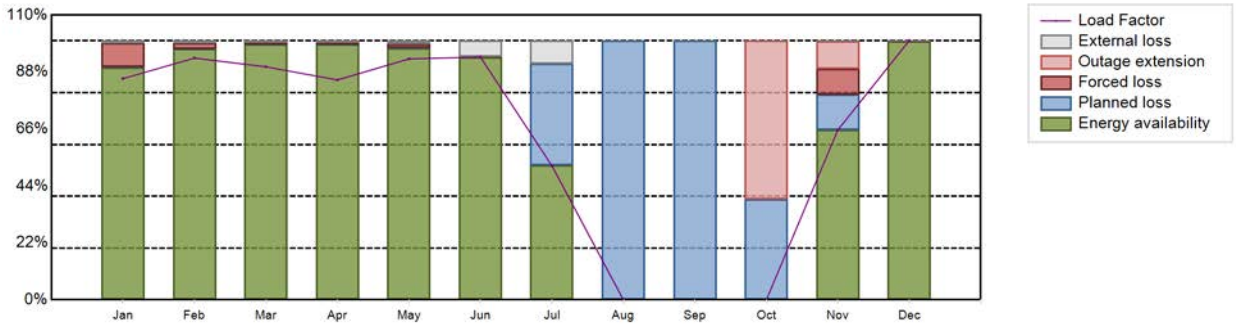
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5009.92 GW(e).h
Energy Availability Factor (EAF)	:	65.83 %
Unit Capability Factor (UCF)	:	67.44 %
Load Factor (LF)	:	63.02 %
Operating Factor (OF)	:	70.41 %

Forced Loss Rate (FLR)	:	2.92 %
Unplanned Capability Loss Factor (UCL)	:	8.08 %
Planned Unavailability Factor (PUF)	:	24.48 %
Externally cause unavailability (XUF)	:	1.61 %
Total off-line time	:	2599 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	575.20	588.13	605.08	553.39	626.47	610.99	348.65	0.00	0.00	0.00	427.58	674.44	5009.92
EAF [%]	89.62	96.82	98.52	98.55	97.13	93.72	52.06	0.00	0.00	0.00	65.63	99.85	65.83
UCF [%]	90.43	97.59	99.13	99.29	98.27	99.84	60.96	0.00	0.00	0.00	65.79	99.88	67.44
LF [%]	85.43	93.37	89.99	84.93	93.04	93.77	51.78	0.00	0.00	0.00	65.62	100.17	63.02
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	61.42	0.00	0.00	0.00	85.69	100.00	70.41
FLR [%]	9.38	2.32	0.68	0.58	1.57	0.08	0.00	0.00	0.00	0.00	12.96	0.01	2.92
UCL [%]	9.36	2.32	0.68	0.58	1.57	0.08	0.00	0.00	0.00	61.07	20.53	0.01	8.08
PUF [%]	0.22	0.09	0.19	0.13	0.16	0.08	39.04	100.00	100.00	38.93	13.68	0.11	24.48
XUF [%]	0.81	0.77	0.61	0.73	1.14	6.12	8.90	0.00	0.00	0.00	0.16	0.03	1.61

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Historical Summary

Lifetime energy generation	:	232559.41 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.21 %
Cumulative Energy Availability Factor (EAF)	:	76.06 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.81 %
Cumulative Unit Capability Factor (UCF)	:	78.2 %	Cumulative Planned Unavailability Factor (PUF)	:	13.99 %
Cumulative Load Factor (LF)	:	72.18 %	Cumulative Externally cause unavailability (XUF)	:	2.14 %
Cumulative Operating Factor (OF)	:	77.55 %			

Electricity Production (net) [GWh]

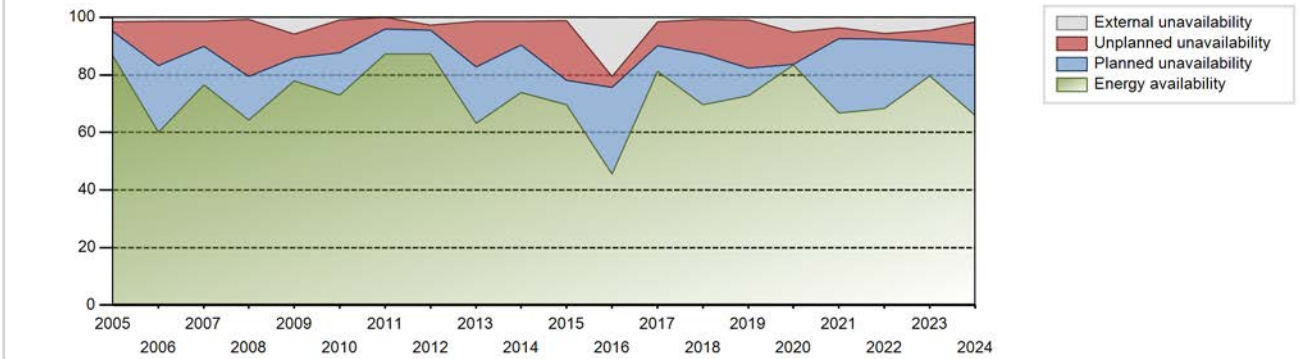


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	5394.00	7226	870	91.69	91.69	75.83	81.27	8.31	8.31	0.00	0.00
1985	5037.40	6201	870	67.88	69.30	66.10	70.79	4.44	3.22	27.48	1.42
1986	6215.10	7639	870	86.02	86.42	81.55	87.20	3.85	3.46	10.11	0.40
1987	5618.80	7171	870	80.73	81.14	73.73	81.86	9.38	8.40	10.46	0.41
1988	4425.00	5731	870	67.26	68.40	57.90	65.24	23.79	21.36	10.25	1.14
1989	6043.40	7873	870	91.22	94.36	79.30	89.87	1.27	1.21	4.43	3.15
1990	5216.99	6714	870	84.12	84.42	68.45	76.64	7.80	7.14	8.44	0.30
1991	3142.20	3921	870	53.19	55.79	41.23	44.76	29.04	22.83	21.38	2.59
1992	6295.44	7321	870	80.76	81.98	82.38	83.34	2.05	1.72	16.30	1.23
1993	5491.59	6867	870	76.25	81.41	72.06	78.39	6.53	5.68	12.90	5.17
1994	6174.63	7407	905	83.94	84.73	77.89	84.55	4.32	3.82	11.45	0.79
1995	6356.32	7741	905	85.98	86.08	80.18	88.37	3.28	2.92	11.01	0.09
1996	5287.61	6206	905	69.38	69.62	66.51	70.65	7.32	5.49	24.89	0.24
1997	6637.94	7622	905	85.20	86.50	83.73	87.01	1.86	1.64	11.86	1.30
1998	6186.39	7136	905	79.85	80.36	78.03	81.46	7.20	6.24	13.40	0.51
1999	5900.93	7075	905	78.96	79.10	74.43	80.76	10.24	9.03	11.87	0.15
2000	6177.00	7260	905	80.81	81.16	77.70	82.65	5.21	4.46	14.37	0.35
2001	6646.20	7846	905	87.52	88.49	83.83	89.57	2.09	1.89	9.63	0.97
2002	6155.60	7404	905	85.35	86.22	77.65	84.52	0.87	0.76	13.02	0.86
2003	5746.23	7163	905	78.72	81.28	72.48	81.77	9.09	8.13	10.59	2.56
2004	6133.37	7252	905	80.62	80.94	77.15	82.56	6.56	5.68	13.38	0.31
2005	6659.58	7882	905	86.50	88.00	84.00	89.98	1.73	3.38	8.62	1.50
2006	4548.84	5503	905	60.11	61.45	57.38	62.82	12.98	15.37	23.19	1.34
2007	5965.94	7023	905	76.58	77.85	75.25	80.17	4.21	8.74	13.41	1.27
2008	5038.27	5852	905	64.24	64.95	63.38	66.62	2.43	19.75	15.30	0.71
2009	6111.50	7485	905	77.93	83.83	77.09	85.45	3.97	8.11	8.05	5.90
2010	5735.14	6561	905	72.95	73.96	72.34	74.90	3.67	11.20	14.85	1.01
2011	6863.39	7733	905	87.23	87.30	86.57	88.28	1.00	3.94	8.77	0.07
2012	6880.86	7965	905	87.34	90.04	86.56	90.68	2.01	1.85	8.11	2.69
2013	4538.32	5483	905	63.15	64.52	57.25	62.59	2.30	15.85	19.63	1.37
2014	5721.41	6565	905	73.83	75.14	72.17	74.94	3.86	8.28	16.58	1.31
2015	5495.29	6235	905	69.57	70.62	69.32	71.18	22.10	20.79	8.59	1.06
2016	3614.86	4251	905	45.53	65.98	45.47	48.39	0.50	3.78	30.24	20.45
2017	6249.36	7345	905	81.21	82.73	78.83	83.85	3.64	8.43	8.84	1.52
2018	5352.55	6303	905	69.60	70.32	67.52	71.95	0.69	12.09	17.59	0.73
2019	5716.24	6607	905	72.70	73.62	72.10	75.42	13.61	16.80	9.59	0.91
2020	6431.85	7452	905	83.51	88.72	80.91	84.84	11.15	11.13	0.15	5.21

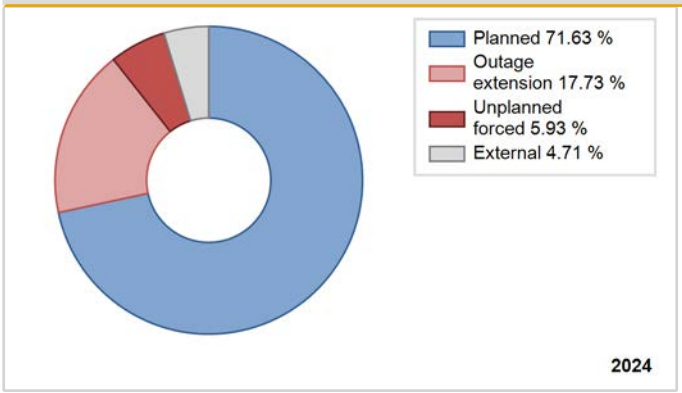
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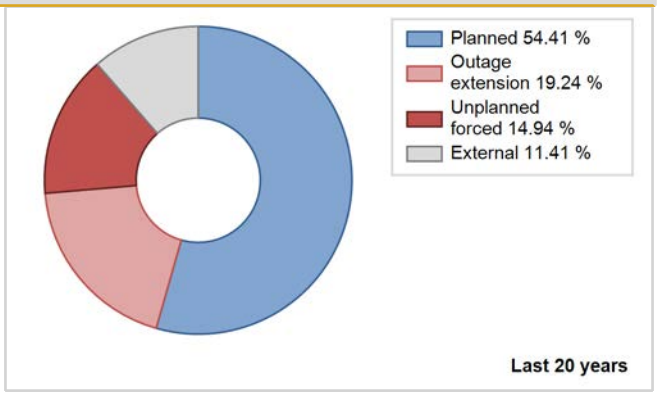
2021	4938.64	6083	905	66.64	70.25	62.30	69.44	2.89	3.68	26.07	3.62
2022	5078.62	6285	905	68.32	73.94	64.06	71.75	1.31	1.97	24.09	5.62
2023	6100.43	7436	905	79.58	84.12	76.95	84.89	0.85	4.04	11.83	4.55
2024	5009.92	6185	905	65.83	67.44	63.02	70.41	2.92	8.08	24.48	1.61

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		558			550	
B. Refuelling without maintenance				156		
C. Inspection, maintenance or repair combined with refuelling	2041			1001	7	
D. Inspection, maintenance or repair without refuelling				2		
E. Testing of plant systems or components				11	1	
H. Nuclear regulatory requirements					13	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						33
L. Human factor related					15	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
O. Load dispatching, prioritization						1
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					4	58
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			0		8	19
Z. Other					17	2
Subtotal	2041	558	0	1170	615	115
Total	**2599**			**1900**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		13
12. Reactor I&C Systems		16
13. Reactor Auxiliary Systems		29
14. Safety Systems		27
15. Reactor Cooling Systems		39
16. Steam generation systems		86
17. Safety I&C Systems (excluding reactor I&C)		5
21. Fuel Handling and Storage Facilities		18
31. Turbine and auxiliaries	26	57
32. Feedwater and Main Steam System		22
33. Circulating Water System		3
34. Miscellaneous Systems	532	129
35. All other I&C Systems		2
41. Main Generator Systems		102
42. Electrical Power Supply Systems		39
Total	**558**	**587**

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2024 Operating Experience

FR-56 CHINON B-3 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP2
Thermal power	:	2785 MWth
Gross electrical power	:	954 MWe
Reference unit power (net)	:	905 MWe

Key Dates

Construction Date	:	1980-10-01
Grid Date	:	1986-10-20
Commercial Date	:	1987-03-04
Age at end of year	:	38 years

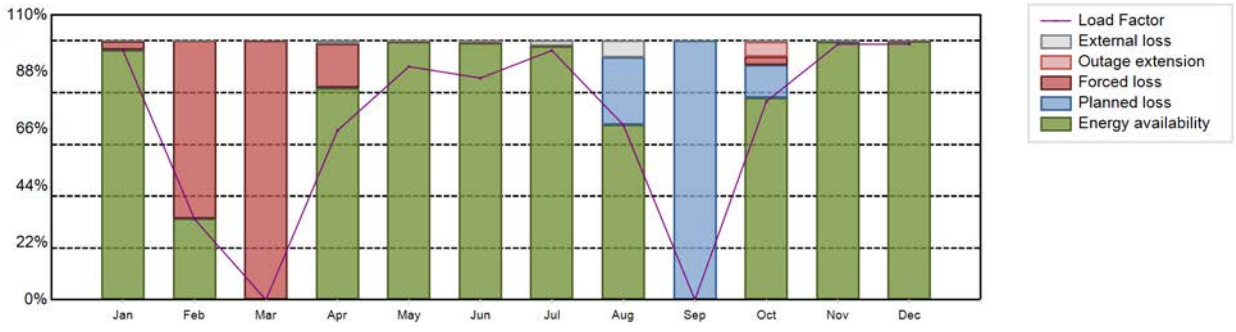
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	38
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5363.61 GW(e).h
Energy Availability Factor (EAF)	:	71.18 %
Unit Capability Factor (UCF)	:	72.1 %
Load Factor (LF)	:	67.47 %
Operating Factor (OF)	:	71.97 %
Forced Loss Rate (FLR)	:	18.02 %
Unplanned Capability Loss Factor (UCL)	:	16.34 %
Planned Unavailability Factor (PUF)	:	11.56 %
Externally cause unavailability (XUF)	:	0.92 %
Total off-line time	:	2462 hours

Annual Summary



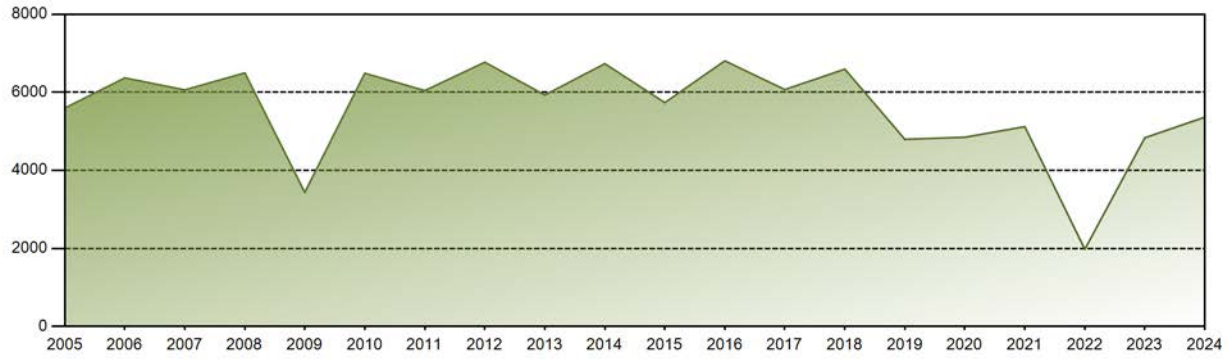
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	648.76	196.50	0.00	426.08	606.51	558.07	648.46	454.63	0.00	516.45	643.12	665.05	5363.61
EAF [%]	96.47	31.33	0.00	81.84	99.55	99.12	97.99	67.52	0.00	77.93	99.67	99.90	71.18
UCF [%]	96.53	31.34	0.00	82.96	99.89	99.75	99.90	73.87	0.00	78.25	99.87	99.93	72.10
LF [%]	96.35	31.20	0.00	65.39	90.08	85.65	96.31	67.52	0.00	76.60	98.70	98.77	67.47
OF [%]	99.60	31.47	0.00	72.78	100.00	94.58	100.00	74.33	0.00	87.52	100.00	100.00	71.97
FLR [%]	3.40	68.65	100.00	16.91	0.03	0.06	0.02	0.00	0.00	3.93	0.00	0.00	18.02
UCL [%]	3.39	68.61	100.00	16.89	0.03	0.06	0.02	0.00	0.00	8.95	0.00	0.00	16.34
PUF [%]	0.07	0.05	0.00	0.15	0.08	0.18	0.08	26.13	100.00	12.80	0.13	0.07	11.56
XUF [%]	0.06	0.00	0.00	1.12	0.35	0.63	1.91	6.35	0.00	0.32	0.19	0.02	0.92

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Historical Summary

Lifetime energy generation	:	216017.56 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.84 %
Cumulative Energy Availability Factor (EAF)	:	75.65 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	9.43 %
Cumulative Unit Capability Factor (UCF)	:	77.3 %	Cumulative Planned Unavailability Factor (PUF)	:	13.27 %
Cumulative Load Factor (LF)	:	71.7 %	Cumulative Externally cause unavailability (XUF)	:	1.65 %
Cumulative Operating Factor (OF)	:	77.44 %			

Electricity Production (net) [GWh]

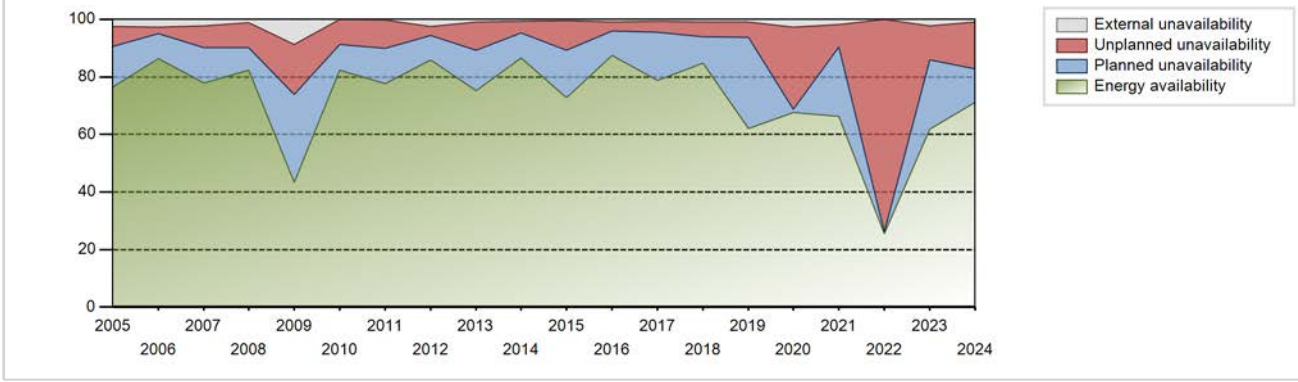


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	4120.60	5311	870	67.61	67.61	52.00	59.68	24.66	22.13	10.26	0.00
1988	4413.00	5354	905	58.90	61.48	55.51	60.95	21.77	17.11	21.41	2.58
1989	5028.58	6125	905	77.81	81.19	63.43	69.92	6.64	5.77	13.04	3.38
1990	5417.63	6274	905	69.12	69.18	68.34	71.62	16.51	13.68	17.15	0.06
1991	7026.39	8204	905	90.66	92.91	88.63	93.65	4.00	3.87	3.22	2.25
1992	6091.45	7468	905	85.62	87.48	76.63	85.02	2.98	2.69	9.83	1.86
1993	5600.75	6827	905	72.61	78.35	70.65	77.93	3.69	3.00	18.65	5.74
1994	5064.02	6325	905	75.45	76.21	63.88	72.20	15.56	14.04	9.75	0.76
1995	6005.65	7177	905	82.54	83.34	75.75	81.93	7.56	6.82	9.84	0.81
1996	6277.96	7761	905	86.86	87.18	78.97	88.35	1.56	1.38	11.44	0.31
1997	5816.77	7249	905	85.07	85.10	73.37	82.75	0.96	0.82	14.08	0.03
1998	6345.64	7472	905	81.32	84.10	80.04	85.30	0.65	0.55	15.35	2.77
1999	5601.97	6656	905	72.19	74.80	70.66	75.98	4.22	3.30	21.90	2.62
2000	6330.11	7386	905	82.52	83.12	79.63	84.08	3.89	3.36	13.52	0.60
2001	6318.00	7665	905	84.76	87.05	79.69	87.50	1.29	1.14	11.82	2.29
2002	6720.45	7971	905	87.57	90.03	84.77	90.99	0.43	0.39	9.58	2.46
2003	5807.75	6954	905	77.57	77.72	73.26	79.38	11.07	9.68	12.60	0.15
2004	5784.36	7444	905	82.34	82.47	72.76	84.74	7.64	6.82	10.70	0.14
2005	5595.37	7287	905	76.52	79.10	70.58	83.18	7.97	6.85	14.05	2.58
2006	6369.75	7930	905	86.29	89.00	80.35	90.53	1.62	2.28	8.72	2.71
2007	6061.29	7310	905	77.89	80.19	76.46	83.45	4.04	7.56	12.25	2.30
2008	6498.11	7760	905	82.30	83.51	81.74	88.34	5.36	8.73	7.76	1.21
2009	3433.46	4114	905	43.40	52.08	43.31	46.96	7.88	17.47	30.45	8.68
2010	6488.82	7485	905	82.45	82.48	81.85	85.45	4.78	8.66	8.87	0.03
2011	6043.83	6906	905	77.58	77.78	76.24	78.84	2.04	9.83	12.40	0.20
2012	6770.53	7662	905	85.87	88.39	85.17	87.23	1.65	3.15	8.46	2.52
2013	5930.23	6823	905	75.27	76.20	74.80	77.89	3.07	9.76	14.04	0.93
2014	6733.16	7711	905	86.59	87.34	84.93	88.03	2.77	3.91	8.75	0.75
2015	5735.52	6515	905	72.75	73.26	72.35	74.37	0.72	10.27	16.47	0.51
2016	6806.55	7949	905	87.43	88.25	85.62	90.49	1.28	3.19	8.56	0.82
2017	6070.41	7079	905	78.88	79.62	76.57	80.81	0.51	3.70	16.68	0.74
2018	6593.67	7668	905	84.70	85.60	83.17	87.53	3.35	5.09	9.31	0.90
2019	4795.66	5526	905	62.11	63.02	60.49	63.08	2.45	5.42	31.56	0.91
2020	4848.50	6046	905	67.64	70.39	60.99	68.83	4.58	28.44	1.17	2.75
2021	5119.31	6022	905	66.21	67.93	64.57	68.74	1.00	7.87	24.20	1.72
2022	1976.92	2323	905	25.54	25.62	24.94	26.52	74.23	73.79	0.60	0.08
2023	4835.37	5722	905	61.94	64.19	60.99	65.32	4.70	11.90	23.91	2.25

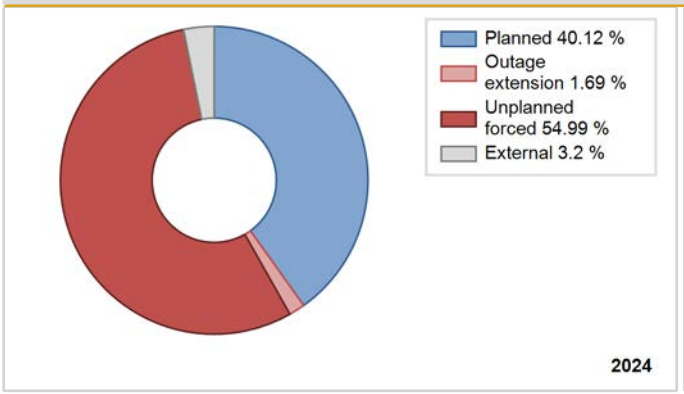
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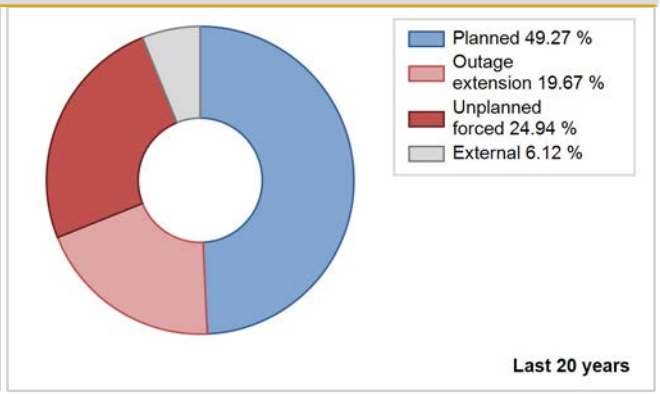
2024	5363.61	6322	905	71.18	72.10	67.47	71.97	18.02	16.34	11.56	0.92

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1987 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		1387			637	
B.	Refuelling without maintenance	960			138		
C.	Inspection, maintenance or repair combined with refuelling				937	20	
D.	Inspection, maintenance or repair without refuelling				24		
E.	Testing of plant systems or components				22	1	
H.	Nuclear regulatory requirements					11	
J.	Grid limitation, failure or grid unavailability						3
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L.	Human factor related					13	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			1			0
O.	Load dispatching, prioritization			115			4
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					2	26
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					7	4
Z.	Other					39	1
Subtotal		960	1387	116	1121	730	38
Total			**2463**			**1889**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		22
12. Reactor I&C Systems	0	9
13. Reactor Auxiliary Systems		31
14. Safety Systems		172
15. Reactor Cooling Systems		21
16. Steam generation systems		22
21. Fuel Handling and Storage Facilities		19
31. Turbine and auxiliaries	0	65
32. Feedwater and Main Steam System	3	29
33. Circulating Water System		3
34. Miscellaneous Systems	43	174
35. All other I&C Systems		1
41. Main Generator Systems		27
42. Electrical Power Supply Systems	1340	42
Total	**1386**	**637**

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2024 Operating Experience

FR-57 CHINON B-4 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP2
Thermal power	:	2785 MWth
Gross electrical power	:	954 MWe
Reference unit power (net)	:	905 MWe

Key Dates

Construction Date	:	1981-02-01
Grid Date	:	1987-11-14
Commercial Date	:	1988-04-01
Age at end of year	:	37 years

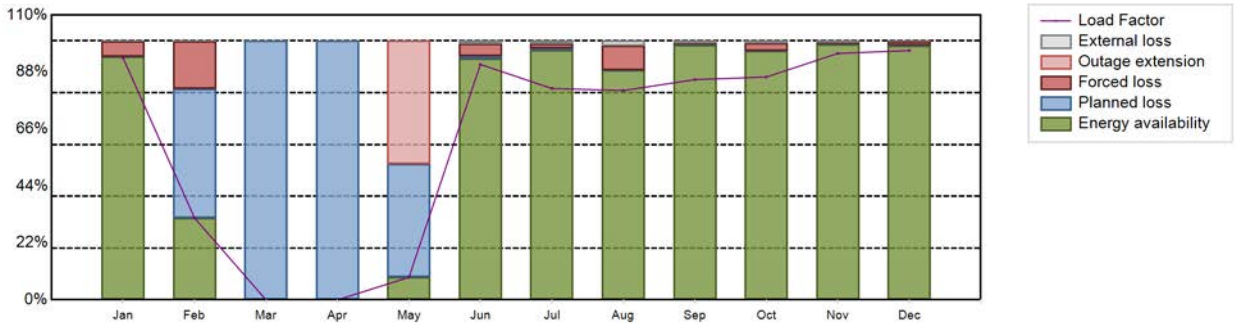
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.4
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	38	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4976.72 GW(e).h	Forced Loss Rate (FLR)	:	5.24 %
Energy Availability Factor (EAF)	:	67.13 %	Unplanned Capability Loss Factor (UCL)	:	7.77 %
Unit Capability Factor (UCF)	:	67.71 %	Planned Unavailability Factor (PUF)	:	24.52 %
Load Factor (LF)	:	62.6 %	Externally cause unavailability (XUF)	:	0.59 %
Operating Factor (OF)	:	69.85 %	Total off-line time	:	2648 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	629.57	199.49	0.00	0.00	58.52	592.34	549.67	544.31	554.14	580.28	620.13	648.27	4976.72
EAF [%]	93.81	31.68	0.00	0.00	8.69	93.25	96.41	88.72	98.39	96.05	98.57	98.24	67.13
UCF [%]	94.05	31.76	0.00	0.00	8.69	94.44	97.50	90.63	99.22	96.86	99.22	98.45	67.71
LF [%]	93.50	31.67	0.00	0.00	8.69	90.91	81.64	80.84	85.04	86.07	95.17	96.28	62.60
OF [%]	96.64	32.18	0.00	0.00	16.26	100.00	100.00	91.40	100.00	99.87	100.00	100.00	69.85
FLR [%]	5.78	36.63	0.00	0.00	0.00	4.79	1.85	9.30	0.58	2.99	0.58	1.43	5.24
UCL [%]	5.77	18.36	0.00	0.00	47.46	4.76	1.84	9.29	0.58	2.99	0.58	1.42	7.77
PUF [%]	0.17	49.88	100.00	100.00	43.84	0.80	0.66	0.07	0.20	0.16	0.20	0.13	24.52
XUF [%]	0.24	0.08	0.00	0.00	0.00	1.19	1.09	1.91	0.83	0.80	0.65	0.21	0.59

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Historical Summary

Lifetime energy generation	:	217845.96 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.58 %
Cumulative Energy Availability Factor (EAF)	:	78.09 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.09 %
Cumulative Unit Capability Factor (UCF)	:	80.31 %	Cumulative Planned Unavailability Factor (PUF)	:	13.6 %
Cumulative Load Factor (LF)	:	74.32 %	Cumulative Externally cause unavailability (XUF)	:	2.22 %
Cumulative Operating Factor (OF)	:	80.2 %			

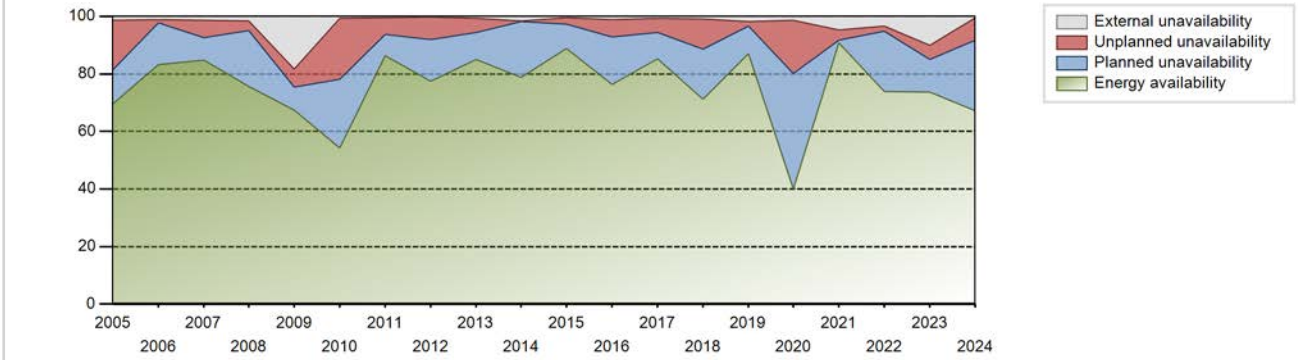
Electricity Production (net) [GWh]



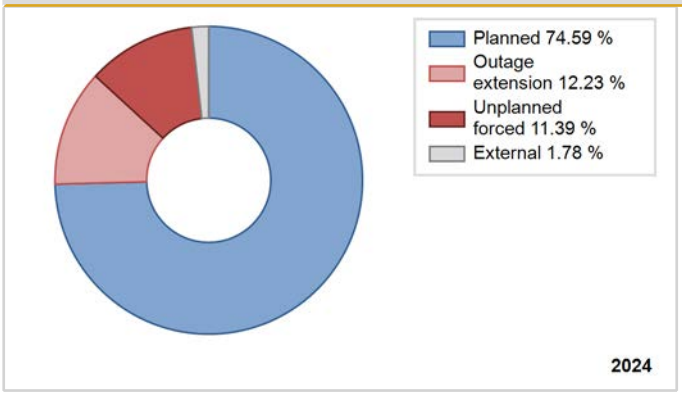
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	4410.00	5897	905	86.17	89.04	56.36	67.79	10.96	10.96	0.00	2.86
1989	4688.12	5664	905	60.39	63.58	59.14	64.66	13.81	10.18	26.24	3.19
1990	6098.01	7003	905	77.01	77.22	76.92	79.94	11.20	9.74	13.04	0.21
1991	6339.97	7204	905	79.24	79.96	79.97	82.24	7.12	6.13	13.91	0.71
1992	6387.95	7544	905	82.80	85.03	80.36	85.88	0.66	0.56	14.40	2.23
1993	6016.91	7359	905	80.12	85.77	75.90	84.01	3.60	3.20	11.03	5.65
1994	5935.09	7196	905	81.25	82.44	74.86	82.15	2.73	2.31	15.25	1.19
1995	6566.02	7805	905	87.88	88.17	82.82	89.10	1.73	1.55	10.28	0.29
1996	6574.24	7764	905	87.03	87.64	82.70	88.39	1.90	1.70	10.66	0.61
1997	6345.37	7795	905	85.64	88.73	80.04	88.98	1.09	0.98	10.29	3.09
1998	5940.13	7326	905	80.18	83.14	74.93	83.63	2.98	2.56	14.31	2.96
1999	5596.27	7059	905	88.17	89.89	70.59	80.58	9.99	9.98	0.13	1.72
2000	5110.70	6445	905	72.91	74.09	64.29	73.37	5.72	4.49	21.42	1.18
2001	5764.99	7078	905	79.91	81.33	72.72	80.80	10.39	9.43	9.24	1.42
2002	6321.31	7584	905	84.03	85.53	79.74	86.58	2.58	2.27	12.20	1.50
2003	6431.76	7811	905	86.62	87.71	81.13	89.17	3.61	3.29	9.00	1.10
2004	5513.22	6883	905	74.88	75.12	69.35	78.36	13.19	11.41	13.47	0.24
2005	5356.45	7030	905	69.72	71.15	67.57	80.25	19.49	17.23	11.63	1.43
2006	6368.95	7558	905	83.27	84.36	80.34	86.28	0.89	1.15	14.48	1.09
2007	6485.73	7691	905	84.82	86.11	81.81	87.80	2.22	6.15	7.74	1.29
2008	5863.53	6881	905	75.65	77.15	73.76	78.34	0.74	3.33	19.52	1.50
2009	5250.85	6232	905	67.43	85.76	66.23	71.14	4.16	6.30	7.94	18.33
2010	4302.57	4902	905	54.34	54.98	54.27	55.96	1.78	21.24	23.78	0.64
2011	6790.85	7868	905	86.40	86.81	85.66	89.82	3.56	5.85	7.34	0.42
2012	6125.00	6958	905	77.51	77.81	77.05	79.21	1.15	7.80	14.38	0.31
2013	6660.90	7573	905	84.94	85.68	84.02	86.45	1.50	4.93	9.39	0.74
2014	6071.89	7092	905	78.89	80.42	76.59	80.96	0.30	0.24	19.34	1.53
2015	6944.68	7944	905	88.88	89.44	87.60	90.68	2.37	2.18	8.38	0.56
2016	6037.90	7119	905	76.24	77.46	75.95	81.05	0.45	5.88	16.66	1.22
2017	6630.00	7624	905	85.17	85.78	83.63	87.03	4.57	4.90	9.31	0.61
2018	5530.08	6388	905	71.13	72.10	69.76	72.92	2.86	10.34	17.56	0.97
2019	6839.72	7843	905	86.97	88.70	86.28	89.53	0.94	1.64	9.67	1.72
2020	3089.77	3583	905	40.03	41.33	38.87	40.79	0.21	18.66	40.01	1.29
2021	6917.88	8441	905	90.91	95.72	87.26	96.36	3.45	3.42	0.86	4.81
2022	5732.97	6868	905	73.98	77.25	72.31	78.40	2.37	1.88	20.87	3.27
2023	5727.02	6665	905	73.68	83.72	72.24	76.08	4.57	4.91	11.37	10.04
2024	4976.72	6136	905	67.13	67.71	62.60	69.85	5.24	7.77	24.52	0.59

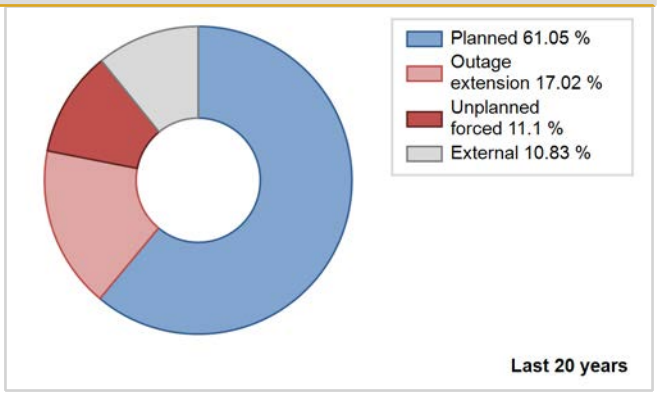
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		558			379	
B.	Refuelling without maintenance				155		
C.	Inspection, maintenance or repair combined with refuelling	2074			961	11	
E.	Testing of plant systems or components	6			22		
H.	Nuclear regulatory requirements					1	
J.	Grid limitation, failure or grid unavailability						0
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						3
L.	Human factor related					4	
M.	Governmental requirements or court decisions						1
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
O.	Load dispatching, prioritization			9			0
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					5	65
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					7	6
Z.	Other					32	14
Subtotal		2080	558	9	1138	439	90
Total		**2647**			**1667**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1988 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		43
12. Reactor I&C Systems		16
13. Reactor Auxiliary Systems		25
14. Safety Systems		10
15. Reactor Cooling Systems		36
16. Steam generation systems		9
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		13
31. Turbine and auxiliaries		36
32. Feedwater and Main Steam System	55	12
33. Circulating Water System		3
34. Miscellaneous Systems	353	111
35. All other I&C Systems		1
41. Main Generator Systems	25	26
42. Electrical Power Supply Systems	125	32
Total	**558**	**374**

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2024 Operating Experience

FR-62 CHOOZ B-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	FRAM (FRAMATOME)

Reactor Unit Details

Reactor type and model	:	PWR / N4 REP 1450
Thermal power	:	4270 MWth
Gross electrical power	:	1560 MWe
Reference unit power (net)	:	1500 MWe

Key Dates

Construction Date	:	1984-01-01
Grid Date	:	1996-08-30
Commercial Date	:	2000-05-15
Age at end of year	:	28 years

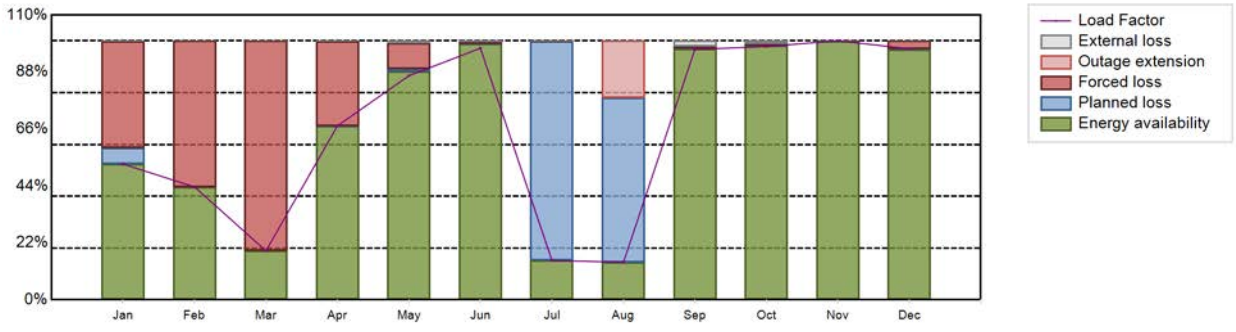
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	39000
Active core diameter [m]	:	3.47
Active core height/length [m]	:	4.267
Number of fissile fuel assemblies/bundles	:	205
Fuel linear heat generation rate [kW/m]	:	17.92
Number of control rod assemblies	:	25
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	329.5
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	4.3
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	7.1
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8625.5 GW(e).h
Energy Availability Factor (EAF)	:	65.76 %
Unit Capability Factor (UCF)	:	66.16 %
Load Factor (LF)	:	65.46 %
Operating Factor (OF)	:	74.97 %
Forced Loss Rate (FLR)	:	22.12 %
Unplanned Capability Loss Factor (UCL)	:	20.66 %
Planned Unavailability Factor (PUF)	:	13.18 %
Externally cause unavailability (XUF)	:	0.4 %
Total off-line time	:	2199 hours

Annual Summary



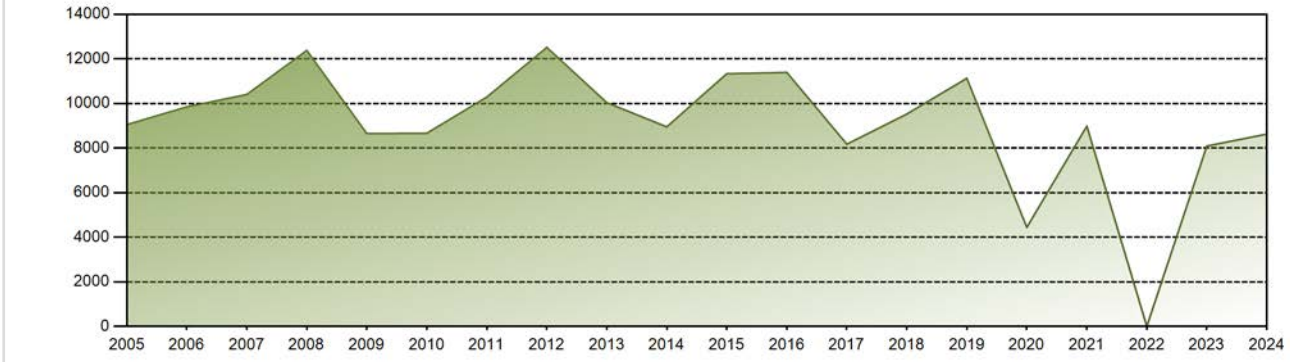
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	585.24	455.59	210.98	725.86	966.00	1049.50	170.15	161.86	1044.47	1093.16	1080.78	1081.92	8625.50
EAF [%]	52.58	43.64	18.94	67.18	88.27	98.77	15.31	14.50	96.85	98.17	99.82	96.75	65.76
UCF [%]	52.67	43.64	18.94	67.31	89.16	99.23	15.42	14.50	98.85	99.35	99.82	96.75	66.16
LF [%]	52.44	43.64	18.93	67.21	86.56	97.18	15.25	14.50	96.71	97.82	100.07	96.95	65.46
OF [%]	82.80	100.00	25.30	71.39	91.26	100.00	15.86	16.94	100.00	99.87	100.00	100.00	74.97
FLR [%]	43.85	56.36	81.06	32.68	10.06	0.66	0.77	0.00	0.79	0.62	0.15	3.19	22.12
UCL [%]	41.14	56.36	81.06	32.68	9.98	0.66	0.12	21.99	0.79	0.62	0.15	3.19	20.66
PUF [%]	6.19	0.00	0.00	0.01	0.86	0.11	84.46	63.51	0.36	0.03	0.03	0.06	13.18
XUF [%]	0.09	0.00	0.00	0.12	0.88	0.46	0.11	0.00	2.00	1.18	0.00	0.00	0.40

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Historical Summary

Lifetime energy generation	:	241998.76 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.29 %
Cumulative Energy Availability Factor (EAF)	:	73.36 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	9.73 %
Cumulative Unit Capability Factor (UCF)	:	76.8 %	Cumulative Planned Unavailability Factor (PUF)	:	13.47 %
Cumulative Load Factor (LF)	:	71.32 %	Cumulative Externally cause unavailability (XUF)	:	3.44 %
Cumulative Operating Factor (OF)	:	75.1 %			

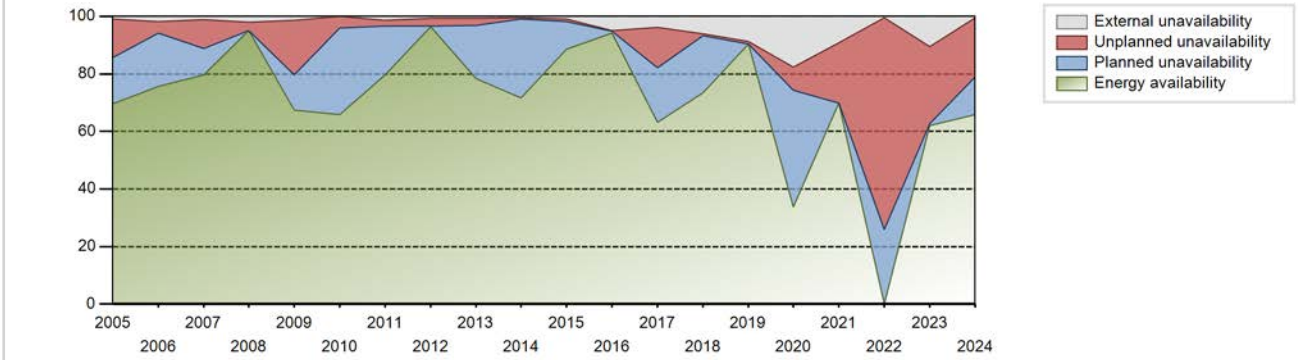
Electricity Production (net) [GWh]



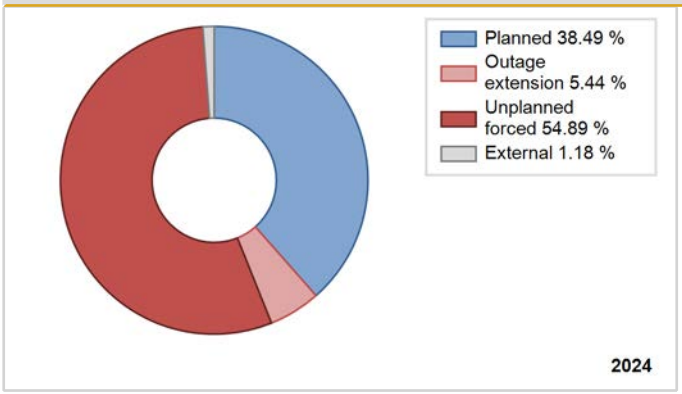
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2000	8429.16	5877	1455	96.94	96.94	98.43	97.13	1.64	1.62	1.43	0.00
2001	9524.35	6800	1455	75.00	78.03	74.73	77.63	6.98	5.85	16.11	3.03
2002	9515.08	6807	1455	80.96	82.39	74.65	77.71	0.08	0.07	17.54	1.43
2003	10021.89	7219	1500	85.61	89.41	76.27	82.41	0.76	0.68	9.91	3.79
2004	10671.09	7657	1500	83.59	86.67	80.99	87.17	4.38	3.97	9.36	3.08
2005	9047.67	6285	1500	69.59	70.47	68.85	71.74	14.26	13.36	16.17	0.88
2006	9845.73	6885	1500	75.64	77.56	74.93	78.60	2.14	3.95	18.49	1.92
2007	10402.28	7154	1500	79.60	80.70	79.16	81.67	0.33	10.12	9.18	1.10
2008	12376.75	8572	1500	95.03	97.01	93.93	97.59	2.98	2.98	0.01	1.98
2009	8649.52	6307	1500	67.49	68.96	65.83	72.00	5.83	18.93	12.11	1.47
2010	8663.04	5962	1500	65.89	65.98	65.93	68.06	3.16	3.94	30.09	0.09
2011	10285.74	7044	1500	79.66	81.08	78.28	80.41	0.75	2.02	16.90	1.43
2012	12512.93	8496	1500	96.49	97.16	94.97	96.72	2.82	2.82	0.02	0.67
2013	10034.78	6905	1500	78.25	78.86	76.37	78.82	0.91	2.49	18.65	0.62
2014	8950.47	6279	1500	71.66	72.24	68.12	71.68	0.49	0.35	27.40	0.58
2015	11334.11	7835	1500	88.55	89.52	86.26	89.44	0.13	0.94	9.55	0.97
2016	11392.17	8671	1500	94.26	99.16	86.46	98.71	0.26	0.25	0.58	4.90
2017	8172.98	5760	1500	63.27	66.99	62.20	65.75	9.41	14.03	18.97	3.72
2018	9526.45	6522	1500	73.38	79.46	72.50	74.45	0.81	0.65	19.89	6.08
2019	11128.09	7952	1500	90.33	98.97	84.69	90.78	1.01	1.01	0.02	8.64
2020	4440.81	3206	1500	33.73	51.27	33.70	36.50	9.13	8.19	40.54	17.54
2021	8981.37	6209	1500	69.79	78.98	68.35	70.88	20.98	20.98	0.04	9.20
2022	0.00	0	1500	0.00	0.55	0.00	0.00	95.43	73.40	26.05	0.55
2023	8089.97	5589	1500	62.09	72.62	61.57	63.80	1.44	26.78	0.61	10.53
2024	8625.50	6585	1500	65.76	66.16	65.46	74.97	22.12	20.66	13.18	0.40

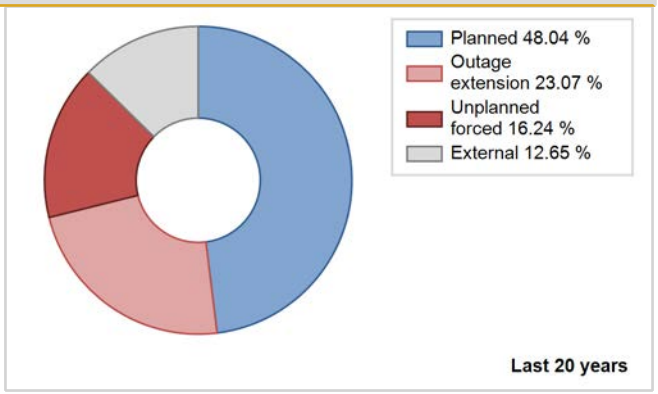
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			2000 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		1094			1033	
B.	Refuelling without maintenance	1056			261		
C.	Inspection, maintenance or repair combined with refuelling				815		
E.	Testing of plant systems or components	45			78		
H.	Nuclear regulatory requirements					1	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						8
L.	Human factor related					45	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						84
O.	Load dispatching, prioritization						10
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						57
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						73
Z.	Other					72	
Subtotal		1101	1094		1154	1151	232
Total		**2195**			**2537**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2000 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		102
13. Reactor Auxiliary Systems		10
14. Safety Systems		47
15. Reactor Cooling Systems	41	33
16. Steam generation systems		6
31. Turbine and auxiliaries	665	290
32. Feedwater and Main Steam System	200	23
34. Miscellaneous Systems	188	341
35. All other I&C Systems		1
41. Main Generator Systems		2
42. Electrical Power Supply Systems		53
Total	**1094**	**911**

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2024 Operating Experience

FR-70 CHOOZ B-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	FRAM (FRAMATOME)

Reactor Unit Details

Reactor type and model	:	PWR / N4 REP 1450
Thermal power	:	4270 MWth
Gross electrical power	:	1560 MWe
Reference unit power (net)	:	1500 MWe

Key Dates

Construction Date	:	1985-12-31
Grid Date	:	1997-04-10
Commercial Date	:	2000-09-29
Age at end of year	:	27 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	39000
Active core diameter [m]	:	3.47
Active core height/length [m]	:	4.267
Number of fissile fuel assemblies/bundles	:	205
Fuel linear heat generation rate [kW/m]	:	17.92
Number of control rod assemblies	:	25
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

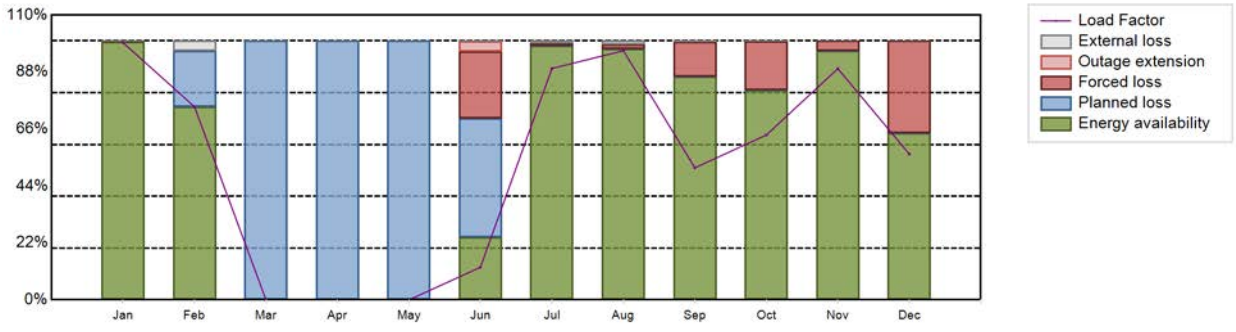
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	329.5
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	4.3
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	7.1
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6948.69 GW(e).h
Energy Availability Factor (EAF)	:	60.12 %
Unit Capability Factor (UCF)	:	60.69 %
Load Factor (LF)	:	52.74 %
Operating Factor (OF)	:	56.16 %

Forced Loss Rate (FLR)	:	12.12 %
Unplanned Capability Loss Factor (UCL)	:	8.71 %
Planned Unavailability Factor (PUF)	:	30.6 %
Externally cause unavailability (XUF)	:	0.57 %
Total off-line time	:	3851 hours

Annual Summary



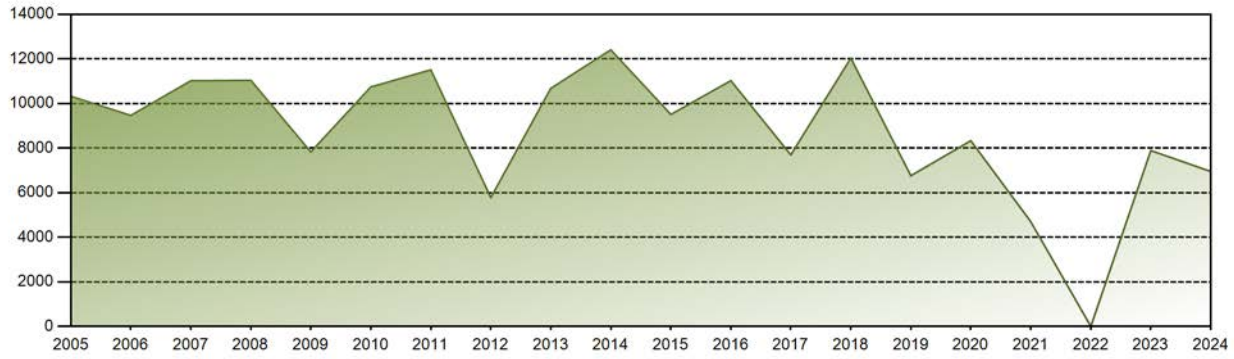
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1108.69	778.75	0.00	0.00	0.00	135.77	997.15	1073.69	550.83	711.44	964.34	628.04	6948.69
EAF [%]	99.68	74.59	0.00	0.00	0.00	24.28	98.03	96.86	86.21	80.93	96.18	64.46	60.12
UCF [%]	99.85	78.44	0.00	0.00	0.00	24.44	98.99	98.31	86.48	81.01	96.18	64.46	60.69
LF [%]	99.34	74.59	0.00	0.00	0.00	12.57	89.35	96.21	51.00	63.66	89.29	56.28	52.74
OF [%]	100.00	79.17	0.00	0.00	0.00	20.83	100.00	100.00	53.75	69.53	92.22	57.93	56.16
FLR [%]	0.06	0.00	0.00	0.00	0.00	51.30	0.97	1.66	13.51	18.98	3.77	35.54	12.12
UCL [%]	0.06	0.00	0.00	0.00	0.00	29.80	0.97	1.66	13.51	18.97	3.77	35.53	8.71
PUF [%]	0.09	21.56	100.00	100.00	100.00	45.76	0.04	0.03	0.01	0.01	0.06	0.00	30.60
XUF [%]	0.18	3.84	0.00	0.00	0.00	0.16	0.96	1.45	0.27	0.08	0.00	0.00	0.57

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Historical Summary

Lifetime energy generation	:	233834.36 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.24 %
Cumulative Energy Availability Factor (EAF)	:	71.55 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.6 %
Cumulative Unit Capability Factor (UCF)	:	78.67 %	Cumulative Planned Unavailability Factor (PUF)	:	13.73 %
Cumulative Load Factor (LF)	:	68.9 %	Cumulative Externally cause unavailability (XUF)	:	7.11 %
Cumulative Operating Factor (OF)	:	72.97 %			

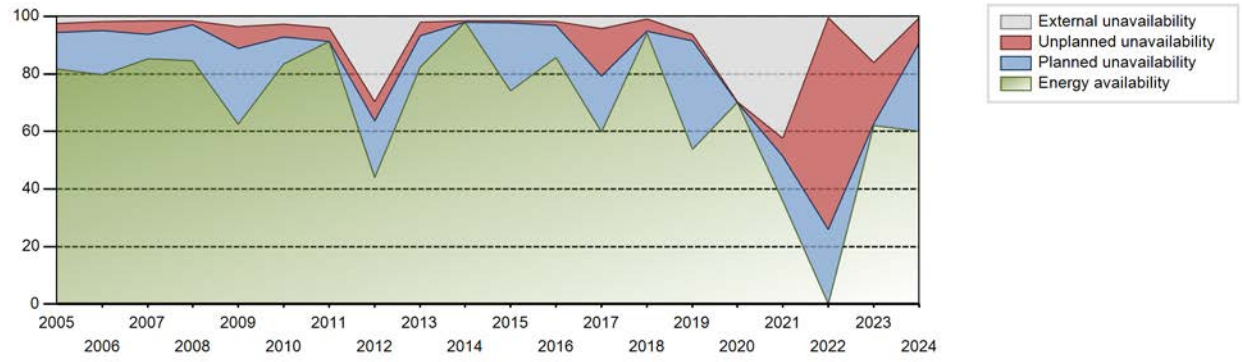
Electricity Production (net) [GWh]



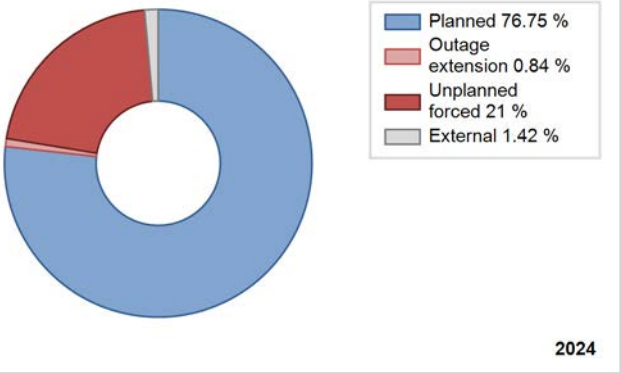
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2000	7213.35	5347	1455	90.19	90.26	92.15	94.70	9.74	9.74	0.00	0.06
2001	10159.53	7221	1455	80.36	83.42	79.71	82.43	0.36	0.30	16.28	3.06
2002	9814.83	7240	1455	81.50	83.02	77.00	82.65	0.48	0.40	16.58	1.52
2003	10472.75	7457	1500	83.30	87.64	79.70	85.13	2.38	2.13	10.23	4.34
2004	10063.94	7061	1500	80.12	88.00	76.38	80.38	3.42	3.12	8.88	7.88
2005	10321.55	7343	1500	81.65	84.06	78.55	83.82	1.24	3.23	12.71	2.41
2006	9460.52	6845	1500	79.64	81.55	72.00	78.14	1.94	2.91	15.53	1.91
2007	11016.49	7725	1500	85.23	86.78	83.84	88.18	3.20	4.71	8.50	1.55
2008	11038.88	7639	1500	84.56	86.12	83.78	86.96	1.19	1.44	12.43	1.56
2009	7821.91	5593	1500	62.48	66.03	59.53	63.85	0.32	7.57	26.40	3.55
2010	10739.75	7529	1500	83.38	86.09	81.73	85.95	2.02	4.45	9.47	2.71
2011	11507.74	8076	1500	91.22	95.24	87.58	92.19	4.75	4.75	0.01	4.03
2012	5773.74	4092	1500	44.03	73.66	43.82	46.58	0.02	6.71	19.62	29.63
2013	10676.71	7351	1500	82.43	84.44	81.25	83.92	0.26	4.75	10.81	2.02
2014	12405.66	8686	1500	98.02	99.71	94.41	99.16	0.27	0.27	0.02	1.69
2015	9504.22	6673	1500	74.11	75.67	72.33	76.18	0.82	0.63	23.71	1.56
2016	11021.73	7791	1500	85.63	87.54	83.65	88.70	1.48	1.32	11.14	1.91
2017	7691.34	5351	1500	59.82	64.05	58.53	61.08	2.81	16.49	19.46	4.23
2018	12031.86	8388	1500	94.16	95.17	91.57	95.75	4.23	4.21	0.62	1.02
2019	6757.53	4846	1500	53.76	60.05	51.43	55.32	0.17	2.23	37.72	6.29
2020	8328.39	6107	1500	70.01	99.67	63.21	69.52	0.31	0.31	0.02	29.66
2021	4693.11	3523	1500	35.72	78.05	35.72	40.22	7.28	6.40	15.55	42.33
2022	0.00	0	1500	0.00	0.55	0.00	0.00	98.90	73.42	26.03	0.55
2023	7888.17	5559	1500	62.09	78.13	60.03	63.46	11.97	21.17	0.70	16.04
2024	6948.69	4933	1500	60.12	60.69	52.74	56.16	12.12	8.71	30.60	0.57

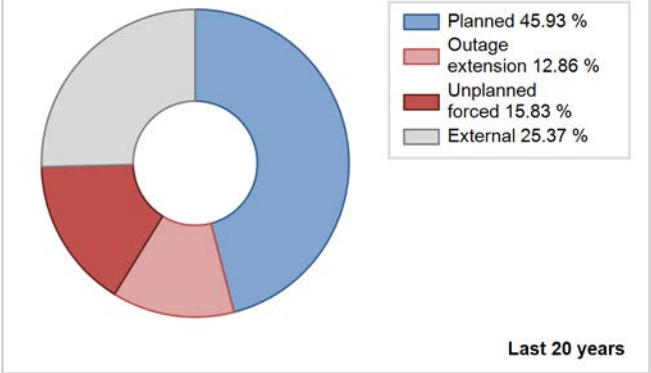
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			2000 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		723			958	
B.	Refuelling without maintenance	2638			288		
C.	Inspection, maintenance or repair combined with refuelling				801		
E.	Testing of plant systems or components				66	0	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			21			39
L.	Human factor related					39	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						64
O.	Load dispatching, prioritization			490			26
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					10	309
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						92
Z.	Other					41	
Subtotal		2638	723	511	1155	1048	530
Total		**3872**			**2733**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2000 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	71	14
12. Reactor I&C Systems		52
13. Reactor Auxiliary Systems		25
14. Safety Systems	145	183
15. Reactor Cooling Systems		6
16. Steam generation systems		14
21. Fuel Handling and Storage Facilities		7
31. Turbine and auxiliaries	164	272
32. Feedwater and Main Steam System		5
33. Circulating Water System	71	24
34. Miscellaneous Systems	29	213
35. All other I&C Systems		2
41. Main Generator Systems	243	19
42. Electrical Power Supply Systems		14
Total	**723**	**850**

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2024 Operating Experience

FR-72 CIVAUX-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / N4 REP 1450
Thermal power	:	4270 MWth
Gross electrical power	:	1561 MWe
Reference unit power (net)	:	1495 MWe

Key Dates

Construction Date	:	1988-10-15
Grid Date	:	1997-12-24
Commercial Date	:	2002-01-29
Age at end of year	:	27 years

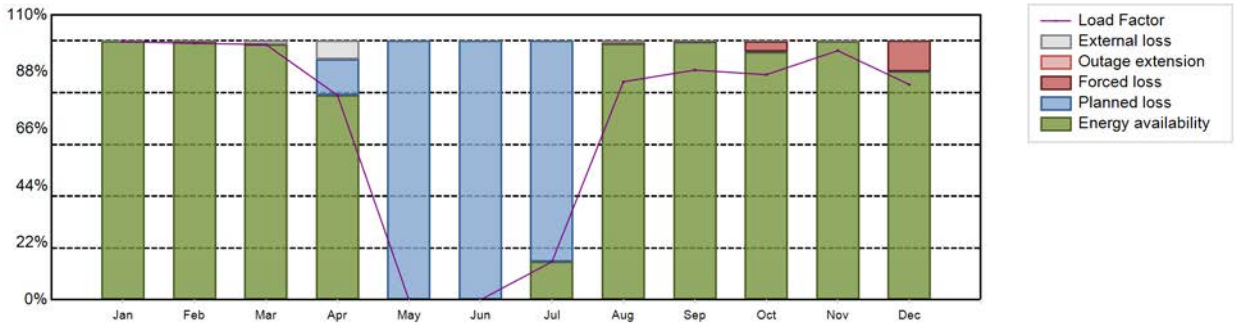
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	35000
Active core diameter [m]	:	3.47
Active core height/length [m]	:	4.267
Number of fissile fuel assemblies/bundles	:	205
Fuel linear heat generation rate [kW/m]	:	17
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	329.5
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	4.3
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	7.1
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9070.79 GW(e).h	Forced Loss Rate (FLR)	:	1.81 %
Energy Availability Factor (EAF)	:	72.77 %	Unplanned Capability Loss Factor (UCL)	:	1.35 %
Unit Capability Factor (UCF)	:	73.57 %	Planned Unavailability Factor (PUF)	:	25.07 %
Load Factor (LF)	:	69.07 %	Externally cause unavailability (XUF)	:	0.8 %
Operating Factor (OF)	:	74.26 %	Total off-line time	:	2261 hours

Annual Summary



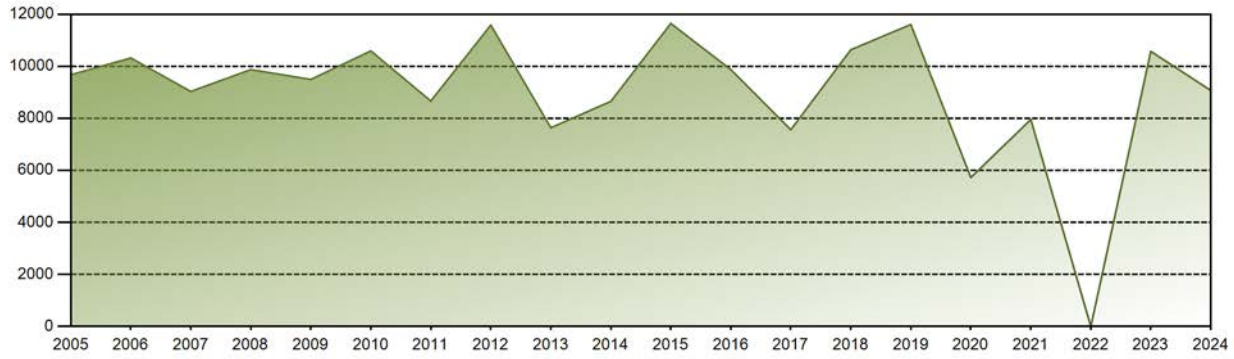
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1109.52	1030.63	1095.29	850.36	0.00	0.00	163.63	936.80	955.33	968.62	1035.91	924.70	9070.79
EAF [%]	99.97	99.89	98.55	79.00	0.00	0.00	14.71	98.96	99.58	95.76	99.97	88.24	72.77
UCF [%]	99.97	99.91	99.97	86.03	0.00	0.00	14.71	99.82	99.82	95.87	99.98	88.24	73.57
LF [%]	99.75	99.05	98.61	79.00	0.00	0.00	14.71	84.22	88.75	86.97	96.24	83.14	69.07
OF [%]	100.00	100.00	100.00	86.81	0.00	0.00	20.56	100.00	100.00	96.78	100.00	88.31	74.26
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	4.11	0.00	11.74	1.81
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	4.11	0.00	11.74	1.35
PUF [%]	0.03	0.09	0.03	13.97	100.00	100.00	85.29	0.16	0.06	0.02	0.02	0.02	25.07
XUF [%]	0.00	0.01	1.42	7.04	0.00	0.00	0.00	0.86	0.23	0.10	0.01	0.00	0.80

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Historical Summary

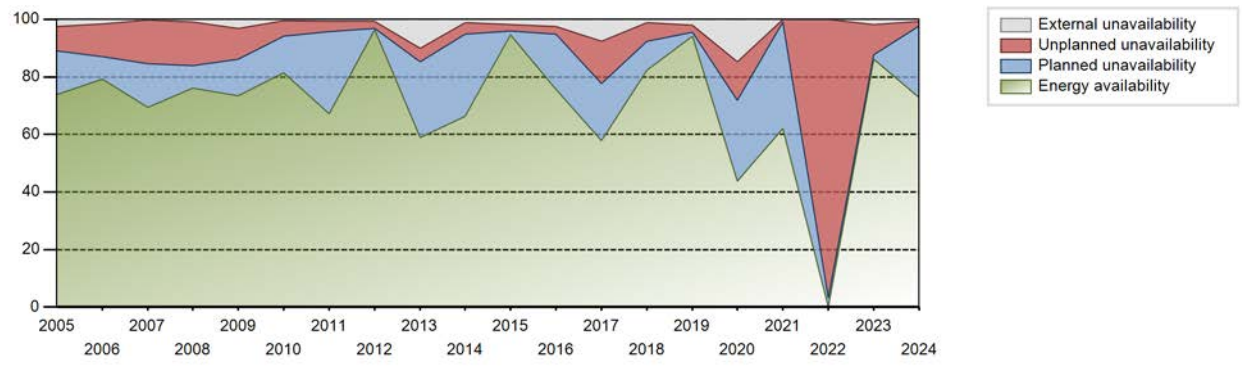
Lifetime energy generation	:	225919.08 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	9.78 %
Cumulative Energy Availability Factor (EAF)	:	72.3 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	10.45 %
Cumulative Unit Capability Factor (UCF)	:	74.82 %	Cumulative Planned Unavailability Factor (PUF)	:	14.73 %
Cumulative Load Factor (LF)	:	70.37 %	Cumulative Externally cause unavailability (XUF)	:	2.52 %
Cumulative Operating Factor (OF)	:	74.52 %			

Electricity Production (net) [GWh]



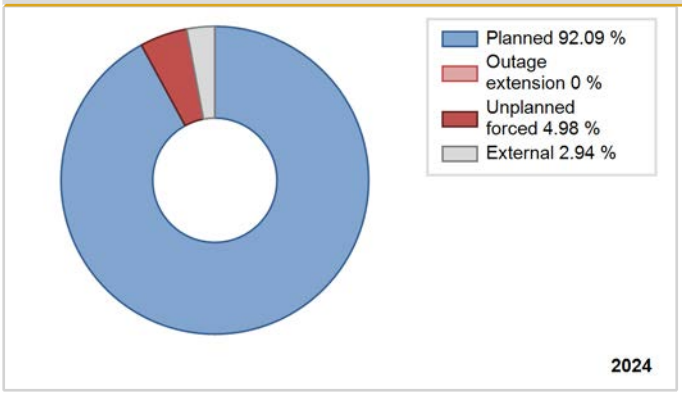
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2002	9544.10	7331	1495	82.62	83.86	74.72	84.81	2.71	2.34	13.81	1.24
2003	10932.08	7438	1495	83.06	84.14	83.48	84.91	2.86	2.48	13.38	1.08
2004	11276.48	7816	1495	86.91	87.98	85.87	88.98	3.22	2.92	9.09	1.08
2005	9672.34	6855	1495	73.78	76.26	73.85	78.24	4.10	8.59	15.15	2.48
2006	10318.21	7189	1495	79.29	80.93	78.79	82.07	8.64	11.25	7.82	1.64
2007	9031.53	6242	1495	69.39	69.64	68.96	71.25	15.77	15.12	15.24	0.25
2008	9872.98	6967	1495	76.04	77.04	75.18	79.31	13.43	14.99	7.97	1.00
2009	9494.39	6852	1495	73.43	76.52	72.50	78.22	9.45	10.84	12.64	3.09
2010	10590.11	7582	1495	81.45	81.98	80.86	86.55	5.84	5.37	12.65	0.53
2011	8663.88	6006	1495	67.23	67.89	66.16	68.56	0.92	3.52	28.59	0.66
2012	11583.20	8487	1495	96.38	97.14	88.21	96.62	2.44	2.43	0.43	0.76
2013	7637.26	5425	1495	58.90	68.87	58.32	61.93	2.52	4.85	26.28	9.97
2014	8649.46	5902	1495	66.26	67.50	66.05	67.37	0.73	3.95	28.54	1.24
2015	11646.17	8359	1495	94.69	96.56	88.93	95.42	2.25	2.22	1.22	1.87
2016	9873.52	7010	1495	75.66	78.10	75.19	79.80	3.46	2.80	19.10	2.44
2017	7559.81	5263	1495	57.73	65.44	57.73	60.08	3.94	14.64	19.92	7.70
2018	10636.19	7321	1495	82.29	83.48	81.22	83.57	4.42	6.45	10.07	1.19
2019	11608.53	8247	1495	94.08	96.03	88.64	94.14	2.55	2.51	1.46	1.94
2020	5723.66	4025	1495	43.72	58.54	43.59	45.82	1.01	13.21	28.25	14.82
2021	7952.74	5519	1495	62.02	62.09	60.73	63.00	1.42	0.90	37.02	0.07
2022	0.00	0	1495	0.00	0.00	0.00	0.00	100.00	96.71	3.29	0.00
2023	10575.26	7878	1495	86.11	88.03	80.75	89.93	10.54	10.37	1.60	1.92
2024	9070.79	6523	1495	72.77	73.57	69.07	74.26	1.81	1.35	25.07	0.80

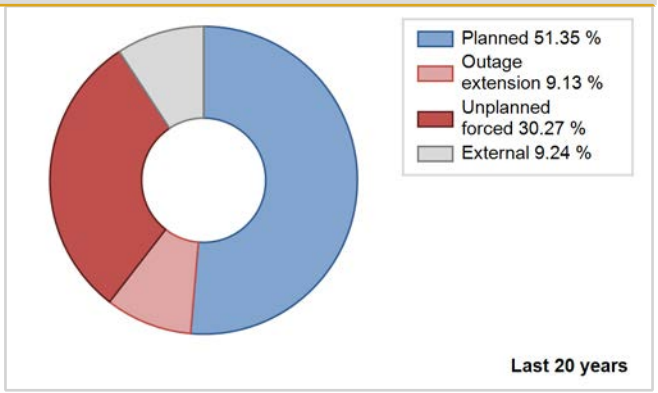
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2002 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		108			758	
B. Refuelling without maintenance	2127			498		
C. Inspection, maintenance or repair combined with refuelling	23			682		
E. Testing of plant systems or components				38		
H. Nuclear regulatory requirements					2	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L. Human factor related					25	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			0			55
O. Load dispatching, prioritization			2			9
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						83
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						9
Z. Other					43	
Subtotal	2150	108	2	1218	828	157
Total	**2260**			**2203**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2002 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		12
12. Reactor I&C Systems		20
13. Reactor Auxiliary Systems		9
14. Safety Systems		423
15. Reactor Cooling Systems		14
16. Steam generation systems		30
21. Fuel Handling and Storage Facilities		7
31. Turbine and auxiliaries	87	18
32. Feedwater and Main Steam System	21	13
33. Circulating Water System		6
34. Miscellaneous Systems		136
35. All other I&C Systems		11
41. Main Generator Systems		15
42. Electrical Power Supply Systems		89
Total	**108**	**803**

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2024 Operating Experience

FR-73 CIVAUX-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / N4 REP 1450
Thermal power	:	4270 MWth
Gross electrical power	:	1561 MWe
Reference unit power (net)	:	1495 MWe

Key Dates

Construction Date	:	1991-04-01
Grid Date	:	1999-12-24
Commercial Date	:	2002-04-23
Age at end of year	:	25 years

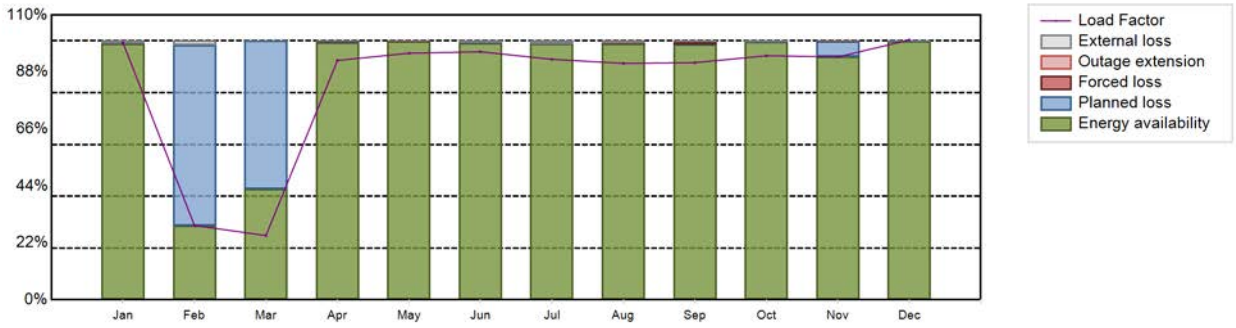
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	329.5
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.3
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	35000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.47	HP cylinder inlet steam pressure [MPa]	:	7.1
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	205	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	17	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10975.93 GW(e).h	Forced Loss Rate (FLR)	:	0.14 %
Energy Availability Factor (EAF)	:	88.45 %	Unplanned Capability Loss Factor (UCL)	:	0.13 %
Unit Capability Factor (UCF)	:	88.97 %	Planned Unavailability Factor (PUF)	:	10.9 %
Load Factor (LF)	:	83.58 %	Externally cause unavailability (XUF)	:	0.52 %
Operating Factor (OF)	:	89.18 %	Total off-line time	:	950 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1104.36	298.92	275.82	995.28	1059.36	1031.21	1033.20	1015.74	986.05	1049.94	1010.01	1116.04	10975.93
EAF [%]	98.98	28.73	42.87	99.44	99.82	99.18	98.76	98.94	98.56	99.62	93.87	99.95	88.45
UCF [%]	99.96	30.41	42.87	99.52	99.93	99.74	99.97	99.84	98.93	99.92	93.89	99.97	88.97
LF [%]	99.29	28.73	24.83	92.46	95.24	95.80	92.89	91.32	91.61	94.27	93.83	100.34	83.58
OF [%]	100.00	31.18	42.13	100.00	100.00	100.00	100.00	100.00	100.00	99.87	94.44	100.00	89.18
FLR [%]	0.00	0.00	0.00	0.43	0.07	0.00	0.00	0.01	0.93	0.00	0.12	0.00	0.14
UCL [%]	0.00	0.00	0.00	0.43	0.07	0.00	0.00	0.01	0.93	0.00	0.11	0.00	0.13
PUF [%]	0.04	69.59	57.13	0.05	0.00	0.26	0.03	0.14	0.15	0.08	5.99	0.03	10.90
XUF [%]	0.99	1.68	0.00	0.08	0.12	0.56	1.21	0.90	0.36	0.30	0.02	0.02	0.52

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Historical Summary

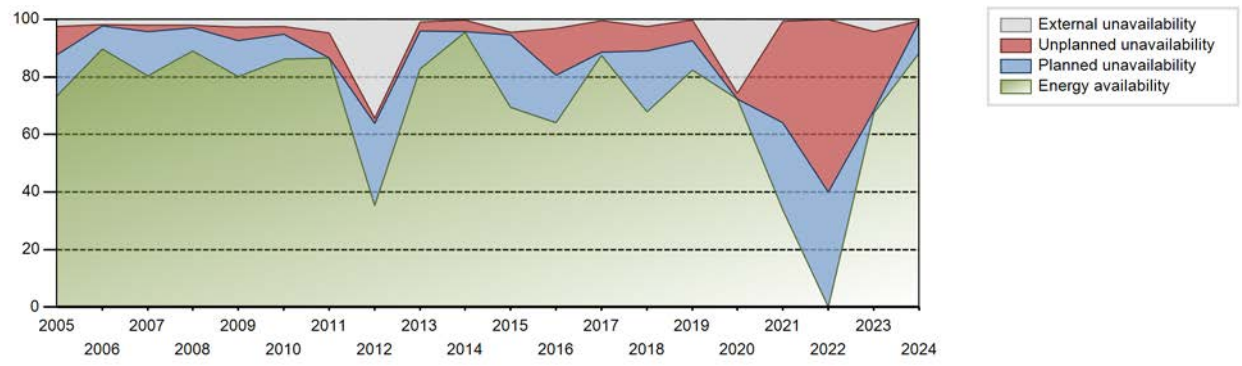
Lifetime energy generation	:	225449.39 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.35 %
Cumulative Energy Availability Factor (EAF)	:	72.93 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	9.57 %
Cumulative Unit Capability Factor (UCF)	:	77.26 %	Cumulative Planned Unavailability Factor (PUF)	:	13.17 %
Cumulative Load Factor (LF)	:	70.17 %	Cumulative Externally cause unavailability (XUF)	:	4.33 %
Cumulative Operating Factor (OF)	:	75.14 %			

Electricity Production (net) [GWh]



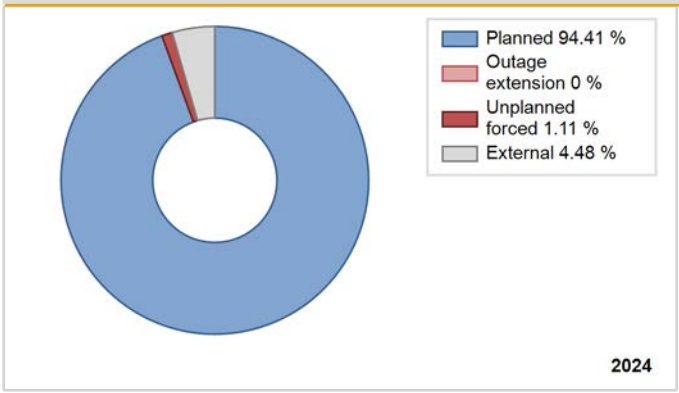
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2002	7491.29	6080	1495	91.94	94.81	70.33	85.80	0.68	0.65	4.55	2.86
2003	9084.75	6542	1495	70.38	70.48	69.37	74.68	10.67	8.42	21.10	0.10
2004	11698.64	8042	1495	89.64	90.04	89.08	91.55	0.90	0.82	9.14	0.40
2005	9621.39	6748	1495	73.47	75.92	73.47	77.03	2.45	9.90	14.18	2.44
2006	11140.10	7811	1495	89.78	91.57	85.06	89.17	0.33	0.55	7.89	1.78
2007	9973.85	7141	1495	80.24	82.26	76.15	81.51	1.58	2.36	15.38	2.01
2008	11321.50	8085	1495	89.02	91.06	86.21	92.04	0.61	1.00	7.94	2.04
2009	10293.33	7219	1495	80.14	82.76	78.60	82.41	0.14	4.84	12.40	2.62
2010	11094.03	7743	1495	86.06	88.55	84.71	88.39	0.92	2.71	8.74	2.48
2011	10640.60	7717	1495	86.58	91.40	81.25	88.09	8.58	8.58	0.03	4.81
2012	4561.72	3228	1495	35.27	69.60	34.74	36.75	0.92	1.93	28.48	34.32
2013	10581.57	7344	1495	82.73	83.76	80.80	83.84	2.15	2.95	13.29	1.04
2014	10918.20	8091	1495	95.40	95.63	83.37	92.36	1.85	3.95	0.42	0.23
2015	8920.04	6332	1495	69.44	73.89	68.11	72.28	1.14	0.85	25.26	4.45
2016	8169.29	5944	1495	63.97	67.12	62.21	67.67	2.01	16.19	16.68	3.15
2017	11390.13	7884	1495	87.55	88.06	86.97	90.00	3.66	10.93	1.01	0.51
2018	8867.46	6063	1495	67.90	70.32	67.71	69.21	1.69	8.46	21.23	2.41
2019	10630.33	7243	1495	82.37	82.53	81.17	82.68	3.91	7.30	10.17	0.17
2020	9482.62	8184	1495	72.26	97.99	72.21	93.17	1.96	1.96	0.05	25.73
2021	4424.47	3077	1495	33.74	34.36	33.78	35.13	25.44	35.28	30.37	0.61
2022	0.00	0	1495	0.00	0.00	0.00	0.00	100.00	60.03	39.97	0.00
2023	8513.71	6021	1495	67.32	71.62	65.01	68.73	27.73	27.49	0.90	4.30
2024	10975.93	7834	1495	88.45	88.97	83.58	89.18	0.14	0.13	10.90	0.52

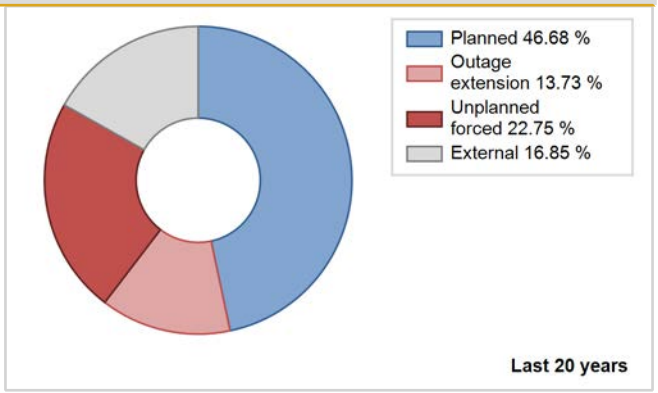
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2002 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		1			678	
B. Refuelling without maintenance	874			277		
C. Inspection, maintenance or repair combined with refuelling				812		
E. Testing of plant systems or components	40			20		
H. Nuclear regulatory requirements					88	
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			3			23
L. Human factor related					10	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			3			1
O. Load dispatching, prioritization			34			7
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						160
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						50
Z. Other					11	2
Subtotal	914	1	40	1109	787	243
Total	**955**			**2139**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2002 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		16
12. Reactor I&C Systems		13
13. Reactor Auxiliary Systems		15
14. Safety Systems		373
15. Reactor Cooling Systems		14
16. Steam generation systems	1	87
21. Fuel Handling and Storage Facilities		15
31. Turbine and auxiliaries		40
32. Feedwater and Main Steam System		11
33. Circulating Water System		2
34. Miscellaneous Systems		132
41. Main Generator Systems		3
42. Electrical Power Supply Systems		35
Total	**1**	**756**

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2024 Operating Experience

FR-42 CRUAS-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP2
Thermal power	:	2785 MWth
Gross electrical power	:	956 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1978-08-01
Grid Date	:	1983-04-29
Commercial Date	:	1984-04-02
Age at end of year	:	41 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	41
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

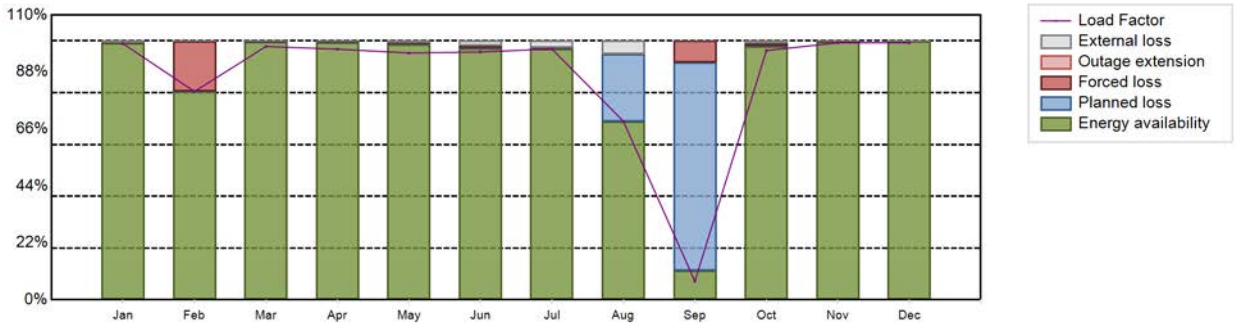
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6930.71 GW(e).h
Energy Availability Factor (EAF)	:	87.58 %
Unit Capability Factor (UCF)	:	88.63 %
Load Factor (LF)	:	86.23 %
Operating Factor (OF)	:	89.72 %

Forced Loss Rate (FLR)	:	2.71 %
Unplanned Capability Loss Factor (UCL)	:	2.47 %
Planned Unavailability Factor (PUF)	:	8.9 %
Externally cause unavailability (XUF)	:	1.05 %
Total off-line time	:	903 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	673.42	512.39	665.22	637.80	649.01	630.52	659.59	469.49	47.33	656.33	653.82	675.79	6930.71
EAF [%]	99.19	80.42	99.55	99.44	98.63	97.25	97.00	68.96	11.32	97.80	99.69	99.90	87.58
UCF [%]	99.78	80.46	99.78	99.67	99.20	99.04	99.71	74.11	11.32	98.72	99.89	99.90	88.63
LF [%]	98.92	80.46	97.85	96.81	95.34	95.71	96.89	68.97	7.18	96.28	99.24	99.27	86.23
OF [%]	100.00	81.61	100.00	100.00	100.00	100.00	100.00	74.46	18.89	99.87	100.00	100.00	89.72
FLR [%]	0.14	19.47	0.05	0.14	0.65	0.77	0.21	0.00	42.41	0.95	0.02	0.00	2.71
UCL [%]	0.14	19.45	0.05	0.14	0.64	0.76	0.21	0.00	8.34	0.95	0.02	0.00	2.47
PUF [%]	0.08	0.09	0.17	0.19	0.16	0.19	0.08	25.89	80.34	0.33	0.09	0.10	8.90
XUF [%]	0.60	0.04	0.23	0.23	0.56	1.79	2.72	5.15	0.00	0.91	0.20	0.00	1.05

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Historical Summary

Lifetime energy generation	:	231174.93 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.78 %
Cumulative Energy Availability Factor (EAF)	:	76.02 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.62 %
Cumulative Unit Capability Factor (UCF)	:	78.62 %	Cumulative Planned Unavailability Factor (PUF)	:	13.76 %
Cumulative Load Factor (LF)	:	70.99 %	Cumulative Externally cause unavailability (XUF)	:	2.61 %
Cumulative Operating Factor (OF)	:	77.34 %			

Electricity Production (net) [GWh]

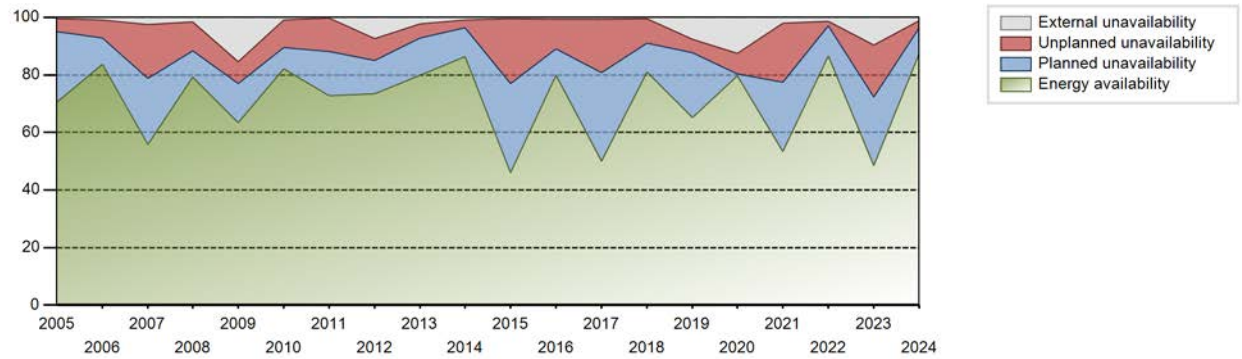


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	5482.00	7165	880	82.63	82.63	82.63	92.86	17.37	17.37	0.00	0.00
1985	5185.20	6615	880	71.95	77.18	67.26	75.51	3.24	2.58	20.24	5.23
1986	5888.00	7377	880	86.03	87.59	76.38	84.21	6.55	6.13	6.27	1.56
1987	5359.50	6860	880	81.83	83.73	69.52	78.31	1.62	1.38	14.89	1.90
1988	4025.00	5562	880	96.69	98.05	52.07	63.32	1.95	1.95	0.00	1.36
1989	5648.89	7239	880	83.65	86.05	73.28	82.64	3.68	3.29	10.66	2.41
1990	4983.52	6809	880	82.63	84.77	64.65	77.73	1.48	1.27	13.95	2.14
1991	4477.80	5762	880	65.27	68.16	58.09	65.78	9.81	7.41	24.43	2.88
1992	5739.40	7183	880	77.77	81.04	74.25	81.77	7.42	6.50	12.46	3.27
1993	6156.63	7353	880	84.56	87.16	79.86	83.94	2.42	2.16	10.68	2.59
1994	6181.24	7498	915	84.25	84.46	77.12	85.59	5.48	4.90	10.64	0.21
1995	4630.41	5624	915	62.47	63.33	57.77	64.20	12.73	9.24	27.43	0.86
1996	6258.55	7478	915	82.96	83.87	77.87	85.13	5.97	5.32	10.81	0.91
1997	5271.22	6784	915	74.09	77.89	65.76	77.44	9.97	8.62	13.49	3.80
1998	6387.28	7864	915	89.54	90.75	79.69	89.77	3.61	3.40	5.85	1.21
1999	5890.67	7367	915	83.80	85.49	73.49	84.10	3.81	3.39	11.12	1.69
2000	6320.52	7742	915	85.96	87.61	78.64	88.14	0.74	0.65	11.73	1.65
2001	5918.31	7264	915	81.07	81.69	73.84	82.92	6.09	5.30	13.02	0.61
2002	6069.76	7349	915	80.46	80.61	75.73	83.89	11.38	10.35	9.04	0.16
2003	6120.53	7403	915	81.14	82.53	76.36	84.51	5.31	4.62	12.84	1.39
2004	5866.08	6907	915	76.11	76.96	72.99	78.63	11.69	10.19	12.85	0.84
2005	5345.43	6311	915	70.60	71.08	66.69	72.04	5.29	4.57	24.35	0.48
2006	6491.00	7716	915	83.73	84.76	80.98	88.08	3.88	6.16	9.08	1.02
2007	4468.50	5506	915	55.86	58.41	55.75	62.85	4.55	18.60	22.99	2.55
2008	6281.45	7285	915	79.29	80.79	78.15	82.93	5.37	10.11	9.10	1.51
2009	5066.64	6016	915	63.43	78.80	63.21	68.68	2.27	7.62	13.58	15.37
2010	6529.54	7413	915	82.19	83.20	81.46	84.62	3.46	9.49	7.31	1.01
2011	5791.82	6573	915	72.78	73.05	72.26	75.03	2.56	11.63	15.32	0.27
2012	5896.70	6640	915	73.48	80.89	73.37	75.59	2.26	7.59	11.51	7.41
2013	6325.06	7087	915	79.90	82.28	78.91	80.90	1.09	4.75	12.98	2.38
2014	6767.39	7720	915	86.34	87.34	84.43	88.13	1.31	2.70	9.97	1.00
2015	3668.25	4245	915	45.93	46.48	45.77	48.46	6.71	22.54	30.98	0.55
2016	6374.97	7417	915	80.00	80.61	79.32	84.44	6.32	10.34	9.05	0.61
2017	3987.13	4655	915	49.92	50.59	49.74	53.14	2.97	18.52	30.89	0.67
2018	6471.31	7364	915	80.93	81.32	80.74	84.06	5.60	8.65	10.03	0.40
2019	5215.27	5891	915	65.17	72.69	65.07	67.25	2.12	4.69	22.62	7.52
2020	6241.26	7161	915	79.62	92.18	77.65	81.52	0.38	7.01	0.81	12.56

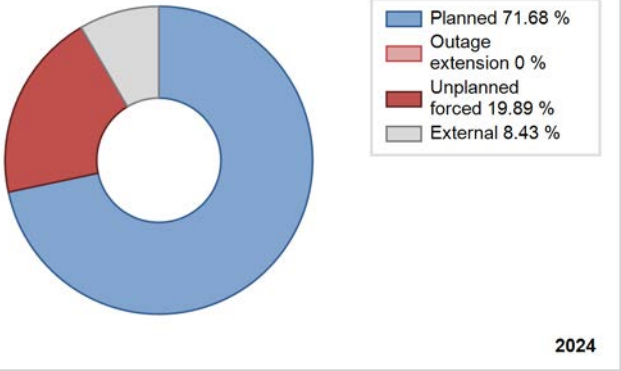
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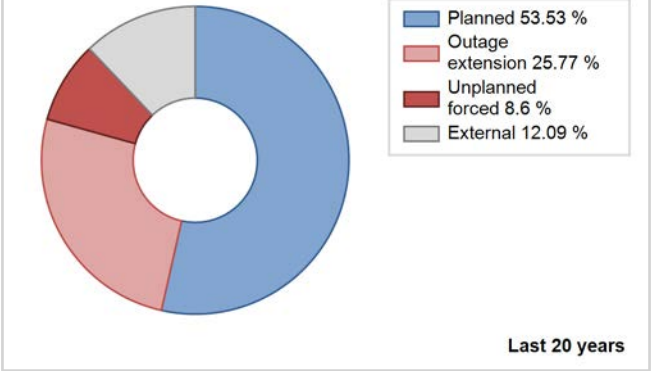
2021	4211.93	4932	915	53.43	55.51	52.55	56.30	1.78	20.52	23.96	2.08
2022	6879.40	7711	915	86.68	88.09	85.83	88.03	1.68	1.51	10.40	1.42
2023	3816.03	4596	915	48.43	58.05	47.61	52.47	3.24	18.10	23.85	9.62
2024	6930.71	7881	915	87.58	88.63	86.23	89.72	2.71	2.47	8.90	1.05

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		153			538	
B.	Refuelling without maintenance	735			165		
C.	Inspection, maintenance or repair combined with refuelling				939	13	
D.	Inspection, maintenance or repair without refuelling				16		
E.	Testing of plant systems or components				13		
H.	Nuclear regulatory requirements					4	
J.	Grid limitation, failure or grid unavailability						1
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						8
L.	Human factor related					54	
M.	Governmental requirements or court decisions						0
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						11
O.	Load dispatching, prioritization			14			4
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					12	75
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						25
Z.	Other				2	34	
Subtotal		735	153	14	1135	655	124
Total		**902**			**1914**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		13
12. Reactor I&C Systems		14
13. Reactor Auxiliary Systems		35
14. Safety Systems	128	39
15. Reactor Cooling Systems		14
16. Steam generation systems		7
17. Safety I&C Systems (excluding reactor I&C)		2
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries	25	32
32. Feedwater and Main Steam System		8
33. Circulating Water System		2
34. Miscellaneous Systems		185
35. All other I&C Systems		2
41. Main Generator Systems		154
42. Electrical Power Supply Systems		21
Total	**153**	**529**

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2024 Operating Experience

FR-43 CRUAS-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP2
Thermal power	:	2785 MWth
Gross electrical power	:	956 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1978-11-15
Grid Date	:	1984-09-06
Commercial Date	:	1985-04-01
Age at end of year	:	40 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	41
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

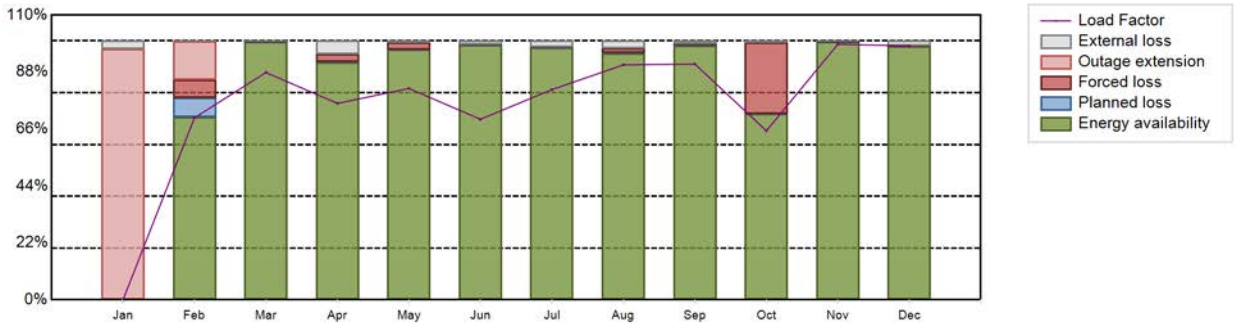
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6092.76 GW(e).h
Energy Availability Factor (EAF)	:	84.67 %
Unit Capability Factor (UCF)	:	86.33 %
Load Factor (LF)	:	75.81 %
Operating Factor (OF)	:	83.85 %

Forced Loss Rate (FLR)	:	3.95 %
Unplanned Capability Loss Factor (UCL)	:	12.94 %
Planned Unavailability Factor (PUF)	:	0.73 %
Externally cause unavailability (XUF)	:	1.66 %
Total off-line time	:	1419 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	447.72	596.87	499.77	555.77	459.49	552.70	617.73	599.87	445.12	650.25	667.47	6092.76
EAF [%]	0.00	70.57	99.55	91.73	96.67	98.29	97.27	95.20	98.19	71.74	99.57	97.95	84.67
UCF [%]	3.23	70.62	99.63	96.96	97.32	99.76	99.73	97.99	99.27	72.46	99.77	99.88	86.33
LF [%]	0.00	70.30	87.79	75.86	81.64	69.75	81.19	90.74	91.05	65.30	98.70	98.05	75.81
OF [%]	0.00	84.91	100.00	95.28	94.49	77.22	88.31	98.92	100.00	68.32	100.00	100.00	83.85
FLR [%]	0.00	8.77	0.27	2.87	2.61	0.16	0.11	1.78	0.48	27.39	0.08	0.01	3.95
UCL [%]	96.77	21.86	0.27	2.87	2.61	0.16	0.11	1.77	0.47	27.33	0.08	0.01	12.94
PUF [%]	0.00	7.52	0.10	0.18	0.08	0.08	0.16	0.23	0.26	0.20	0.16	0.11	0.73
XUF [%]	3.23	0.05	0.07	5.22	0.65	1.47	2.46	2.80	1.08	0.73	0.20	1.93	1.66

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Historical Summary

Lifetime energy generation	:	232614.88 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.04 %
Cumulative Energy Availability Factor (EAF)	:	76.85 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.64 %
Cumulative Unit Capability Factor (UCF)	:	80.21 %	Cumulative Planned Unavailability Factor (PUF)	:	13.16 %
Cumulative Load Factor (LF)	:	72.57 %	Cumulative Externally cause unavailability (XUF)	:	3.36 %
Cumulative Operating Factor (OF)	:	79.52 %			

Electricity Production (net) [GWh]

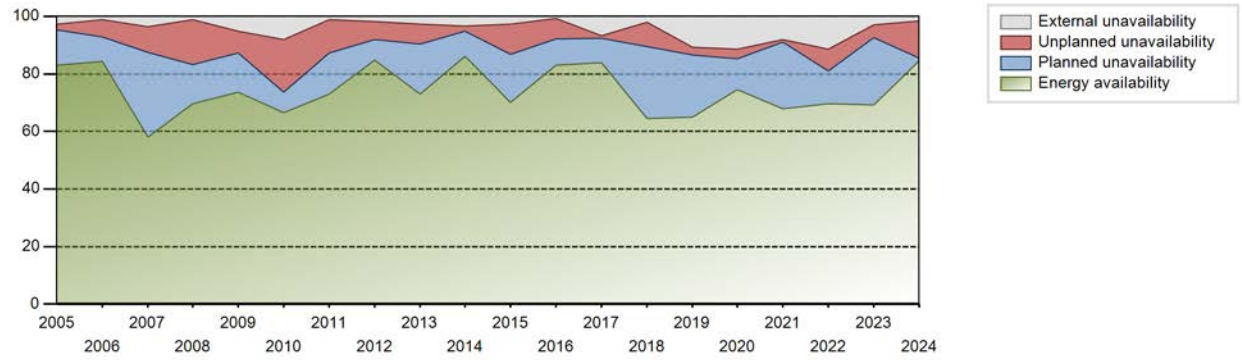


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	6103.20	8330	880	96.00	98.29	83.40	97.33	1.71	1.71	0.00	2.29
1986	4955.00	6258	880	70.06	70.42	64.28	71.44	22.40	20.33	9.25	0.36
1987	5559.90	6761	900	79.13	79.79	70.52	77.18	1.84	1.50	18.72	0.65
1988	5698.00	7176	915	80.60	84.97	70.89	81.69	4.03	3.57	11.46	4.37
1989	6298.51	7697	915	83.27	86.17	78.58	87.87	3.45	3.08	10.74	2.91
1990	6001.78	7114	915	77.72	79.83	74.88	81.21	9.42	8.30	11.87	2.11
1991	4099.88	4838	915	53.75	55.32	51.15	55.23	27.56	21.05	23.63	1.58
1992	5946.87	6910	915	76.96	76.99	73.99	78.67	11.95	10.44	12.57	0.03
1993	5441.04	6463	915	73.54	78.13	67.88	73.78	12.01	10.66	11.20	4.59
1994	5566.06	6765	915	94.12	96.79	69.44	77.23	3.16	3.16	0.05	2.66
1995	5366.77	6581	915	72.41	76.26	66.96	75.13	11.85	10.25	13.48	3.85
1996	6521.86	7870	915	87.09	88.83	81.14	89.59	1.32	1.19	9.98	1.75
1997	5176.08	6596	915	76.47	80.91	64.58	75.30	0.87	0.71	18.38	4.44
1998	6003.57	7396	915	79.02	82.81	74.90	84.43	3.10	2.65	14.54	3.79
1999	6393.81	7787	915	85.31	88.14	79.77	88.89	0.23	0.20	11.65	2.84
2000	6420.91	7755	915	85.55	86.99	79.89	88.29	0.81	0.71	12.31	1.43
2001	5914.40	7053	915	76.50	79.70	73.79	80.51	8.14	7.06	13.23	3.20
2002	6547.44	7776	915	85.99	86.53	81.69	88.77	3.83	3.45	10.03	0.54
2003	5727.93	6927	915	75.57	75.77	71.46	79.08	12.21	10.54	13.69	0.20
2004	6612.96	7661	915	84.92	85.96	82.28	87.22	0.57	0.49	13.55	1.04
2005	6504.12	7684	915	83.04	85.81	81.14	87.71	1.42	1.88	12.31	2.77
2006	6509.49	7736	915	84.34	85.58	81.21	88.31	3.94	5.89	8.52	1.24
2007	4617.90	5602	915	58.03	61.62	57.61	63.95	1.94	8.91	29.47	3.59
2008	5597.43	6633	915	69.75	70.93	69.64	75.51	6.25	15.48	13.59	1.18
2009	5862.16	6886	915	73.60	78.67	73.14	78.61	2.91	7.61	13.71	5.07
2010	5305.44	6036	915	66.55	74.51	66.19	68.90	11.78	18.28	7.21	7.96
2011	5791.15	6577	915	73.02	74.13	72.25	75.08	6.56	11.55	14.31	1.12
2012	6761.59	7665	915	84.70	86.48	84.13	87.26	0.15	6.31	7.21	1.78
2013	5729.40	6729	915	73.03	75.71	71.48	76.82	1.26	7.02	17.27	2.67
2014	6708.45	7931	915	86.15	89.62	83.69	90.54	1.26	1.69	8.69	3.47
2015	5568.66	6630	915	70.20	72.96	69.47	75.68	3.80	10.54	16.50	2.76
2016	6596.10	7743	915	83.08	83.78	82.07	88.15	4.55	7.17	9.05	0.71
2017	6505.00	7739	915	84.01	90.78	81.16	88.34	0.97	0.89	8.34	6.77
2018	4984.84	5958	915	64.41	66.36	62.19	68.01	2.10	8.57	25.07	1.94
2019	4872.15	6038	915	65.06	75.74	60.78	68.93	1.70	2.75	21.51	10.68
2020	5761.69	6924	915	74.50	85.90	71.69	78.83	0.96	3.35	10.75	11.40
2021	5251.28	6401	915	67.89	76.01	65.51	73.07	0.61	0.79	23.20	8.12

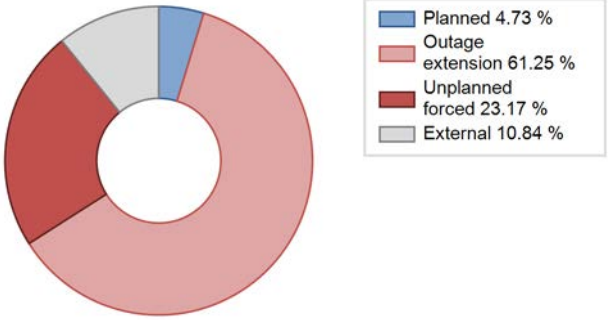
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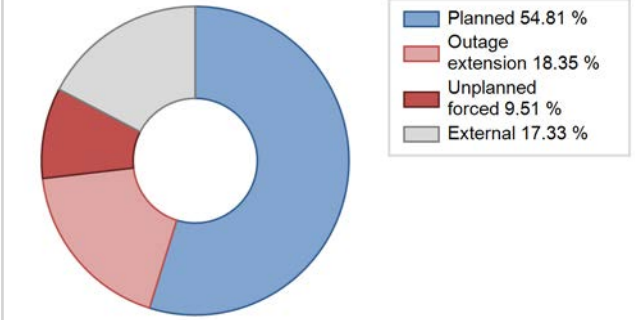
2022	5384.34	6707	915	69.59	81.04	67.17	76.56	3.48	7.50	11.46	11.45
2023	5425.63	6336	915	69.23	72.19	67.69	72.33	0.37	4.36	23.46	2.95
2024	6092.76	7365	915	84.67	86.33	75.81	83.85	3.95	12.94	0.73	1.66

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		1028			373	
B.	Refuelling without maintenance				128		
C.	Inspection, maintenance or repair combined with refuelling				931	6	
E.	Testing of plant systems or components				6	0	
H.	Nuclear regulatory requirements					5	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L.	Human factor related					41	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						31
O.	Load dispatching, prioritization			332			11
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)			24		7	44
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			34		3	37
Z.	Other					38	0
Subtotal			1028	390	1065	473	123
Total			**1418**			**1661**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		24
12. Reactor I&C Systems	153	17
13. Reactor Auxiliary Systems		9
14. Safety Systems		9
15. Reactor Cooling Systems	41	9
16. Steam generation systems		19
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries	8	79
32. Feedwater and Main Steam System		15
33. Circulating Water System		2
34. Miscellaneous Systems	825	86
35. All other I&C Systems		2
41. Main Generator Systems		94
42. Electrical Power Supply Systems		6
Total	**1027**	**372**

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2024 Operating Experience

FR-44 CRUAS-3 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP2
Thermal power	:	2785 MWth
Gross electrical power	:	956 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1979-04-15
Grid Date	:	1984-05-14
Commercial Date	:	1984-09-10
Age at end of year	:	40 years

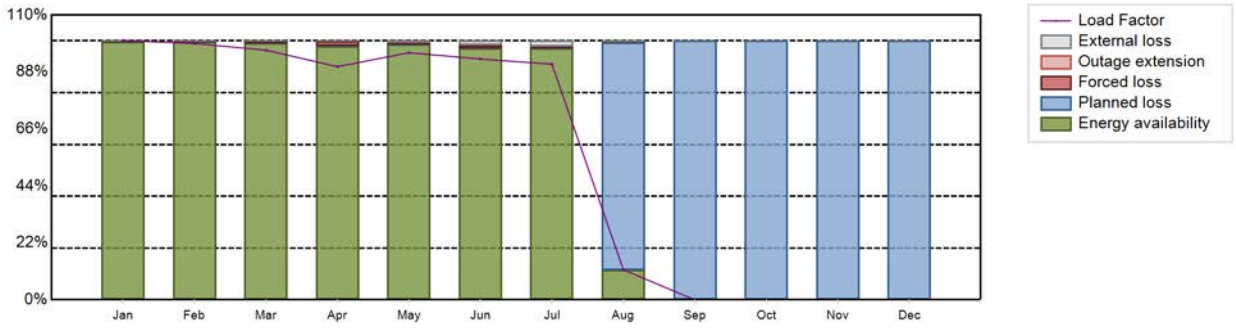
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	41
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4521.86 GW(e).h
Energy Availability Factor (EAF)	:	58.26 %
Unit Capability Factor (UCF)	:	58.72 %
Load Factor (LF)	:	56.26 %
Operating Factor (OF)	:	59.28 %
Forced Loss Rate (FLR)	:	0.72 %
Unplanned Capability Loss Factor (UCL)	:	0.42 %
Planned Unavailability Factor (PUF)	:	40.85 %
Externally cause unavailability (XUF)	:	0.46 %
Total off-line time	:	3577 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	681.72	630.33	655.54	593.37	649.64	612.74	619.59	78.92	0.00	0.00	0.00	0.00	4521.86
EAF [%]	99.72	99.61	99.09	97.96	98.57	97.02	97.12	11.60	0.00	0.00	0.00	0.00	58.26
UCF [%]	99.74	99.68	99.33	98.21	99.31	98.53	99.31	12.09	0.00	0.00	0.00	0.00	58.72
LF [%]	100.14	98.98	96.43	90.07	95.43	93.01	91.01	11.59	0.00	0.00	0.00	0.00	56.26
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	12.90	0.00	0.00	0.00	0.00	59.28
FLR [%]	0.08	0.25	0.58	1.66	0.60	1.26	0.59	0.89	0.00	0.00	0.00	0.00	0.72
UCL [%]	0.08	0.25	0.58	1.65	0.60	1.26	0.59	0.11	0.00	0.00	0.00	0.00	0.42
PUF [%]	0.18	0.07	0.09	0.13	0.10	0.21	0.10	87.80	100.00	100.00	100.00	100.00	40.85
XUF [%]	0.02	0.07	0.25	0.25	0.73	1.51	2.19	0.49	0.00	0.00	0.00	0.00	0.46

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Historical Summary

Lifetime energy generation	:	229310.56 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.3 %
Cumulative Energy Availability Factor (EAF)	:	76.01 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.82 %
Cumulative Unit Capability Factor (UCF)	:	79.53 %	Cumulative Planned Unavailability Factor (PUF)	:	13.64 %
Cumulative Load Factor (LF)	:	70.98 %	Cumulative Externally cause unavailability (XUF)	:	3.53 %
Cumulative Operating Factor (OF)	:	77.58 %			

Electricity Production (net) [GWh]

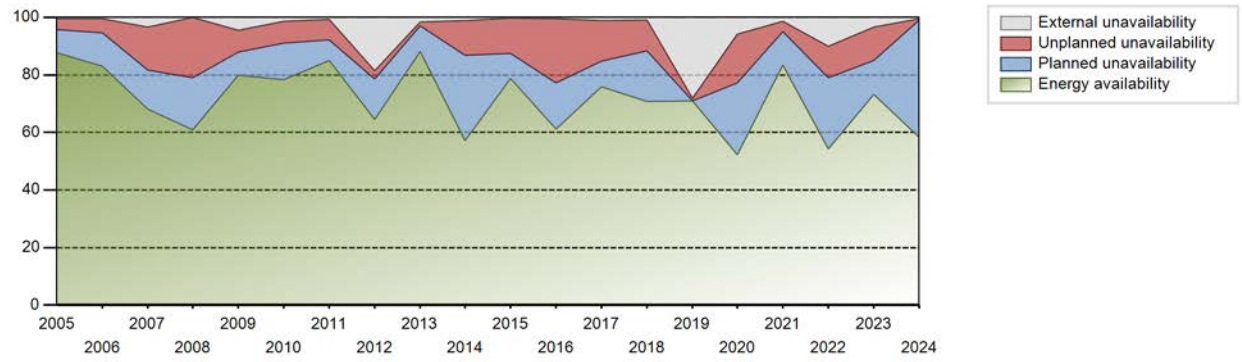


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	3272.00	4380	880	91.93	91.93	89.66	92.73	8.07	8.07	0.00	0.00
1985	5247.40	6557	880	72.54	74.60	68.07	74.85	8.27	6.72	18.68	2.06
1986	5967.08	7456	880	89.23	89.52	77.41	85.11	1.96	1.79	8.70	0.28
1987	4721.40	6013	880	75.08	75.71	61.25	68.64	11.51	9.84	14.45	0.63
1988	4773.00	6679	880	98.63	99.87	61.75	76.04	0.13	0.13	0.00	1.24
1989	5577.93	6571	880	72.81	74.19	72.36	75.01	8.98	7.32	18.49	1.38
1990	6129.16	7499	915	85.18	87.48	76.47	85.61	1.04	0.92	11.60	2.30
1991	6003.22	7374	915	84.75	85.16	74.90	84.18	2.27	1.97	12.87	0.41
1992	5174.61	6323	915	70.99	73.16	64.38	71.98	9.76	7.91	18.93	2.17
1993	5715.35	7232	915	73.91	85.66	71.30	82.56	2.81	2.47	11.87	11.75
1994	5013.99	6428	915	78.11	78.86	62.55	73.38	0.72	0.57	20.57	0.75
1995	6032.66	7525	915	84.28	89.56	75.26	85.90	0.94	0.85	9.59	5.29
1996	5882.20	7724	915	91.89	99.67	73.19	87.93	0.22	0.22	0.11	7.78
1997	5347.79	6961	915	80.20	86.11	66.72	79.46	0.27	0.24	13.66	5.91
1998	6281.40	7758	915	78.69	81.74	78.37	88.56	7.63	6.75	11.51	3.05
1999	6316.70	7654	915	87.83	89.77	78.81	87.37	2.25	2.07	8.17	1.93
2000	5493.99	6914	915	78.98	81.39	68.36	78.71	6.81	5.94	12.67	2.40
2001	5867.85	7254	915	79.61	82.12	73.21	82.81	8.89	8.02	9.86	2.51
2002	6052.00	7307	915	80.94	82.10	75.50	83.41	6.56	5.77	12.14	1.16
2003	5779.36	7146	915	76.75	79.21	72.10	81.58	7.77	6.67	14.13	2.45
2004	5081.25	6074	915	64.07	65.92	63.22	69.15	12.26	9.21	24.87	1.85
2005	6941.58	7863	915	87.79	88.28	86.59	89.75	2.66	3.72	8.00	0.49
2006	6487.52	7520	915	83.06	83.49	80.94	85.84	2.45	4.95	11.56	0.43
2007	5435.78	6456	915	68.07	71.39	67.82	73.70	5.03	14.99	13.62	3.32
2008	4858.57	5750	915	60.85	61.00	60.45	65.46	6.02	20.85	18.16	0.14
2009	6365.97	7392	915	79.89	84.35	79.42	84.38	5.10	7.58	8.07	4.45
2010	6277.78	7004	915	78.27	79.59	78.32	79.95	3.10	7.69	12.72	1.32
2011	6741.60	7580	915	85.02	85.72	84.11	86.53	5.39	7.15	7.14	0.70
2012	5106.74	5899	915	64.48	83.03	63.54	67.16	2.31	2.90	14.07	18.55
2013	6866.75	7750	915	88.16	89.86	85.67	88.47	0.32	1.26	8.88	1.70
2014	4529.71	5148	915	57.11	58.35	56.51	58.77	1.09	12.03	29.62	1.24
2015	6297.99	7085	915	78.71	79.01	78.57	80.88	11.58	12.23	8.76	0.30
2016	4910.49	6144	915	61.26	61.76	61.10	69.95	6.85	22.17	16.07	0.50
2017	6067.31	6910	915	75.99	77.24	75.70	78.88	3.27	14.04	8.71	1.25
2018	5672.76	6425	915	70.87	71.89	70.77	73.34	5.03	10.67	17.44	1.02
2019	5632.07	6451	915	70.96	99.01	70.27	73.64	0.87	0.87	0.12	28.05
2020	4171.74	4917	915	52.15	57.98	51.90	55.98	0.83	17.00	25.02	5.84

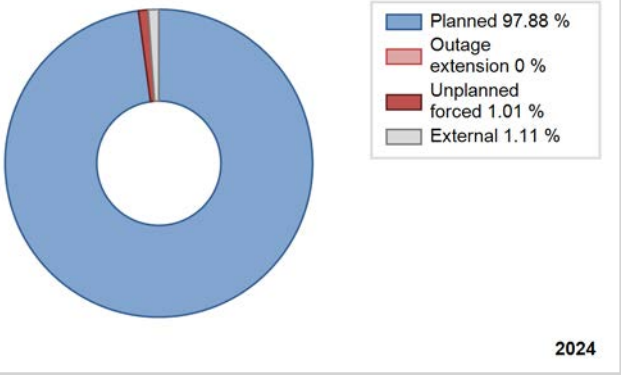
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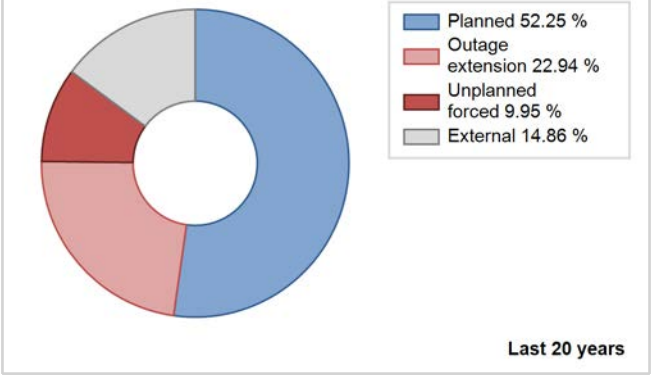
2021	6628.24	7614	915	83.54	84.88	82.69	86.92	4.10	3.63	11.48	1.35
2022	3797.13	4493	915	54.22	64.23	53.92	59.44	3.73	10.99	24.79	10.01
2023	5869.28	6796	915	73.27	76.56	73.23	77.58	0.34	11.70	11.74	3.29
2024	4521.86	5207	915	58.26	58.72	56.26	59.28	0.72	0.42	40.85	0.46

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					367	
B.	Refuelling without maintenance				144		
C.	Inspection, maintenance or repair combined with refuelling	3577			977	21	
D.	Inspection, maintenance or repair without refuelling					4	
E.	Testing of plant systems or components				6		
J.	Grid limitation, failure or grid unavailability						3
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L.	Human factor related					64	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						28
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						60
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						38
Z.	Other					48	12
Subtotal		3577			1127	504	142
Total		**3577**			**1773**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		5
12. Reactor I&C Systems		22
13. Reactor Auxiliary Systems		14
14. Safety Systems		16
15. Reactor Cooling Systems		54
16. Steam generation systems		19
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		48
32. Feedwater and Main Steam System		11
34. Miscellaneous Systems		148
35. All other I&C Systems		2
41. Main Generator Systems		15
42. Electrical Power Supply Systems		31
Total		**386**

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2024 Operating Experience

FR-45 CRUAS-4 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP2
Thermal power	:	2785 MWth
Gross electrical power	:	956 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1979-10-01
Grid Date	:	1984-10-27
Commercial Date	:	1985-02-11
Age at end of year	:	40 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	41
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

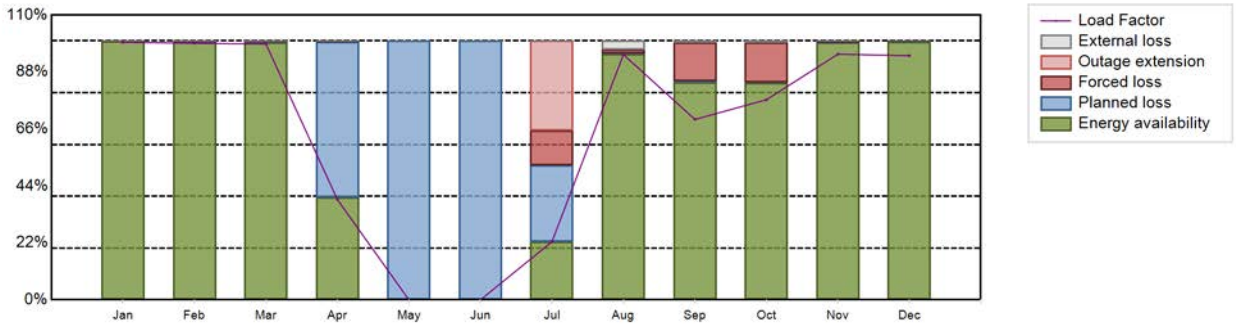
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5284.95 GW(e).h
Energy Availability Factor (EAF)	:	68.46 %
Unit Capability Factor (UCF)	:	68.92 %
Load Factor (LF)	:	65.75 %
Operating Factor (OF)	:	69.87 %

Forced Loss Rate (FLR)	:	5.37 %
Unplanned Capability Loss Factor (UCL)	:	6.84 %
Planned Unavailability Factor (PUF)	:	24.25 %
Externally cause unavailability (XUF)	:	0.46 %
Total off-line time	:	2647 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	677.30	631.01	671.54	254.96	0.00	0.00	152.49	644.88	459.08	526.78	625.03	641.87	5284.95
EAF [%]	99.79	99.55	99.49	39.46	0.00	0.00	22.40	94.81	83.86	83.81	99.26	99.50	68.46
UCF [%]	99.82	99.58	99.66	39.59	0.00	0.00	22.40	98.27	84.60	84.50	99.42	99.50	68.92
LF [%]	99.49	99.09	98.78	38.70	0.00	0.00	22.40	94.73	69.68	77.28	94.87	94.29	65.75
OF [%]	100.00	100.00	100.00	40.00	0.00	0.00	39.65	100.00	75.14	83.49	100.00	100.00	69.87
FLR [%]	0.12	0.29	0.25	0.43	0.00	0.00	37.67	1.42	14.90	15.40	0.43	0.23	5.37
UCL [%]	0.12	0.29	0.25	0.17	0.00	0.00	48.10	1.41	14.81	15.39	0.43	0.23	6.84
PUF [%]	0.06	0.13	0.09	60.24	100.00	100.00	29.50	0.32	0.59	0.12	0.15	0.27	24.25
XUF [%]	0.03	0.03	0.17	0.13	0.00	0.00	0.00	3.46	0.74	0.69	0.17	0.00	0.46

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Historical Summary

Lifetime energy generation	:	226004.7 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.35 %
Cumulative Energy Availability Factor (EAF)	:	74.75 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.04 %
Cumulative Unit Capability Factor (UCF)	:	77.78 %	Cumulative Planned Unavailability Factor (PUF)	:	14.17 %
Cumulative Load Factor (LF)	:	70.71 %	Cumulative Externally cause unavailability (XUF)	:	3.04 %
Cumulative Operating Factor (OF)	:	76.04 %			

Electricity Production (net) [GWh]

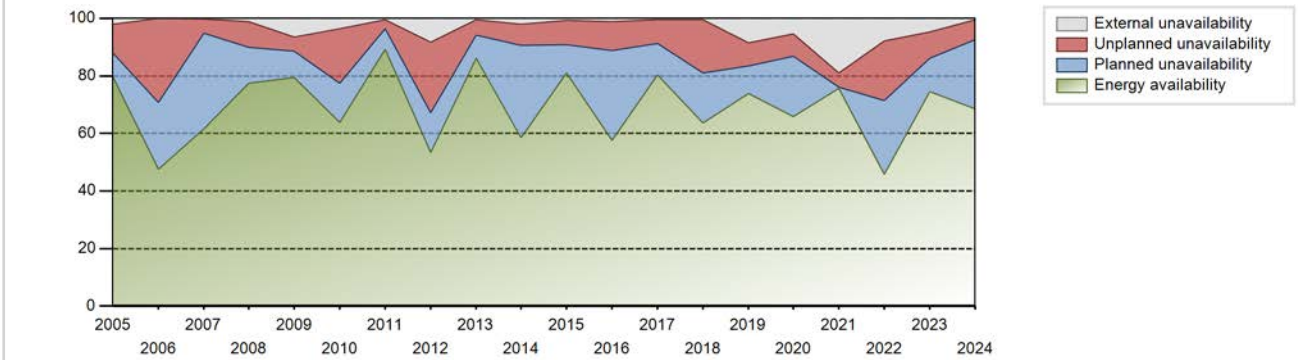


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	5773.60	7434	880	85.67	87.12	73.53	84.32	12.88	12.88	0.00	1.45
1986	5452.60	6816	880	76.67	80.33	70.73	77.81	0.60	0.48	19.18	3.66
1987	5313.40	6888	880	84.24	85.14	68.93	78.63	4.76	4.25	10.60	0.90
1988	3247.00	4271	880	74.17	75.95	42.01	48.62	15.53	13.96	10.09	1.79
1989	4852.19	6025	880	71.30	71.43	62.94	68.78	17.85	15.52	13.05	0.14
1990	6215.34	7607	880	86.02	86.39	80.63	86.84	8.69	8.23	5.38	0.38
1991	6005.38	7259	880	81.10	83.93	77.90	82.87	8.63	7.93	8.13	2.83
1992	4953.60	5862	880	64.95	66.00	64.08	66.73	13.05	9.90	24.10	1.04
1993	5279.97	6653	880	77.14	84.92	68.49	75.95	2.69	2.35	12.73	7.78
1994	5552.11	6856	915	83.79	86.83	69.27	78.26	2.94	2.63	10.54	3.04
1995	6280.30	7375	915	82.14	85.97	78.35	84.19	4.78	4.31	9.71	3.83
1996	5886.51	7180	915	79.43	80.67	73.24	81.74	0.71	0.58	18.75	1.24
1997	5976.62	7334	915	80.23	84.06	74.56	83.72	1.47	1.25	14.69	3.83
1998	6629.20	7885	915	85.52	88.69	82.71	90.01	0.97	0.87	10.43	3.18
1999	5829.81	7159	915	81.90	85.43	72.73	81.72	1.81	1.57	13.00	3.53
2000	6630.69	7915	915	88.43	89.66	82.50	90.11	0.72	0.65	9.69	1.22
2001	5915.77	7172	915	80.63	83.26	73.81	81.87	2.82	2.42	14.32	2.63
2002	6399.58	7474	915	82.89	83.41	79.84	85.32	3.93	3.41	13.18	0.53
2003	6296.69	7371	915	81.63	82.86	78.56	84.14	5.97	5.26	11.88	1.23
2004	6377.38	7443	915	80.62	83.44	79.35	84.73	4.36	3.80	12.75	2.82
2005	6255.06	7360	915	79.62	81.58	78.04	84.02	10.98	10.06	8.35	1.96
2006	3752.65	4259	915	47.64	47.64	46.82	48.62	21.85	29.21	23.15	0.00
2007	4947.25	5839	915	61.73	61.97	61.72	66.66	5.80	5.03	33.00	0.24
2008	6228.77	7011	915	77.36	78.52	77.50	79.82	0.47	8.84	12.64	1.16
2009	6321.83	7347	915	79.49	86.09	78.87	83.87	1.17	4.77	9.14	6.60
2010	5107.05	5779	915	63.76	67.48	63.72	65.97	3.99	18.93	13.60	3.72
2011	7152.54	7938	915	89.16	89.73	89.23	90.62	0.83	3.06	7.21	0.57
2012	4305.94	4853	915	53.33	61.67	53.57	55.25	0.78	24.41	13.91	8.34
2013	6916.18	7727	915	86.05	86.62	86.29	88.21	0.72	5.31	8.07	0.57
2014	4677.86	5611	915	58.41	60.46	58.36	64.05	2.88	7.31	32.23	2.05
2015	6465.66	7267	915	81.10	81.88	80.67	82.96	8.14	8.35	9.77	0.78
2016	4642.10	5435	915	57.68	58.89	57.76	61.87	8.02	10.04	31.07	1.20
2017	6395.66	7187	915	80.24	80.72	79.79	82.04	1.59	8.30	10.97	0.49
2018	5094.14	5821	915	63.65	64.08	63.55	66.45	2.29	18.62	17.30	0.43
2019	5902.70	7017	915	73.89	82.37	73.64	80.10	8.64	8.14	9.48	8.48
2020	5265.57	6262	915	65.86	71.21	65.51	71.29	1.03	7.79	20.99	5.35
2021	5846.62	6851	915	75.77	94.85	72.94	78.21	4.91	4.90	0.26	19.08

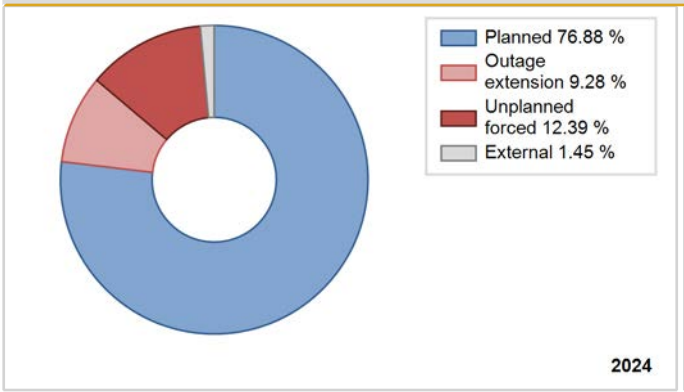
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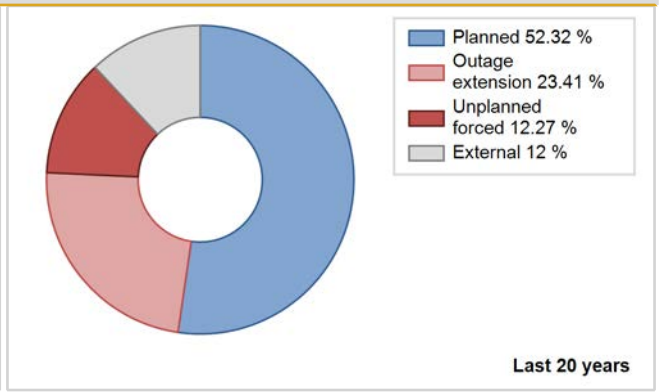
2022	3668.57	4363	915	45.76	53.60	45.77	49.81	6.71	20.82	25.58	7.84
2023	5923.87	6695	915	74.47	79.18	73.91	76.43	5.06	9.23	11.59	4.71
2024	5284.95	6137	915	68.46	68.92	65.75	69.87	5.37	6.84	24.25	0.46

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		470			521	
B.	Refuelling without maintenance				172		
C.	Inspection, maintenance or repair combined with refuelling	2064			883	35	
D.	Inspection, maintenance or repair without refuelling				6		
E.	Testing of plant systems or components				8	2	
G.	Major backfitting, refurbishment or upgrading activities without refuelling				67		
H.	Nuclear regulatory requirements					2	
J.	Grid limitation, failure or grid unavailability						1
L.	Human factor related					16	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						24
O.	Load dispatching, prioritization			88			3
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)			24			82
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						43
Z.	Other					21	
Subtotal		2064	470	112	1136	597	153
Total		**2646**			**1886**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		12
13. Reactor Auxiliary Systems		22
14. Safety Systems	103	26
15. Reactor Cooling Systems		30
16. Steam generation systems		83
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		4
31. Turbine and auxiliaries		82
32. Feedwater and Main Steam System	110	16
34. Miscellaneous Systems	257	191
41. Main Generator Systems		24
42. Electrical Power Supply Systems		27
Total	**470**	**520**

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2024 Operating Experience

FR-22 DAMPIERRE-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	937 MWe
Reference unit power (net)	:	890 MWe

Key Dates

Construction Date	:	1975-02-01
Grid Date	:	1980-03-23
Commercial Date	:	1980-09-10
Age at end of year	:	44 years

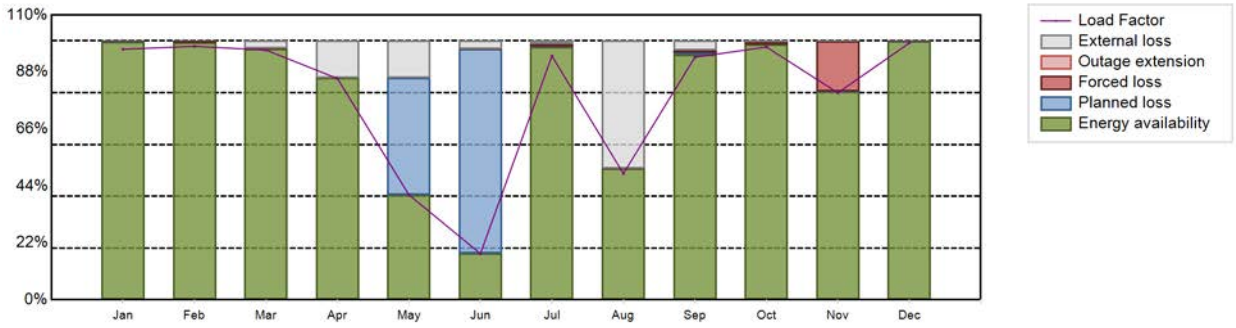
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	41	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6179.42 GW(e).h	Forced Loss Rate (FLR)	:	2.19 %
Energy Availability Factor (EAF)	:	80.18 %	Unplanned Capability Loss Factor (UCL)	:	1.96 %
Unit Capability Factor (UCF)	:	87.66 %	Planned Unavailability Factor (PUF)	:	10.38 %
Load Factor (LF)	:	79.04 %	Externally cause unavailability (XUF)	:	7.48 %
Operating Factor (OF)	:	88.46 %	Total off-line time	:	1014 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	640.82	606.54	637.83	547.82	268.67	114.23	623.62	322.90	600.38	647.41	512.36	656.82	6179.42
EAF [%]	99.71	99.33	96.84	85.72	40.57	17.92	97.60	50.65	94.63	98.69	80.46	99.89	80.18
UCF [%]	99.71	99.33	99.78	100.00	54.79	21.00	98.71	99.85	98.24	99.20	80.50	99.89	87.66
LF [%]	96.78	97.92	96.46	85.49	40.58	17.83	94.18	48.77	93.69	97.64	79.96	99.19	79.04
OF [%]	100.00	100.00	100.00	100.00	54.97	23.89	100.00	100.00	100.00	99.87	81.94	100.00	88.46
FLR [%]	0.24	0.67	0.22	0.00	0.00	0.77	1.09	0.14	1.01	0.80	19.48	0.05	2.19
UCL [%]	0.24	0.67	0.22	0.00	0.00	0.16	1.09	0.14	1.00	0.80	19.47	0.05	1.96
PUF [%]	0.05	0.00	0.00	0.00	45.21	78.84	0.20	0.01	0.76	0.00	0.02	0.06	10.38
XUF [%]	0.00	0.00	2.94	14.28	14.22	3.07	1.12	49.20	3.61	0.51	0.04	0.00	7.48

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Historical Summary

Lifetime energy generation	:	245856.16 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.83 %
Cumulative Energy Availability Factor (EAF)	:	74.55 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.23 %
Cumulative Unit Capability Factor (UCF)	:	77.89 %	Cumulative Planned Unavailability Factor (PUF)	:	14.89 %
Cumulative Load Factor (LF)	:	70.74 %	Cumulative Externally cause unavailability (XUF)	:	3.34 %
Cumulative Operating Factor (OF)	:	76.75 %			

Electricity Production (net) [GWh]

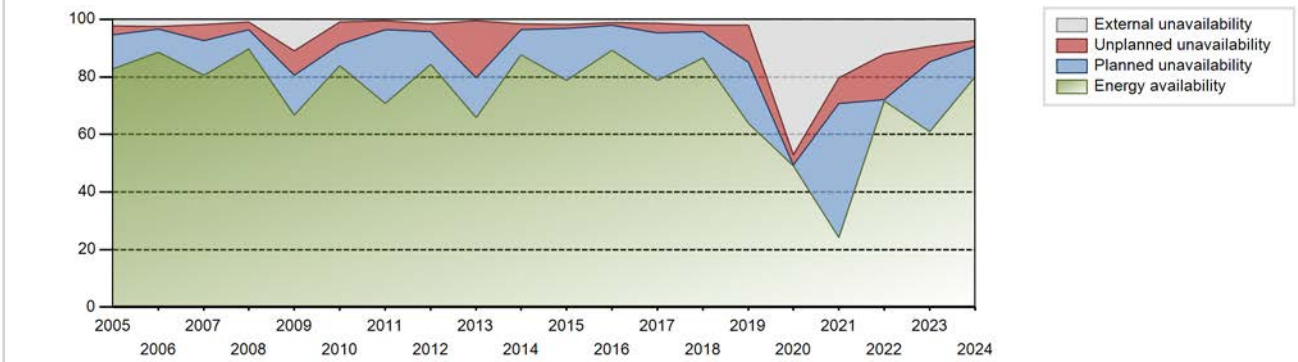


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	2764.00	3950	898	61.91	61.91	69.14	73.12	5.60	3.67	34.41	0.00
1981	4322.10	5270	900	55.90	55.90	54.82	60.16	14.79	9.70	34.39	0.00
1982	5043.90	5994	890	65.56	65.56	64.70	68.42	20.59	17.00	17.43	0.00
1983	6263.00	7847	890	85.88	85.88	80.33	89.58	14.12	14.12	0.00	0.00
1984	5391.00	6777	890	73.61	73.61	68.96	77.15	9.12	7.38	19.01	0.00
1985	5738.50	7223	890	80.64	80.91	73.60	82.45	7.64	6.69	12.40	0.27
1986	5157.40	6673	890	75.73	75.91	66.15	76.18	5.33	4.27	19.82	0.18
1987	4780.20	6245	890	65.93	67.88	61.31	71.29	12.79	9.96	22.16	1.95
1988	3920.00	5239	890	59.60	61.15	50.14	59.64	25.06	20.45	18.39	1.55
1989	6467.63	8207	890	97.86	98.65	82.96	93.69	1.22	1.22	0.13	0.79
1990	2187.08	3110	890	33.96	36.33	28.05	35.50	6.49	2.52	61.15	2.37
1991	6390.92	7305	890	81.80	82.25	81.97	83.39	5.49	4.78	12.97	0.45
1992	6305.06	7293	890	80.73	81.73	80.65	83.03	1.93	1.61	16.66	1.00
1993	6702.80	7676	890	86.38	86.64	85.97	87.63	2.63	2.34	11.02	0.26
1994	5299.19	6185	890	68.88	69.68	67.97	70.61	20.96	18.48	11.85	0.80
1995	6193.95	7413	890	82.91	84.36	79.45	84.62	4.82	4.27	11.37	1.44
1996	5895.50	7378	890	82.24	83.11	75.41	83.99	5.96	5.27	11.62	0.88
1997	5172.13	6465	890	71.92	72.27	66.34	73.80	14.89	12.65	15.08	0.35
1998	6042.70	7294	890	80.53	81.91	77.51	83.26	5.07	4.38	13.71	1.39
1999	5492.41	6815	890	75.31	76.85	70.45	77.80	15.21	13.79	9.36	1.54
2000	6153.75	7676	890	85.40	87.01	78.72	87.39	1.08	0.95	12.04	1.61
2001	4125.07	5152	890	56.67	56.75	52.91	58.81	35.87	31.74	11.50	0.09
2002	6249.59	7586	890	86.84	87.56	80.16	86.60	0.58	1.91	10.54	0.72
2003	5733.30	6964	890	76.79	78.32	73.54	79.50	10.57	9.26	12.42	1.53
2004	6091.18	7840	890	89.26	89.71	77.91	89.25	1.97	1.81	8.48	0.45
2005	5838.83	7554	890	82.84	85.19	74.89	86.23	1.46	3.00	11.81	2.35
2006	6615.07	8077	890	88.56	91.15	84.85	92.20	0.96	0.89	7.96	2.59
2007	6050.04	7329	890	80.66	82.56	77.60	83.66	0.92	5.59	11.84	1.90
2008	6545.33	8051	890	89.68	90.71	83.72	91.66	1.59	2.47	6.82	1.03
2009	4973.23	6048	890	66.69	77.56	63.79	69.04	7.83	8.58	13.86	10.87
2010	6357.03	7511	890	83.94	84.85	81.54	85.74	2.34	7.82	7.33	0.91
2011	5426.06	6373	890	70.74	71.18	69.60	72.75	1.60	3.20	25.62	0.43
2012	6464.50	7623	890	84.47	86.10	82.69	86.78	0.74	2.69	11.21	1.63
2013	5072.13	5882	890	65.93	66.35	65.06	67.15	3.87	19.87	13.78	0.42
2014	6775.73	7927	890	87.71	89.35	86.91	90.49	0.64	1.87	8.78	1.64
2015	6035.49	7168	890	78.68	80.56	77.41	81.83	1.62	1.33	18.11	1.89
2016	6803.89	8073	890	89.34	90.51	87.03	91.91	0.77	0.92	8.56	1.18

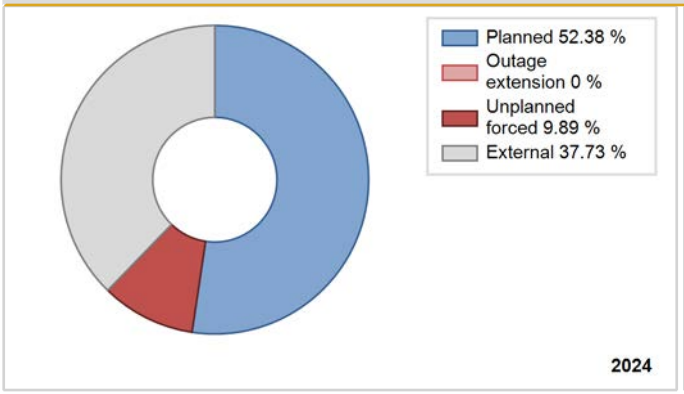
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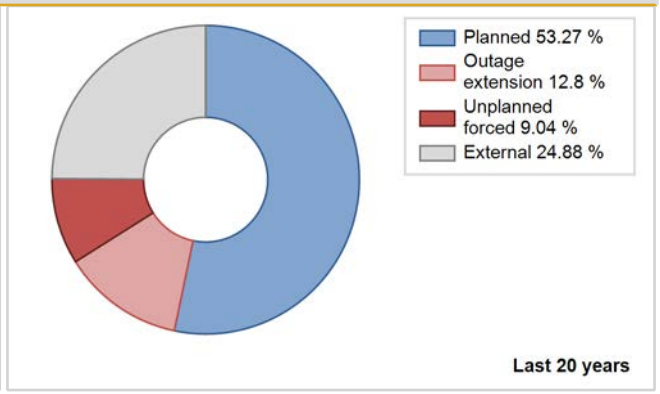
2017	6000.03	7027	890	78.72	79.99	76.96	80.22	0.30	3.42	16.59	1.27
2018	6520.92	7824	890	86.61	88.58	83.64	89.32	1.40	2.23	9.19	1.97
2019	4901.76	5699	890	63.90	65.93	62.87	65.06	10.34	12.95	21.11	2.03
2020	3532.86	4156	890	49.03	96.01	45.19	47.31	3.66	3.65	0.34	46.98
2021	1862.24	2238	890	24.11	44.47	23.89	25.55	3.90	8.93	46.60	20.36
2022	5530.96	6476	890	71.56	83.54	70.94	73.93	7.04	15.97	0.50	11.98
2023	4348.67	5699	890	60.94	70.25	55.78	65.06	5.02	5.36	24.40	9.31
2024	6179.42	7770	890	80.18	87.66	79.04	88.46	2.19	1.96	10.38	7.48

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1980 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		130			352	
B.	Refuelling without maintenance	862			142		
C.	Inspection, maintenance or repair combined with refuelling				1049	24	
D.	Inspection, maintenance or repair without refuelling				42	1	
E.	Testing of plant systems or components				2	1	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L.	Human factor related					26	
M.	Governmental requirements or court decisions						6
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
O.	Load dispatching, prioritization						1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)			21			57
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					5	158
Z.	Other					120	
Subtotal		862	130	21	1235	529	227
Total		**1013**			**1991**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		9
12. Reactor I&C Systems		28
13. Reactor Auxiliary Systems		12
14. Safety Systems		26
15. Reactor Cooling Systems		29
16. Steam generation systems		34
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries	130	20
32. Feedwater and Main Steam System		21
33. Circulating Water System		1
34. Miscellaneous Systems		111
35. All other I&C Systems		1
41. Main Generator Systems		40
42. Electrical Power Supply Systems		16
Total	**130**	**349**

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2024 Operating Experience

FR-29 DAMPIERRE-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	937 MWe
Reference unit power (net)	:	890 MWe

Key Dates

Construction Date	:	1975-04-01
Grid Date	:	1980-12-10
Commercial Date	:	1981-02-16
Age at end of year	:	44 years

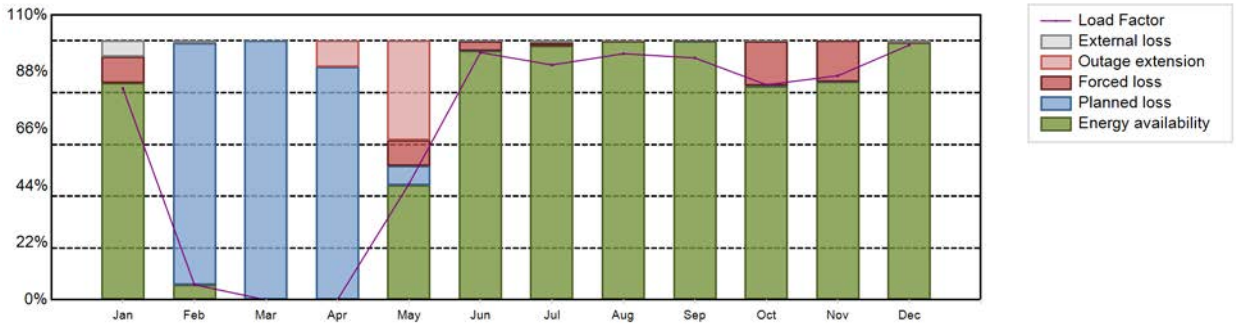
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	41	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5070.05 GW(e).h	Forced Loss Rate (FLR)	:	6.76 %
Energy Availability Factor (EAF)	:	66.45 %	Unplanned Capability Loss Factor (UCL)	:	8.93 %
Unit Capability Factor (UCF)	:	67.19 %	Planned Unavailability Factor (PUF)	:	23.88 %
Load Factor (LF)	:	64.85 %	Externally cause unavailability (XUF)	:	0.73 %
Operating Factor (OF)	:	68.24 %	Total off-line time	:	2790 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	540.08	36.15	0.00	0.00	296.16	612.01	600.73	629.42	598.58	550.76	554.57	651.59	5070.05
EAF [%]	83.73	5.84	0.00	0.00	44.27	96.15	98.11	99.78	99.83	82.61	84.23	99.31	66.45
UCF [%]	89.74	6.81	0.00	0.00	44.27	96.37	98.78	99.88	99.83	82.70	84.23	99.99	67.19
LF [%]	81.56	5.84	0.00	0.00	44.73	95.51	90.72	95.06	93.41	83.07	86.54	98.40	64.85
OF [%]	87.90	6.90	0.00	0.00	52.42	100.00	100.00	100.00	100.00	82.95	85.00	100.00	68.24
FLR [%]	10.26	0.00	0.00	0.00	18.22	3.59	1.22	0.12	0.10	17.22	15.74	0.01	6.76
UCL [%]	10.26	0.00	0.00	10.00	48.17	3.59	1.22	0.12	0.10	17.20	15.73	0.01	8.93
PUF [%]	0.00	93.19	100.00	90.00	7.56	0.05	0.00	0.00	0.08	0.10	0.04	0.00	23.88
XUF [%]	6.01	0.98	0.00	0.00	0.00	0.22	0.67	0.10	0.00	0.09	0.00	0.68	0.73

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Historical Summary

Lifetime energy generation	:	242921.44 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.67 %
Cumulative Energy Availability Factor (EAF)	:	75.9 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.35 %
Cumulative Unit Capability Factor (UCF)	:	77.65 %	Cumulative Planned Unavailability Factor (PUF)	:	15.01 %
Cumulative Load Factor (LF)	:	70.66 %	Cumulative Externally cause unavailability (XUF)	:	1.74 %
Cumulative Operating Factor (OF)	:	76.18 %			

Electricity Production (net) [GWh]

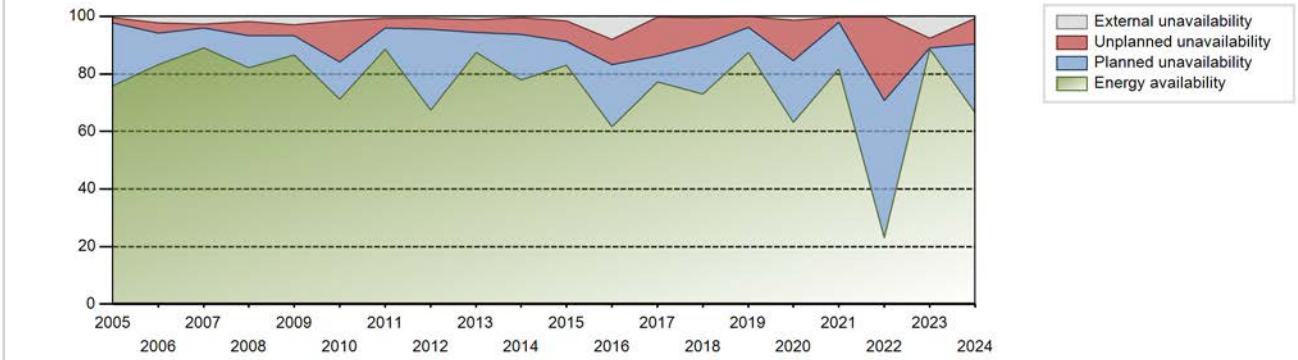


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	5818.40	7306	900	75.54	75.54	73.88	81.74	3.68	2.89	21.58	0.00
1982	4110.80	4848	890	53.04	53.04	52.73	55.34	19.31	12.69	34.27	0.00
1983	5191.00	6139	890	67.67	67.67	66.58	70.08	13.96	10.98	21.36	0.00
1984	5781.00	6884	890	76.07	76.07	73.95	78.37	8.21	6.80	17.12	0.00
1985	6056.90	7400	890	84.34	84.47	77.69	84.47	8.91	8.26	7.27	0.13
1986	5658.50	6983	890	81.99	82.18	72.58	79.71	2.22	1.87	15.95	0.19
1987	4855.97	5715	890	76.42	78.85	62.28	65.24	9.38	8.16	12.99	2.43
1988	4583.00	6153	890	92.39	95.06	58.62	70.05	4.94	4.94	0.00	2.67
1989	5485.29	6927	890	76.96	79.73	70.36	79.08	2.27	1.85	18.42	2.77
1990	4869.51	6292	890	67.77	69.95	62.46	71.83	10.53	8.23	21.82	2.18
1991	4201.95	5407	890	63.27	67.59	53.90	61.72	8.16	6.00	26.41	4.32
1992	5049.75	6429	890	74.74	75.87	64.59	73.19	11.67	10.02	14.11	1.13
1993	5976.57	7625	890	79.62	87.41	76.66	87.04	1.28	1.13	11.46	7.80
1994	4444.99	5328	890	84.77	84.84	57.01	60.82	3.76	3.31	11.85	0.07
1995	5562.04	6952	890	94.97	95.55	71.34	79.36	4.38	4.38	0.07	0.58
1996	5761.00	7437	890	81.47	84.23	73.69	84.67	3.01	2.61	13.16	2.75
1997	4966.59	6204	890	67.53	69.32	63.70	70.82	21.57	19.06	11.62	1.79
1998	5855.92	7192	890	78.32	80.33	75.11	82.10	5.67	4.82	14.85	2.01
1999	5312.90	6688	890	69.21	72.58	68.15	76.35	16.72	14.57	12.85	3.37
2000	5866.14	7121	890	76.03	77.55	75.04	81.07	10.45	9.05	13.40	1.52
2001	5355.88	6593	890	72.43	75.09	68.70	75.26	10.96	9.25	15.66	2.67
2002	4307.55	5196	890	55.95	56.33	55.25	59.32	22.06	15.94	27.72	0.38
2003	6268.32	7631	890	81.32	81.37	80.40	87.11	8.14	7.21	11.42	0.04
2004	5983.93	7286	890	93.70	95.73	76.54	82.95	2.41	2.36	1.91	2.03
2005	5255.28	6719	890	75.79	76.34	67.41	76.70	1.27	1.64	22.02	0.55
2006	5880.50	7371	890	83.23	85.47	75.43	84.14	1.12	3.63	10.90	2.24
2007	6582.66	8201	890	88.94	91.70	84.43	93.62	1.32	1.23	7.07	2.76
2008	6014.89	7462	890	82.11	83.97	76.94	84.95	2.95	4.77	11.26	1.86
2009	6455.29	7902	890	86.56	89.50	82.80	90.21	2.14	3.72	6.78	2.94
2010	5399.78	6491	890	71.18	72.78	69.26	74.10	3.65	14.22	13.00	1.60
2011	6741.93	7890	890	88.69	89.33	86.47	90.07	1.08	3.34	7.32	0.64
2012	5117.98	6091	890	67.39	68.14	65.47	69.34	0.96	3.72	28.15	0.74
2013	6508.82	7666	890	87.41	88.66	83.48	87.51	1.66	4.38	6.96	1.25
2014	5771.73	6913	890	77.81	78.39	74.03	78.92	0.99	5.71	15.89	0.58
2015	6402.25	7490	890	82.98	84.49	82.12	85.50	7.87	7.21	8.30	1.51
2016	4932.37	5619	890	61.60	69.59	63.09	63.97	0.64	8.86	21.55	7.99
2017	6153.50	6869	890	77.15	77.36	78.93	78.41	13.03	13.67	8.97	0.21

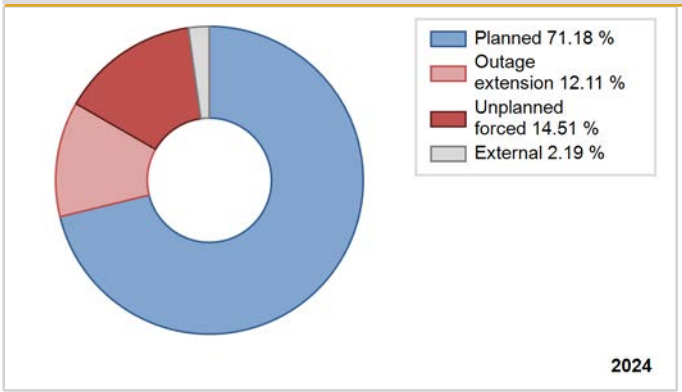
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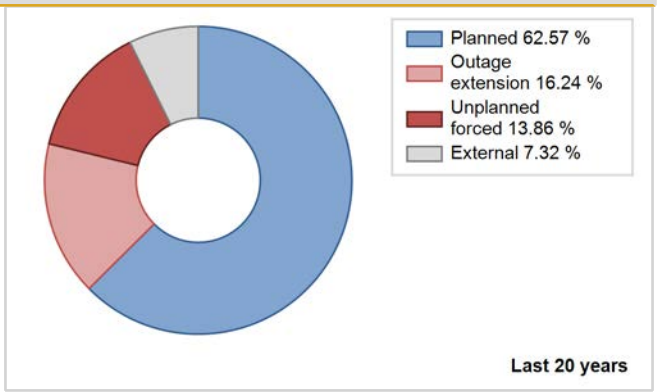
2018	5831.89	6585	890	72.94	73.46	74.80	75.17	5.93	9.23	17.30	0.53
2019	7062.17	7793	890	87.56	87.57	90.58	88.96	4.20	3.84	8.58	0.01
2020	5081.11	6011	890	63.08	64.56	64.99	68.43	9.29	13.96	21.48	1.48
2021	6520.64	7346	890	81.73	81.93	83.64	83.86	1.98	1.94	16.14	0.20
2022	1855.50	2069	890	23.07	23.21	23.80	23.62	27.60	28.99	47.79	0.14
2023	6679.55	7843	890	88.49	96.09	85.67	89.53	3.32	3.30	0.62	7.60
2024	5070.05	5994	890	66.45	67.19	64.85	68.24	6.76	8.93	23.88	0.73

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		735			415	
B.	Refuelling without maintenance				137		
C.	Inspection, maintenance or repair combined with refuelling	2063			1055	11	
D.	Inspection, maintenance or repair without refuelling				52		
E.	Testing of plant systems or components				5	0	
H.	Nuclear regulatory requirements					3	
J.	Grid limitation, failure or grid unavailability						2
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						2
L.	Human factor related					13	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
O.	Load dispatching, prioritization			16			2
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					1	19
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					8	14
Z.	Other					91	14
Subtotal		2063	735	16	1249	542	53
Total		**2814**			**1844**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		11
13. Reactor Auxiliary Systems		10
14. Safety Systems	74	27
15. Reactor Cooling Systems		34
16. Steam generation systems		34
21. Fuel Handling and Storage Facilities		6
31. Turbine and auxiliaries	235	72
32. Feedwater and Main Steam System		17
34. Miscellaneous Systems	426	137
35. All other I&C Systems		0
41. Main Generator Systems		34
42. Electrical Power Supply Systems		43
Total	**735**	**429**

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2024 Operating Experience

FR-30 DAMPIERRE-3 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	937 MWe
Reference unit power (net)	:	890 MWe

Key Dates

Construction Date	:	1975-09-01
Grid Date	:	1981-01-30
Commercial Date	:	1981-05-27
Age at end of year	:	43 years

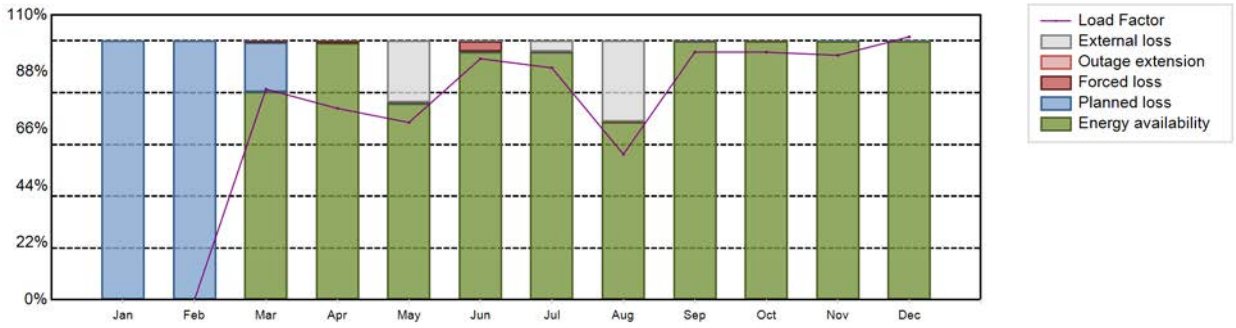
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	41	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5552.7 GW(e).h	Forced Loss Rate (FLR)	:	0.62 %
Energy Availability Factor (EAF)	:	76.42 %	Unplanned Capability Loss Factor (UCL)	:	0.51 %
Unit Capability Factor (UCF)	:	81.43 %	Planned Unavailability Factor (PUF)	:	18.07 %
Load Factor (LF)	:	71.03 %	Externally cause unavailability (XUF)	:	5 %
Operating Factor (OF)	:	76.48 %	Total off-line time	:	2066 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	538.01	473.75	453.57	596.70	593.21	372.16	613.23	634.21	605.23	672.61	5552.70
EAF [%]	0.00	0.00	80.34	99.01	75.87	95.75	95.63	68.56	99.95	99.93	99.98	99.97	76.42
UCF [%]	0.00	0.00	80.34	99.01	99.64	95.96	99.70	99.60	99.95	99.93	99.98	99.97	81.43
LF [%]	0.00	0.00	81.36	73.93	68.50	93.12	89.59	56.20	95.70	95.65	94.45	101.58	71.03
OF [%]	0.00	0.00	94.08	89.72	77.28	94.44	96.24	69.35	100.00	99.87	94.17	100.00	76.48
FLR [%]	0.00	0.00	0.72	0.99	0.31	4.00	0.18	0.07	0.02	0.00	0.00	0.00	0.62
UCL [%]	0.00	0.00	0.58	0.99	0.31	4.00	0.18	0.07	0.02	0.00	0.00	0.00	0.51
PUF [%]	100.00	100.00	19.08	0.00	0.05	0.04	0.12	0.33	0.03	0.07	0.02	0.03	18.07
XUF [%]	0.00	0.00	0.00	0.00	23.77	0.21	4.08	31.04	0.00	0.00	0.00	0.00	5.00

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Historical Summary

Lifetime energy generation	:	254366.09 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.54 %
Cumulative Energy Availability Factor (EAF)	:	77.56 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.84 %
Cumulative Unit Capability Factor (UCF)	:	79.33 %	Cumulative Planned Unavailability Factor (PUF)	:	14.83 %
Cumulative Load Factor (LF)	:	74.35 %	Cumulative Externally cause unavailability (XUF)	:	1.78 %
Cumulative Operating Factor (OF)	:	78.94 %			

Electricity Production (net) [GWh]

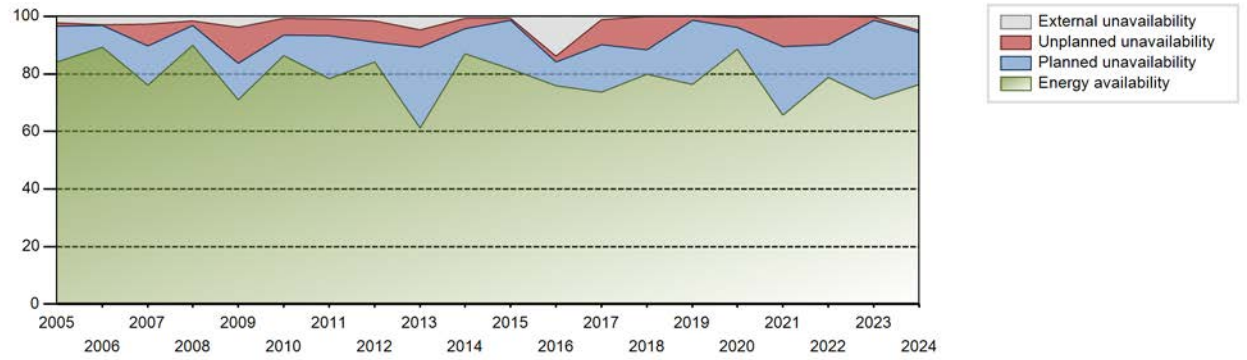


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	5123.40	6452	900	83.51	83.51	81.70	86.95	3.93	3.41	13.08	0.00
1982	3767.60	4632	890	48.72	48.72	48.32	52.88	22.04	13.77	37.51	0.00
1983	5517.00	6638	890	72.69	72.69	70.76	75.78	12.35	10.24	17.07	0.00
1984	6206.00	7121	890	79.68	79.68	79.38	81.07	7.35	6.32	14.00	0.00
1985	6364.40	7523	890	84.89	85.11	81.63	85.88	2.99	2.62	12.26	0.22
1986	6717.20	8330	890	99.52	99.87	86.16	95.09	0.13	0.13	0.00	0.35
1987	5019.50	6269	890	79.33	82.43	64.38	71.56	7.76	6.94	10.63	3.10
1988	4964.00	6435	890	68.53	72.91	63.50	73.26	8.48	6.75	20.34	4.37
1989	5912.85	7242	890	78.38	82.16	75.84	82.67	5.95	5.20	12.65	3.78
1990	5996.46	7348	890	79.77	82.50	76.91	83.88	1.91	1.61	15.89	2.73
1991	5124.05	6244	890	69.56	70.04	65.72	71.28	18.40	15.79	14.17	0.47
1992	4875.11	5814	890	65.50	65.51	62.36	66.19	5.88	4.10	30.40	0.00
1993	6148.83	7333	890	82.76	82.76	78.87	83.71	4.85	4.22	13.02	0.00
1994	5537.56	7013	890	82.73	86.17	71.03	80.06	0.38	0.33	13.50	3.43
1995	4773.50	6343	890	80.20	83.44	61.23	72.41	0.78	0.65	15.91	3.24
1996	5575.09	6940	890	77.08	77.63	71.31	79.01	7.66	6.44	15.93	0.55
1997	5720.89	7211	890	78.29	81.02	73.38	82.32	8.56	7.59	11.39	2.73
1998	5905.83	7210	890	81.44	82.67	75.75	82.31	6.68	5.91	11.41	1.24
1999	5779.45	7186	890	78.23	80.89	74.13	82.03	6.34	5.47	13.64	2.66
2000	4308.35	5378	890	57.58	59.78	55.11	61.22	31.56	27.56	12.66	2.20
2001	5993.02	7060	890	77.38	77.75	76.87	80.59	5.76	7.77	14.48	0.38
2002	5929.80	6877	890	76.85	77.42	76.06	78.50	9.75	8.36	14.22	0.57
2003	5346.90	6152	890	68.91	68.98	68.58	70.23	4.75	3.44	27.59	0.07
2004	6867.17	7920	890	87.98	89.25	87.84	90.16	0.43	0.39	10.36	1.27
2005	6242.37	7627	890	84.13	86.49	80.06	87.06	1.25	1.10	12.41	2.36
2006	6228.48	7991	890	89.29	92.26	79.89	91.22	0.30	0.28	7.46	2.98
2007	5614.09	6928	890	76.03	78.72	72.01	79.09	7.35	7.58	13.69	2.69
2008	6725.61	8100	890	89.97	91.52	86.03	92.21	0.31	1.52	6.97	1.55
2009	5364.97	6486	890	71.00	74.75	68.81	74.04	3.64	12.66	12.59	3.75
2010	6642.91	7660	890	86.31	87.03	85.20	87.44	3.52	5.89	7.08	0.72
2011	5999.40	7020	890	78.44	79.35	76.95	80.14	0.30	5.88	14.77	0.91
2012	6513.75	7595	890	84.17	85.86	83.32	86.46	0.30	7.24	6.90	1.68
2013	4747.59	5438	890	61.14	65.81	60.89	62.08	0.78	6.13	28.06	4.67
2014	6746.72	7824	890	87.13	87.95	86.54	89.32	0.89	3.42	8.64	0.82
2015	6378.71	7269	890	81.62	82.37	81.82	82.98	0.68	0.57	17.06	0.75
2016	6045.05	6807	890	75.83	89.75	77.32	77.49	0.36	1.94	8.32	13.91
2017	5832.29	6540	890	73.65	74.76	74.81	74.66	6.55	8.80	16.44	1.11

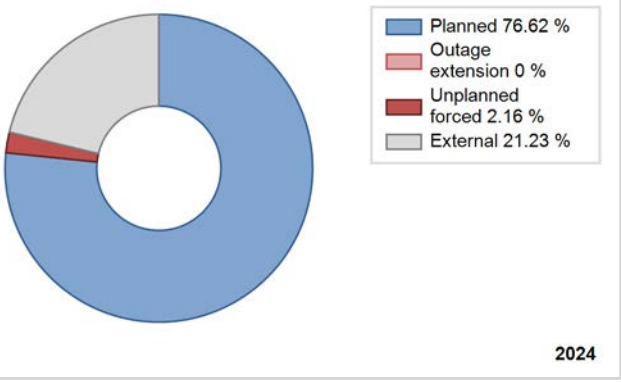
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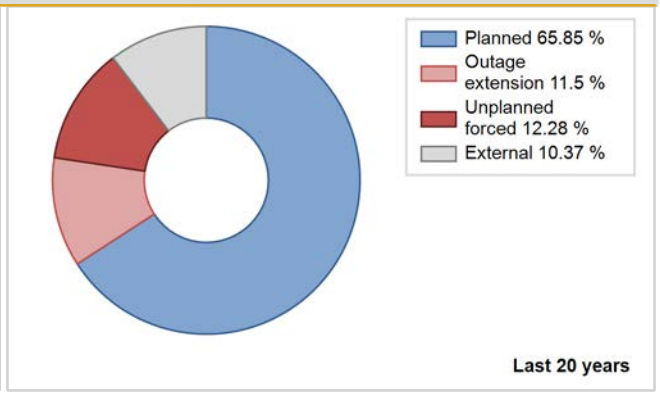
2018	6252.31	7054	890	79.82	79.84	80.19	80.53	7.26	11.58	8.58	0.02
2019	6079.01	6794	890	76.33	76.40	77.97	77.56	1.66	1.29	22.31	0.08
2020	6930.71	7929	890	88.50	88.90	88.65	90.27	3.82	3.53	7.57	0.40
2021	5127.77	5899	890	65.67	65.84	65.77	67.34	12.25	10.35	23.81	0.16
2022	6238.98	6953	890	78.77	78.92	80.02	79.37	9.73	9.67	11.42	0.15
2023	5490.16	6294	890	71.24	71.52	70.42	71.85	1.45	1.05	27.43	0.28
2024	5552.70	6718	890	76.42	81.43	71.03	76.48	0.62	0.51	18.07	5.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		26			325	
B.	Refuelling without maintenance				102		
C.	Inspection, maintenance or repair combined with refuelling	1484			1136	6	
D.	Inspection, maintenance or repair without refuelling				19	1	
E.	Testing of plant systems or components				4	1	
I.	Grid capacity limitation						0
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						2
L.	Human factor related					22	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
O.	Load dispatching, prioritization			130			5
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					3	42
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			425		5	11
Z.	Other					66	
Subtotal		1484	26	555	1261	429	60
Total		**2065**			**1750**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		1
12. Reactor I&C Systems		5
13. Reactor Auxiliary Systems		6
14. Safety Systems		42
15. Reactor Cooling Systems		56
16. Steam generation systems		59
31. Turbine and auxiliaries		34
32. Feedwater and Main Steam System	26	10
33. Circulating Water System		1
34. Miscellaneous Systems		74
35. All other I&C Systems		3
41. Main Generator Systems		21
42. Electrical Power Supply Systems		38
Total	**26**	**350**

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2024 Operating Experience

FR-31 DAMPIERRE-4 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	937 MWe
Reference unit power (net)	:	890 MWe

Key Dates

Construction Date	:	1975-12-01
Grid Date	:	1981-08-18
Commercial Date	:	1981-11-20
Age at end of year	:	43 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	41
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

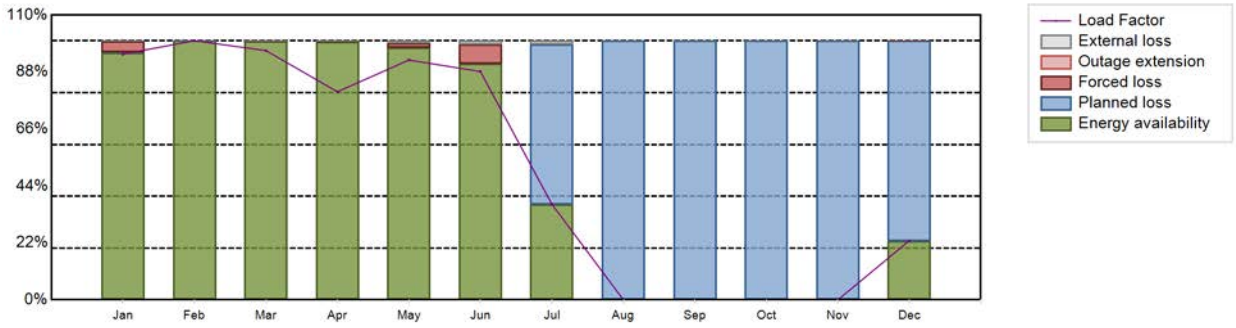
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.61
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3973.68 GW(e).h
Energy Availability Factor (EAF)	:	53.4 %
Unit Capability Factor (UCF)	:	53.71 %
Load Factor (LF)	:	50.83 %
Operating Factor (OF)	:	53.85 %

Forced Loss Rate (FLR)	:	2.12 %
Unplanned Capability Loss Factor (UCL)	:	1.17 %
Planned Unavailability Factor (PUF)	:	45.13 %
Externally cause unavailability (XUF)	:	0.31 %
Total off-line time	:	4054 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	628.33	619.99	636.46	514.95	613.23	564.99	244.36	0.00	0.00	0.00	0.00	151.36	3973.68
EAF [%]	95.52	99.99	99.80	99.68	97.41	91.10	36.90	0.00	0.00	0.00	0.00	22.76	53.40
UCF [%]	95.53	99.99	99.83	99.75	98.33	92.36	38.32	0.00	0.00	0.00	0.00	22.76	53.71
LF [%]	94.89	100.09	96.25	80.36	92.61	88.17	36.90	0.00	0.00	0.00	0.00	22.86	50.83
OF [%]	100.00	100.00	100.00	85.42	100.00	91.25	38.58	0.00	0.00	0.00	0.00	32.80	53.85
FLR [%]	4.42	0.00	0.17	0.10	1.67	7.64	0.00	0.00	0.00	0.00	0.00	0.03	2.12
UCL [%]	4.42	0.00	0.17	0.10	1.67	7.64	0.00	0.00	0.00	0.00	0.00	0.01	1.17
PUF [%]	0.05	0.01	0.00	0.15	0.00	0.00	61.68	100.00	100.00	100.00	100.00	77.23	45.13
XUF [%]	0.02	0.00	0.03	0.07	0.92	1.26	1.42	0.00	0.00	0.00	0.00	0.00	0.31

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Historical Summary

Lifetime energy generation	:	240123.61 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.44 %
Cumulative Energy Availability Factor (EAF)	:	74.87 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.37 %
Cumulative Unit Capability Factor (UCF)	:	77.12 %	Cumulative Planned Unavailability Factor (PUF)	:	14.51 %
Cumulative Load Factor (LF)	:	71.09 %	Cumulative Externally cause unavailability (XUF)	:	2.25 %
Cumulative Operating Factor (OF)	:	76.97 %			

Electricity Production (net) [GWh]

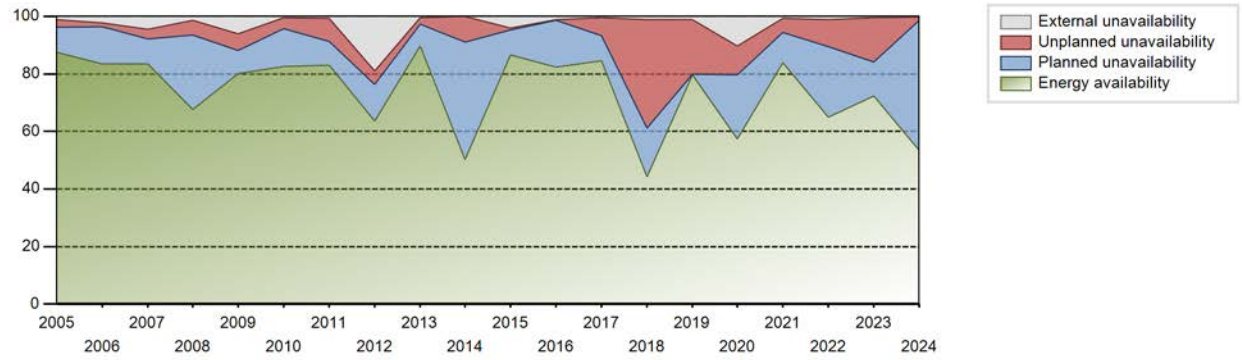


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	1569.50	2392	894	77.30	77.30	77.30	79.30	0.00	0.00	22.70	0.00
1982	5745.60	7413	890	81.81	81.81	73.70	84.62	18.19	18.19	0.00	0.00
1983	4156.00	5207	890	57.60	57.60	53.31	59.44	13.86	9.27	33.13	0.00
1984	6276.00	7765	890	85.10	85.10	80.28	88.40	4.15	3.69	11.21	0.00
1985	5859.90	7387	890	78.92	83.46	75.16	84.33	5.42	4.78	11.76	4.54
1986	6664.90	7862	890	88.47	88.80	85.49	89.75	1.03	0.93	10.28	0.33
1987	5447.80	6795	890	78.10	78.40	69.88	77.57	6.17	5.15	16.44	0.31
1988	5086.00	6645	890	79.93	82.92	65.06	75.65	4.87	4.25	12.83	2.99
1989	5392.37	6621	890	72.88	73.73	69.16	75.58	6.75	5.33	20.94	0.85
1990	5153.00	6792	890	87.31	91.20	66.09	77.53	2.32	2.17	6.63	3.89
1991	6062.80	7612	890	86.70	88.34	77.76	86.89	3.50	3.21	8.45	1.64
1992	5331.48	6832	890	74.50	76.68	68.20	77.78	10.71	9.19	14.13	2.18
1993	4827.70	6103	890	63.35	69.25	61.92	69.67	8.17	6.16	24.59	5.90
1994	5263.99	7103	890	79.52	80.74	67.52	81.08	9.93	8.90	10.36	1.22
1995	5488.04	6997	890	75.36	78.84	70.39	79.87	10.89	9.63	11.52	3.48
1996	6118.49	7596	890	82.93	83.67	78.26	86.48	4.95	4.35	11.98	0.74
1997	5918.58	7178	890	80.46	80.86	75.91	81.94	5.26	4.48	14.66	0.39
1998	4506.48	5435	890	58.98	60.59	57.80	62.04	26.81	22.20	17.22	1.60
1999	4642.53	5770	890	64.13	64.76	59.55	65.87	28.25	25.50	9.74	0.63
2000	5598.66	6752	890	75.15	76.02	71.61	76.87	11.87	10.24	13.74	0.87
2001	5361.82	6422	890	70.08	70.91	68.77	73.31	28.41	28.14	0.95	0.83
2002	6134.48	7576	890	83.77	85.28	78.68	86.48	2.77	2.43	12.30	1.50
2003	5547.40	6759	890	73.37	77.39	71.15	77.16	3.55	9.60	13.02	4.02
2004	4531.79	5551	890	59.44	61.31	57.97	63.19	16.90	12.47	26.23	1.87
2005	6566.95	7956	890	87.56	88.67	84.22	90.81	1.62	2.61	8.71	1.11
2006	5905.36	7428	890	83.57	85.77	75.74	84.79	1.50	1.45	12.79	2.20
2007	5763.52	7384	890	83.51	88.11	73.93	84.29	3.21	3.30	8.59	4.60
2008	5249.14	6317	890	67.53	68.82	67.14	71.91	4.44	5.11	26.07	1.29
2009	6259.13	7151	890	80.17	86.31	80.28	81.63	2.04	5.80	7.90	6.13
2010	6472.40	7344	890	82.59	83.17	83.02	83.84	0.18	3.71	13.12	0.59
2011	6433.47	7506	890	83.13	83.74	82.52	85.68	5.60	8.16	8.10	0.61
2012	5014.64	5644	890	63.57	82.56	64.14	64.25	0.30	4.66	12.78	18.98
2013	7074.86	7942	890	89.80	90.31	90.75	90.66	0.65	2.17	7.51	0.52
2014	3970.80	4507	890	50.26	50.26	50.93	51.45	0.36	8.86	40.87	0.00
2015	6750.08	8025	890	86.66	90.66	86.58	91.61	0.38	0.81	8.53	4.00
2016	6456.43	7442	890	82.44	83.60	82.59	84.72	0.19	0.16	16.24	1.16
2017	6599.79	7688	890	84.58	85.18	84.65	87.76	3.79	6.03	8.80	0.60

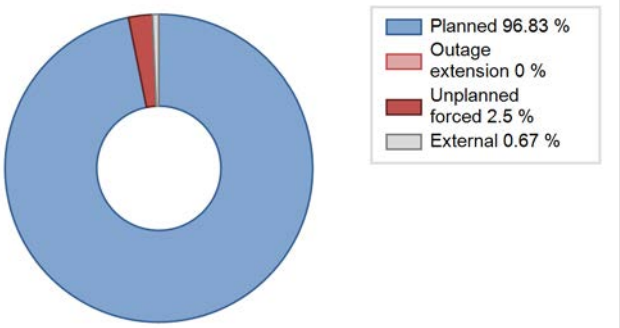
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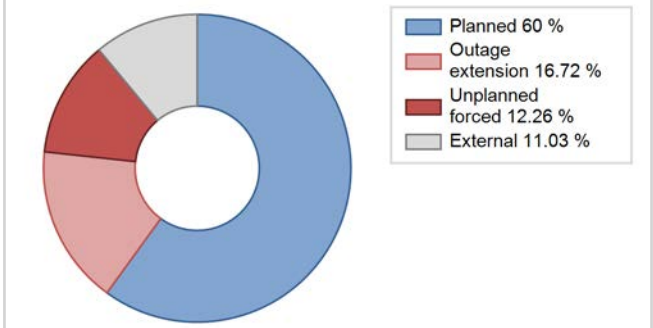
2018	3438.52	4116	890	44.32	45.36	44.10	46.99	4.16	37.73	16.91	1.03
2019	5979.78	7196	890	79.76	80.98	76.70	82.15	19.00	19.00	0.03	1.21
2020	4457.67	5335	890	57.36	67.76	57.02	60.74	4.49	9.84	22.40	10.40
2021	6437.40	7571	890	83.92	84.56	82.57	86.43	5.59	5.01	10.43	0.64
2022	5033.31	6027	890	65.03	66.22	64.56	68.80	2.58	9.39	24.39	1.19
2023	5490.50	6634	890	72.42	72.97	70.42	75.73	12.94	15.36	11.68	0.54
2024	3973.68	4730	890	53.40	53.71	50.83	53.85	2.12	1.17	45.13	0.31

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		42			512	
B.	Refuelling without maintenance				135		
C.	Inspection, maintenance or repair combined with refuelling	3886			1074	20	
D.	Inspection, maintenance or repair without refuelling				3	1	
E.	Testing of plant systems or components				4	1	
H.	Nuclear regulatory requirements					1	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						12
L.	Human factor related					17	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						23
O.	Load dispatching, prioritization			126			5
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					3	60
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					6	1
Z.	Other					61	6
Subtotal		3886	42	126	1216	622	107
Total		**4054**			**1945**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		35
12. Reactor I&C Systems		6
13. Reactor Auxiliary Systems		37
14. Safety Systems		8
15. Reactor Cooling Systems		13
16. Steam generation systems		127
21. Fuel Handling and Storage Facilities		9
31. Turbine and auxiliaries	22	39
32. Feedwater and Main Steam System		26
33. Circulating Water System		1
34. Miscellaneous Systems		121
35. All other I&C Systems		0
41. Main Generator Systems	20	70
42. Electrical Power Supply Systems		17
Total	**42**	**509**

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2024 Operating Experience

FR-46 FLAMANVILLE-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1382 MWe
Reference unit power (net)	:	1330 MWe

Key Dates

Construction Date	:	1979-12-01
Grid Date	:	1985-12-04
Commercial Date	:	1986-12-01
Age at end of year	:	39 years

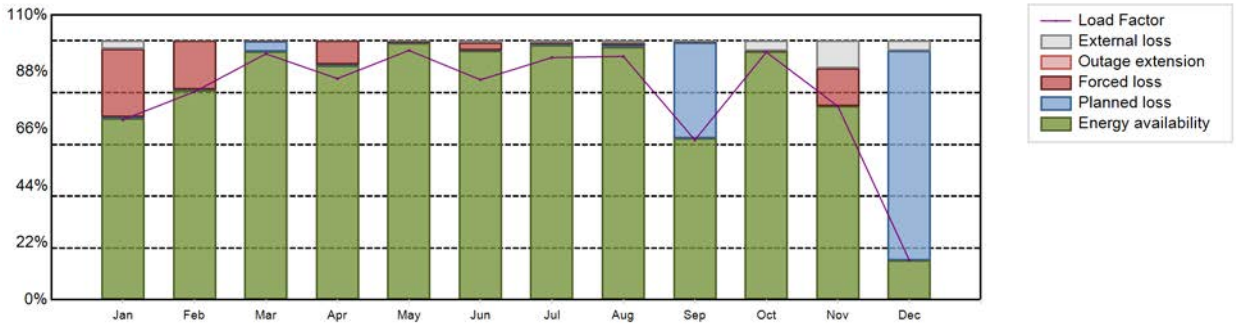
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9219.03 GW(e).h	Forced Loss Rate (FLR)	:	6.8 %
Energy Availability Factor (EAF)	:	81.42 %	Unplanned Capability Loss Factor (UCL)	:	6.09 %
Unit Capability Factor (UCF)	:	83.4 %	Planned Unavailability Factor (PUF)	:	10.51 %
Load Factor (LF)	:	78.91 %	Externally cause unavailability (XUF)	:	1.98 %
Operating Factor (OF)	:	85.45 %	Total off-line time	:	1278 hours

Annual Summary



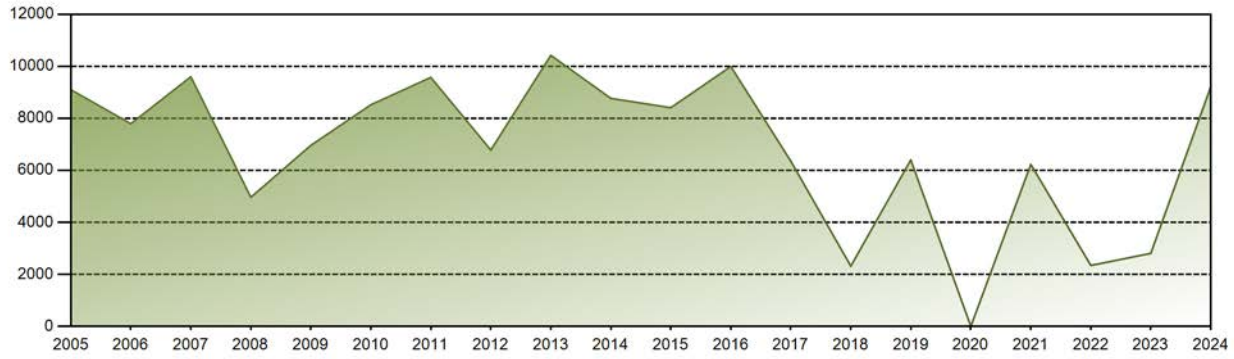
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	688.55	743.78	938.95	818.20	953.16	813.97	925.92	930.30	591.31	947.73	715.99	151.18	9219.03
EAF [%]	70.18	81.03	95.79	90.38	99.03	96.12	98.27	97.62	62.46	96.00	74.77	15.28	81.42
UCF [%]	73.41	81.03	95.79	90.38	99.13	96.74	98.79	98.43	62.93	99.77	85.23	19.08	83.40
LF [%]	69.58	80.35	95.02	85.44	96.33	85.00	93.57	94.02	61.75	95.65	74.77	15.28	78.91
OF [%]	77.96	82.18	100.00	89.86	100.00	100.00	100.00	100.00	66.94	99.87	89.44	19.09	85.45
FLR [%]	26.37	18.72	0.03	9.13	0.48	2.96	0.63	0.89	0.24	0.02	14.77	0.00	6.80
UCL [%]	26.29	18.67	0.03	9.08	0.48	2.95	0.62	0.89	0.15	0.02	14.77	0.00	6.09
PUF [%]	0.30	0.30	4.18	0.54	0.39	0.31	0.59	0.68	36.92	0.20	0.00	80.92	10.51
XUF [%]	3.23	0.00	0.00	0.00	0.10	0.62	0.52	0.81	0.47	3.78	10.46	3.80	1.98

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Historical Summary

Lifetime energy generation	:	284691.52 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	16.2 %
Cumulative Energy Availability Factor (EAF)	:	67.23 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	16.62 %
Cumulative Unit Capability Factor (UCF)	:	70.29 %	Cumulative Planned Unavailability Factor (PUF)	:	13.09 %
Cumulative Load Factor (LF)	:	63.46 %	Cumulative Externally cause unavailability (XUF)	:	3.06 %
Cumulative Operating Factor (OF)	:	69.64 %			

Electricity Production (net) [GWh]

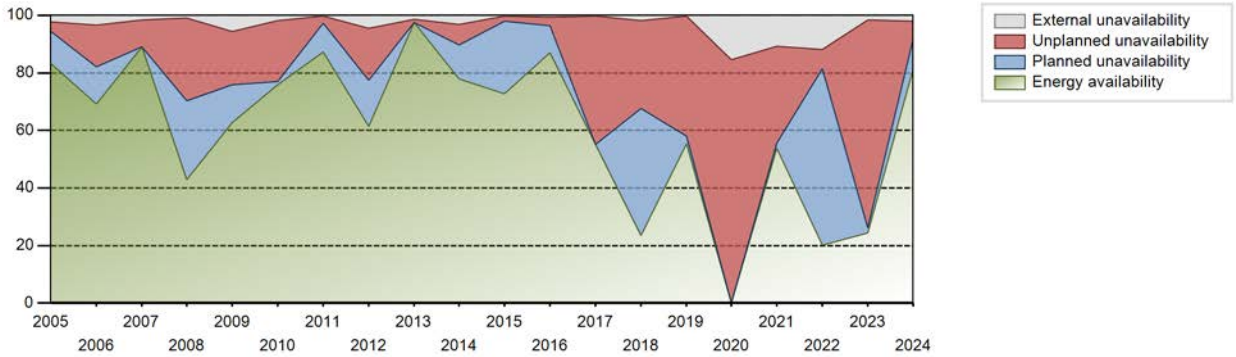


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	5273.00	4840	1290	97.32	97.34	100.64	97.58	2.66	2.66	0.00	0.02
1987	7150.80	5656	1290	62.17	63.23	63.28	64.57	15.78	11.84	24.93	1.06
1988	7175.00	5757	1330	66.02	67.42	61.42	65.54	19.17	15.99	16.59	1.40
1989	8775.16	7146	1330	80.59	81.02	75.32	81.58	18.90	18.88	0.10	0.43
1990	7089.98	6360	1330	65.70	67.04	60.85	72.60	18.85	15.57	17.39	1.35
1991	5882.88	5481	1330	59.40	68.35	50.49	62.57	15.52	12.56	19.09	8.96
1992	7606.83	5901	1330	66.20	66.20	65.11	67.18	20.37	16.93	16.87	0.00
1993	9301.82	7936	1330	87.17	96.79	79.84	90.59	3.15	3.15	0.06	9.63
1994	7145.81	6515	1330	75.32	80.13	61.33	74.37	5.29	4.48	15.39	4.81
1995	7665.06	6654	1330	73.20	77.40	65.79	75.96	10.29	8.87	13.72	4.20
1996	8598.28	7050	1330	77.80	84.58	73.60	80.26	4.04	3.56	11.86	6.79
1997	6853.94	5529	1330	62.33	63.92	58.83	63.12	16.88	12.98	23.09	1.60
1998	9469.38	7855	1330	86.66	86.67	81.28	89.67	11.93	11.74	1.59	0.01
1999	6979.37	5906	1330	64.45	66.13	59.90	67.42	12.88	9.78	24.10	1.68
2000	8035.27	6607	1330	74.51	75.55	68.78	75.22	10.11	8.50	15.95	1.04
2001	10038.55	8126	1330	92.54	92.57	86.16	92.76	6.82	6.77	0.66	0.03
2002	8141.77	6736	1330	73.11	75.51	69.88	76.89	11.60	9.91	14.57	2.40
2003	7510.77	6090	1330	67.81	68.17	64.47	69.52	12.17	9.45	22.38	0.36
2004	10630.05	8668	1330	96.85	98.20	90.99	98.68	1.67	1.66	0.13	1.35
2005	9099.89	7627	1330	83.28	85.64	78.10	87.06	3.77	3.36	11.00	2.36
2006	7790.93	6675	1330	69.12	72.51	66.87	76.20	9.65	14.55	12.93	3.39
2007	9595.59	8041	1330	88.98	90.50	82.36	91.79	9.49	9.49	0.02	1.52
2008	4962.39	4018	1330	42.91	43.78	42.48	45.74	26.40	28.80	27.41	0.87
2009	6956.71	5593	1330	62.70	68.20	59.71	63.85	5.98	18.71	13.09	5.50
2010	8519.72	6955	1330	75.78	77.58	73.13	79.39	14.73	21.22	1.21	1.80
2011	9572.66	7768	1330	87.24	87.45	82.16	88.68	0.75	2.59	9.97	0.21
2012	6778.12	5618	1330	61.38	65.94	58.02	63.96	5.74	18.02	16.04	4.57
2013	10422.78	8682	1330	97.47	98.81	89.46	99.11	1.17	1.17	0.02	1.34
2014	8767.06	7002	1330	77.96	81.21	75.25	79.93	6.24	7.04	11.75	3.26
2015	8408.87	6584	1330	72.76	72.92	72.17	75.16	2.46	1.84	25.24	0.16
2016	9991.47	8013	1330	87.04	87.68	85.52	91.22	3.22	2.92	9.41	0.64
2017	6352.00	5245	1330	55.17	55.42	54.52	59.87	44.56	44.55	0.04	0.25
2018	2316.68	1832	1330	23.48	25.31	19.88	20.91	10.02	30.57	44.12	1.83
2019	6402.31	5227	1330	55.39	55.57	54.95	59.67	38.19	41.69	2.74	0.18
2020	0.00	0	1330	0.00	15.43	0.00	0.00	84.57	84.57	0.00	15.43
2021	6229.83	5161	1330	53.77	64.47	53.47	58.92	34.32	33.69	1.83	10.70
2022	2342.90	1940	1330	20.17	32.02	20.11	22.15	0.49	6.71	61.27	11.85

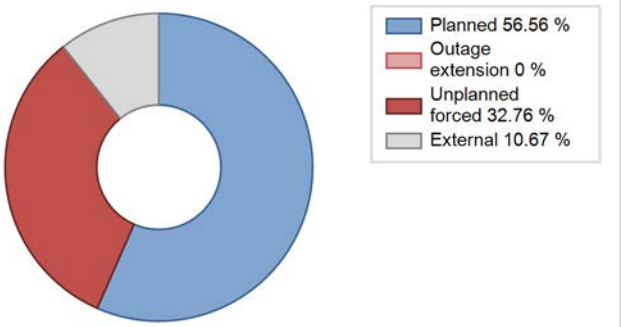
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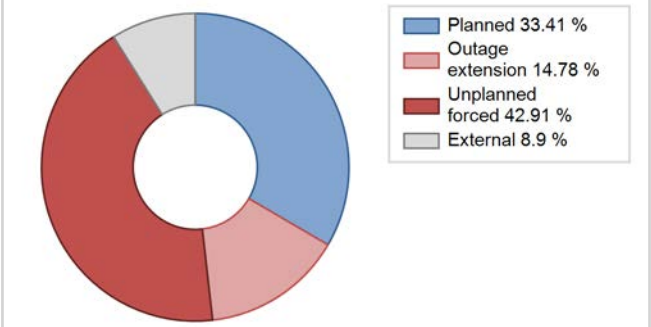
2023	2809.51	2330	1330	24.31	25.83	24.11	26.60	69.28	72.21	1.96	1.52
2024	9219.03	7506	1330	81.42	83.40	78.91	85.45	6.80	6.09	10.51	1.98

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		401			1382	
B.	Refuelling without maintenance				231		
C.	Inspection, maintenance or repair combined with refuelling	602			841		
D.	Inspection, maintenance or repair without refuelling	238			27		
E.	Testing of plant systems or components				8	1	
J.	Grid limitation, failure or grid unavailability						9
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L.	Human factor related					12	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						54
O.	Load dispatching, prioritization			14			1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)			24		1	36
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			0			46
Z.	Other					15	1
Subtotal		840	401	38	1107	1411	148
Total		**1279**			**2666**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		81
12. Reactor I&C Systems	32	33
13. Reactor Auxiliary Systems		36
14. Safety Systems		390
15. Reactor Cooling Systems		16
16. Steam generation systems		44
21. Fuel Handling and Storage Facilities		8
31. Turbine and auxiliaries	76	126
32. Feedwater and Main Steam System	233	61
33. Circulating Water System		14
34. Miscellaneous Systems	60	198
35. All other I&C Systems		2
41. Main Generator Systems		94
42. Electrical Power Supply Systems		254
Total	**401**	**1357**

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2024 Operating Experience

FR-47 FLAMANVILLE-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1382 MWe
Reference unit power (net)	:	1330 MWe

Key Dates

Construction Date	:	1980-05-01
Grid Date	:	1986-07-18
Commercial Date	:	1987-03-09
Age at end of year	:	38 years

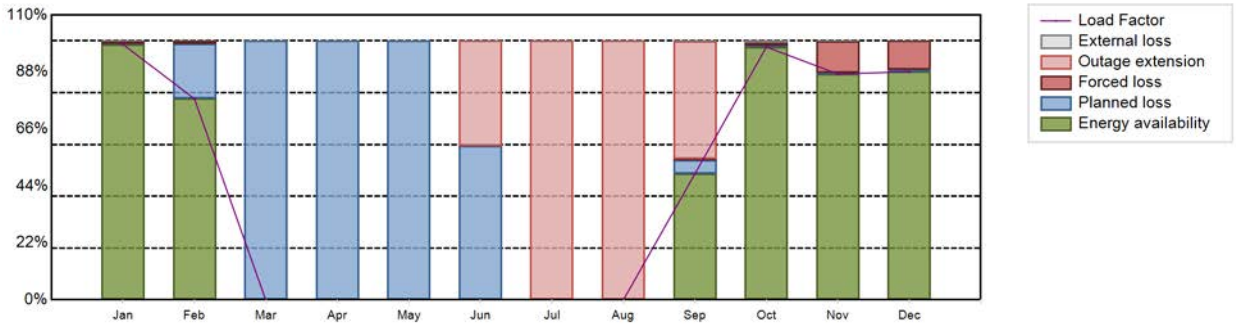
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4831.74 GW(e).h	Forced Loss Rate (FLR)	:	5.13 %
Energy Availability Factor (EAF)	:	41.41 %	Unplanned Capability Loss Factor (UCL)	:	26.23 %
Unit Capability Factor (UCF)	:	41.49 %	Planned Unavailability Factor (PUF)	:	32.28 %
Load Factor (LF)	:	41.36 %	Externally cause unavailability (XUF)	:	0.08 %
Operating Factor (OF)	:	43.62 %	Total off-line time	:	4952 hours

Annual Summary



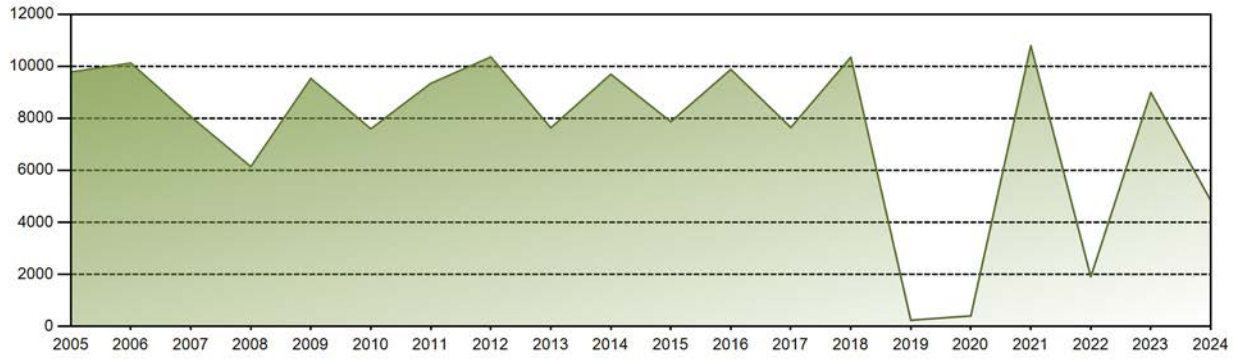
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	976.11	718.69	-3.28	0.00	0.00	0.00	0.00	0.00	465.81	967.45	835.56	871.41	4831.74
EAF [%]	98.68	77.67	0.00	0.00	0.00	0.00	0.00	0.00	48.63	97.68	87.27	88.20	41.41
UCF [%]	98.81	77.67	0.00	0.00	0.00	0.00	0.00	0.00	48.78	98.22	87.45	88.20	41.49
LF [%]	98.64	77.64	-0.33	0.00	0.00	0.00	0.00	0.00	48.64	97.64	87.26	88.06	41.36
OF [%]	100.00	79.17	0.00	0.00	0.00	0.00	0.00	0.00	54.58	99.87	100.00	91.40	43.62
FLR [%]	1.05	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.79	1.27	12.17	11.13	5.13
UCL [%]	1.05	1.07	0.00	0.00	0.00	40.56	100.00	100.00	45.79	1.26	12.12	11.05	26.23
PUF [%]	0.14	21.26	100.00	100.00	100.00	59.44	0.00	0.00	5.43	0.52	0.43	0.76	32.28
XUF [%]	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.54	0.17	0.00	0.08

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Historical Summary

Lifetime energy generation	:	297150.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	9.52 %
Cumulative Energy Availability Factor (EAF)	:	71.46 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.66 %
Cumulative Unit Capability Factor (UCF)	:	73.45 %	Cumulative Planned Unavailability Factor (PUF)	:	13.88 %
Cumulative Load Factor (LF)	:	66.69 %	Cumulative Externally cause unavailability (XUF)	:	2 %
Cumulative Operating Factor (OF)	:	72.51 %			

Electricity Production (net) [GWh]

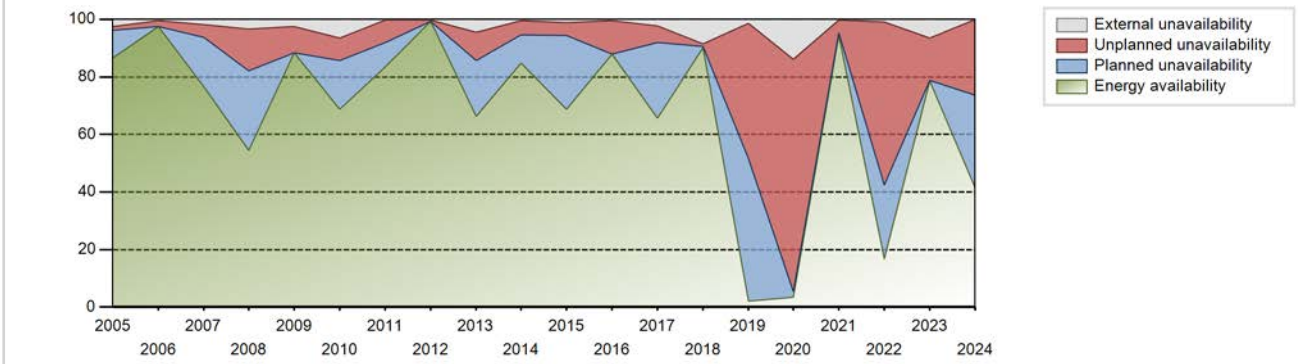


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	7140.20	6310	1290	88.69	88.92	58.89	69.36	11.08	11.08	0.00	0.23
1988	7106.00	5674	1330	65.40	67.44	60.82	64.59	8.21	6.03	26.53	2.04
1989	4824.50	3836	1330	48.67	50.57	41.41	43.79	38.47	31.61	17.82	1.89
1990	7819.60	6392	1330	75.74	76.63	67.12	72.97	22.84	22.68	0.69	0.89
1991	7965.71	6432	1330	70.59	72.34	68.37	73.42	10.85	8.80	18.86	1.75
1992	8842.44	6962	1330	77.96	78.17	75.69	79.26	6.18	5.15	16.68	0.21
1993	7985.20	6338	1330	69.15	71.43	68.54	72.35	10.51	8.39	20.18	2.28
1994	8384.27	6711	1330	75.34	75.40	71.96	76.61	10.72	9.06	15.54	0.06
1995	8962.41	7264	1330	81.40	82.14	76.93	82.92	5.55	4.83	13.03	0.74
1996	9387.50	7685	1330	86.62	87.51	80.35	87.49	1.62	1.44	11.05	0.89
1997	8546.04	7351	1330	95.30	95.36	73.35	83.92	4.22	4.20	0.43	0.06
1998	5656.61	4880	1330	55.37	55.40	48.55	55.71	9.47	5.79	38.81	0.03
1999	7248.90	6034	1330	65.22	67.42	62.22	68.88	12.53	9.65	22.92	2.20
2000	9907.94	8122	1330	93.75	94.20	84.81	92.46	4.93	4.89	0.91	0.45
2001	8565.10	6863	1330	76.22	77.88	73.52	78.34	8.51	7.24	14.88	1.66
2002	8502.35	6839	1330	77.94	78.05	72.98	78.07	11.37	10.02	11.93	0.12
2003	10065.35	8365	1330	93.39	93.64	86.39	95.49	5.35	5.29	1.07	0.25
2004	7499.84	6125	1330	66.76	68.31	64.20	69.73	12.84	10.06	21.63	1.55
2005	9779.11	7894	1330	86.69	89.11	83.94	90.11	1.25	1.37	9.52	2.42
2006	10125.81	8438	1330	97.55	98.01	86.91	96.32	1.97	1.97	0.01	0.47
2007	8063.02	7021	1330	76.52	78.31	69.21	80.15	2.12	4.44	17.25	1.79
2008	6140.92	5052	1330	54.39	57.86	52.56	57.51	6.63	14.49	27.65	3.47
2009	9531.78	8016	1330	88.36	90.94	81.81	91.51	9.04	9.03	0.03	2.57
2010	7594.30	6329	1330	68.79	75.21	65.18	72.25	3.69	7.81	16.97	6.42
2011	9342.70	7438	1330	83.49	83.83	80.19	84.91	3.44	7.77	8.39	0.34
2012	10359.02	8733	1330	99.27	99.52	88.67	99.42	0.47	0.47	0.02	0.25
2013	7631.58	6183	1330	66.34	70.74	65.50	70.58	2.11	9.95	19.31	4.40
2014	9693.92	7610	1330	84.82	85.27	83.20	86.87	3.88	5.01	9.72	0.45
2015	7869.45	6149	1330	68.68	69.94	67.54	70.19	3.76	4.32	25.75	1.26
2016	9880.46	8013	1330	87.97	88.51	84.57	91.22	11.45	11.45	0.04	0.54
2017	7646.67	6107	1330	65.67	68.03	65.63	69.71	7.65	5.63	26.33	2.36
2018	10350.78	8415	1330	90.14	98.71	88.84	96.06	0.84	0.84	0.45	8.57
2019	236.76	217	1330	2.04	3.40	2.03	2.48	0.00	47.00	49.60	1.36
2020	404.48	479	1330	3.47	17.25	3.46	5.45	0.70	80.83	1.91	13.79
2021	10791.47	8547	1330	94.33	94.55	92.62	97.57	4.62	4.58	0.87	0.22
2022	1910.62	1577	1330	16.75	17.65	16.40	18.00	76.25	56.69	25.66	0.91
2023	8993.91	7489	1330	78.52	85.08	77.20	85.49	14.75	14.72	0.21	6.56

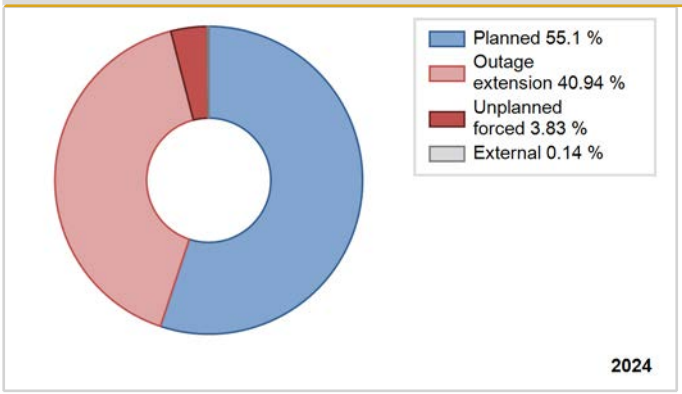
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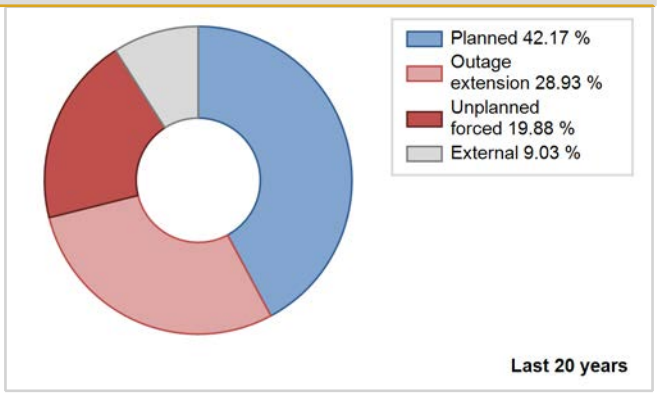
2024	4831.74	3832	1330	41.41	41.49	41.36	43.62	5.13	26.23	32.28	0.08

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		2171			1018	
B.	Refuelling without maintenance	120			121		
C.	Inspection, maintenance or repair combined with refuelling	2660			979	21	
D.	Inspection, maintenance or repair without refuelling				61		
E.	Testing of plant systems or components				15	1	0
H.	Nuclear regulatory requirements					13	
J.	Grid limitation, failure or grid unavailability						6
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L.	Human factor related					6	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						55
O.	Load dispatching, prioritization						1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					1	21
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				1		8
Z.	Other					15	
Subtotal		2780	2171		1177	1075	91
Total		**4951**			**2343**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		9
12. Reactor I&C Systems	7	32
13. Reactor Auxiliary Systems		35
14. Safety Systems	57	140
15. Reactor Cooling Systems		122
16. Steam generation systems		46
17. Safety I&C Systems (excluding reactor I&C)		2
21. Fuel Handling and Storage Facilities		6
31. Turbine and auxiliaries		73
32. Feedwater and Main Steam System		34
33. Circulating Water System		1
34. Miscellaneous Systems	2107	377
35. All other I&C Systems		5
41. Main Generator Systems		47
42. Electrical Power Supply Systems		76
Total	**2171**	**1005**

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2024 Operating Experience

FR-74 FLAMANVILLE-3 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	ORANO (ORANO)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / EPR
Thermal power	:	4300 MWth
Gross electrical power	:	1650 MWe
Reference unit power (net)	:	1630 MWe

Key Dates

Construction Date	:	2007-12-03
Grid Date	:	2024-12-21
Commercial Date	:	
Age at end of year	:	0 years

Design Characteristics

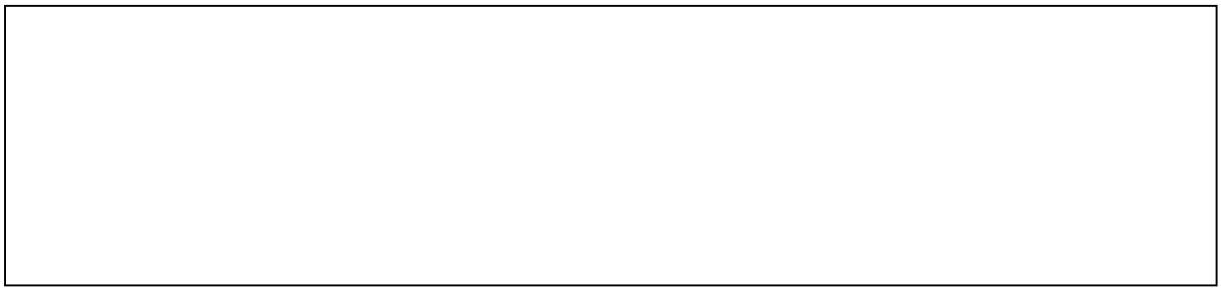
Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	0 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0 %	Total off-line time	:	264 hours

Annual Summary

No data found



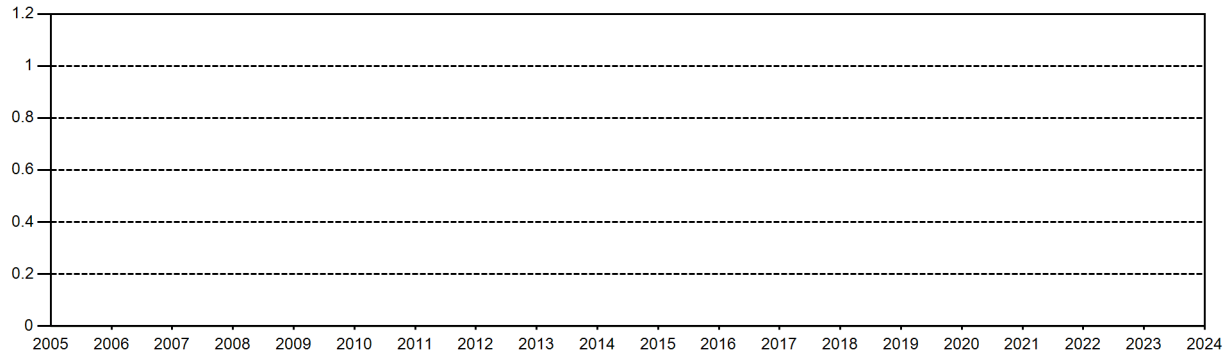
	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

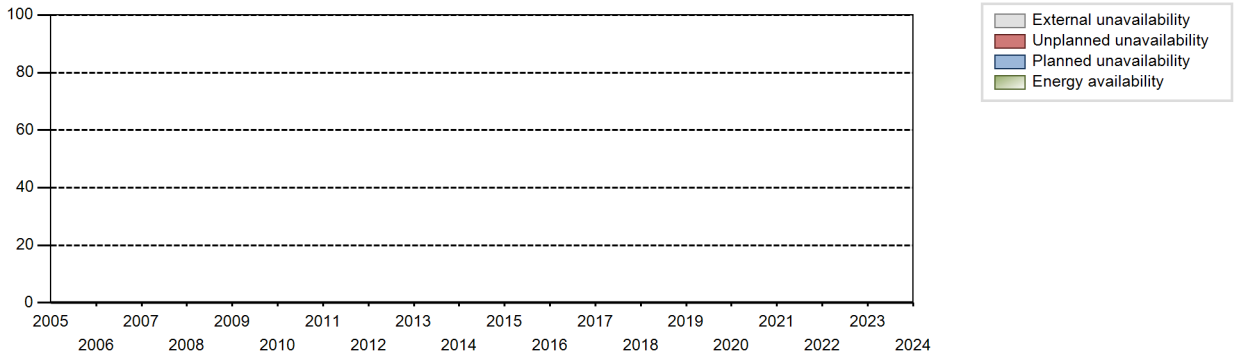
Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0 %
Cumulative Energy Availability Factor (EAF)	:	0 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0 %
Cumulative Unit Capability Factor (UCF)	:	0 %	Cumulative Planned Unavailability Factor (PUF)	:	0 %
Cumulative Load Factor (LF)	:	0 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	0 %			

Electricity Production (net) [GWh]

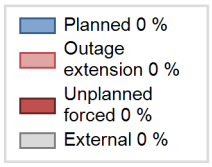


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]

Key Factors in Last 20 Years [%]



Energy Losses by Type



2024

No Data Available

Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024			1 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
Subtotal						
Total	0			0		

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1 to 2024
	Hours Lost	Average hours lost per reactor-year
Total		

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2024 Operating Experience

FR-61 GOLFECH-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1363 MWe
Reference unit power (net)	:	1310 MWe

Key Dates

Construction Date	:	1982-11-17
Grid Date	:	1990-06-07
Commercial Date	:	1991-02-01
Age at end of year	:	34 years

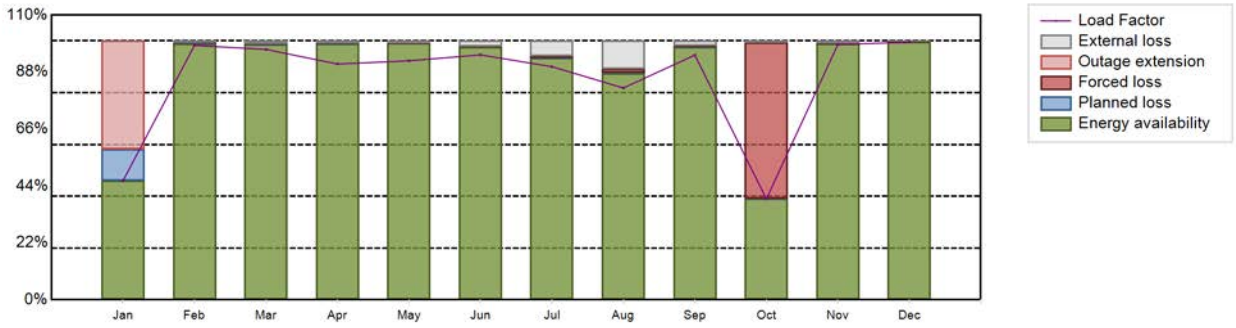
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9783.41 GW(e).h	Forced Loss Rate (FLR)	:	5.7 %
Energy Availability Factor (EAF)	:	87.74 %	Unplanned Capability Loss Factor (UCL)	:	8.97 %
Unit Capability Factor (UCF)	:	89.89 %	Planned Unavailability Factor (PUF)	:	1.14 %
Load Factor (LF)	:	85.02 %	Externally cause unavailability (XUF)	:	2.16 %
Operating Factor (OF)	:	91.43 %	Total off-line time	:	753 hours

Annual Summary



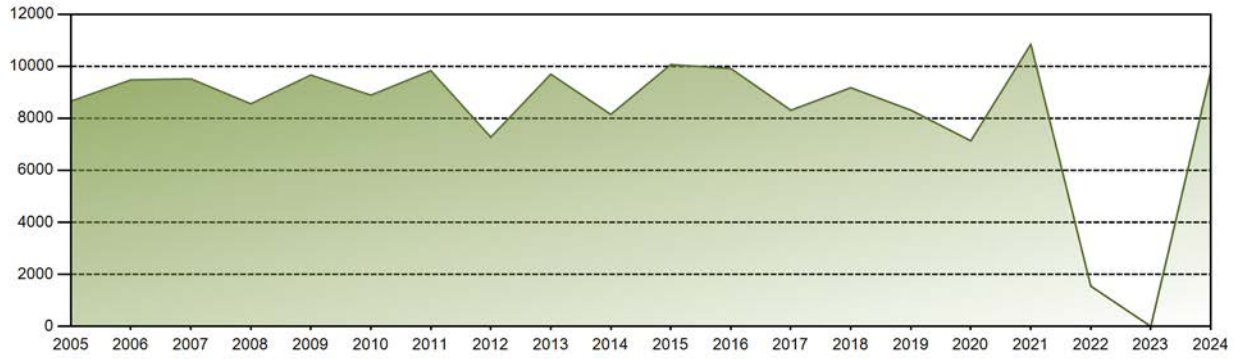
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	448.03	895.92	941.30	859.08	899.74	892.44	877.59	797.66	891.46	380.38	929.84	969.98	9783.41
EAF [%]	45.96	98.75	98.53	98.86	99.01	97.72	93.38	87.55	97.66	39.05	98.83	99.73	87.74
UCF [%]	45.96	99.33	99.58	99.62	99.85	99.85	99.12	98.48	99.65	39.69	99.68	99.88	89.89
LF [%]	45.97	98.26	96.71	91.08	92.31	94.62	90.04	81.84	94.51	38.98	98.58	99.52	85.02
OF [%]	58.06	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	40.81	100.00	100.00	91.43
FLR [%]	0.00	0.40	0.31	0.32	0.06	0.07	0.79	1.36	0.30	60.31	0.12	0.09	5.70
UCL [%]	41.78	0.40	0.31	0.32	0.06	0.07	0.79	1.35	0.30	60.30	0.12	0.09	8.97
PUF [%]	12.26	0.28	0.11	0.06	0.09	0.09	0.09	0.17	0.05	0.02	0.20	0.03	1.14
XUF [%]	0.00	0.58	1.05	0.77	0.84	2.13	5.75	10.93	1.99	0.64	0.85	0.15	2.16

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Historical Summary

Lifetime energy generation	:	286010.71 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.46 %
Cumulative Energy Availability Factor (EAF)	:	78.52 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.91 %
Cumulative Unit Capability Factor (UCF)	:	81.4 %	Cumulative Planned Unavailability Factor (PUF)	:	11.69 %
Cumulative Load Factor (LF)	:	72.85 %	Cumulative Externally cause unavailability (XUF)	:	2.88 %
Cumulative Operating Factor (OF)	:	80.5 %			

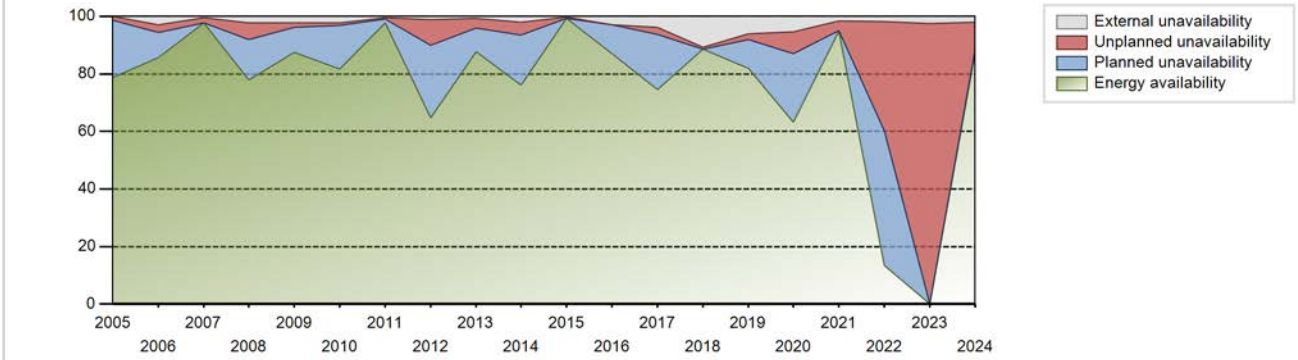
Electricity Production (net) [GWh]



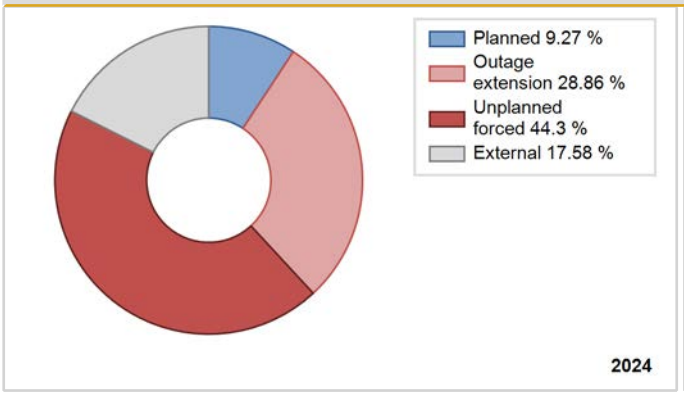
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1991	9536.95	8167	1310	96.09	97.76	84.48	94.91	2.21	2.21	0.02	1.68
1992	7065.89	6128	1310	64.35	67.86	61.40	69.76	4.27	3.02	29.11	3.51
1993	7925.62	7143	1310	72.66	82.63	69.06	81.54	1.85	1.55	15.81	9.98
1994	7756.13	7215	1310	77.76	81.29	67.59	82.36	5.91	5.10	13.61	3.53
1995	7897.84	7005	1310	75.60	83.48	68.82	79.97	2.12	1.81	14.71	7.89
1996	8862.41	7598	1310	83.25	84.83	77.02	86.50	1.33	1.14	14.02	1.58
1997	9151.57	8000	1310	94.51	94.63	79.75	91.32	5.19	5.18	0.19	0.12
1998	8576.56	7472	1310	81.11	84.75	74.74	85.30	1.96	1.69	13.56	3.64
1999	7926.35	6837	1310	77.23	80.77	69.07	78.05	6.76	5.86	13.37	3.54
2000	8766.29	7901	1310	93.90	94.09	76.18	89.95	5.59	5.57	0.34	0.19
2001	7511.92	6147	1310	68.41	69.14	65.46	70.17	4.63	3.36	27.50	0.74
2002	9242.42	7301	1310	81.36	82.54	80.54	83.34	4.01	3.45	14.01	1.19
2003	10342.73	8252	1310	93.92	99.20	90.13	94.20	0.76	0.76	0.04	5.28
2004	9051.07	7721	1310	84.75	87.60	78.66	87.90	2.63	2.36	10.04	2.85
2005	8653.53	7014	1310	78.73	78.73	75.40	80.06	1.77	1.42	19.85	0.00
2006	9475.13	7848	1310	85.72	88.74	82.57	89.59	0.14	2.57	8.69	3.02
2007	9517.60	8554	1310	97.73	98.16	82.94	97.65	1.82	1.82	0.02	0.43
2008	8556.94	7104	1310	77.81	80.02	74.36	80.87	0.58	5.81	14.17	2.22
2009	9662.38	7932	1310	87.58	89.93	84.20	90.55	1.13	1.43	8.63	2.36
2010	8888.69	7290	1310	81.68	83.88	77.46	83.22	0.76	0.93	15.19	2.19
2011	9830.09	8546	1310	97.79	98.34	85.66	97.56	0.25	0.41	1.25	0.54
2012	7272.39	5889	1310	64.64	65.74	63.20	67.04	0.27	8.88	25.38	1.10
2013	9694.33	7793	1310	87.80	88.49	84.48	88.96	1.25	3.45	8.05	0.69
2014	8149.57	6728	1310	76.10	78.18	71.02	76.80	0.16	4.40	17.41	2.08
2015	10067.40	8721	1310	99.33	99.69	87.73	99.55	0.24	0.24	0.06	0.36
2016	9913.55	7917	1310	87.08	89.93	86.15	90.13	0.01	0.00	10.06	2.85
2017	8310.56	6654	1310	74.48	78.36	72.42	75.96	0.47	2.39	19.25	3.88
2018	9174.78	8075	1310	88.51	99.32	79.95	92.18	0.58	0.58	0.09	10.81
2019	8314.41	7199	1310	81.91	88.03	72.45	82.18	2.01	1.97	10.00	6.12
2020	7133.37	5836	1310	63.14	68.53	61.99	66.44	0.12	7.54	23.93	5.39
2021	10847.21	8542	1310	94.88	96.43	94.52	97.51	3.45	3.44	0.12	1.55
2022	1546.16	1346	1310	13.47	15.33	13.47	15.37	71.14	37.80	46.87	1.86
2023	0.00	0	1310	0.00	2.55	0.00	0.00	91.92	97.45	0.00	2.55
2024	9783.41	8031	1310	87.74	89.89	85.02	91.43	5.70	8.97	1.14	2.16

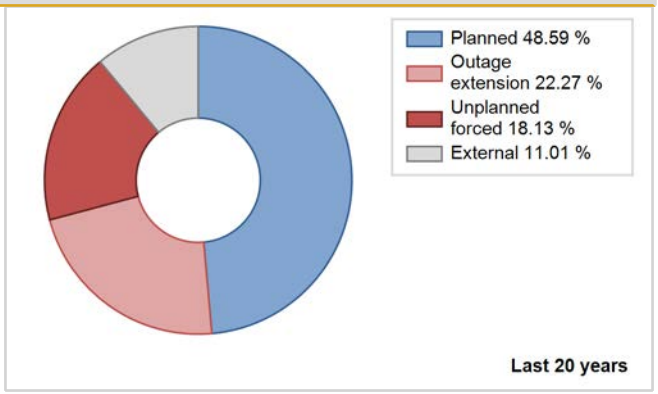
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1991 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		751			552	
B.	Refuelling without maintenance				88		
C.	Inspection, maintenance or repair combined with refuelling				875	1	
D.	Inspection, maintenance or repair without refuelling				33		
E.	Testing of plant systems or components	1			36		
F.	Major backfitting, refurbishment or upgrading activities with refuelling				3		
H.	Nuclear regulatory requirements					3	
J.	Grid limitation, failure or grid unavailability						0
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						3
L.	Human factor related					21	1
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						23
O.	Load dispatching, prioritization						2
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					0	29
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						30
Z.	Other					8	3
Subtotal		1	751		1035	585	91
Total			**752**			**1711**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1991 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		15
12. Reactor I&C Systems		23
13. Reactor Auxiliary Systems		4
14. Safety Systems		161
15. Reactor Cooling Systems		15
16. Steam generation systems		11
17. Safety I&C Systems (excluding reactor I&C)		3
31. Turbine and auxiliaries		6
32. Feedwater and Main Steam System	91	10
33. Circulating Water System		3
34. Miscellaneous Systems	660	265
35. All other I&C Systems		2
41. Main Generator Systems		25
42. Electrical Power Supply Systems		6
Total	**751**	**549**

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2024 Operating Experience

FR-68 GOLFECH-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1363 MWe
Reference unit power (net)	:	1310 MWe

Key Dates

Construction Date	:	1984-10-01
Grid Date	:	1993-06-18
Commercial Date	:	1994-03-04
Age at end of year	:	31 years

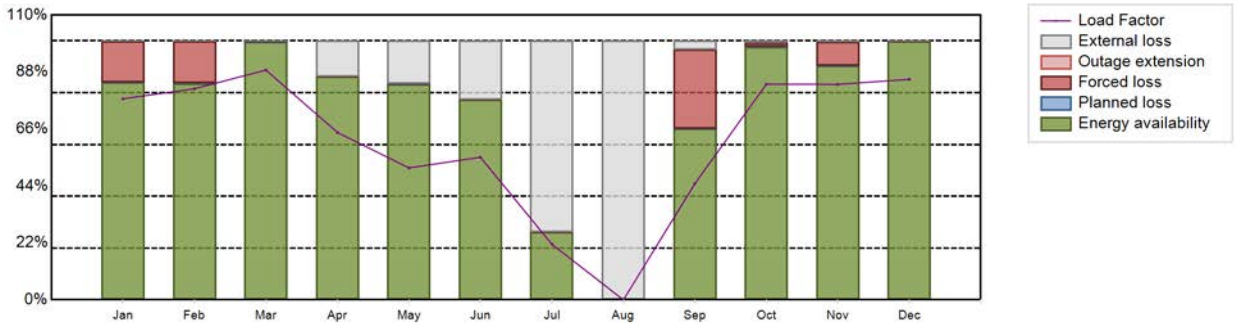
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	16
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	4.267
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.5
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	328.7
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	4.1
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.95
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7049.95 GW(e).h
Energy Availability Factor (EAF)	:	74.41 %
Unit Capability Factor (UCF)	:	93.92 %
Load Factor (LF)	:	61.27 %
Operating Factor (OF)	:	74.35 %
Forced Loss Rate (FLR)	:	6.03 %
Unplanned Capability Loss Factor (UCL)	:	6.02 %
Planned Unavailability Factor (PUF)	:	0.05 %
Externally cause unavailability (XUF)	:	19.51 %
Total off-line time	:	2253 hours

Annual Summary



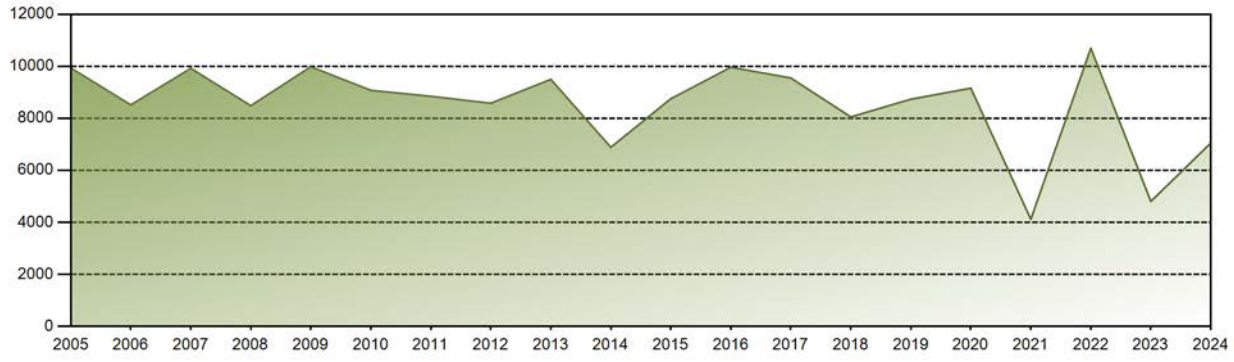
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	756.73	743.36	863.72	609.71	496.76	519.40	209.20	0.00	423.26	812.84	785.01	829.98	7049.95
EAF [%]	83.97	83.57	99.63	86.29	83.18	77.24	26.09	0.00	66.17	97.70	90.43	99.93	74.41
UCF [%]	84.08	83.81	99.86	99.96	99.80	99.91	99.97	100.00	69.44	98.37	90.76	99.95	93.92
LF [%]	77.64	81.53	88.74	64.64	50.97	55.07	21.46	0.00	44.87	83.29	83.23	85.16	61.27
OF [%]	92.88	84.77	100.00	86.53	83.60	78.06	26.48	0.00	61.67	99.87	87.50	92.07	74.35
FLR [%]	15.89	16.13	0.05	0.02	0.07	0.06	0.01	0.00	30.52	1.56	9.15	0.01	6.03
UCL [%]	15.88	16.12	0.05	0.02	0.07	0.06	0.01	0.00	30.51	1.56	9.14	0.01	6.02
PUF [%]	0.03	0.08	0.09	0.02	0.12	0.03	0.02	0.00	0.05	0.07	0.10	0.03	0.05
XUF [%]	0.11	0.24	0.23	13.67	16.62	22.66	73.87	100.00	3.27	0.67	0.33	0.02	19.51

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Historical Summary

Lifetime energy generation	:	265264.18 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.66 %
Cumulative Energy Availability Factor (EAF)	:	81.22 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.6 %
Cumulative Unit Capability Factor (UCF)	:	83.76 %	Cumulative Planned Unavailability Factor (PUF)	:	11.64 %
Cumulative Load Factor (LF)	:	74.01 %	Cumulative Externally cause unavailability (XUF)	:	2.54 %
Cumulative Operating Factor (OF)	:	82.55 %			

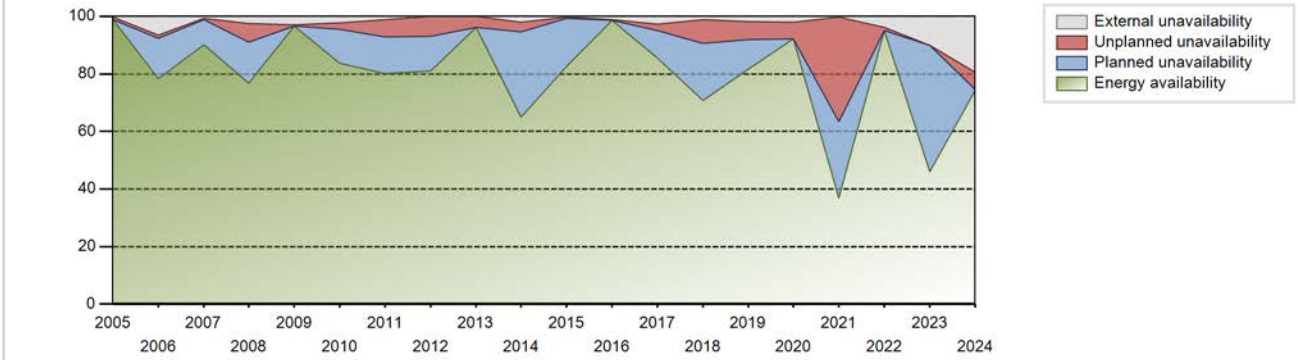
Electricity Production (net) [GWh]



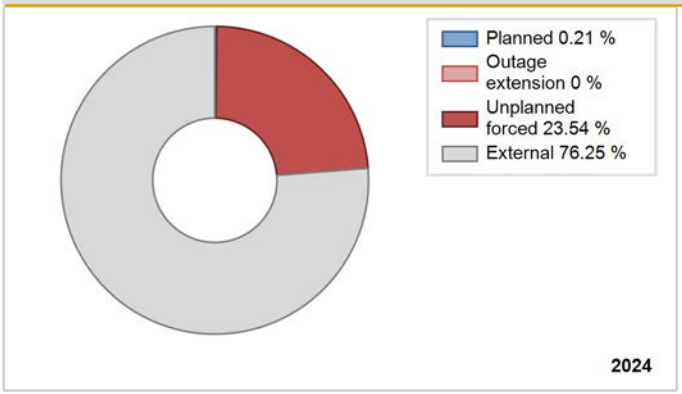
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1994	7281.51	6577	1310	99.45	99.75	67.64	80.50	0.25	0.25	0.01	0.30
1995	7030.15	6002	1310	62.92	66.66	61.26	68.52	12.67	9.67	23.66	3.75
1996	9016.38	7549	1310	83.58	84.69	78.36	85.94	3.50	3.07	12.24	1.11
1997	8649.91	7414	1310	80.22	83.68	75.38	84.63	5.05	4.45	11.87	3.47
1998	8359.56	7222	1310	82.89	85.07	72.85	82.44	6.43	5.84	9.09	2.17
1999	9516.92	8407	1310	97.70	98.02	82.93	95.97	1.16	1.15	0.82	0.32
2000	8877.61	7535	1310	81.82	84.45	77.15	85.78	1.43	1.23	14.32	2.64
2001	8958.29	7586	1310	84.33	85.31	78.06	86.60	2.14	1.87	12.82	0.98
2002	9847.13	8553	1310	97.32	97.32	85.81	97.64	2.30	2.29	0.40	0.00
2003	7614.92	7115	1310	75.24	77.69	66.36	81.22	11.19	9.79	12.52	2.45
2004	7093.66	6129	1310	65.70	65.72	61.65	69.77	5.74	4.00	30.28	0.02
2005	9936.28	8715	1310	98.89	99.19	86.58	99.47	0.79	0.79	0.02	0.30
2006	8516.61	7150	1310	78.24	84.83	74.21	81.62	1.10	0.94	14.23	6.59
2007	9922.05	8026	1310	90.15	90.86	86.46	91.62	0.49	0.48	8.66	0.71
2008	8484.22	7095	1310	76.69	79.15	73.73	80.77	2.28	6.43	14.41	2.46
2009	9982.79	8301	1310	96.63	99.53	86.99	94.76	0.45	0.45	0.02	2.90
2010	9076.12	7574	1310	83.62	85.83	79.09	86.46	0.56	2.20	11.98	2.21
2011	8848.37	7177	1310	80.20	81.36	77.11	81.93	0.60	5.97	12.68	1.16
2012	8580.05	7152	1310	81.00	81.03	74.56	81.42	0.07	6.90	12.07	0.03
2013	9498.61	8292	1310	96.15	96.15	82.77	94.66	3.83	3.82	0.03	0.00
2014	6885.14	5885	1310	64.88	66.94	60.00	67.18	0.42	3.33	29.73	2.05
2015	8751.76	7332	1310	82.56	82.90	76.26	83.70	0.40	0.33	16.77	0.34
2016	9963.09	8765	1310	98.52	99.60	86.58	99.78	0.36	0.36	0.04	1.08
2017	9551.16	7756	1310	85.41	88.04	83.23	88.54	1.73	2.33	9.63	2.63
2018	8054.15	6380	1310	70.73	71.79	70.19	72.83	1.27	8.38	19.84	1.06
2019	8734.82	7205	1310	81.66	83.43	76.12	82.25	1.22	6.40	10.17	1.77
2020	9160.17	8145	1310	92.18	94.17	79.60	92.73	5.76	5.75	0.08	1.99
2021	4117.16	3319	1310	36.85	37.20	35.88	37.89	0.58	36.30	26.49	0.35
2022	10693.10	8662	1310	95.03	98.79	93.18	98.88	1.10	1.10	0.11	3.76
2023	4805.98	4279	1310	45.92	56.02	41.88	48.85	0.04	0.02	43.96	10.10
2024	7049.95	6531	1310	74.41	93.92	61.27	74.35	6.03	6.02	0.05	19.51

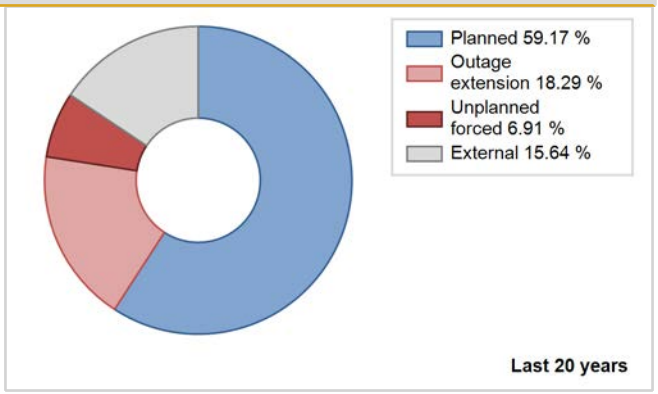
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1994 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		409			375	
B. Refuelling without maintenance				238		
C. Inspection, maintenance or repair combined with refuelling				723	1	
D. Inspection, maintenance or repair without refuelling				5		
E. Testing of plant systems or components				29		
H. Nuclear regulatory requirements					1	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			68			3
L. Human factor related					15	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			120			18
O. Load dispatching, prioritization			89			7
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					21	22
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			1566		3	55
Z. Other					8	15
Subtotal		409	1843	995	424	120
Total		**2252**			**1539**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1994 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		1
12. Reactor I&C Systems	184	39
13. Reactor Auxiliary Systems		4
14. Safety Systems		11
15. Reactor Cooling Systems		6
16. Steam generation systems		2
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		25
32. Feedwater and Main Steam System	165	6
33. Circulating Water System		1
34. Miscellaneous Systems	60	176
41. Main Generator Systems		90
42. Electrical Power Supply Systems		7
Total	**409**	**369**

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2024 Operating Experience

FR-20 GRAVELINES-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1975-02-01
Grid Date	:	1980-03-13
Commercial Date	:	1980-11-25
Age at end of year	:	44 years

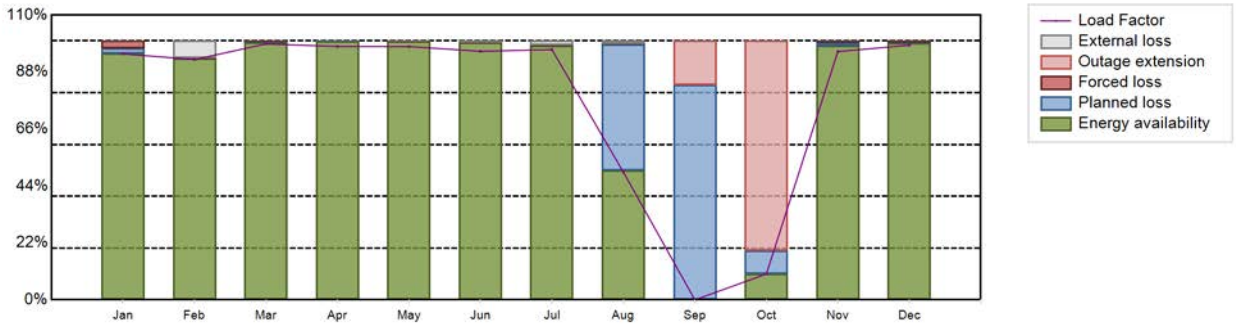
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	41	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6181.04 GW(e).h	Forced Loss Rate (FLR)	:	0.56 %
Energy Availability Factor (EAF)	:	78.48 %	Unplanned Capability Loss Factor (UCL)	:	8.71 %
Unit Capability Factor (UCF)	:	79.28 %	Planned Unavailability Factor (PUF)	:	12.01 %
Load Factor (LF)	:	77.33 %	Externally cause unavailability (XUF)	:	0.8 %
Operating Factor (OF)	:	80.45 %	Total off-line time	:	1717 hours

Annual Summary



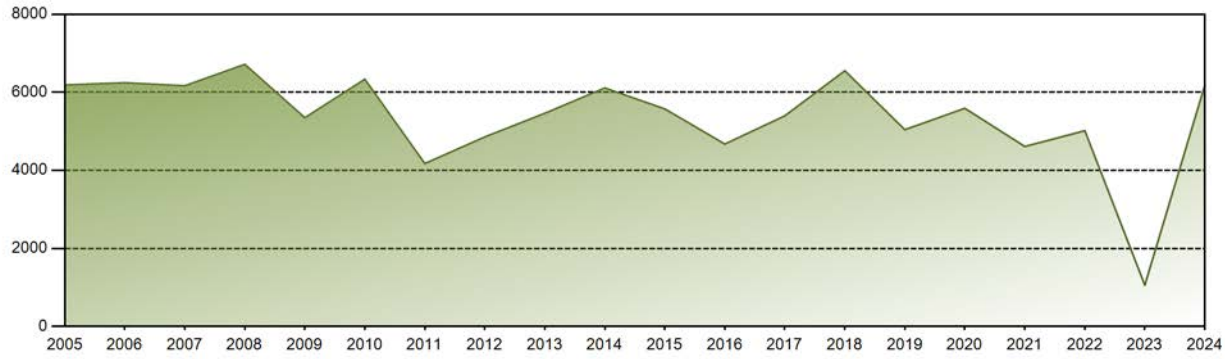
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	642.96	587.80	668.13	641.17	662.24	628.90	654.30	333.99	0.00	67.69	628.25	665.61	6181.04
EAF [%]	95.07	93.15	99.46	99.97	99.94	99.26	98.21	49.95	0.00	9.99	98.17	99.15	78.48
UCF [%]	95.07	99.69	99.46	99.97	100.00	99.79	99.73	51.16	0.00	9.99	98.17	99.15	79.28
LF [%]	94.97	92.81	98.82	97.86	97.81	95.99	96.64	49.33	0.00	9.98	95.89	98.31	77.33
OF [%]	100.00	95.40	100.00	100.00	100.00	100.00	100.00	51.61	0.00	18.79	100.00	100.00	80.45
FLR [%]	2.88	0.12	0.41	0.00	0.00	0.16	0.27	0.32	0.00	0.00	0.70	0.72	0.56
UCL [%]	2.82	0.12	0.41	0.00	0.00	0.16	0.27	0.16	16.96	81.01	0.69	0.72	8.71
PUF [%]	2.11	0.19	0.13	0.03	0.00	0.05	0.00	48.68	83.04	9.01	1.14	0.13	12.01
XUF [%]	0.00	6.54	0.00	0.00	0.05	0.53	1.52	1.21	0.00	0.00	0.00	0.00	0.80

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Historical Summary

Lifetime energy generation	:	242001.05 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.47 %
Cumulative Energy Availability Factor (EAF)	:	72.6 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	10.01 %
Cumulative Unit Capability Factor (UCF)	:	74.84 %	Cumulative Planned Unavailability Factor (PUF)	:	15.15 %
Cumulative Load Factor (LF)	:	68.34 %	Cumulative Externally cause unavailability (XUF)	:	2.23 %
Cumulative Operating Factor (OF)	:	74.39 %			

Electricity Production (net) [GWh]

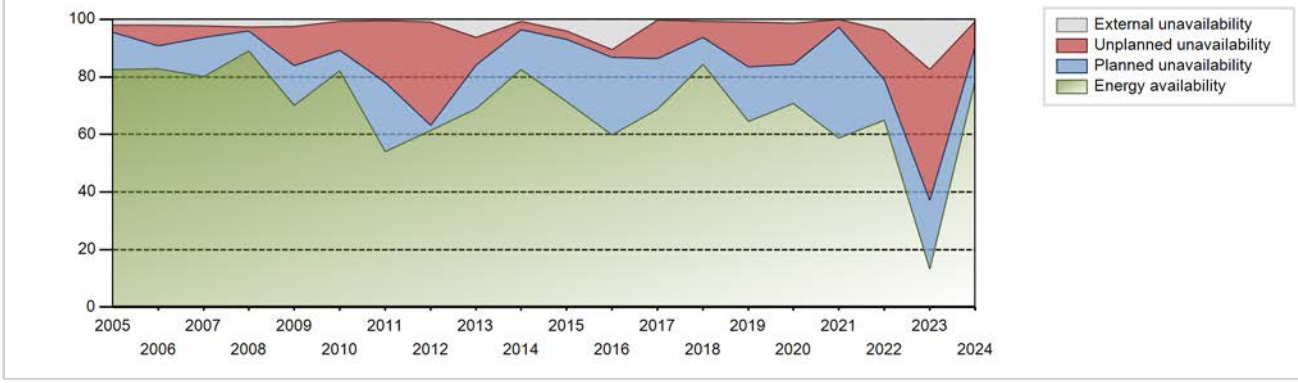


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	1466.00	2477	918	72.30	72.30	72.03	74.06	21.78	20.13	7.57	0.00
1981	5001.80	5785	920	63.25	63.25	62.06	66.04	11.18	7.96	28.79	0.00
1982	2987.50	3602	910	38.24	38.24	37.48	41.12	59.89	57.10	4.65	0.00
1983	5537.00	6237	910	69.92	69.92	69.46	71.20	4.66	3.42	26.66	0.00
1984	6617.00	7654	910	86.22	86.22	82.78	87.14	5.90	5.40	8.38	0.00
1985	6211.70	7218	910	80.31	81.27	77.92	82.40	3.98	3.37	15.36	0.96
1986	5725.50	6508	910	73.40	74.80	71.82	74.29	10.69	8.95	16.24	1.40
1987	4650.10	5895	910	89.01	89.34	58.33	67.29	4.67	4.38	6.28	0.33
1988	4289.00	5306	910	56.96	57.63	53.66	60.41	34.00	29.69	12.69	0.66
1989	5109.64	6224	910	67.66	67.68	64.10	71.05	22.39	19.52	12.80	0.02
1990	4463.57	5425	910	59.17	61.27	55.99	61.93	14.31	10.23	28.50	2.10
1991	5675.04	6619	910	73.35	74.00	71.19	75.56	14.90	12.96	13.05	0.64
1992	5834.68	7250	910	80.65	84.00	72.99	82.54	3.31	2.88	13.12	3.35
1993	5866.85	7794	910	80.54	93.84	73.60	88.97	2.71	2.62	3.54	13.30
1994	4657.72	5729	910	67.67	68.60	58.43	65.40	3.77	2.69	28.71	0.93
1995	6123.14	7461	910	82.76	83.75	76.81	85.17	6.18	5.52	10.73	0.99
1996	6089.15	7357	910	80.34	83.55	76.18	83.75	4.70	4.12	12.33	3.21
1997	5860.44	7236	910	81.72	82.89	73.52	82.60	5.61	4.93	12.18	1.17
1998	6321.38	7622	910	83.74	87.05	79.30	87.01	3.19	2.87	10.07	3.32
1999	5841.29	7116	910	78.55	80.27	73.28	81.23	2.16	1.78	17.95	1.72
2000	6531.94	7705	910	88.11	88.20	81.72	87.72	0.99	0.88	10.91	0.09
2001	5289.37	6034	910	66.69	67.59	66.35	68.88	7.47	5.46	26.96	0.90
2002	5769.34	7057	910	86.32	88.64	72.37	80.56	0.63	0.56	10.80	2.32
2003	5919.51	7420	910	85.05	85.70	74.26	84.70	0.99	0.85	13.44	0.65
2004	6213.89	7664	910	86.23	86.35	77.74	87.25	5.06	4.60	9.04	0.13
2005	6188.68	7400	910	82.51	84.55	77.63	84.47	1.18	2.46	12.99	2.04
2006	6244.37	7567	910	82.81	84.92	78.33	86.38	2.54	7.15	7.93	2.11
2007	6168.23	7312	910	80.11	82.37	77.38	83.47	1.38	4.00	13.64	2.26
2008	6716.74	8146	910	89.12	91.78	84.03	92.74	0.35	1.30	6.92	2.66
2009	5348.22	6527	910	70.03	72.56	67.09	74.51	0.53	13.64	13.80	2.54
2010	6334.91	7348	910	82.04	82.67	79.47	83.88	9.70	10.14	7.19	0.63
2011	4173.88	4827	910	53.96	54.47	52.36	55.10	4.82	21.39	24.15	0.50
2012	4856.13	5711	910	61.43	62.36	60.75	65.02	18.32	35.99	1.65	0.93
2013	5462.13	6283	910	68.89	75.07	68.52	71.72	5.15	9.73	15.20	6.18
2014	6111.90	7416	910	82.59	83.30	76.67	84.66	3.26	2.81	13.89	0.71
2015	5575.19	6554	910	71.34	75.34	69.94	74.82	3.19	2.93	21.73	3.99
2016	4673.39	5763	910	59.92	70.41	58.47	65.61	2.00	2.73	26.86	10.49

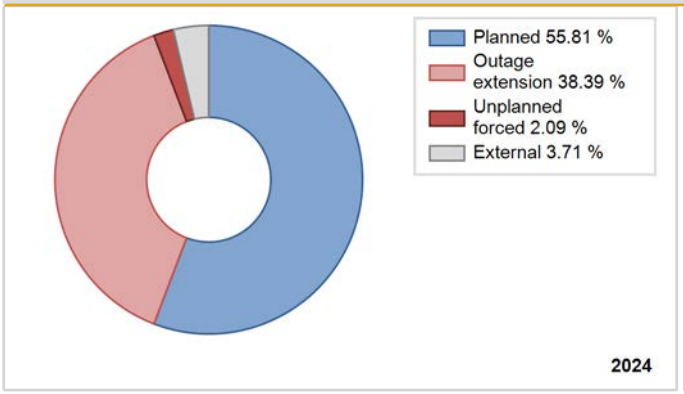
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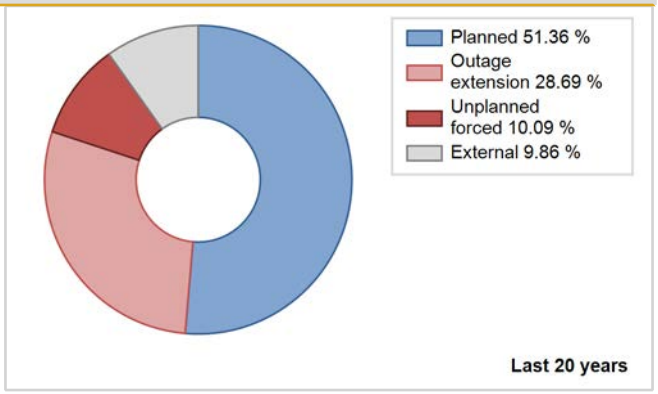
2017	5397.15	6249	910	68.65	68.97	67.70	71.34	1.77	13.22	17.81	0.32
2018	6553.27	7548	910	84.31	84.97	82.21	86.16	2.50	5.72	9.31	0.65
2019	5041.04	5827	910	64.56	65.44	63.24	66.52	2.62	15.61	18.95	0.87
2020	5590.40	6736	910	70.87	72.30	69.94	76.68	9.14	14.13	13.58	1.42
2021	4611.67	5312	910	58.82	58.83	57.85	60.64	4.41	2.72	38.45	0.01
2022	5015.76	6131	910	64.99	68.73	62.92	69.99	5.67	17.18	14.10	3.74
2023	1055.48	1277	910	13.26	30.68	13.24	14.58	1.34	45.47	23.85	17.42
2024	6181.04	7067	910	78.48	79.28	77.33	80.45	0.56	8.71	12.01	0.80

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1980 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		726			713	
B. Refuelling without maintenance	958			174		
C. Inspection, maintenance or repair combined with refuelling				1083	11	
D. Inspection, maintenance or repair without refuelling				17	3	
E. Testing of plant systems or components				10	4	
H. Nuclear regulatory requirements					5	
J. Grid limitation, failure or grid unavailability						1
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						7
L. Human factor related		1			12	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			32			4
O. Load dispatching, prioritization						0
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					0	57
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						15
Z. Other					33	2
Subtotal	958	727	32	1284	781	86
Total	**1717**			**2151**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		179
12. Reactor I&C Systems		9
13. Reactor Auxiliary Systems		14
14. Safety Systems		7
15. Reactor Cooling Systems		67
16. Steam generation systems		65
21. Fuel Handling and Storage Facilities		0
31. Turbine and auxiliaries		45
32. Feedwater and Main Steam System		42
33. Circulating Water System		8
34. Miscellaneous Systems	726	238
35. All other I&C Systems		0
41. Main Generator Systems		9
42. Electrical Power Supply Systems		24
Total	**726**	**707**

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2024 Operating Experience

FR-21 GRAVELINES-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1975-03-01
Grid Date	:	1980-08-26
Commercial Date	:	1980-12-01
Age at end of year	:	44 years

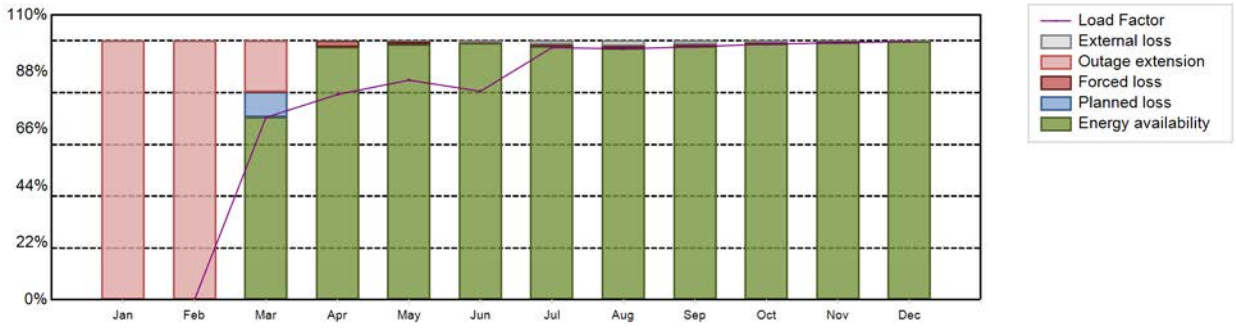
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	41	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6050 GW(e).h	Forced Loss Rate (FLR)	:	0.76 %
Energy Availability Factor (EAF)	:	79.97 %	Unplanned Capability Loss Factor (UCL)	:	18.67 %
Unit Capability Factor (UCF)	:	80.47 %	Planned Unavailability Factor (PUF)	:	0.86 %
Load Factor (LF)	:	75.69 %	Externally cause unavailability (XUF)	:	0.5 %
Operating Factor (OF)	:	81.93 %	Total off-line time	:	1587 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	476.29	519.61	574.51	527.67	659.54	656.21	640.43	669.41	650.74	675.61	6050.00
EAF [%]	0.00	0.00	70.47	97.63	98.69	99.04	97.96	97.06	97.87	98.86	99.44	99.82	79.97
UCF [%]	0.00	0.00	70.47	97.63	98.87	99.59	99.33	98.92	99.17	99.39	99.56	99.88	80.47
LF [%]	0.00	0.00	70.44	79.31	84.86	80.54	97.42	96.92	97.75	98.74	99.32	99.79	75.69
OF [%]	0.00	0.00	80.35	100.00	100.00	100.00	100.00	100.00	100.00	99.87	100.00	100.00	81.93
FLR [%]	0.00	0.00	0.11	2.37	1.13	0.41	0.67	0.90	0.83	0.61	0.32	0.09	0.76
UCL [%]	100.00	100.00	19.72	2.37	1.13	0.41	0.67	0.90	0.83	0.61	0.32	0.09	18.67
PUF [%]	0.00	0.00	9.81	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.12	0.03	0.86
XUF [%]	0.00	0.00	0.00	0.00	0.18	0.55	1.37	1.86	1.30	0.53	0.12	0.06	0.50

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Historical Summary

Lifetime energy generation	:	254004.76 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.7 %
Cumulative Energy Availability Factor (EAF)	:	76.11 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.72 %
Cumulative Unit Capability Factor (UCF)	:	78.13 %	Cumulative Planned Unavailability Factor (PUF)	:	15.15 %
Cumulative Load Factor (LF)	:	71.91 %	Cumulative Externally cause unavailability (XUF)	:	2.02 %
Cumulative Operating Factor (OF)	:	78.04 %			

Electricity Production (net) [GWh]

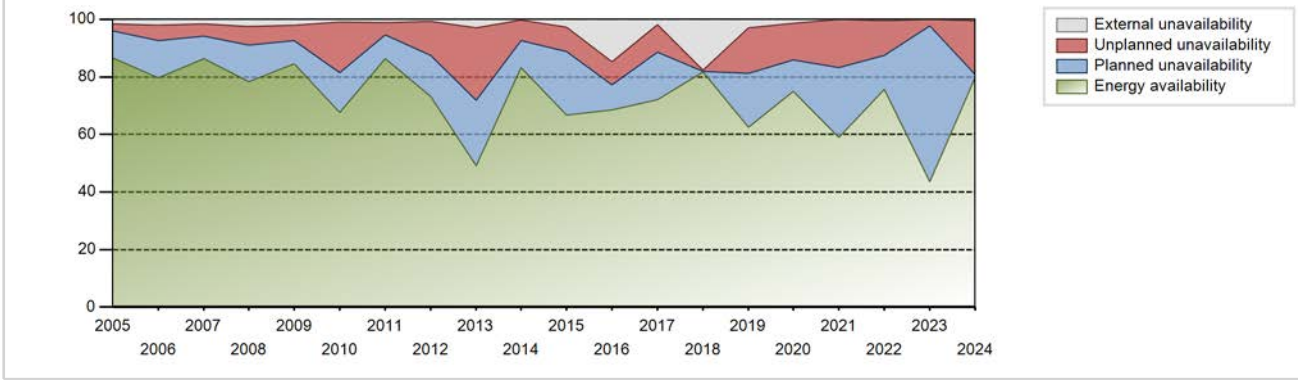


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	1282.00	1916	914	74.70	74.70	75.24	76.75	25.30	25.30	0.00	0.00
1981	5949.20	7276	920	81.21	81.21	73.82	83.06	2.26	1.88	16.91	0.00
1982	2118.50	2732	910	29.21	29.21	26.58	31.19	37.78	17.73	53.06	0.00
1983	6130.00	6917	910	77.92	77.92	76.90	78.96	2.89	2.32	19.76	0.00
1984	5749.00	6751	910	82.03	82.03	71.92	76.86	5.46	4.74	13.23	0.00
1985	6829.70	7950	910	89.65	90.22	85.68	90.75	3.69	3.45	6.33	0.56
1986	6422.00	7956	910	96.41	96.56	80.56	90.82	3.44	3.44	0.00	0.14
1987	5357.90	6807	910	75.18	77.39	67.21	77.71	7.43	6.21	16.40	2.22
1988	5577.00	7227	910	77.16	81.27	69.77	82.27	7.78	6.86	11.87	4.12
1989	6412.93	7460	910	83.57	84.61	80.45	85.16	3.29	2.88	12.51	1.04
1990	6143.08	7164	910	79.64	80.59	77.06	81.78	5.17	4.39	15.01	0.96
1991	4915.91	5648	910	62.98	63.55	61.67	64.47	9.87	6.96	29.49	0.58
1992	6124.15	7149	910	78.18	80.61	76.61	81.39	1.08	0.88	18.51	2.43
1993	6219.87	7297	910	79.28	82.31	78.03	83.30	5.01	4.34	13.34	3.03
1994	6293.68	7638	910	82.69	86.25	78.95	87.19	2.15	1.90	11.86	3.56
1995	5599.66	6735	910	74.61	75.59	70.25	76.88	14.78	13.11	11.30	0.98
1996	5235.92	6361	910	69.71	70.72	65.50	72.42	1.04	0.74	28.54	1.01
1997	6641.23	8006	910	97.85	97.96	83.31	91.39	2.03	2.03	0.01	0.11
1998	5531.44	6896	910	82.10	82.22	69.39	78.72	2.16	1.81	15.97	0.11
1999	6394.43	7705	910	85.34	87.76	80.22	87.96	1.37	1.22	11.02	2.42
2000	5582.71	6952	910	77.30	80.54	69.84	79.14	2.81	2.33	17.13	3.24
2001	5984.52	7601	910	85.00	85.49	75.07	86.77	3.62	3.21	11.30	0.49
2002	5254.30	6658	910	72.30	74.31	65.91	76.00	0.34	0.25	25.44	2.01
2003	6553.92	7986	910	89.20	89.61	82.22	91.16	1.65	1.50	8.89	0.41
2004	6009.04	7262	910	80.44	81.80	75.17	82.67	6.42	5.61	12.59	1.36
2005	6622.59	7880	910	86.64	88.22	83.07	89.94	2.62	2.53	9.26	1.58
2006	6222.36	7369	910	79.61	81.73	78.06	84.12	3.93	5.18	13.09	2.13
2007	6522.56	7796	910	86.44	87.98	81.82	89.00	2.20	4.21	7.81	1.54
2008	6124.09	7271	910	78.32	80.70	76.61	82.78	2.30	6.57	12.73	2.38
2009	6537.36	7696	910	84.50	86.53	82.01	87.85	2.00	5.28	8.20	2.03
2010	5223.13	6149	910	67.71	68.74	65.52	70.19	11.95	17.41	13.85	1.03
2011	6861.91	7723	910	86.35	87.50	86.08	88.16	0.30	4.31	8.18	1.15
2012	5832.88	6776	910	73.13	73.81	72.97	77.14	8.56	11.94	14.25	0.68
2013	3895.35	4421	910	49.04	51.94	48.87	50.47	3.09	25.15	22.91	2.90
2014	6274.40	7318	910	83.17	83.47	78.71	83.54	4.72	7.14	9.40	0.30
2015	5211.80	5969	910	66.65	69.37	65.38	68.14	1.07	8.57	22.06	2.72
2016	5282.11	6349	910	68.63	83.43	66.08	72.28	1.99	7.89	8.68	14.80

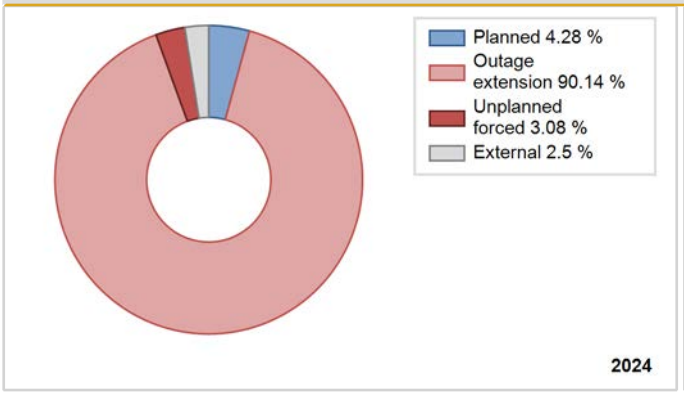
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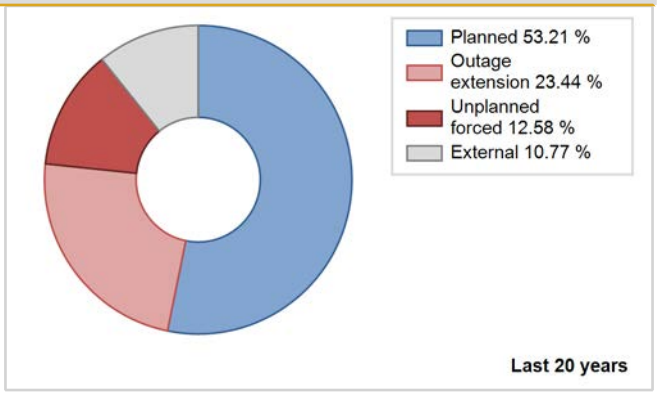
2017	5611.13	6531	910	72.19	74.06	70.39	74.55	1.30	9.61	16.33	1.87
2018	6258.08	7767	910	81.64	99.35	78.50	88.66	0.32	0.32	0.33	17.71
2019	4834.97	5890	910	62.58	65.56	60.65	67.24	11.33	15.73	18.71	2.98
2020	5847.85	6666	910	75.06	76.38	73.16	75.89	9.10	12.86	10.76	1.32
2021	4704.52	5336	910	59.00	59.00	59.02	60.91	13.71	16.84	24.17	0.00
2022	6014.85	6926	910	75.71	76.23	75.45	79.06	5.47	11.96	11.81	0.52
2023	3459.28	3839	910	43.60	43.62	43.40	43.82	0.29	2.33	54.05	0.02
2024	6050.00	7197	910	79.97	80.47	75.69	81.93	0.76	18.67	0.86	0.50

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1980 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		1586			414	
B. Refuelling without maintenance				134		
C. Inspection, maintenance or repair combined with refuelling				1036	29	
D. Inspection, maintenance or repair without refuelling				50		
E. Testing of plant systems or components				18		
H. Nuclear regulatory requirements					1	
J. Grid limitation, failure or grid unavailability						2
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						7
L. Human factor related					10	
M. Governmental requirements or court decisions						2
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						3
O. Load dispatching, prioritization						2
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						37
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						23
Z. Other				14	41	37
Subtotal		1586		1252	495	113
Total		**1586**			**1860**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		23
12. Reactor I&C Systems		21
13. Reactor Auxiliary Systems		10
14. Safety Systems		12
15. Reactor Cooling Systems		17
16. Steam generation systems		41
21. Fuel Handling and Storage Facilities		9
31. Turbine and auxiliaries		19
32. Feedwater and Main Steam System		18
33. Circulating Water System		11
34. Miscellaneous Systems	1586	206
35. All other I&C Systems		0
41. Main Generator Systems		26
42. Electrical Power Supply Systems		25
Total	**1586**	**438**

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2024 Operating Experience

FR-27 GRAVELINES-3 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1975-12-01
Grid Date	:	1980-12-12
Commercial Date	:	1981-06-01
Age at end of year	:	44 years

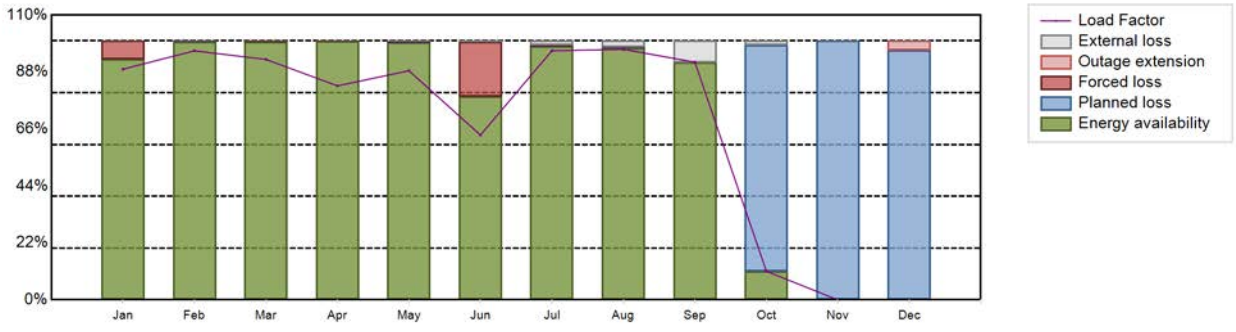
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.2
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	323
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.5
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	45	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5380.4 GW(e).h	Forced Loss Rate (FLR)	:	3.29 %
Energy Availability Factor (EAF)	:	72.21 %	Unplanned Capability Loss Factor (UCL)	:	2.8 %
Unit Capability Factor (UCF)	:	73.39 %	Planned Unavailability Factor (PUF)	:	23.81 %
Load Factor (LF)	:	67.31 %	Externally cause unavailability (XUF)	:	1.18 %
Operating Factor (OF)	:	73.1 %	Total off-line time	:	2363 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	603.22	609.12	627.88	541.50	599.08	416.95	651.30	655.06	601.42	74.87	0.00	0.00	5380.40
EAF [%]	92.93	99.72	99.61	99.87	99.39	78.52	97.77	97.14	91.79	11.05	0.00	0.00	72.21
UCF [%]	92.93	99.72	99.61	99.87	99.58	78.88	99.30	99.47	100.00	12.65	0.00	0.00	73.39
LF [%]	89.10	96.17	92.86	82.65	88.49	63.64	96.20	96.75	91.79	11.04	0.00	0.00	67.31
OF [%]	93.28	100.00	100.00	100.00	100.00	72.36	100.00	100.00	100.00	12.75	0.00	0.00	73.10
FLR [%]	7.07	0.20	0.39	0.13	0.36	21.12	0.52	0.39	0.00	0.00	0.00	0.00	3.29
UCL [%]	7.07	0.20	0.39	0.13	0.36	21.12	0.52	0.39	0.00	0.00	0.00	3.56	2.80
PUF [%]	0.00	0.08	0.00	0.00	0.06	0.00	0.18	0.14	0.00	87.35	100.00	96.44	23.81
XUF [%]	0.00	0.00	0.00	0.00	0.19	0.35	1.53	2.34	8.21	1.60	0.00	0.00	1.18

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Historical Summary

Lifetime energy generation	:	253050.47 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.35 %
Cumulative Energy Availability Factor (EAF)	:	76.1 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.66 %
Cumulative Unit Capability Factor (UCF)	:	77.65 %	Cumulative Planned Unavailability Factor (PUF)	:	14.69 %
Cumulative Load Factor (LF)	:	72.35 %	Cumulative Externally cause unavailability (XUF)	:	1.55 %
Cumulative Operating Factor (OF)	:	77.8 %			

Electricity Production (net) [GWh]

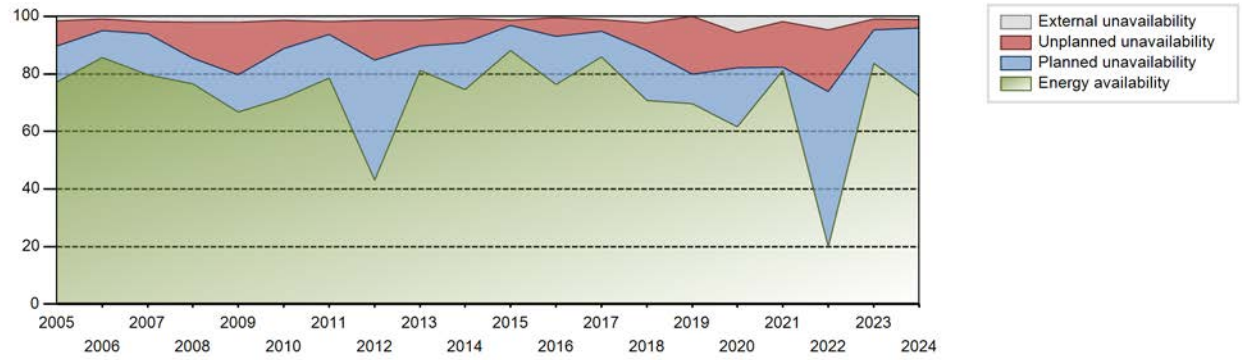


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	5170.10	6405	920	84.42	84.42	78.30	86.88	14.93	14.82	0.76	0.00
1982	3445.00	4260	910	47.62	47.62	43.22	48.63	27.74	18.28	34.10	0.00
1983	6006.00	7194	910	78.49	78.58	75.34	82.12	10.51	9.23	12.19	0.08
1984	6746.00	7505	910	83.87	83.87	84.39	85.44	5.25	4.65	11.48	0.00
1985	6294.40	7151	910	80.09	80.13	78.96	81.63	9.61	8.52	11.36	0.04
1986	6504.50	7335	910	81.73	81.73	81.60	83.73	10.22	9.30	8.97	0.00
1987	5382.90	6188	910	74.28	75.54	67.53	70.64	9.24	7.69	16.76	1.27
1988	4819.00	6724	910	95.45	96.20	60.29	76.55	3.80	3.80	0.00	0.75
1989	6307.71	7320	910	79.49	82.34	79.13	83.56	5.72	5.00	12.66	2.85
1990	6121.52	7114	910	77.61	80.65	76.79	81.21	7.42	6.47	12.89	3.03
1991	6306.28	7086	910	80.52	81.34	79.11	80.89	6.85	5.98	12.67	0.82
1992	4772.40	5388	910	59.96	60.35	59.70	61.34	15.94	11.44	28.21	0.39
1993	6588.06	7567	910	82.87	85.16	82.64	86.38	4.38	3.90	10.95	2.29
1994	6308.88	7116	910	82.95	83.80	79.14	81.23	3.56	3.09	13.10	0.85
1995	6221.69	7326	910	83.00	84.33	78.05	83.63	5.09	4.53	11.15	1.33
1996	5937.24	7377	910	83.00	85.91	74.28	83.98	2.37	2.08	12.01	2.91
1997	5752.68	6938	910	78.88	81.12	72.16	79.20	5.88	5.06	13.81	2.24
1998	6152.36	7330	910	82.99	83.86	77.18	83.68	2.09	1.79	14.35	0.86
1999	5412.92	6709	910	76.90	79.13	67.90	76.59	10.46	9.24	11.63	2.23
2000	6112.36	7396	910	82.92	84.60	76.47	84.20	2.99	2.60	12.79	1.69
2001	6198.04	7597	910	83.91	92.64	77.75	86.72	2.14	2.02	5.34	8.73
2002	5282.46	6401	910	76.78	76.80	66.27	73.07	2.52	1.98	21.22	0.01
2003	6045.52	7482	910	85.79	85.79	75.84	85.41	1.88	1.64	12.57	0.00
2004	6393.08	7499	910	83.78	83.86	79.98	85.37	6.69	6.01	10.13	0.08
2005	6075.92	7126	910	77.24	78.93	76.21	81.34	2.84	8.64	12.44	1.69
2006	6501.20	7834	910	85.66	86.65	81.55	89.43	3.94	4.03	9.32	0.99
2007	6265.62	7267	910	79.59	81.38	78.59	82.95	1.02	4.26	14.36	1.79
2008	6027.10	7335	910	76.49	78.58	75.40	83.50	10.88	12.43	8.99	2.08
2009	5272.78	6303	910	66.68	68.82	66.14	71.95	18.00	18.22	12.97	2.13
2010	5689.33	6550	910	71.72	73.16	71.37	74.77	6.04	9.83	17.01	1.44
2011	6227.87	7117	910	78.51	80.39	78.13	81.24	4.80	4.33	15.27	1.89
2012	3423.44	4028	910	43.10	44.54	42.83	45.86	3.38	13.66	41.80	1.44
2013	6407.37	7268	910	81.27	82.58	80.38	82.97	0.83	8.92	8.50	1.30
2014	5818.43	6694	910	74.63	75.40	72.99	76.42	5.71	8.50	16.10	0.76
2015	6840.51	7929	910	88.19	89.51	85.81	90.51	1.75	1.82	8.68	1.32
2016	6043.29	7044	910	76.35	76.78	75.60	80.19	4.10	6.57	16.65	0.42
2017	6722.26	7620	910	85.99	87.22	84.33	86.99	0.73	4.00	8.79	1.23

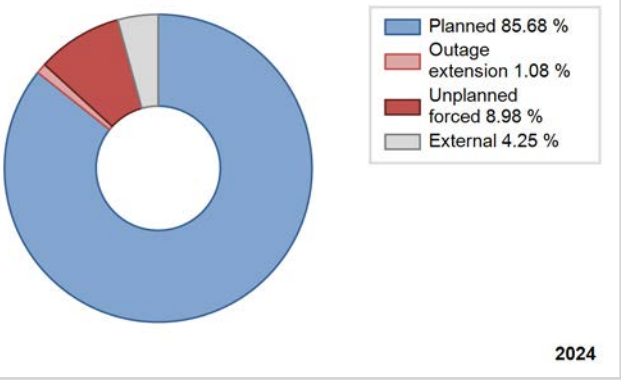
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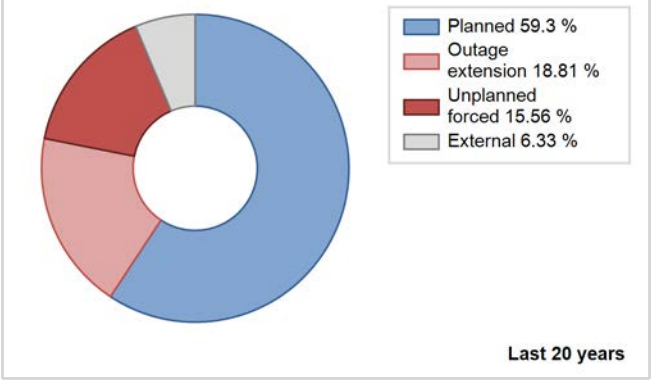
2018	5466.29	6525	910	70.81	73.03	68.57	74.49	3.18	9.66	17.31	2.22
2019	5539.99	6877	910	69.60	69.61	69.50	78.50	19.25	20.06	10.33	0.02
2020	4907.62	5881	910	61.51	67.15	61.40	66.95	5.88	12.30	20.54	5.64
2021	6162.84	7395	910	81.23	83.15	77.31	84.42	5.33	15.80	1.05	1.92
2022	1550.09	1983	910	19.97	24.77	19.45	22.64	0.06	21.35	53.88	4.79
2023	6448.18	7594	910	83.60	84.52	80.89	86.69	4.09	3.81	11.66	0.93
2024	5380.40	6421	910	72.21	73.39	67.31	73.10	3.29	2.80	23.81	1.18

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		222			464	
B.	Refuelling without maintenance				157		
C.	Inspection, maintenance or repair combined with refuelling	2087			1067	18	
D.	Inspection, maintenance or repair without refuelling				1		
E.	Testing of plant systems or components				6	1	2
H.	Nuclear regulatory requirements					2	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						5
L.	Human factor related					10	1
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
O.	Load dispatching, prioritization			54			3
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						13
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						2
Z.	Other					34	43
Subtotal		2087	222	54	1231	529	71
Total		**2363**			**1831**		

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		9
12. Reactor I&C Systems		20
13. Reactor Auxiliary Systems	29	17
14. Safety Systems		10
15. Reactor Cooling Systems		25
16. Steam generation systems		48
17. Safety I&C Systems (excluding reactor I&C)		5
21. Fuel Handling and Storage Facilities		8
31. Turbine and auxiliaries		29
32. Feedwater and Main Steam System	145	24
34. Miscellaneous Systems	26	168
35. All other I&C Systems		1
41. Main Generator Systems		77
42. Electrical Power Supply Systems	21	25
Total	**221**	**466**

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2024 Operating Experience

FR-28 GRAVELINES-4 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1976-04-01
Grid Date	:	1981-06-14
Commercial Date	:	1981-10-01
Age at end of year	:	43 years

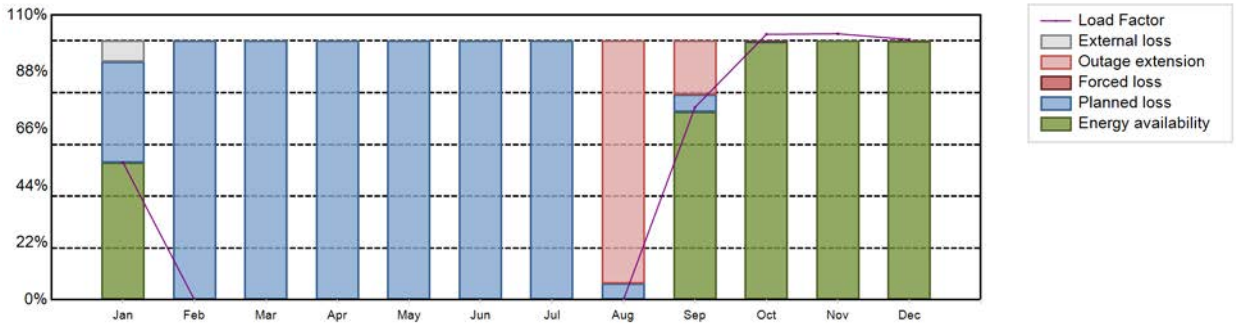
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.2
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	323
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.5
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	45	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	2894.99 GW(e).h	Forced Loss Rate (FLR)	:	0.09 %
Energy Availability Factor (EAF)	:	35.55 %	Unplanned Capability Loss Factor (UCL)	:	9.67 %
Unit Capability Factor (UCF)	:	36.24 %	Planned Unavailability Factor (PUF)	:	54.09 %
Load Factor (LF)	:	36.22 %	Externally cause unavailability (XUF)	:	0.69 %
Operating Factor (OF)	:	36.82 %	Total off-line time	:	5550 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	359.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	486.81	695.11	673.19	680.59	2894.99
EAF [%]	53.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72.56	99.58	100.00	99.95	35.55
UCF [%]	61.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72.56	99.58	100.00	99.95	36.24
LF [%]	53.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74.30	102.53	102.75	100.52	36.22
OF [%]	61.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	79.17	99.87	100.00	100.00	36.82
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.09
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.67	20.79	0.39	0.00	0.00	9.67
PUF [%]	38.79	100.00	100.00	100.00	100.00	100.00	100.00	6.33	6.64	0.03	0.00	0.05	54.09
XUF [%]	8.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69

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Historical Summary

Lifetime energy generation	:	258033.57 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.3 %
Cumulative Energy Availability Factor (EAF)	:	77.14 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.52 %
Cumulative Unit Capability Factor (UCF)	:	78.55 %	Cumulative Planned Unavailability Factor (PUF)	:	14.92 %
Cumulative Load Factor (LF)	:	74.5 %	Cumulative Externally cause unavailability (XUF)	:	1.42 %
Cumulative Operating Factor (OF)	:	78.64 %			

Electricity Production (net) [GWh]

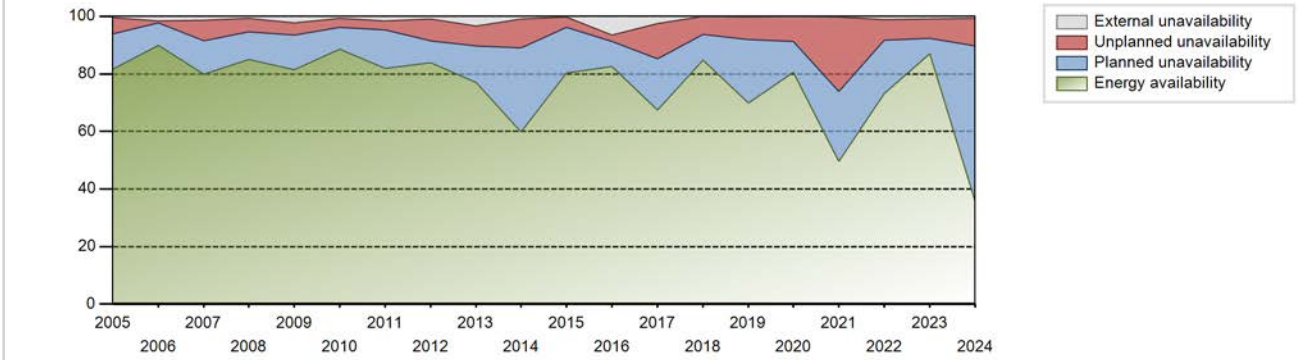


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	2636.60	3434	915	85.39	85.39	84.78	91.98	2.84	2.50	12.12	0.00
1982	5498.20	7193	910	80.76	80.76	68.97	82.11	19.24	19.24	0.00	0.00
1983	4062.00	4986	910	54.50	54.50	50.96	56.92	12.53	7.81	37.69	0.01
1984	6006.00	7173	910	82.77	82.77	75.14	81.66	7.35	6.57	10.67	0.00
1985	6178.80	7387	910	80.87	83.60	77.51	84.33	5.89	5.23	11.17	2.74
1986	6556.60	7862	910	88.64	88.70	82.25	89.75	2.14	1.94	9.35	0.06
1987	5472.80	6787	910	75.78	77.16	68.65	77.48	7.48	6.24	16.61	1.37
1988	6221.00	7789	910	85.93	87.85	77.83	88.67	1.83	1.64	10.51	1.93
1989	4982.33	6025	910	66.86	67.37	62.50	68.78	16.17	12.99	19.64	0.50
1990	6151.73	7058	910	77.18	79.44	77.17	80.57	9.13	7.98	12.58	2.26
1991	6261.99	7067	910	80.47	81.82	78.55	80.67	6.36	5.55	12.63	1.35
1992	6419.80	7137	910	80.20	81.01	80.31	81.25	2.41	2.00	16.98	0.82
1993	4680.57	6112	910	75.31	76.47	58.72	69.77	13.65	12.08	11.45	1.16
1994	6039.34	6824	910	82.47	83.27	75.76	77.90	6.37	5.67	11.07	0.80
1995	6289.53	7313	910	85.42	86.42	78.90	83.48	3.40	3.04	10.54	1.00
1996	6288.41	7552	910	83.16	85.50	78.67	85.97	4.28	3.82	10.68	2.34
1997	5986.68	7206	910	80.46	81.31	75.10	82.26	2.57	2.15	16.54	0.85
1998	6519.35	7570	910	84.10	85.44	81.78	86.42	1.97	1.72	12.84	1.35
1999	5550.87	6734	910	74.28	76.41	69.63	76.87	11.82	10.24	13.35	2.13
2000	4563.64	5453	910	57.74	69.50	57.09	62.08	0.50	0.35	30.15	11.76
2001	5990.69	7094	910	78.26	79.76	75.15	80.98	8.38	7.29	12.95	1.50
2002	6028.10	7219	910	80.04	81.12	75.62	82.41	9.31	8.32	10.55	1.08
2003	5701.86	6589	910	74.19	74.19	71.53	75.22	1.28	0.96	24.84	0.00
2004	6544.62	7693	910	85.39	85.39	81.87	87.58	5.42	4.90	9.71	0.00
2005	6437.07	7354	910	81.75	82.20	80.75	83.95	4.33	5.72	12.09	0.45
2006	7123.08	8079	910	89.94	91.49	89.36	92.23	0.19	0.82	7.69	1.55
2007	6341.02	7164	910	79.79	81.07	79.54	81.77	3.88	7.20	11.73	1.28
2008	6663.01	7678	910	85.04	85.78	83.36	87.41	5.01	4.71	9.52	0.73
2009	6312.54	7342	910	81.40	83.61	79.19	83.81	0.60	4.37	12.02	2.22
2010	6785.73	7958	910	88.51	89.11	85.12	90.84	1.18	3.23	7.66	0.59
2011	6464.37	7383	910	82.01	83.66	81.09	84.28	0.22	3.16	13.18	1.66
2012	6669.67	7612	910	83.89	84.85	83.44	86.66	5.09	7.62	7.52	0.96
2013	6120.30	6967	910	77.10	80.44	76.78	79.53	1.80	7.01	12.55	3.34
2014	4797.97	5335	910	59.73	60.73	60.19	60.90	6.39	9.88	29.39	1.00
2015	6476.69	7127	910	80.29	80.52	81.25	81.36	1.96	3.57	15.91	0.22
2016	6716.29	7445	910	82.50	89.06	84.02	84.76	0.76	2.05	8.88	6.56
2017	5517.18	6063	910	67.52	69.95	69.21	69.21	2.19	12.36	17.69	2.43

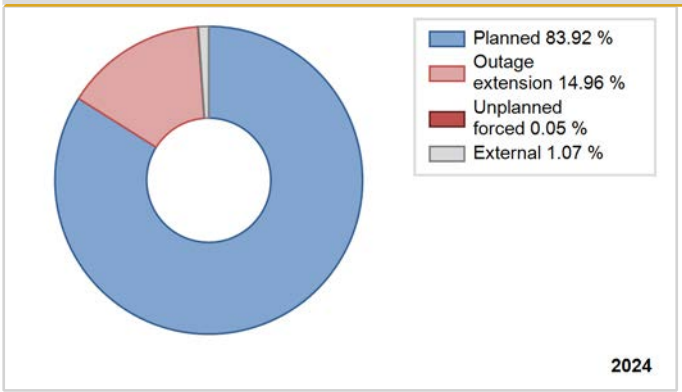
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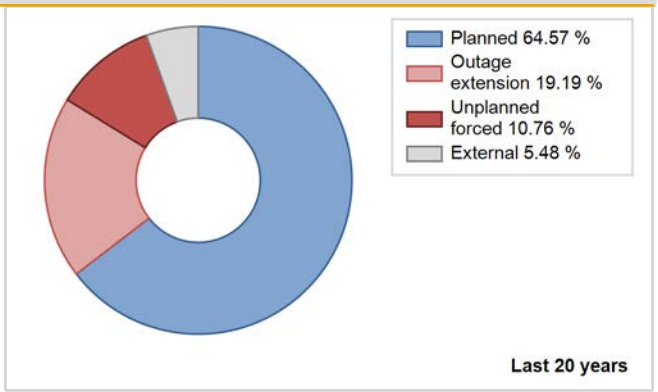
2018	6884.99	7474	910	84.81	84.81	86.37	85.32	4.34	6.19	9.00	0.00
2019	5724.80	6192	910	69.76	69.91	71.81	70.68	3.50	7.85	22.24	0.15
2020	6658.46	7155	910	80.63	80.75	83.30	81.45	0.12	8.53	10.72	0.12
2021	4015.61	4480	910	49.61	49.94	50.37	51.14	13.82	25.79	24.28	0.33
2022	5937.41	6452	910	73.21	74.25	74.48	73.65	9.00	7.34	18.41	1.04
2023	6792.53	7826	910	86.96	87.96	85.21	89.34	2.58	6.71	5.33	1.01
2024	2894.99	3234	910	35.55	36.24	36.22	36.82	0.09	9.67	54.09	0.69

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		847			484	
B.	Refuelling without maintenance				115		
C.	Inspection, maintenance or repair combined with refuelling	4702			1120	7	
D.	Inspection, maintenance or repair without refuelling				5	3	
E.	Testing of plant systems or components				3	1	1
H.	Nuclear regulatory requirements					7	
I.	Grid capacity limitation						0
J.	Grid limitation, failure or grid unavailability						1
L.	Human factor related					6	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						3
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					0	27
Z.	Other					14	21
Subtotal		4702	847		1243	522	53
Total		**5549**			**1818**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		23
12. Reactor I&C Systems		40
13. Reactor Auxiliary Systems		7
14. Safety Systems		13
15. Reactor Cooling Systems		23
16. Steam generation systems		59
21. Fuel Handling and Storage Facilities		3
31. Turbine and auxiliaries		27
32. Feedwater and Main Steam System		20
33. Circulating Water System		6
34. Miscellaneous Systems	847	167
35. All other I&C Systems		6
41. Main Generator Systems		37
42. Electrical Power Supply Systems		70
Total	**847**	**501**

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2024 Operating Experience

FR-51 GRAVELINES-5 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1979-10-01
Grid Date	:	1984-08-28
Commercial Date	:	1985-01-15
Age at end of year	:	40 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	47000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.85
Number of control rod assemblies	:	36
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

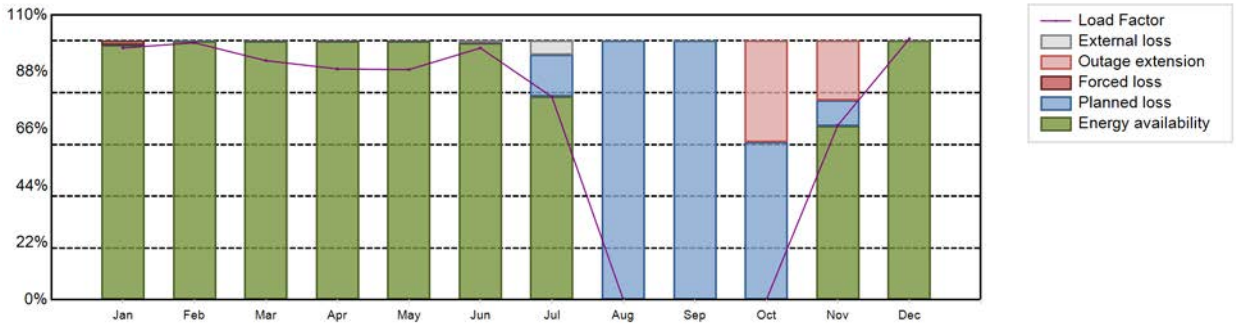
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5390.62 GW(e).h
Energy Availability Factor (EAF)	:	70.07 %
Unit Capability Factor (UCF)	:	70.56 %
Load Factor (LF)	:	67.44 %
Operating Factor (OF)	:	71.6 %

Forced Loss Rate (FLR)	:	0.27 %
Unplanned Capability Loss Factor (UCL)	:	5.39 %
Planned Unavailability Factor (PUF)	:	24.05 %
Externally cause unavailability (XUF)	:	0.49 %
Total off-line time	:	2495 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	658.65	628.76	624.58	584.32	601.94	637.20	530.78	0.00	0.00	0.00	441.86	682.52	5390.62
EAF [%]	98.29	99.93	99.89	99.91	99.77	99.08	78.40	0.00	0.00	0.00	67.12	100.00	70.07
UCF [%]	98.29	99.93	99.89	99.91	99.77	99.60	83.72	0.00	0.00	0.00	67.12	100.00	70.56
LF [%]	97.28	99.27	92.38	89.18	88.91	97.25	78.40	0.00	0.00	0.00	67.44	100.81	67.44
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	83.87	0.00	0.00	0.00	76.94	100.00	71.60
FLR [%]	1.60	0.00	0.08	0.06	0.19	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.27
UCL [%]	1.59	0.00	0.08	0.06	0.19	0.32	0.00	0.00	0.00	38.99	23.07	0.00	5.39
PUF [%]	0.11	0.07	0.03	0.03	0.05	0.08	16.28	100.00	100.00	61.01	9.81	0.00	24.05
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.52	5.32	0.00	0.00	0.00	0.00	0.00	0.49

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Historical Summary

Lifetime energy generation	:	231211.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.75 %
Cumulative Energy Availability Factor (EAF)	:	75.89 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.56 %
Cumulative Unit Capability Factor (UCF)	:	77.55 %	Cumulative Planned Unavailability Factor (PUF)	:	13.9 %
Cumulative Load Factor (LF)	:	72.1 %	Cumulative Externally cause unavailability (XUF)	:	1.66 %
Cumulative Operating Factor (OF)	:	77.86 %			

Electricity Production (net) [GWh]

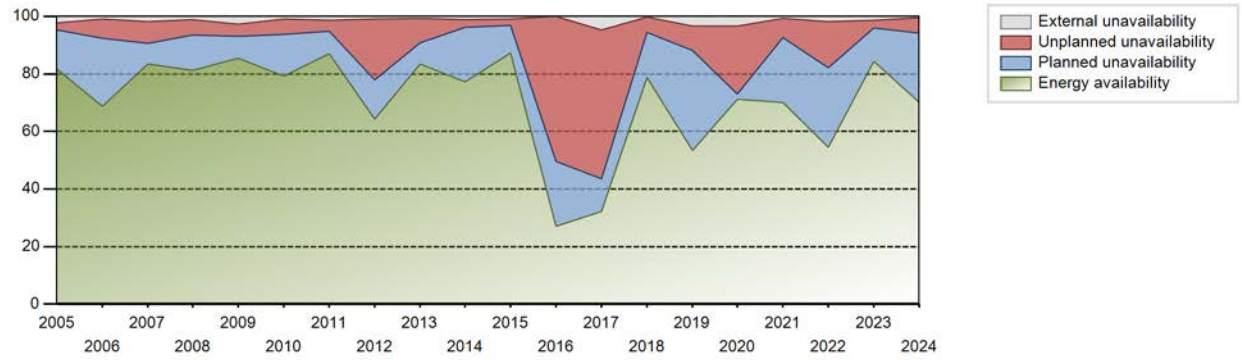


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	6768.40	7785	910	90.02	90.06	84.91	88.87	9.94	9.94	0.00	0.04
1986	5152.60	6673	910	75.24	77.10	64.64	76.18	3.23	2.57	20.33	1.86
1987	5236.50	6818	910	80.63	81.53	65.69	77.83	8.13	7.21	11.26	0.90
1988	4964.00	6306	910	71.75	75.25	62.10	71.79	7.10	5.75	18.99	3.50
1989	6020.57	7198	910	80.64	80.98	75.53	82.17	11.01	10.02	9.00	0.34
1990	5992.77	7367	910	80.68	83.24	75.18	84.10	4.58	3.99	12.77	2.56
1991	5276.17	6352	910	69.61	72.16	66.19	72.51	4.86	3.68	24.16	2.55
1992	6308.02	7361	910	82.64	82.65	78.91	83.80	3.06	2.61	14.74	0.00
1993	6180.53	7290	910	78.59	82.73	77.53	83.22	6.30	5.56	11.71	4.15
1994	5793.25	7147	910	83.21	84.37	72.67	81.59	3.60	3.15	12.48	1.16
1995	6180.98	7704	910	85.99	87.59	77.54	87.95	2.11	1.88	10.52	1.60
1996	5495.18	6652	910	72.12	75.29	68.75	75.73	6.30	5.06	19.65	3.17
1997	6429.86	7586	910	86.07	87.63	80.66	86.60	2.13	1.91	10.46	1.56
1998	6884.31	8286	910	95.83	97.34	86.36	94.59	2.05	2.04	0.62	1.52
1999	5124.26	6127	910	67.03	68.06	64.28	69.94	21.44	18.57	13.37	1.03
2000	5985.50	7444	910	81.45	84.37	74.88	84.74	4.94	4.38	11.25	2.92
2001	5762.64	6990	910	78.23	80.15	72.29	79.79	8.59	7.54	12.31	1.93
2002	6423.39	7662	910	84.68	85.83	80.58	87.47	4.07	3.64	10.52	1.15
2003	6473.43	7518	910	84.32	85.14	81.21	85.82	1.24	1.07	13.79	0.83
2004	6613.48	7836	910	86.25	88.79	82.74	89.21	2.01	1.82	9.38	2.55
2005	6410.04	7524	910	81.68	84.01	80.40	85.88	2.21	2.47	13.51	2.33
2006	5313.17	6313	910	68.84	69.82	66.65	72.07	7.46	6.54	23.64	0.97
2007	6510.19	7592	910	83.46	85.36	81.66	86.66	4.99	7.39	7.24	1.90
2008	6357.76	7352	910	81.16	82.33	79.54	83.70	4.48	5.29	12.38	1.17
2009	6652.21	7846	910	85.54	88.33	83.45	89.57	0.88	4.13	7.54	2.79
2010	6228.43	7120	910	79.28	80.20	78.13	81.28	2.02	5.32	14.47	0.92
2011	6859.22	7807	910	87.04	88.52	86.05	89.12	0.02	3.77	7.71	1.48
2012	5099.17	5943	910	64.29	65.27	63.79	67.66	7.74	21.09	13.64	0.99
2013	6635.01	7427	910	83.51	84.20	83.23	84.78	1.29	8.42	7.38	0.69
2014	6114.63	6972	910	77.24	78.28	76.71	79.59	1.17	2.71	19.01	1.04
2015	6727.72	7810	910	87.21	88.12	84.40	89.16	1.06	2.26	9.62	0.91
2016	2133.02	2378	910	26.98	26.99	26.68	27.07	0.11	50.31	22.70	0.01
2017	2547.59	3150	910	32.12	36.86	31.96	35.96	5.90	51.76	11.38	4.73
2018	6253.07	7131	910	78.87	79.07	78.44	81.40	1.64	5.31	15.62	0.20
2019	4192.74	4915	910	53.33	56.72	52.60	56.11	6.87	8.43	34.85	3.39
2020	5493.20	6571	910	71.15	74.50	68.72	74.81	11.28	23.73	1.77	3.35
2021	5293.14	6199	910	70.02	70.72	66.40	70.76	8.54	6.61	22.68	0.70

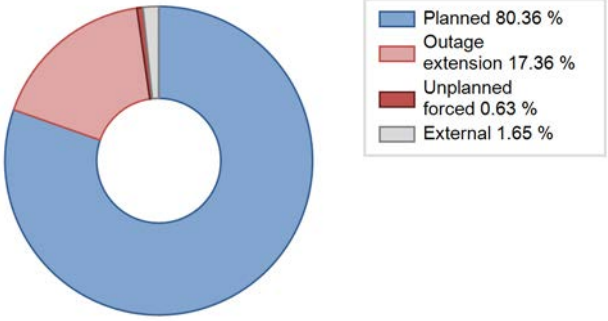
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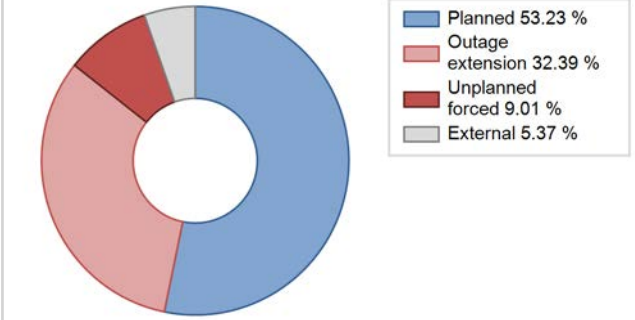
2022	4304.69	4979	910	54.48	56.19	54.00	56.84	2.07	16.22	27.59	1.71
2023	6479.71	7581	910	84.35	85.69	81.28	86.54	0.12	2.61	11.70	1.34
2024	5390.62	6289	910	70.07	70.56	67.44	71.60	0.27	5.39	24.05	0.49

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		457			439	
B. Refuelling without maintenance				135		
C. Inspection, maintenance or repair combined with refuelling	2039			1008	16	
D. Inspection, maintenance or repair without refuelling				2		
E. Testing of plant systems or components				4	0	
H. Nuclear regulatory requirements					216	
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					14	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
O. Load dispatching, prioritization						2
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						19
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						2
Z. Other					13	
Subtotal	2039	457		1149	698	27
Total	**2496**			**1874**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		15
12. Reactor I&C Systems		17
13. Reactor Auxiliary Systems		22
14. Safety Systems		16
15. Reactor Cooling Systems		57
16. Steam generation systems		229
21. Fuel Handling and Storage Facilities		5
31. Turbine and auxiliaries		42
32. Feedwater and Main Steam System		13
33. Circulating Water System		4
34. Miscellaneous Systems	457	143
35. All other I&C Systems		0
41. Main Generator Systems		47
42. Electrical Power Supply Systems		48
Total	**457**	**658**

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2024 Operating Experience

FR-52 GRAVELINES-6 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	910 MWe

Key Dates

Construction Date	:	1979-10-01
Grid Date	:	1985-08-01
Commercial Date	:	1985-10-25
Age at end of year	:	39 years

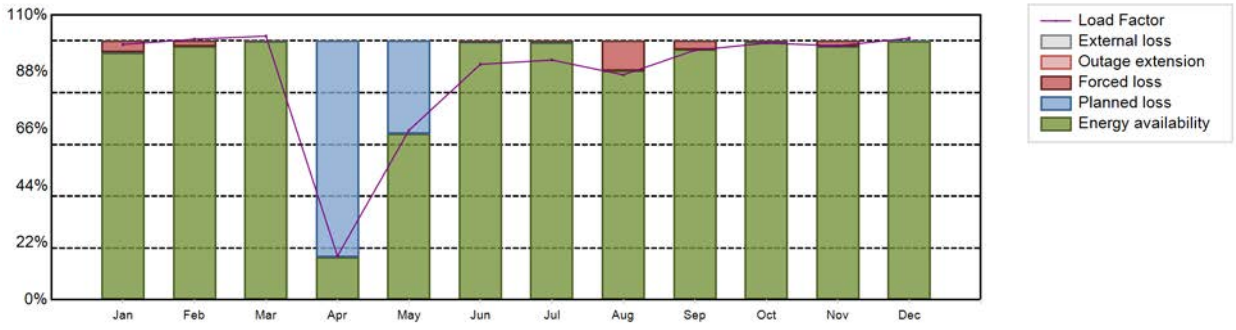
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	47000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.85	Number of main condensate pumps	:	-
Number of control rod assemblies	:	36	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6990.28 GW(e).h	Forced Loss Rate (FLR)	:	2.31 %
Energy Availability Factor (EAF)	:	88 %	Unplanned Capability Loss Factor (UCL)	:	2.08 %
Unit Capability Factor (UCF)	:	88 %	Planned Unavailability Factor (PUF)	:	9.92 %
Load Factor (LF)	:	87.45 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	90.8 %	Total off-line time	:	808 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	667.78	637.68	688.64	110.73	443.29	596.08	626.98	588.22	631.52	672.16	643.03	684.16	6990.28
EAF [%]	95.49	97.84	99.87	16.46	64.13	99.56	99.48	88.52	96.53	99.54	97.87	99.96	88.00
UCF [%]	95.49	97.84	99.87	16.46	64.13	99.56	99.48	88.52	96.53	99.54	97.87	99.96	88.00
LF [%]	98.63	100.68	101.85	16.90	65.48	90.98	92.61	86.88	96.39	99.15	98.14	101.05	87.45
OF [%]	100.00	100.00	100.00	16.67	72.18	100.00	100.00	100.00	100.00	99.87	100.00	100.00	90.80
FLR [%]	4.39	2.16	0.12	0.00	0.00	0.37	0.48	11.48	3.47	0.34	2.12	0.00	2.31
UCL [%]	4.38	2.16	0.12	0.00	0.00	0.37	0.48	11.48	3.47	0.34	2.12	0.00	2.08
PUF [%]	0.13	0.00	0.02	83.54	35.87	0.07	0.04	0.00	0.00	0.12	0.00	0.04	9.92
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	237824.26 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.75 %
Cumulative Energy Availability Factor (EAF)	:	77.83 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.43 %
Cumulative Unit Capability Factor (UCF)	:	79.38 %	Cumulative Planned Unavailability Factor (PUF)	:	14.19 %
Cumulative Load Factor (LF)	:	75.7 %	Cumulative Externally cause unavailability (XUF)	:	1.56 %
Cumulative Operating Factor (OF)	:	79.61 %			

Electricity Production (net) [GWh]

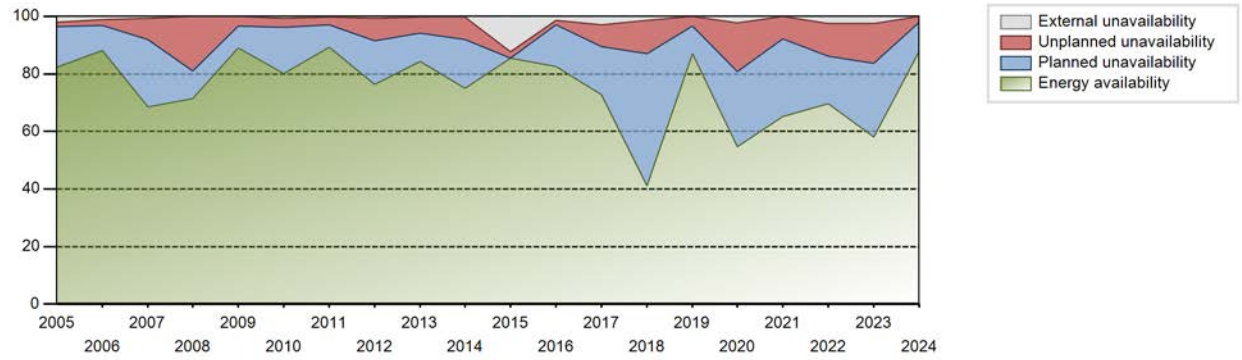


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	2337.10	3111	910	97.26	97.26	94.68	97.61	2.74	2.74	0.00	0.00
1986	5540.40	6677	910	75.88	76.32	69.50	76.22	3.96	3.15	20.53	0.44
1987	5583.90	7031	910	80.14	80.57	70.05	80.26	9.39	8.34	11.09	0.42
1988	6490.00	7453	910	81.43	83.77	81.19	84.85	14.30	13.97	2.25	2.34
1989	5177.26	6274	910	71.08	71.17	64.95	71.62	9.18	7.19	21.63	0.09
1990	6120.26	7553	910	87.07	87.56	76.78	86.22	12.41	12.41	0.03	0.49
1991	5888.22	6953	910	77.47	78.53	73.86	79.37	9.62	8.36	13.11	1.06
1992	5085.13	6246	910	69.03	70.27	63.62	71.11	11.78	9.38	20.35	1.24
1993	5293.57	6751	910	73.42	82.03	66.41	77.07	7.24	6.40	11.57	8.61
1994	6053.73	7487	910	83.89	86.00	75.94	85.47	1.80	1.58	12.42	2.11
1995	6769.36	7922	910	88.83	89.78	84.92	90.43	0.95	0.86	9.36	0.95
1996	6609.47	7755	910	86.39	86.77	82.69	88.29	3.48	3.13	10.11	0.37
1997	4545.45	5437	910	59.49	60.58	57.02	62.07	23.50	18.61	20.81	1.09
1998	6531.81	7746	910	86.08	88.53	81.94	88.42	1.63	1.47	10.00	2.45
1999	6141.43	7222	910	80.29	80.92	77.04	82.44	4.70	3.99	15.10	0.63
2000	6720.94	7887	910	87.03	88.68	84.08	89.79	0.35	0.32	11.01	1.65
2001	6148.66	7265	910	80.24	82.23	77.13	82.93	5.74	5.01	12.76	1.99
2002	6690.91	7784	910	86.02	87.49	83.93	88.86	3.39	3.07	9.44	1.48
2003	6462.57	7410	910	82.50	83.26	81.07	84.59	1.98	1.69	15.05	0.76
2004	6936.10	7850	910	86.85	88.32	86.77	89.37	4.00	3.68	8.00	1.47
2005	6536.49	7511	910	82.35	84.30	82.00	85.74	1.97	1.69	14.01	1.95
2006	7058.37	7907	910	88.25	89.35	88.54	90.26	1.41	1.98	8.68	1.09
2007	5455.66	6087	910	68.42	69.10	68.44	69.49	1.42	7.46	23.44	0.68
2008	5792.75	6383	910	71.49	71.53	72.47	72.67	2.96	18.85	9.62	0.04
2009	7108.24	7866	910	88.95	89.00	89.17	89.79	0.12	3.34	7.66	0.04
2010	6363.90	7125	910	80.15	80.86	79.83	81.34	1.53	3.12	16.02	0.71
2011	7101.91	7859	910	89.19	89.51	89.09	89.71	0.11	2.52	7.97	0.32
2012	6115.18	6810	910	76.26	76.97	76.50	77.53	1.43	7.81	15.22	0.71
2013	6773.04	7544	910	84.27	84.52	84.96	86.12	3.46	5.58	9.90	0.26
2014	5768.07	6619	910	74.93	75.30	72.36	75.56	9.21	7.64	17.06	0.37
2015	6824.41	7703	910	85.51	97.72	85.61	87.93	2.25	2.25	0.04	12.21
2016	6544.45	7506	910	82.51	83.79	81.87	85.45	1.87	1.60	14.61	1.28
2017	5875.43	6627	910	72.85	75.77	73.70	75.65	1.93	7.68	16.54	2.93
2018	3320.31	3714	910	41.15	42.63	41.65	42.40	1.19	11.55	45.82	1.48
2019	6947.55	7703	910	87.09	87.16	87.15	87.93	1.39	3.38	9.47	0.07
2020	4343.71	4880	910	54.60	56.84	54.34	55.56	3.90	16.86	26.30	2.23
2021	5250.30	5755	910	65.23	65.29	65.86	65.70	10.63	7.76	26.95	0.06

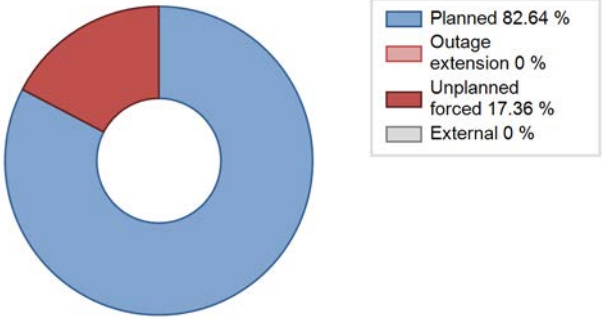
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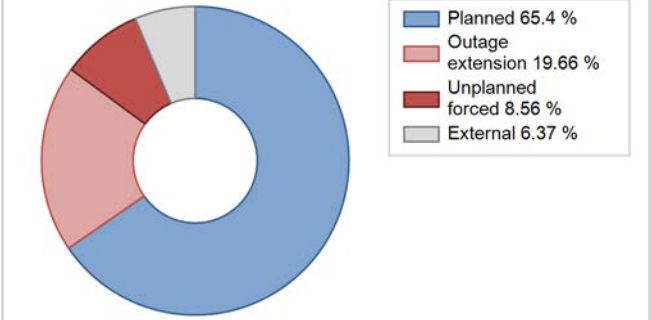
2022	5604.12	6290	910	69.65	72.05	70.30	71.80	4.16	11.52	16.43	2.40
2023	4707.20	5332	910	58.06	60.51	59.05	60.87	0.51	13.93	25.56	2.46
2024	6990.28	7976	910	88.00	88.00	87.45	90.80	2.31	2.08	9.92	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					433	
B.	Refuelling without maintenance	807			203		
C.	Inspection, maintenance or repair combined with refuelling				967	19	
D.	Inspection, maintenance or repair without refuelling					14	
E.	Testing of plant systems or components				7		
H.	Nuclear regulatory requirements					3	
J.	Grid limitation, failure or grid unavailability						1
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						2
L.	Human factor related					24	1
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						10
O.	Load dispatching, prioritization						0
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					2	11
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						22
Z.	Other					29	1
Subtotal		807			1177	524	48
Total		**807**			**1749**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		30
13. Reactor Auxiliary Systems		56
14. Safety Systems		12
15. Reactor Cooling Systems		21
16. Steam generation systems		5
21. Fuel Handling and Storage Facilities		4
31. Turbine and auxiliaries		56
32. Feedwater and Main Steam System		17
33. Circulating Water System		8
34. Miscellaneous Systems		167
35. All other I&C Systems		0
41. Main Generator Systems		13
42. Electrical Power Supply Systems		41
Total		**432**

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2024 Operating Experience

FR-58 NOGENT-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1363 MWe
Reference unit power (net)	:	1310 MWe

Key Dates

Construction Date	:	1981-05-26
Grid Date	:	1987-10-21
Commercial Date	:	1988-02-24
Age at end of year	:	37 years

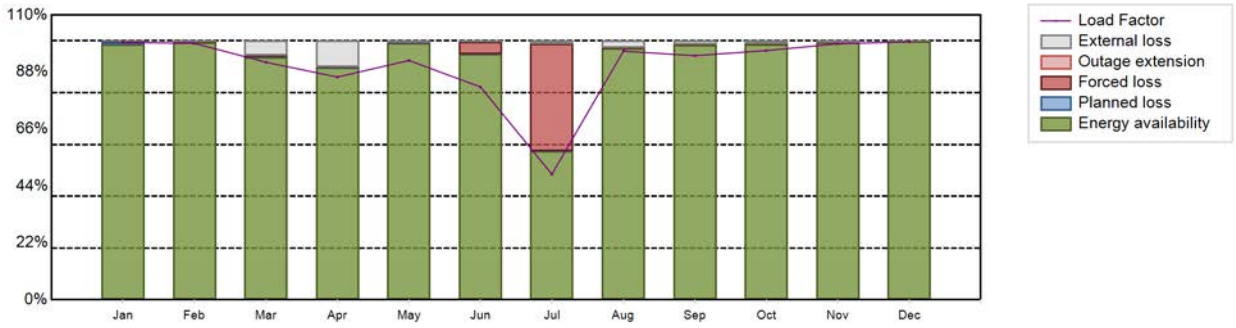
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.05
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10395.78 GW(e).h	Forced Loss Rate (FLR)	:	4.01 %
Energy Availability Factor (EAF)	:	93.84 %	Unplanned Capability Loss Factor (UCL)	:	4 %
Unit Capability Factor (UCF)	:	95.83 %	Planned Unavailability Factor (PUF)	:	0.17 %
Load Factor (LF)	:	90.34 %	Externally cause unavailability (XUF)	:	1.99 %
Operating Factor (OF)	:	94.73 %	Total off-line time	:	463 hours

Annual Summary



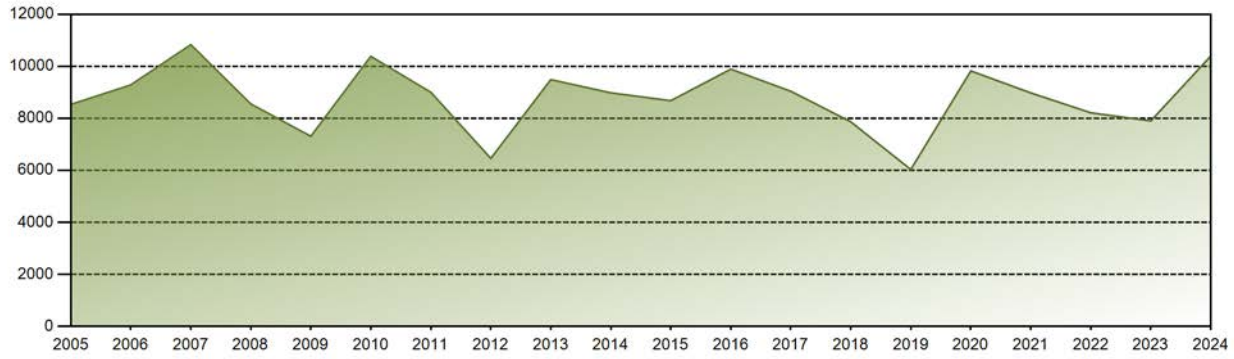
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	969.11	903.10	893.17	811.58	901.17	775.63	472.80	936.09	889.46	939.62	932.67	971.40	10395.78
EAF [%]	98.72	99.49	93.75	89.69	99.15	94.98	57.41	97.18	98.47	98.70	99.35	99.78	93.84
UCF [%]	98.84	99.87	99.40	99.65	99.75	95.31	58.46	99.69	99.93	99.89	99.87	99.96	95.83
LF [%]	99.43	99.05	91.76	86.05	92.46	82.23	48.51	96.04	94.30	96.28	98.88	99.67	90.34
OF [%]	100.00	100.00	95.02	90.97	100.00	93.33	58.06	100.00	100.00	99.87	100.00	100.00	94.73
FLR [%]	0.01	0.11	0.39	0.33	0.17	4.67	41.53	0.14	0.03	0.01	0.03	0.01	4.01
UCL [%]	0.01	0.11	0.39	0.33	0.17	4.67	41.52	0.14	0.03	0.01	0.03	0.01	4.00
PUF [%]	1.15	0.02	0.21	0.02	0.09	0.02	0.02	0.17	0.04	0.11	0.10	0.03	0.17
XUF [%]	0.13	0.38	5.65	9.96	0.60	0.33	1.05	2.51	1.46	1.19	0.52	0.18	1.99

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Historical Summary

Lifetime energy generation	:	294088.8 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.95 %
Cumulative Energy Availability Factor (EAF)	:	77.75 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.05 %
Cumulative Unit Capability Factor (UCF)	:	79.84 %	Cumulative Planned Unavailability Factor (PUF)	:	13.12 %
Cumulative Load Factor (LF)	:	72.92 %	Cumulative Externally cause unavailability (XUF)	:	2.09 %
Cumulative Operating Factor (OF)	:	79.99 %			

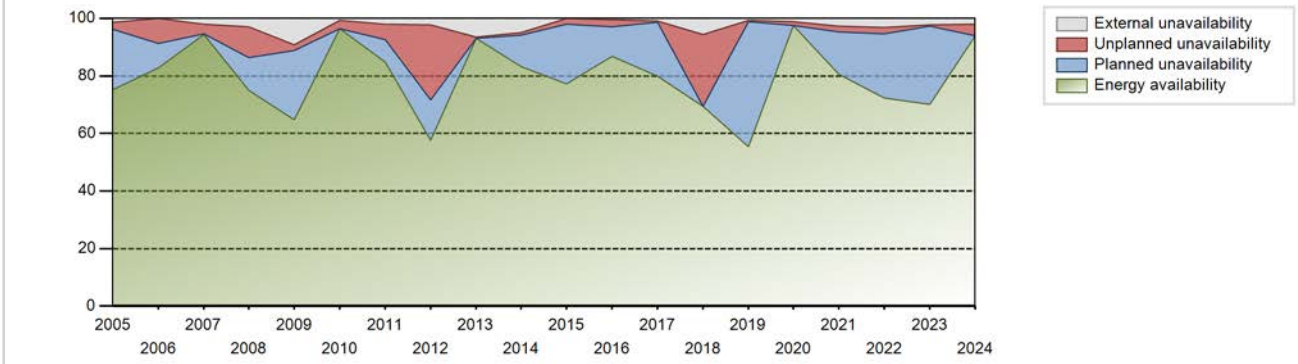
Electricity Production (net) [GWh]



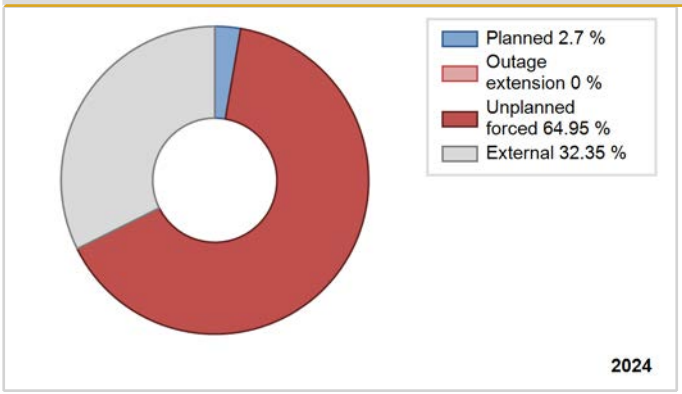
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	7715.00	7324	1310	86.78	87.76	63.93	81.77	12.24	12.24	0.00	0.98
1989	3172.66	2663	1310	28.26	30.25	27.65	30.40	57.21	40.43	29.32	1.99
1990	6614.12	5590	1310	67.54	67.68	57.64	63.81	23.93	21.29	11.03	0.14
1991	6868.61	5768	1310	62.93	64.20	59.85	65.84	12.05	8.79	27.00	1.27
1992	7812.47	6386	1310	70.41	71.52	67.89	72.70	12.10	9.85	18.63	1.10
1993	7705.63	6432	1310	68.47	72.17	67.15	73.42	16.38	14.14	13.70	3.69
1994	8292.35	7429	1310	80.05	83.16	72.26	84.81	1.39	1.17	15.67	3.11
1995	7358.33	6946	1310	83.91	84.35	64.12	79.29	15.64	15.63	0.02	0.44
1996	8227.87	7222	1310	79.58	81.08	71.50	82.22	2.34	1.94	16.98	1.50
1997	8571.62	7488	1310	81.11	83.70	74.69	85.48	3.33	2.89	13.41	2.59
1998	6585.51	5334	1310	57.17	59.18	57.39	60.89	21.82	16.52	24.30	2.01
1999	9704.97	8284	1310	91.77	92.53	84.57	94.57	5.53	5.42	2.05	0.76
2000	9088.25	7626	1310	83.03	85.17	78.98	86.82	0.64	0.54	14.28	2.15
2001	9142.69	7580	1310	83.82	84.71	79.67	86.53	1.51	1.30	13.99	0.89
2002	9010.98	7738	1310	87.13	87.25	78.52	88.33	0.45	0.39	12.36	0.12
2003	9974.35	8621	1310	98.03	98.28	86.92	98.41	1.11	1.10	0.62	0.25
2004	8535.34	7152	1310	77.82	80.97	74.17	81.42	5.44	4.66	14.37	3.15
2005	8534.36	6803	1310	75.13	76.47	74.37	77.66	0.72	2.46	21.07	1.34
2006	9284.82	7331	1310	82.89	82.89	80.91	83.69	7.77	8.62	8.49	0.00
2007	10831.76	8484	1310	94.48	96.54	94.39	96.85	3.37	3.37	0.09	2.06
2008	8553.25	7052	1310	74.93	77.96	74.33	80.28	5.79	10.52	11.52	3.03
2009	7308.98	5871	1310	64.72	73.79	63.69	67.02	1.07	2.16	24.05	9.07
2010	10382.38	8482	1310	96.38	97.19	90.47	96.83	2.78	2.78	0.03	0.81
2011	9001.39	7562	1310	84.76	86.91	78.44	86.32	2.50	5.14	7.95	2.15
2012	6456.97	5429	1310	57.68	60.02	56.11	61.81	4.10	25.93	14.05	2.34
2013	9487.59	8116	1310	92.95	99.38	82.68	92.65	0.59	0.59	0.03	6.43
2014	8980.03	7826	1310	83.31	88.17	78.25	89.34	0.75	1.08	10.75	4.86
2015	8678.84	6948	1310	77.18	77.21	75.63	79.32	1.01	2.01	20.78	0.02
2016	9891.23	7916	1310	86.86	87.29	85.96	90.12	1.54	2.58	10.13	0.43
2017	9040.03	7190	1310	79.92	80.83	78.78	82.08	0.54	0.44	18.73	0.91
2018	7865.33	6508	1310	69.43	74.96	68.54	74.29	25.00	24.98	0.06	5.53
2019	6030.72	5050	1310	55.31	55.96	52.55	57.65	0.93	0.53	43.51	0.66
2020	9822.26	8696	1310	97.52	98.71	85.36	99.00	1.24	1.24	0.06	1.19
2021	8977.03	7509	1310	80.55	83.22	78.23	85.72	2.48	2.14	14.65	2.67
2022	8212.68	6602	1310	72.36	75.60	71.57	75.37	2.78	2.16	22.24	3.24
2023	7901.27	6333	1310	70.14	72.30	68.85	72.29	0.82	0.60	27.10	2.16
2024	10395.78	8321	1310	93.84	95.83	90.34	94.73	4.01	4.00	0.17	1.99

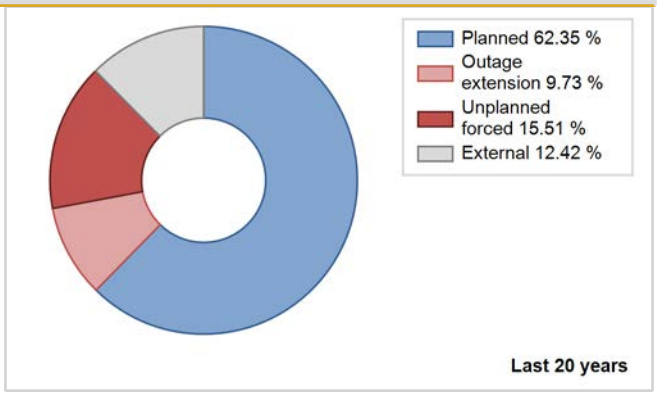
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		281			457	
B. Refuelling without maintenance				78		
C. Inspection, maintenance or repair combined with refuelling				979	1	
D. Inspection, maintenance or repair without refuelling				48		
E. Testing of plant systems or components				42		1
H. Nuclear regulatory requirements					9	
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L. Human factor related					41	1
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			0			0
O. Load dispatching, prioritization			80			2
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						40
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			102			21
Z. Other					6	1
Subtotal		281	182	1147	514	67
Total		**463**			**1728**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1988 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		44
12. Reactor I&C Systems		86
13. Reactor Auxiliary Systems		1
14. Safety Systems		2
15. Reactor Cooling Systems		17
16. Steam generation systems		69
17. Safety I&C Systems (excluding reactor I&C)		9
21. Fuel Handling and Storage Facilities		5
31. Turbine and auxiliaries		43
32. Feedwater and Main Steam System	190	19
33. Circulating Water System		46
34. Miscellaneous Systems		20
35. All other I&C Systems		2
41. Main Generator Systems	91	77
42. Electrical Power Supply Systems		16
Total	**281**	**456**

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2024 Operating Experience

FR-59 NOGENT-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1363 MWe
Reference unit power (net)	:	1310 MWe

Key Dates

Construction Date	:	1982-01-01
Grid Date	:	1988-12-14
Commercial Date	:	1989-05-01
Age at end of year	:	36 years

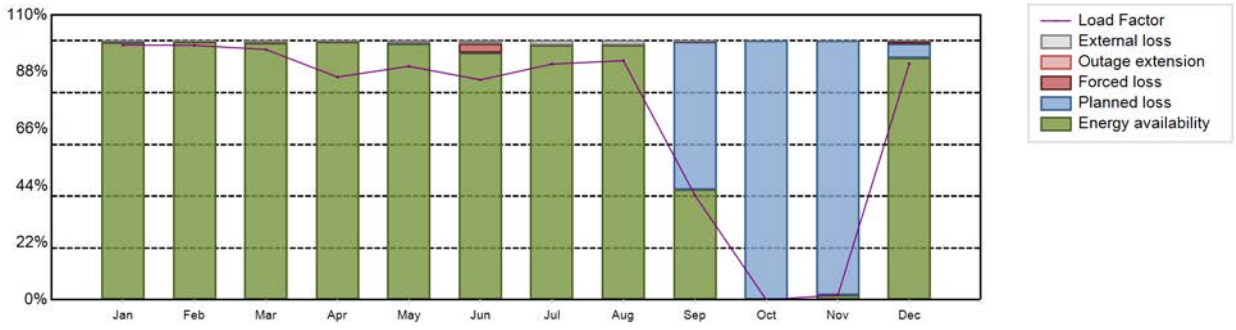
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8364.49 GW(e).h	Forced Loss Rate (FLR)	:	0.57 %
Energy Availability Factor (EAF)	:	77.27 %	Unplanned Capability Loss Factor (UCL)	:	0.45 %
Unit Capability Factor (UCF)	:	77.87 %	Planned Unavailability Factor (PUF)	:	21.68 %
Load Factor (LF)	:	72.69 %	Externally cause unavailability (XUF)	:	0.6 %
Operating Factor (OF)	:	78.89 %	Total off-line time	:	1854 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	959.26	895.99	940.96	811.75	879.07	801.36	887.53	900.22	381.20	0.00	17.65	889.51	8364.49
EAF [%]	99.43	99.57	99.21	99.64	98.89	95.32	98.32	98.31	42.48	0.00	1.88	93.51	77.27
UCF [%]	99.77	99.98	99.80	99.92	99.74	96.43	99.83	99.89	42.91	0.00	1.88	93.57	77.87
LF [%]	98.42	98.27	96.67	86.06	90.19	84.96	91.06	92.36	40.42	0.00	1.87	91.27	72.69
OF [%]	100.00	100.00	100.00	100.00	100.00	96.94	100.00	100.00	43.33	0.00	5.69	100.00	78.89
FLR [%]	0.18	0.01	0.15	0.07	0.20	3.48	0.15	0.05	0.17	0.00	0.00	1.12	0.57
UCL [%]	0.18	0.01	0.15	0.07	0.20	3.47	0.15	0.05	0.07	0.00	0.00	1.06	0.45
PUF [%]	0.05	0.01	0.05	0.01	0.06	0.09	0.02	0.06	57.02	100.00	98.12	5.36	21.68
XUF [%]	0.34	0.40	0.59	0.28	0.85	1.11	1.51	1.58	0.43	0.00	0.00	0.06	0.60

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Historical Summary

Lifetime energy generation	:	305832.61 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.48 %
Cumulative Energy Availability Factor (EAF)	:	79.45 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.72 %
Cumulative Unit Capability Factor (UCF)	:	81.74 %	Cumulative Planned Unavailability Factor (PUF)	:	12.54 %
Cumulative Load Factor (LF)	:	74.15 %	Cumulative Externally cause unavailability (XUF)	:	2.29 %
Cumulative Operating Factor (OF)	:	80.53 %			

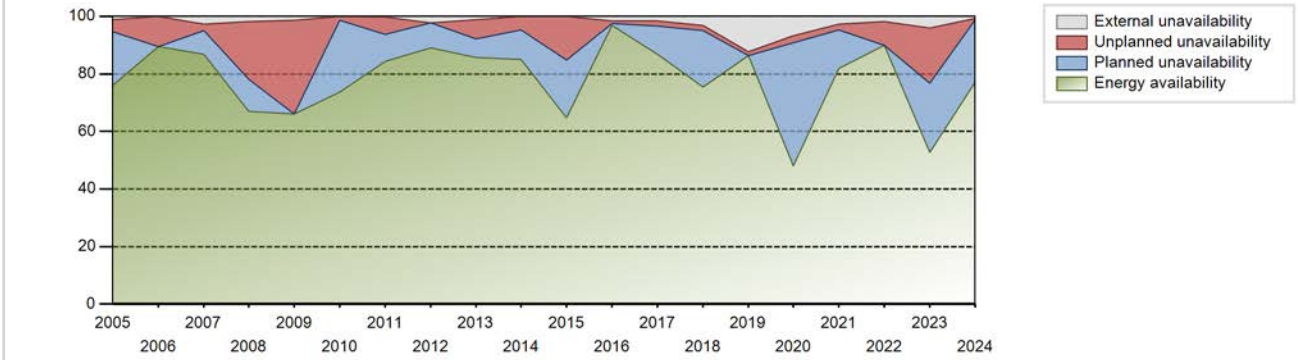
Electricity Production (net) [GWh]



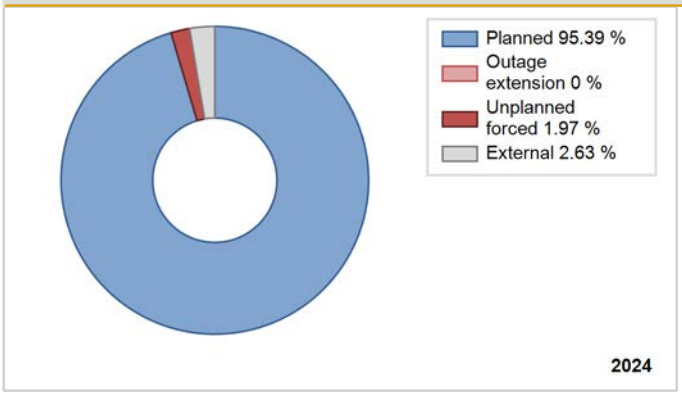
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	7470.05	6660	1310	78.93	78.94	72.84	80.67	21.06	21.05	0.01	0.01
1990	7532.95	6094	1310	68.29	69.37	65.64	69.57	3.95	2.85	27.78	1.07
1991	8331.15	7008	1310	73.49	78.80	72.60	80.00	7.15	6.07	15.12	5.31
1992	8312.33	6937	1310	74.10	77.44	72.24	78.97	5.17	4.22	18.34	3.34
1993	9191.68	7594	1310	80.77	85.85	80.10	86.69	1.34	1.17	12.98	5.08
1994	6483.02	6027	1310	94.82	98.01	56.49	68.80	1.95	1.95	0.05	3.19
1995	7545.41	6862	1310	75.87	78.45	65.75	78.33	9.48	8.22	13.33	2.58
1996	8477.02	7229	1310	76.95	80.52	73.67	82.30	5.35	4.55	14.93	3.57
1997	8925.81	7656	1310	81.96	85.98	77.78	87.40	1.49	1.30	12.72	4.02
1998	8830.03	7386	1310	97.77	98.00	76.95	84.32	1.67	1.67	0.33	0.23
1999	7957.34	6732	1310	74.70	76.24	69.34	76.85	0.52	0.40	23.37	1.54
2000	9672.12	7654	1310	84.62	85.92	84.05	87.14	0.69	0.60	13.48	1.31
2001	9378.95	7589	1310	83.40	85.15	81.73	86.63	0.97	0.83	14.02	1.74
2002	8205.53	7241	1310	84.15	84.17	71.50	82.66	5.01	4.44	11.39	0.02
2003	9447.11	7954	1310	91.51	91.53	82.32	90.80	2.07	1.93	6.54	0.02
2004	8216.70	7044	1310	75.14	78.65	71.41	80.19	9.24	8.01	13.34	3.51
2005	8393.26	6907	1310	76.14	77.20	73.14	78.85	5.27	4.30	18.50	1.06
2006	10046.50	7854	1310	89.52	89.52	87.55	89.66	10.45	10.45	0.04	0.00
2007	9885.89	7918	1310	86.86	89.52	86.15	90.39	1.09	2.19	8.29	2.67
2008	7594.22	6175	1310	67.01	68.79	66.00	70.30	1.40	20.02	11.18	1.79
2009	7156.37	6227	1310	66.02	67.32	62.36	71.08	32.67	32.66	0.01	1.30
2010	8055.24	6576	1310	73.65	73.69	70.19	75.07	1.92	1.45	24.87	0.04
2011	9424.39	7468	1310	84.47	84.67	82.13	85.25	0.24	6.03	9.30	0.20
2012	9853.20	7964	1310	89.02	91.21	85.63	90.66	0.02	0.02	8.77	2.19
2013	9161.96	7595	1310	85.62	86.80	79.84	86.70	1.87	6.70	6.50	1.19
2014	7715.38	6584	1310	84.99	84.99	67.23	75.16	2.73	4.61	10.40	0.00
2015	7148.17	5730	1310	64.79	64.79	62.29	65.41	19.00	15.20	20.01	0.00
2016	10673.55	8665	1310	96.88	98.45	92.76	98.65	0.97	0.96	0.59	1.57
2017	9933.24	7797	1310	86.90	88.39	86.56	89.01	0.98	1.86	9.75	1.49
2018	8618.65	6984	1310	75.45	78.64	75.10	79.73	2.24	1.80	19.56	3.18
2019	9599.33	7762	1310	86.29	98.63	83.65	88.61	1.34	1.34	0.03	12.34
2020	5223.23	4455	1310	48.00	54.82	45.39	50.72	4.12	2.36	42.82	6.82
2021	9090.75	7397	1310	81.98	84.69	79.22	84.44	1.39	2.08	13.23	2.72
2022	9909.52	8092	1310	89.93	91.67	86.35	92.37	8.25	8.25	0.08	1.74
2023	5785.29	4972	1310	52.78	56.95	50.41	56.76	25.13	19.12	23.94	4.16
2024	8364.49	6930	1310	77.27	77.87	72.69	78.89	0.57	0.45	21.68	0.60

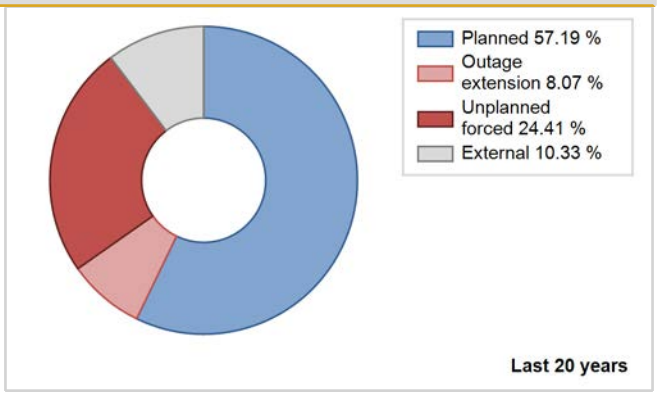
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		14			424	
B. Refuelling without maintenance				74		
C. Inspection, maintenance or repair combined with refuelling	1832			942		
E. Testing of plant systems or components				24		
J. Grid limitation, failure or grid unavailability						2
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						28
L. Human factor related					7	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						14
O. Load dispatching, prioritization			15			3
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						12
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						25
Z. Other				1	31	
Subtotal	1832	14	15	1041	462	84
Total	**1861**			**1587**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1989 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		12
12. Reactor I&C Systems		30
13. Reactor Auxiliary Systems		30
14. Safety Systems		21
15. Reactor Cooling Systems		17
16. Steam generation systems		25
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		50
31. Turbine and auxiliaries	14	43
32. Feedwater and Main Steam System		6
33. Circulating Water System		24
34. Miscellaneous Systems		9
35. All other I&C Systems		9
41. Main Generator Systems		123
42. Electrical Power Supply Systems		20
Total	**14**	**419**

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2024 Operating Experience

FR-36 PALUEL-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1382 MWe
Reference unit power (net)	:	1330 MWe

Key Dates

Construction Date	:	1977-08-15
Grid Date	:	1984-06-22
Commercial Date	:	1985-12-01
Age at end of year	:	40 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	16
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	4.267
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.2
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

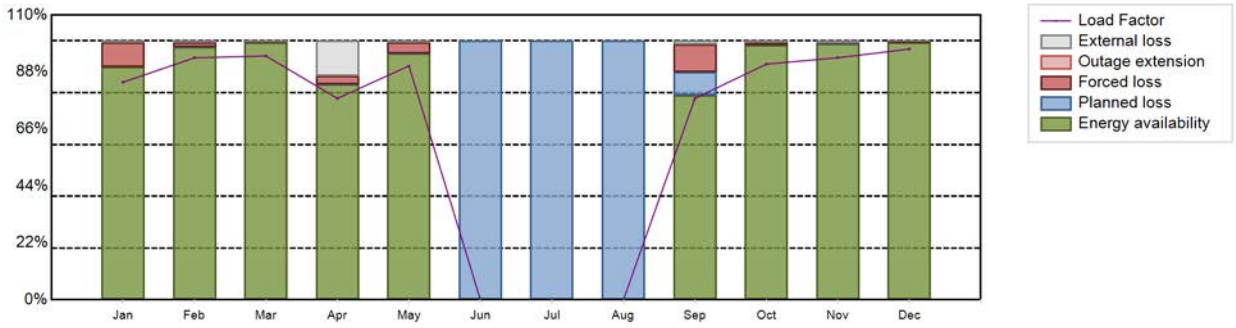
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	328.7
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	4.2
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.95
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7767.13 GW(e).h
Energy Availability Factor (EAF)	:	69.97 %
Unit Capability Factor (UCF)	:	71.5 %
Load Factor (LF)	:	66.48 %
Operating Factor (OF)	:	72.35 %

Forced Loss Rate (FLR)	:	3.56 %
Unplanned Capability Loss Factor (UCL)	:	2.64 %
Planned Unavailability Factor (PUF)	:	25.87 %
Externally cause unavailability (XUF)	:	1.52 %
Total off-line time	:	2429 hours

Annual Summary



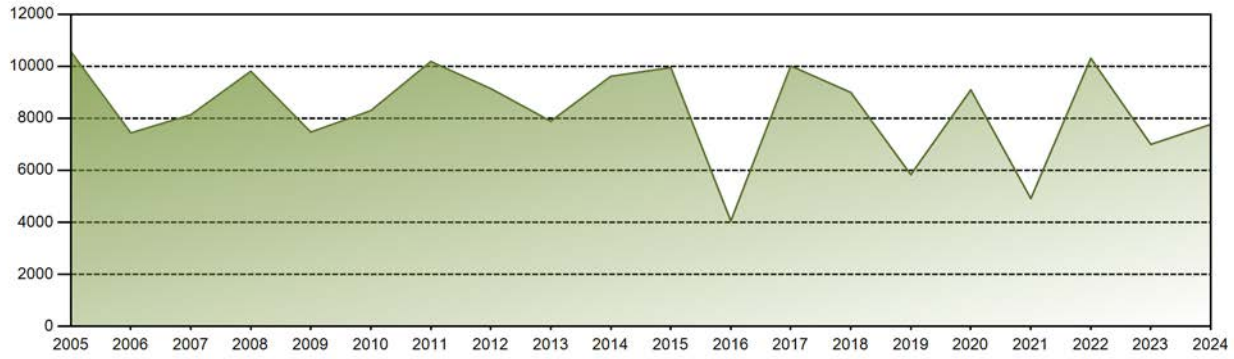
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	831.74	865.17	930.80	745.03	893.95	0.00	0.00	0.01	744.75	902.10	895.26	958.33	7767.13
EAF [%]	89.87	97.67	99.38	83.22	95.07	0.00	0.00	0.00	79.13	98.34	98.85	99.33	69.97
UCF [%]	90.43	98.21	99.74	96.83	95.66	0.00	0.00	0.00	80.38	98.98	99.70	99.43	71.50
LF [%]	84.05	93.46	94.19	77.80	90.34	0.00	0.00	0.00	77.77	91.04	93.49	96.85	66.48
OF [%]	100.00	100.00	100.00	84.72	96.24	0.00	0.00	0.00	88.61	99.87	100.00	100.00	72.35
FLR [%]	9.57	1.76	0.26	3.15	4.21	0.00	0.00	0.00	11.96	1.02	0.27	0.57	3.56
UCL [%]	9.57	1.76	0.26	3.15	4.20	0.00	0.00	0.00	10.92	1.02	0.27	0.57	2.64
PUF [%]	0.00	0.03	0.00	0.02	0.13	100.00	100.00	100.00	8.70	0.00	0.03	0.00	25.87
XUF [%]	0.56	0.54	0.36	13.61	0.60	0.00	0.00	0.00	1.25	0.64	0.86	0.10	1.52

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Historical Summary

Lifetime energy generation	:	325167.97 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.26 %
Cumulative Energy Availability Factor (EAF)	:	75.52 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.89 %
Cumulative Unit Capability Factor (UCF)	:	78.14 %	Cumulative Planned Unavailability Factor (PUF)	:	13.97 %
Cumulative Load Factor (LF)	:	70.28 %	Cumulative Externally cause unavailability (XUF)	:	2.62 %
Cumulative Operating Factor (OF)	:	77.36 %			

Electricity Production (net) [GWh]

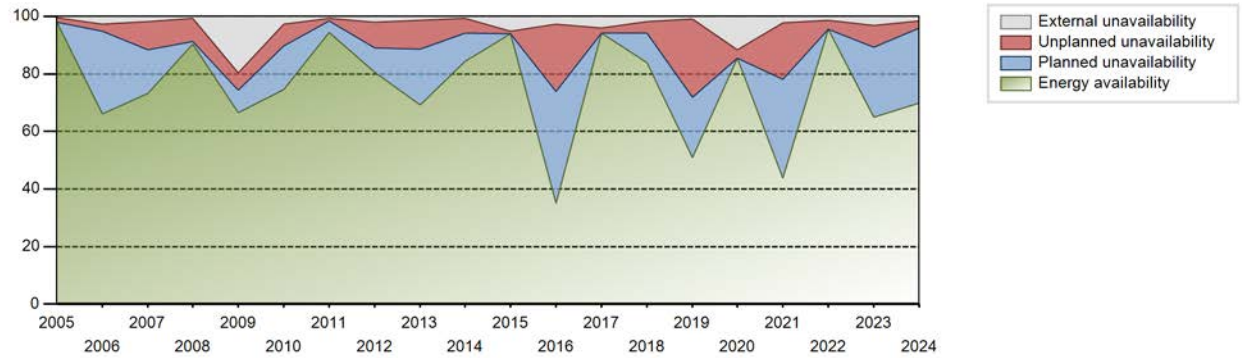


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	4685.80	4104	1290	94.92	94.92	98.72	98.25	5.08	5.08	0.00	0.00
1986	5169.70	4455	1290	50.23	52.32	45.75	50.86	26.61	18.97	28.71	2.09
1987	8184.80	6527	1330	76.58	76.96	70.25	74.51	7.69	6.41	16.63	0.38
1988	9291.00	7332	1330	95.28	96.82	79.53	83.47	3.13	3.12	0.05	1.55
1989	7902.78	6567	1330	70.38	72.57	67.83	74.97	9.49	7.61	19.82	2.19
1990	7323.87	6288	1330	66.40	70.07	62.86	71.78	15.18	12.54	17.39	3.67
1991	7159.94	5987	1330	63.19	66.65	61.45	68.34	13.16	10.10	23.25	3.47
1992	8640.41	6858	1330	76.61	76.62	73.96	78.07	5.82	4.74	18.65	0.01
1993	8068.09	6906	1330	70.88	77.24	69.25	78.84	4.94	4.02	18.74	6.36
1994	6549.93	5790	1330	76.95	77.10	56.22	66.10	22.88	22.88	0.02	0.15
1995	8768.17	7292	1330	79.61	82.18	75.26	83.24	4.24	3.64	14.18	2.58
1996	5483.15	4763	1330	48.69	52.72	46.93	54.22	26.24	18.76	28.52	4.04
1997	9019.66	7537	1330	83.76	84.49	77.42	86.04	5.67	5.08	10.43	0.72
1998	9718.11	8132	1330	91.25	91.28	83.41	92.83	5.26	5.07	3.65	0.03
1999	8181.87	6938	1330	76.15	78.56	70.23	79.20	4.32	3.55	17.89	2.41
2000	9088.99	7533	1330	83.48	83.97	77.80	85.76	2.13	1.83	14.20	0.49
2001	9752.15	8382	1330	97.58	98.29	83.70	95.68	1.51	1.51	0.20	0.72
2002	7153.91	6081	1330	66.55	68.27	61.40	69.42	12.86	10.07	21.66	1.72
2003	8526.18	6882	1330	77.18	77.59	73.18	78.56	11.48	10.06	12.35	0.41
2004	8596.32	7103	1330	77.37	79.37	73.58	80.86	5.53	4.64	15.99	1.99
2005	10565.55	8654	1330	97.86	98.39	90.69	98.79	1.49	1.49	0.12	0.53
2006	7437.70	6133	1330	65.98	68.61	63.84	70.01	1.80	2.61	28.79	2.63
2007	8135.11	6641	1330	73.26	75.11	69.82	75.81	3.73	9.76	15.13	1.84
2008	9808.67	8116	1330	90.35	91.10	83.96	92.40	2.16	8.06	0.84	0.75
2009	7469.32	6108	1330	66.51	86.13	64.11	69.73	1.75	6.06	7.81	19.61
2010	8295.24	6661	1330	74.55	77.25	71.20	76.04	0.75	7.55	15.20	2.70
2011	10184.08	8349	1330	94.32	94.98	87.41	95.31	1.04	1.00	4.02	0.66
2012	9140.88	7351	1330	80.57	82.60	78.24	83.69	4.02	9.04	8.36	2.03
2013	7888.06	6203	1330	69.21	70.62	67.70	70.81	0.12	9.95	19.43	1.41
2014	9615.90	7567	1330	84.41	85.21	82.53	86.38	4.29	4.98	9.82	0.79
2015	9949.97	8222	1330	93.87	99.04	85.40	93.86	0.91	0.91	0.05	5.17
2016	4050.04	3503	1330	35.15	37.84	34.67	39.88	4.48	23.46	38.70	2.70
2017	10013.99	8379	1330	94.17	98.22	85.95	95.65	1.71	1.71	0.07	4.05
2018	8993.47	7597	1330	83.95	85.74	77.19	86.72	3.08	4.15	10.11	1.79
2019	5834.12	4711	1330	50.93	51.95	50.07	53.78	4.45	27.16	20.89	1.03
2020	9093.82	7712	1330	85.42	97.03	77.84	87.80	2.88	2.87	0.10	11.61
2021	4912.69	4117	1330	43.76	46.00	42.17	47.00	16.06	19.71	34.29	2.23

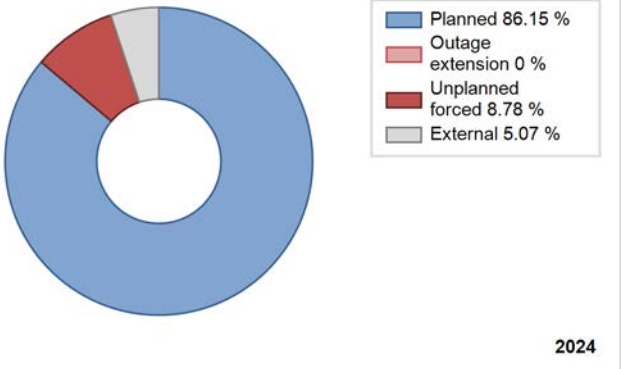
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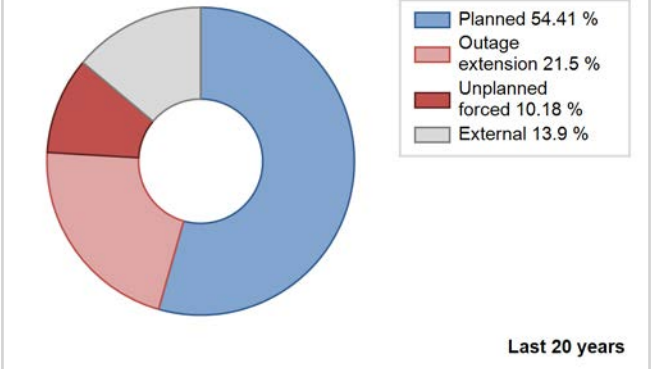
2022	10306.63	8544	1330	95.57	96.88	88.46	97.53	3.09	3.09	0.03	1.31
2023	6998.25	6061	1330	64.93	68.03	60.07	69.19	5.98	7.55	24.42	3.10
2024	7767.13	6355	1330	69.97	71.50	66.48	72.35	3.56	2.64	25.87	1.52

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		120			500	2
B.	Refuelling without maintenance	456			124		
C.	Inspection, maintenance or repair combined with refuelling	1753			1010	36	
D.	Inspection, maintenance or repair without refuelling				92		
E.	Testing of plant systems or components				17	1	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				9		
H.	Nuclear regulatory requirements					10	
J.	Grid limitation, failure or grid unavailability						3
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			0			1
L.	Human factor related					28	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
O.	Load dispatching, prioritization						0
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						56
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			99			45
Z.	Other					60	
Subtotal		2209	120	99	1252	635	108
Total		**2428**			**1995**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		15
12. Reactor I&C Systems	42	42
13. Reactor Auxiliary Systems		24
14. Safety Systems		2
15. Reactor Cooling Systems		9
16. Steam generation systems		13
21. Fuel Handling and Storage Facilities		8
31. Turbine and auxiliaries	17	40
32. Feedwater and Main Steam System		25
33. Circulating Water System	34	14
34. Miscellaneous Systems		190
35. All other I&C Systems		1
41. Main Generator Systems		84
42. Electrical Power Supply Systems	27	17
Total	**120**	**484**

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2024 Operating Experience

FR-37 PALUEL-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1382 MWe
Reference unit power (net)	:	1330 MWe

Key Dates

Construction Date	:	1978-01-01
Grid Date	:	1984-09-14
Commercial Date	:	1985-12-01
Age at end of year	:	40 years

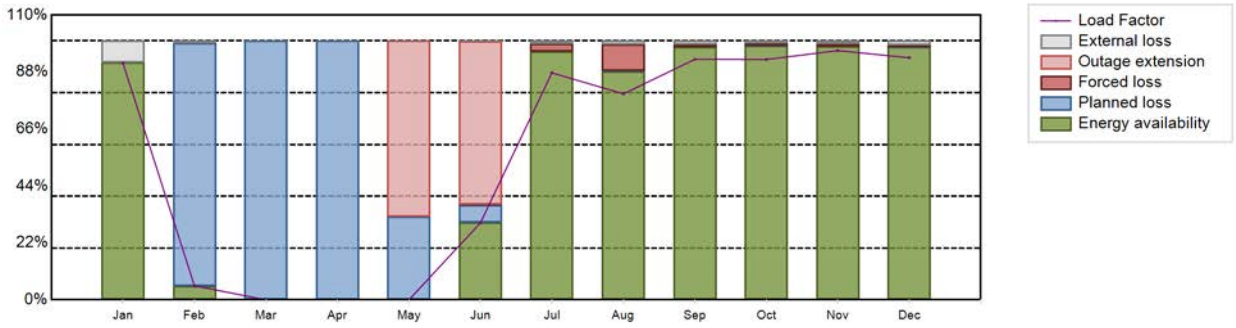
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.2
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6550.31 GW(e).h	Forced Loss Rate (FLR)	:	2.31 %
Energy Availability Factor (EAF)	:	58.88 %	Unplanned Capability Loss Factor (UCL)	:	12.35 %
Unit Capability Factor (UCF)	:	60.28 %	Planned Unavailability Factor (PUF)	:	27.36 %
Load Factor (LF)	:	56.07 %	Externally cause unavailability (XUF)	:	1.41 %
Operating Factor (OF)	:	61.65 %	Total off-line time	:	3369 hours

Annual Summary



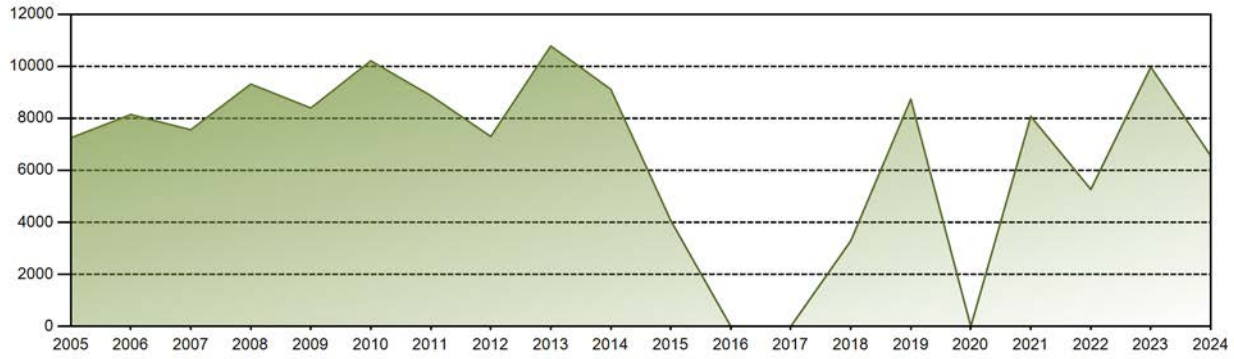
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	904.15	50.27	0.00	0.00	0.00	284.88	867.61	787.25	889.59	919.74	921.80	925.02	6550.31
EAF [%]	91.75	5.43	0.00	0.00	0.00	29.84	95.96	88.31	97.72	98.11	97.85	97.65	58.88
UCF [%]	100.00	6.38	0.00	0.00	0.00	29.94	97.07	89.64	99.07	99.10	98.97	99.19	60.28
LF [%]	91.37	5.43	0.00	0.00	0.00	29.75	87.68	79.56	92.90	92.82	96.26	93.48	56.07
OF [%]	100.00	6.75	0.00	0.00	0.00	36.81	100.00	92.34	100.00	99.87	100.00	100.00	61.65
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.22	2.93	10.32	0.93	0.86	1.03	0.78	2.31
UCL [%]	0.00	0.00	0.00	0.00	67.88	63.23	2.93	10.32	0.93	0.86	1.03	0.78	12.35
PUF [%]	0.00	93.62	100.00	100.00	32.12	6.83	0.00	0.04	0.00	0.04	0.00	0.03	27.36
XUF [%]	8.25	0.95	0.00	0.00	0.00	0.10	1.11	1.33	1.36	0.99	1.12	1.54	1.41

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Historical Summary

Lifetime energy generation	:	289335.53 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.45 %
Cumulative Energy Availability Factor (EAF)	:	66.85 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	16.71 %
Cumulative Unit Capability Factor (UCF)	:	69.39 %	Cumulative Planned Unavailability Factor (PUF)	:	13.9 %
Cumulative Load Factor (LF)	:	62.45 %	Cumulative Externally cause unavailability (XUF)	:	2.54 %
Cumulative Operating Factor (OF)	:	69.25 %			

Electricity Production (net) [GWh]

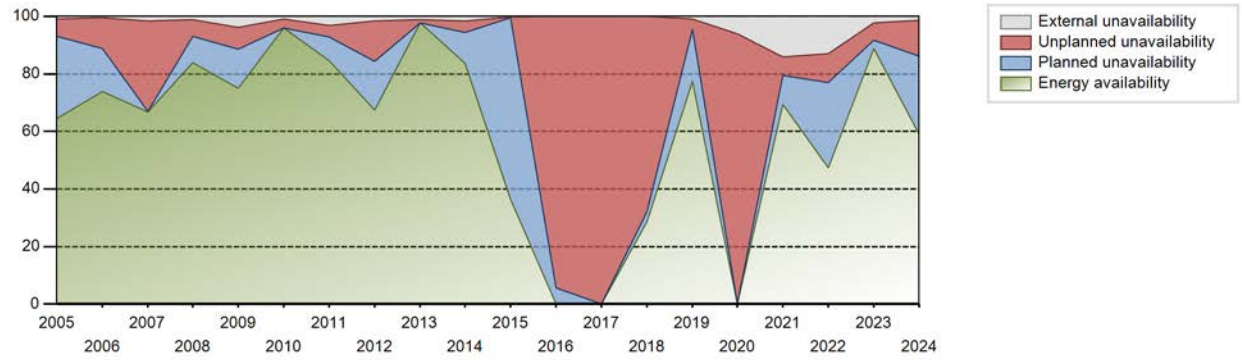


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	5997.80	5548	1290	99.64	99.64	103.20	100.00	0.36	0.36	0.00	0.00
1986	6040.90	4804	1290	52.22	52.33	53.46	54.84	19.74	12.87	34.80	0.12
1987	8859.60	6837	1290	76.84	77.30	78.40	78.05	8.19	6.90	15.80	0.46
1988	7725.00	6017	1330	73.49	75.49	66.12	68.50	6.03	4.84	19.66	2.00
1989	8956.44	7358	1330	80.09	83.35	76.87	84.00	12.29	11.68	4.96	3.26
1990	6496.27	5328	1330	59.05	59.09	55.76	60.82	20.84	15.56	25.35	0.04
1991	6140.31	4996	1330	54.92	55.13	52.70	57.03	28.23	21.68	23.19	0.21
1992	6906.92	5618	1330	61.74	63.63	59.12	63.96	20.80	16.71	19.67	1.89
1993	7954.42	7217	1330	76.90	87.91	68.27	82.39	10.19	9.98	2.11	11.01
1994	7115.24	6671	1330	74.52	77.62	61.07	76.15	4.06	3.28	19.10	3.10
1995	6934.50	6252	1330	65.76	70.46	59.52	71.37	2.39	1.72	27.82	4.69
1996	8407.42	7195	1330	78.51	83.80	71.96	81.91	6.22	5.56	10.64	5.29
1997	8139.80	7182	1330	83.47	83.90	69.86	81.99	15.12	14.94	1.16	0.43
1998	7300.40	6583	1330	69.09	73.11	62.66	75.15	11.87	9.84	17.05	4.02
1999	9243.77	7705	1330	84.11	85.59	79.34	87.96	1.64	1.42	12.98	1.49
2000	9849.89	8271	1330	94.43	96.04	84.31	94.16	3.55	3.54	0.42	1.61
2001	7843.13	6861	1330	76.04	76.68	67.32	78.32	8.36	6.99	16.33	0.64
2002	7984.37	6569	1330	72.01	73.19	68.53	74.99	11.67	9.67	17.14	1.18
2003	8814.93	7490	1330	81.14	82.10	75.66	85.50	6.51	5.72	12.18	0.95
2004	9562.68	8039	1330	89.87	92.58	81.85	91.52	6.49	6.42	1.00	2.71
2005	7246.43	5823	1330	64.47	65.28	62.19	66.47	3.68	6.15	28.56	0.81
2006	8143.51	6673	1330	73.89	74.40	69.90	76.18	11.60	10.70	14.90	0.51
2007	7558.05	6021	1330	66.80	68.30	64.87	68.73	31.67	31.65	0.06	1.49
2008	9315.58	7595	1330	83.97	85.07	79.74	86.46	3.03	5.92	9.01	1.09
2009	8393.37	6815	1330	74.97	78.79	72.04	77.80	2.23	7.58	13.63	3.82
2010	10209.97	8496	1330	95.98	96.93	87.63	96.99	3.04	3.04	0.03	0.96
2011	8868.96	7697	1330	84.55	87.68	76.12	87.87	1.01	4.10	8.22	3.13
2012	7298.37	6084	1330	67.34	68.96	62.47	69.26	1.66	14.03	17.01	1.61
2013	10778.91	8675	1330	97.70	98.86	92.52	99.03	1.11	1.11	0.03	1.16
2014	9113.01	7499	1330	83.67	85.18	78.22	85.61	1.93	4.13	10.69	1.51
2015	4064.60	3217	1330	36.33	36.48	34.89	36.72	0.79	0.29	63.23	0.15
2016	0.00	0	1330	0.04	0.04	0.00	0.00	0.00	94.22	5.73	0.00
2017	0.00	0	1330	0.02	0.02	0.00	0.00	0.00	99.98	0.00	0.00
2018	3289.82	2950	1330	28.54	28.64	28.24	33.68	29.16	67.65	3.71	0.11
2019	8734.15	6924	1330	77.44	78.36	74.97	79.04	3.53	3.67	17.97	0.92
2020	0.00	0	1330	0.06	6.19	0.00	0.00	0.00	93.81	0.00	6.13
2021	8070.60	7004	1330	69.37	83.43	69.27	79.95	2.25	6.47	10.10	14.06

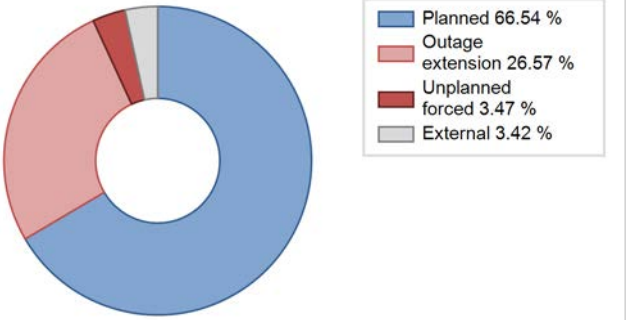
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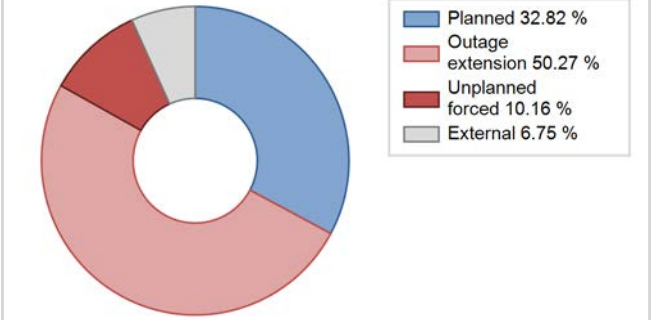
2022	5266.59	4525	1330	47.46	60.41	45.20	51.66	0.97	10.09	29.50	12.95
2023	9968.67	8132	1330	88.87	91.08	85.56	92.83	6.33	6.15	2.77	2.21
2024	6550.31	5415	1330	58.88	60.28	56.07	61.65	2.31	12.35	27.36	1.41

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		1012			1312	2
B.	Refuelling without maintenance	23			182		
C.	Inspection, maintenance or repair combined with refuelling	2328			730	74	
D.	Inspection, maintenance or repair without refuelling				30	6	
E.	Testing of plant systems or components				13	1	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				154		
H.	Nuclear regulatory requirements					6	
I.	Grid capacity limitation						0
J.	Grid limitation, failure or grid unavailability						3
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L.	Human factor related					10	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						14
O.	Load dispatching, prioritization			5			0
P.	Fire					43	
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						5
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						59
Z.	Other					29	1
Subtotal		2351	1012	5	1109	1481	85
Total		**3368**			**2675**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		13
12. Reactor I&C Systems		71
13. Reactor Auxiliary Systems		9
14. Safety Systems		26
15. Reactor Cooling Systems	46	52
16. Steam generation systems		523
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		5
31. Turbine and auxiliaries		38
32. Feedwater and Main Steam System	6	27
33. Circulating Water System		40
34. Miscellaneous Systems	960	301
35. All other I&C Systems		1
41. Main Generator Systems		146
42. Electrical Power Supply Systems		25
Total	**1012**	**1278**

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2024 Operating Experience

FR-38 PALUEL-3 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1382 MWe
Reference unit power (net)	:	1330 MWe

Key Dates

Construction Date	:	1979-02-01
Grid Date	:	1985-09-30
Commercial Date	:	1986-02-01
Age at end of year	:	39 years

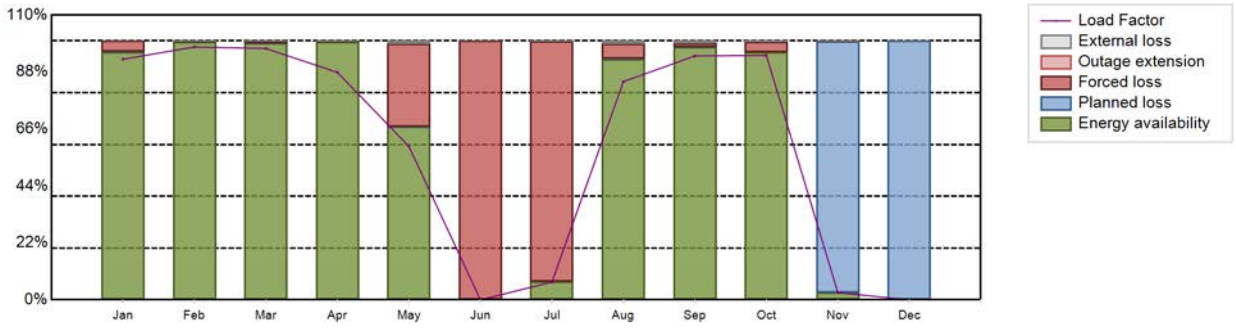
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.2
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6975.82 GW(e).h	Forced Loss Rate (FLR)	:	24.15 %
Energy Availability Factor (EAF)	:	63.02 %	Unplanned Capability Loss Factor (UCL)	:	20.18 %
Unit Capability Factor (UCF)	:	63.37 %	Planned Unavailability Factor (PUF)	:	16.46 %
Load Factor (LF)	:	59.71 %	Externally cause unavailability (XUF)	:	0.35 %
Operating Factor (OF)	:	64.29 %	Total off-line time	:	3137 hours

Annual Summary



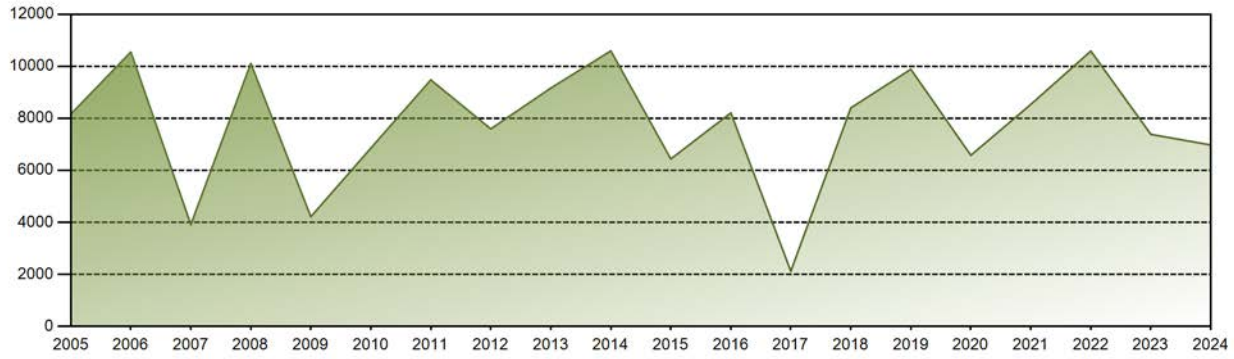
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	919.62	903.91	959.02	841.34	586.08	0.00	67.88	833.93	902.03	935.38	26.64	0.00	6975.82
EAF [%]	95.67	99.65	99.08	99.73	66.76	0.00	6.99	93.00	97.65	95.58	2.82	0.00	63.02
UCF [%]	95.67	99.78	99.25	99.77	67.83	0.00	7.10	94.16	98.59	96.07	2.84	0.00	63.37
LF [%]	92.94	97.65	97.05	87.86	59.23	0.00	6.86	84.28	94.20	94.40	2.78	0.00	59.71
OF [%]	100.00	100.00	100.00	100.00	66.40	0.00	7.53	95.03	100.00	99.87	3.19	0.00	64.29
FLR [%]	4.19	0.22	0.72	0.23	32.15	100.00	92.90	5.80	1.37	3.93	0.44	0.00	24.15
UCL [%]	4.18	0.22	0.72	0.23	32.13	100.00	92.90	5.80	1.37	3.93	0.01	0.00	20.18
PUF [%]	0.14	0.00	0.04	0.00	0.04	0.00	0.00	0.04	0.04	0.00	97.15	100.00	16.46
XUF [%]	0.00	0.13	0.16	0.04	1.07	0.00	0.11	1.16	0.94	0.49	0.02	0.00	0.35

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Historical Summary

Lifetime energy generation	:	308826.83 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	10.66 %
Cumulative Energy Availability Factor (EAF)	:	71.9 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.08 %
Cumulative Unit Capability Factor (UCF)	:	74.3 %	Cumulative Planned Unavailability Factor (PUF)	:	13.62 %
Cumulative Load Factor (LF)	:	67.57 %	Cumulative Externally cause unavailability (XUF)	:	2.4 %
Cumulative Operating Factor (OF)	:	73.8 %			

Electricity Production (net) [GWh]

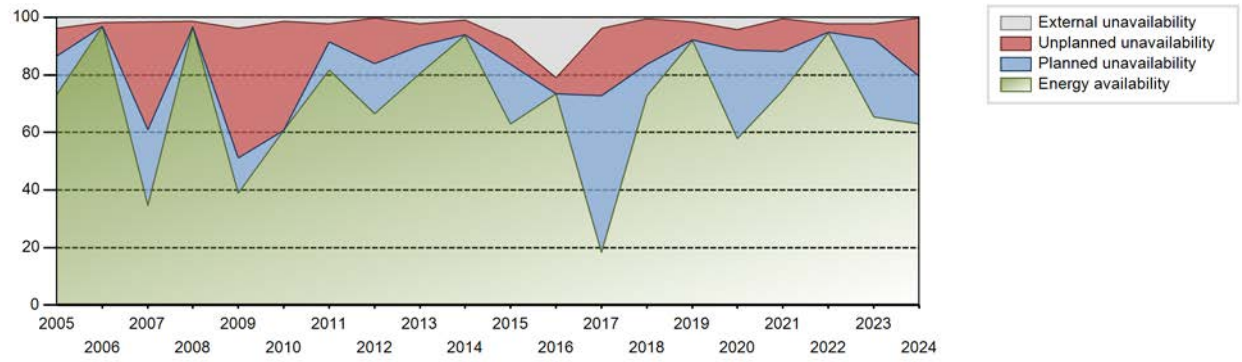


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	8321.70	6503	1290	72.10	72.10	71.52	71.84	7.84	6.13	21.77	0.00
1987	7716.60	6104	1290	78.31	78.35	68.29	69.68	15.09	13.93	7.72	0.04
1988	6763.00	5413	1330	59.22	68.73	57.89	61.62	16.92	14.00	17.27	9.51
1989	8124.44	6288	1330	70.16	70.70	69.73	71.78	14.82	12.30	17.00	0.54
1990	7321.98	6008	1330	66.25	67.22	62.85	68.58	2.17	1.49	31.29	0.97
1991	9587.15	7634	1330	86.25	86.48	82.29	87.15	10.69	10.36	3.16	0.23
1992	6886.61	5671	1330	62.95	63.20	58.95	64.56	24.89	20.94	15.86	0.24
1993	8459.03	6951	1330	73.36	77.52	72.60	79.35	2.29	1.81	20.67	4.16
1994	6703.62	5590	1330	61.83	63.39	57.54	63.81	23.27	19.22	17.39	1.56
1995	8733.26	7598	1330	84.09	85.55	74.96	86.74	1.21	1.05	13.40	1.47
1996	8027.69	7261	1330	84.55	84.90	68.71	82.66	15.07	15.07	0.03	0.35
1997	7618.80	6494	1330	72.79	73.18	65.39	74.13	1.57	1.17	25.65	0.39
1998	8327.02	6913	1330	76.12	77.61	71.47	78.92	6.54	5.43	16.96	1.49
1999	7636.71	6505	1330	73.75	76.13	65.55	74.26	12.58	10.95	12.92	2.38
2000	9819.79	8199	1330	94.42	94.73	84.05	93.34	4.34	4.30	0.97	0.31
2001	7815.94	6796	1330	79.62	81.62	67.09	77.58	1.48	1.23	17.15	2.00
2002	8900.48	7366	1330	80.37	82.28	76.39	84.09	6.38	5.61	12.11	1.92
2003	8181.73	6567	1330	74.26	74.87	70.22	74.97	24.57	24.39	0.74	0.61
2004	6395.50	5147	1330	56.04	57.01	54.74	58.60	31.91	26.71	16.28	0.97
2005	8157.60	6573	1330	73.15	76.92	70.02	75.03	10.52	9.74	13.33	3.78
2006	10549.56	8671	1330	96.79	98.63	90.55	98.98	1.32	1.32	0.05	1.84
2007	3908.79	3402	1330	34.75	36.28	33.55	38.84	14.66	37.58	26.14	1.52
2008	10106.55	8570	1330	96.59	98.00	86.51	97.56	1.92	1.92	0.08	1.41
2009	4214.55	3670	1330	38.84	42.69	36.17	41.89	39.64	44.94	12.38	3.84
2010	6850.05	5394	1330	60.64	61.91	58.79	61.58	38.08	38.07	0.02	1.27
2011	9475.26	7462	1330	81.69	84.03	81.33	85.18	2.90	6.26	9.70	2.34
2012	7592.85	5934	1330	66.60	66.86	64.99	67.55	1.33	15.83	17.31	0.26
2013	9162.71	7299	1330	80.52	82.69	78.64	83.32	1.31	7.61	9.70	2.17
2014	10592.86	8460	1330	93.80	94.80	90.92	96.58	5.05	5.04	0.17	0.99
2015	6436.51	5656	1330	62.88	70.74	55.25	64.57	0.57	8.37	20.89	7.86
2016	8209.45	7250	1330	73.38	94.35	70.27	82.54	5.61	5.61	0.04	20.98
2017	2121.65	1858	1330	18.27	22.19	18.21	21.21	3.59	23.29	54.52	3.92
2018	8399.29	6597	1330	72.81	73.40	72.09	75.31	1.48	15.69	10.91	0.59
2019	9886.14	8227	1330	91.83	93.43	84.85	93.92	6.27	6.25	0.32	1.60
2020	6577.17	5481	1330	57.82	62.09	56.30	62.40	4.53	7.18	30.73	4.26
2021	8534.76	6749	1330	74.52	75.06	73.25	77.04	13.13	11.34	13.60	0.54
2022	10585.79	8569	1330	94.61	96.93	90.86	97.82	2.87	2.87	0.21	2.31

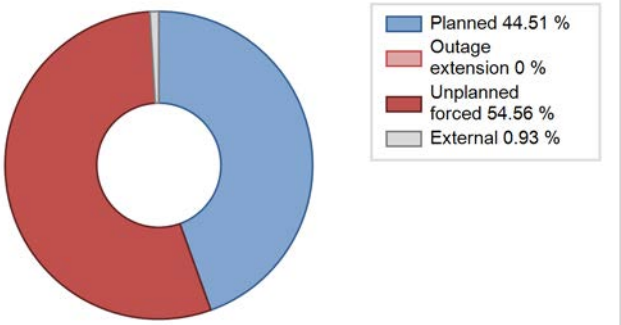
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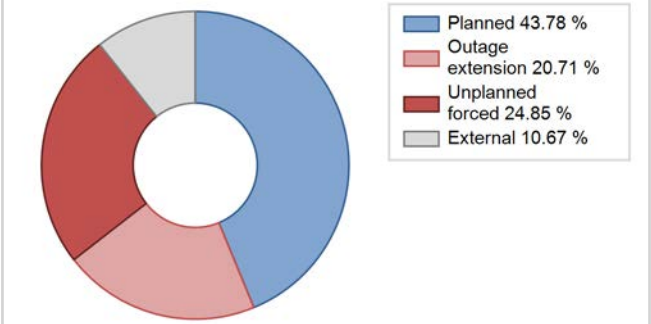
2023	7384.88	6036	1330	65.44	67.79	63.39	68.90	5.45	5.20	27.01	2.35
2024	6975.82	5647	1330	63.02	63.37	59.71	64.29	24.15	20.18	16.46	0.35

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		1676			908	
B.	Refuelling without maintenance				115		
C.	Inspection, maintenance or repair combined with refuelling	1441			986	25	
D.	Inspection, maintenance or repair without refuelling				26		
E.	Testing of plant systems or components				24	7	
H.	Nuclear regulatory requirements					3	
J.	Grid limitation, failure or grid unavailability						2
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						4
L.	Human factor related					11	
M.	Governmental requirements or court decisions						0
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						3
O.	Load dispatching, prioritization			13			0
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					1	28
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			7			62
Z.	Other					21	
Subtotal		1441	1676	20	1151	976	99
Total		**3137**			**2226**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		34
12. Reactor I&C Systems		62
13. Reactor Auxiliary Systems		35
14. Safety Systems		32
15. Reactor Cooling Systems		113
16. Steam generation systems		11
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		9
31. Turbine and auxiliaries		37
32. Feedwater and Main Steam System	136	54
33. Circulating Water System		36
34. Miscellaneous Systems		127
35. All other I&C Systems	37	1
41. Main Generator Systems		236
42. Electrical Power Supply Systems	1503	118
Total	**1676**	**906**

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2024 Operating Experience

FR-39 PALUEL-4 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1382 MWe
Reference unit power (net)	:	1330 MWe

Key Dates

Construction Date	:	1980-02-01
Grid Date	:	1986-04-11
Commercial Date	:	1986-06-01
Age at end of year	:	38 years

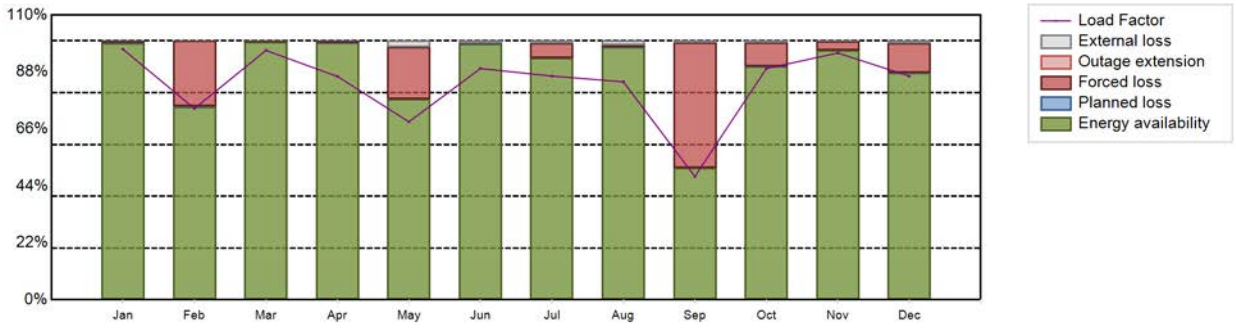
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.2
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	36	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9752.99 GW(e).h	Forced Loss Rate (FLR)	:	10.4 %
Energy Availability Factor (EAF)	:	88.88 %	Unplanned Capability Loss Factor (UCL)	:	10.4 %
Unit Capability Factor (UCF)	:	89.57 %	Planned Unavailability Factor (PUF)	:	0.03 %
Load Factor (LF)	:	83.48 %	Externally cause unavailability (XUF)	:	0.69 %
Operating Factor (OF)	:	92.44 %	Total off-line time	:	664 hours

Annual Summary



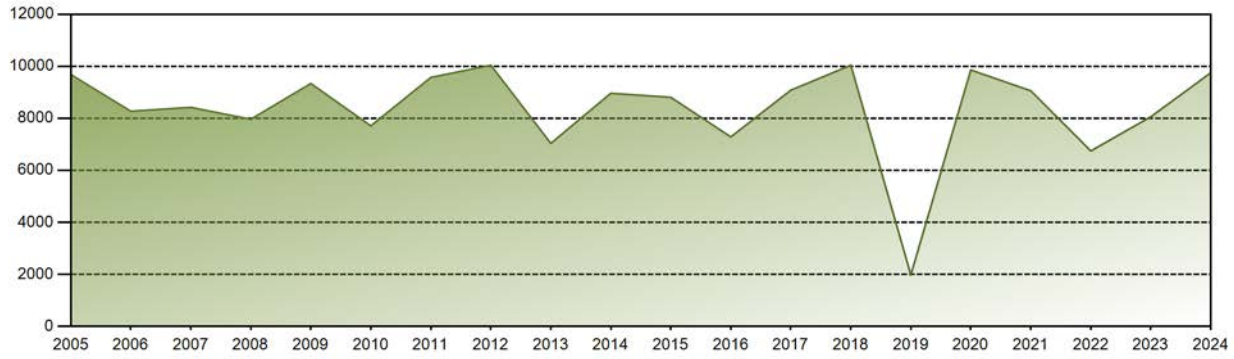
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	957.50	683.88	951.97	826.28	680.46	855.44	855.11	833.09	456.33	885.37	912.72	854.84	9752.99
EAF [%]	99.13	74.64	99.50	99.37	77.54	98.90	93.41	97.64	51.08	90.15	96.35	87.62	88.88
UCF [%]	99.13	74.64	99.50	99.37	79.95	99.73	94.23	99.27	51.80	90.83	96.55	88.53	89.57
LF [%]	96.76	73.88	96.34	86.29	68.77	89.33	86.42	84.19	47.65	89.35	95.31	86.39	83.48
OF [%]	100.00	98.42	100.00	95.69	79.30	100.00	100.00	100.00	52.78	93.42	100.00	89.38	92.44
FLR [%]	0.70	25.33	0.50	0.61	20.05	0.22	5.77	0.69	48.20	9.14	3.45	11.44	10.40
UCL [%]	0.69	25.32	0.50	0.61	20.05	0.22	5.77	0.69	48.20	9.14	3.45	11.43	10.40
PUF [%]	0.18	0.04	0.00	0.03	0.00	0.05	0.00	0.03	0.00	0.03	0.00	0.03	0.03
XUF [%]	0.00	0.00	0.00	0.00	2.41	0.83	0.82	1.63	0.72	0.68	0.20	0.92	0.69

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Historical Summary

Lifetime energy generation	:	318747.73 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.58 %
Cumulative Energy Availability Factor (EAF)	:	76.14 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.72 %
Cumulative Unit Capability Factor (UCF)	:	78.32 %	Cumulative Planned Unavailability Factor (PUF)	:	12.96 %
Cumulative Load Factor (LF)	:	70.73 %	Cumulative Externally cause unavailability (XUF)	:	2.18 %
Cumulative Operating Factor (OF)	:	78.51 %			

Electricity Production (net) [GWh]

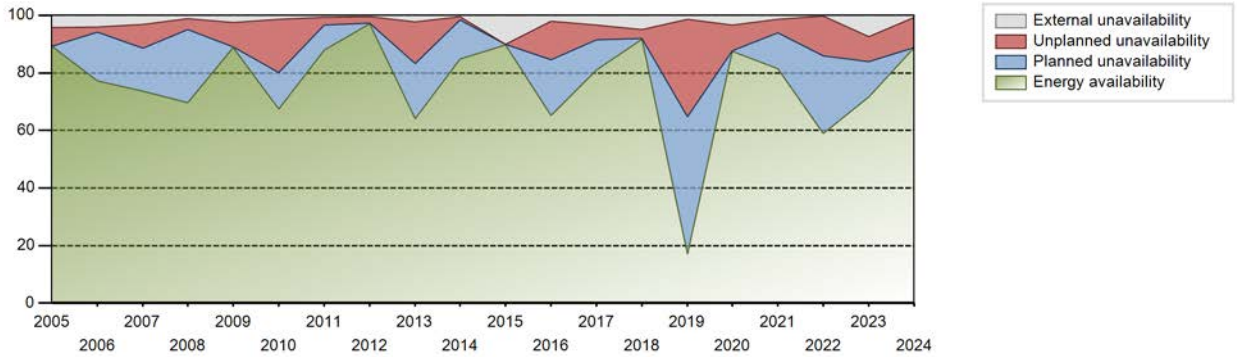


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	6118.60	5343	1300	85.21	85.69	78.04	83.67	14.30	14.30	0.02	0.48
1987	8014.60	6289	1290	69.74	69.84	70.92	71.79	15.59	12.90	17.25	0.11
1988	5909.00	4812	1330	53.58	54.01	50.58	54.78	26.16	19.13	26.86	0.43
1989	8268.30	6349	1330	70.98	72.12	70.97	72.48	14.06	11.80	16.07	1.14
1990	8067.69	6770	1330	78.49	78.70	69.25	77.28	11.57	10.30	11.00	0.21
1991	8325.58	6677	1330	74.20	74.52	71.46	76.22	8.12	6.58	18.89	0.32
1992	5553.31	4529	1330	48.65	48.93	47.53	51.56	35.83	27.32	23.75	0.28
1993	8683.78	6938	1330	75.35	77.78	74.53	79.20	3.29	2.65	19.57	2.43
1994	8329.73	6945	1330	76.49	77.31	71.49	79.28	7.70	6.45	16.24	0.82
1995	8346.82	7354	1330	88.12	88.46	71.64	83.95	11.52	11.52	0.03	0.34
1996	7848.12	6745	1330	72.36	75.21	67.18	76.79	13.07	11.31	13.48	2.85
1997	8633.65	7219	1330	78.22	81.91	74.10	82.41	6.09	5.31	12.78	3.70
1998	7776.71	6506	1330	68.32	71.17	66.75	74.27	4.80	3.59	25.24	2.85
1999	9879.73	8345	1330	94.56	96.10	84.80	95.26	3.08	3.05	0.85	1.53
2000	8358.80	7532	1330	84.44	86.05	71.55	85.75	1.37	1.19	12.76	1.60
2001	8581.02	7489	1330	82.14	84.54	73.65	85.49	1.24	1.06	14.40	2.40
2002	9303.30	8216	1330	92.67	95.66	79.85	93.79	0.70	0.67	3.67	2.99
2003	7960.72	7307	1330	81.93	82.79	68.33	83.41	8.86	8.05	9.17	0.86
2004	7138.56	6027	1330	64.63	67.89	61.10	68.61	18.67	15.58	16.52	3.26
2005	9682.12	7949	1330	89.18	93.34	83.09	90.73	6.61	6.60	0.05	4.16
2006	8270.83	7320	1330	77.23	81.37	70.99	83.56	1.70	1.70	16.93	4.14
2007	8421.51	6824	1330	73.68	76.85	72.28	77.90	1.26	8.29	14.86	3.16
2008	7962.59	6286	1330	69.59	70.82	68.16	71.56	0.21	3.72	25.46	1.23
2009	9337.13	7944	1330	88.89	91.39	80.14	90.68	8.56	8.55	0.06	2.50
2010	7709.46	6085	1330	67.44	68.90	66.17	69.46	2.78	18.44	12.66	1.46
2011	9571.58	7835	1330	87.90	88.66	82.15	89.44	0.57	2.65	8.69	0.76
2012	10040.06	8467	1330	97.16	97.73	85.94	96.39	2.25	2.25	0.03	0.57
2013	7036.36	5984	1330	64.01	66.26	60.39	68.31	6.36	14.57	19.18	2.25
2014	8962.84	7539	1330	84.83	85.39	76.93	86.06	1.21	1.04	13.56	0.56
2015	8807.53	7649	1330	89.81	99.80	75.60	87.32	0.13	0.13	0.06	9.99
2016	7284.06	6369	1330	65.14	67.12	62.35	72.51	12.58	13.54	19.35	1.98
2017	9082.31	7455	1330	80.97	84.31	77.95	85.10	4.09	5.11	10.58	3.35
2018	10041.61	8304	1330	91.73	96.68	86.19	94.79	3.21	3.21	0.12	4.95
2019	1977.33	1688	1330	17.03	18.47	16.97	19.27	6.39	33.73	47.80	1.44
2020	9859.60	8041	1330	87.50	90.89	84.39	91.54	8.91	8.89	0.23	3.39
2021	9058.04	7416	1330	81.50	82.93	77.75	84.66	5.21	4.56	12.51	1.42
2022	6745.15	5375	1330	58.97	59.31	57.89	61.36	5.04	13.85	26.84	0.34

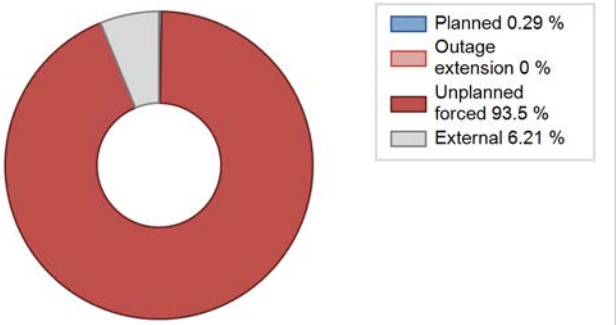
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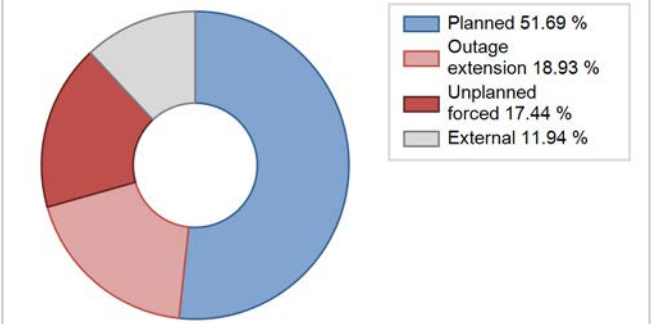
2023	8060.67	6556	1330	71.68	79.08	69.19	74.84	9.78	8.57	12.34	7.41
2024	9752.99	8120	1330	88.88	89.57	83.48	92.44	10.40	10.40	0.03	0.69

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		618			588	1
B.	Refuelling without maintenance				128		
C.	Inspection, maintenance or repair combined with refuelling				901	8	
D.	Inspection, maintenance or repair without refuelling				23		
E.	Testing of plant systems or components				15	0	
H.	Nuclear regulatory requirements					3	
J.	Grid limitation, failure or grid unavailability						6
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						6
L.	Human factor related					15	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
O.	Load dispatching, prioritization			31			3
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					10	24
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			15			29
Z.	Other					53	2
Subtotal			618	46	1067	677	75
Total			**664**			**1819**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		90
12. Reactor I&C Systems		30
13. Reactor Auxiliary Systems		19
14. Safety Systems	114	15
15. Reactor Cooling Systems		24
16. Steam generation systems		44
21. Fuel Handling and Storage Facilities		10
31. Turbine and auxiliaries	90	49
32. Feedwater and Main Steam System		24
33. Circulating Water System		4
34. Miscellaneous Systems	25	153
41. Main Generator Systems		87
42. Electrical Power Supply Systems	389	39
Total	**618**	**588**

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2024 Operating Experience

FR-63 PENLY-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1382 MWe
Reference unit power (net)	:	1330 MWe

Key Dates

Construction Date	:	1982-09-01
Grid Date	:	1990-05-04
Commercial Date	:	1990-12-01
Age at end of year	:	34 years

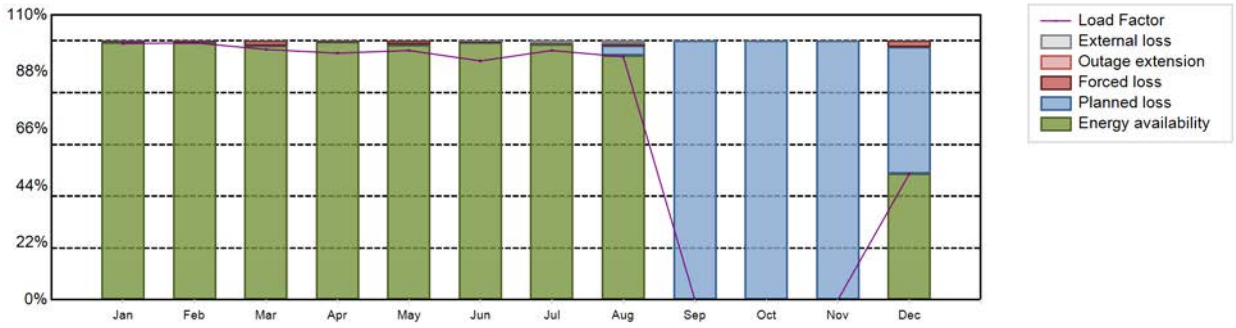
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7966.36 GW(e).h	Forced Loss Rate (FLR)	:	1.01 %
Energy Availability Factor (EAF)	:	69.75 %	Unplanned Capability Loss Factor (UCL)	:	0.71 %
Unit Capability Factor (UCF)	:	69.92 %	Planned Unavailability Factor (PUF)	:	29.37 %
Load Factor (LF)	:	68.19 %	Externally cause unavailability (XUF)	:	0.17 %
Operating Factor (OF)	:	71.24 %	Total off-line time	:	2526 hours

Annual Summary



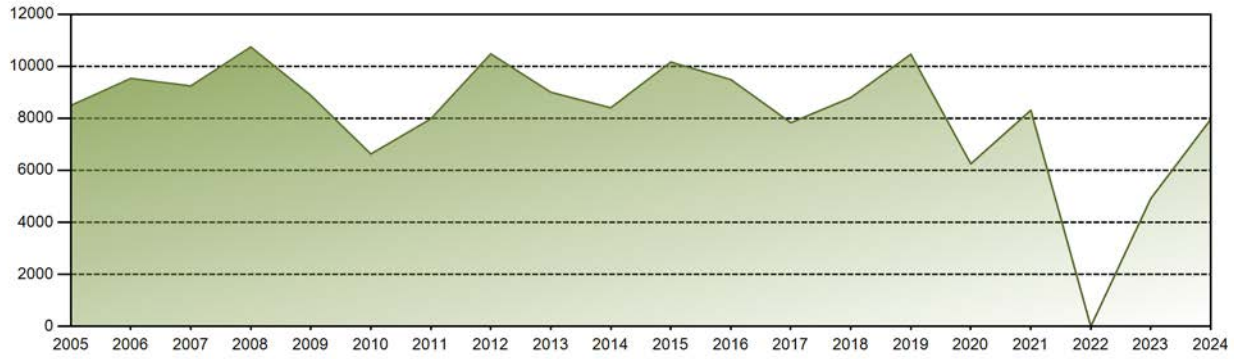
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	979.53	918.93	955.53	912.32	952.89	883.56	952.98	928.75	0.00	0.00	0.00	481.86	7966.36
EAF [%]	99.37	99.48	98.13	99.60	98.46	99.47	98.68	94.52	0.00	0.00	0.00	48.78	69.75
UCF [%]	99.37	99.48	98.13	99.60	98.46	99.52	99.45	95.66	0.00	0.00	0.00	48.78	69.92
LF [%]	98.99	99.27	96.70	95.27	96.30	92.27	96.31	93.86	0.00	0.00	0.00	48.70	68.19
OF [%]	100.00	100.00	98.79	100.00	100.00	100.00	100.00	96.77	0.00	0.00	0.00	58.60	71.24
FLR [%]	0.47	0.43	1.76	0.35	1.45	0.46	0.44	0.77	0.00	0.00	0.00	4.68	1.01
UCL [%]	0.47	0.43	1.76	0.35	1.44	0.46	0.44	0.75	0.00	0.00	0.00	2.40	0.71
PUF [%]	0.16	0.09	0.11	0.06	0.09	0.01	0.11	3.60	100.00	100.00	100.00	48.82	29.37
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.05	0.77	1.13	0.00	0.00	0.00	0.00	0.17

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Historical Summary

Lifetime energy generation	:	288764.12 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.73 %
Cumulative Energy Availability Factor (EAF)	:	76.65 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.71 %
Cumulative Unit Capability Factor (UCF)	:	78.01 %	Cumulative Planned Unavailability Factor (PUF)	:	13.28 %
Cumulative Load Factor (LF)	:	72.17 %	Cumulative Externally cause unavailability (XUF)	:	1.36 %
Cumulative Operating Factor (OF)	:	78.2 %			

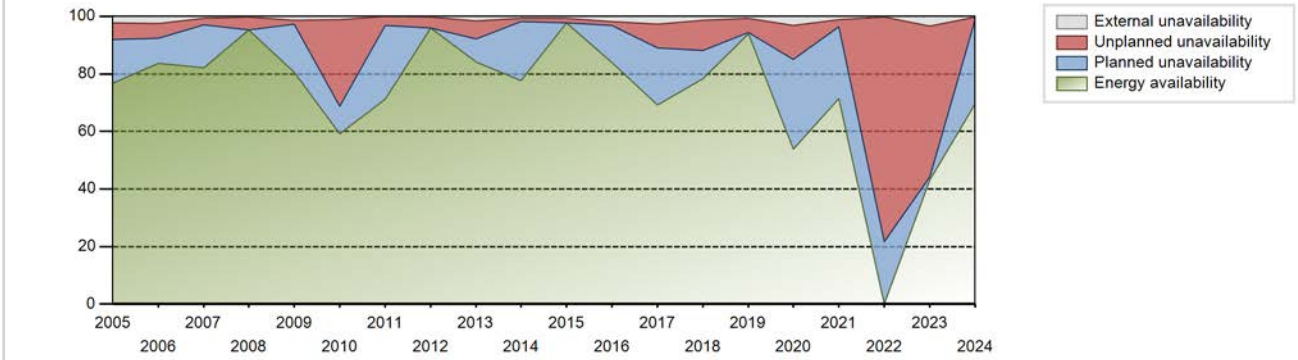
Electricity Production (net) [GWh]



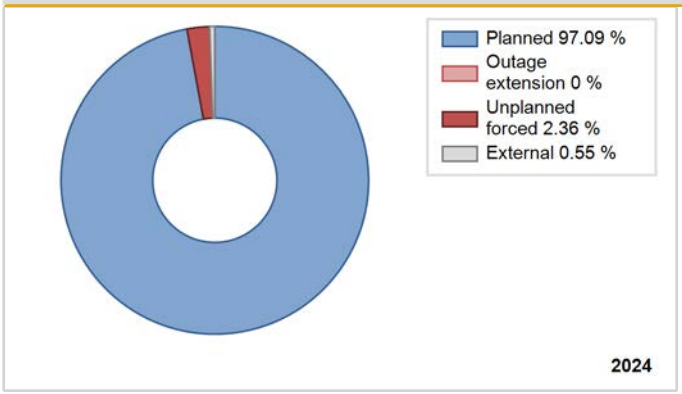
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1990	2887.12	3100	1330	98.94	98.94	98.15	99.19	0.96	0.96	0.10	0.00
1991	8436.71	6645	1330	74.23	74.27	72.41	75.86	10.99	9.17	16.56	0.04
1992	7922.21	6315	1330	70.91	71.23	67.81	71.89	3.72	2.75	26.02	0.32
1993	8023.87	7298	1330	71.90	84.61	68.87	83.31	0.95	0.81	14.58	12.70
1994	7969.13	6654	1330	85.04	86.07	68.40	75.96	0.20	0.18	13.75	1.03
1995	8879.06	7248	1330	80.78	81.87	76.21	82.74	3.62	3.08	15.05	1.09
1996	9530.76	7625	1330	85.23	85.71	81.58	86.81	2.07	1.81	12.48	0.48
1997	8503.41	6872	1330	76.69	77.50	72.99	78.45	11.41	9.98	12.52	0.80
1998	9965.66	8140	1330	97.87	97.97	85.54	92.92	1.07	1.06	0.98	0.10
1999	7998.46	6633	1330	71.52	74.38	68.65	75.72	12.99	11.11	14.51	2.87
2000	8271.73	6640	1330	73.67	73.85	70.80	75.59	13.80	11.82	14.34	0.17
2001	9825.84	8304	1330	98.40	98.69	84.34	94.79	0.55	0.55	0.76	0.29
2002	7146.66	5948	1330	66.91	67.24	61.34	67.90	6.95	5.02	27.74	0.34
2003	9290.83	7525	1330	84.64	84.64	79.74	85.90	3.49	3.06	12.30	0.00
2004	10500.23	8733	1330	98.57	98.93	89.88	99.42	0.74	0.74	0.33	0.37
2005	8491.26	7104	1330	76.88	79.06	72.88	81.10	4.78	5.86	15.08	2.18
2006	9533.15	7656	1330	83.60	86.07	81.82	87.40	4.87	5.09	8.84	2.46
2007	9243.57	7356	1330	82.07	82.73	79.34	83.97	1.85	2.32	14.95	0.66
2008	10743.35	8424	1330	95.24	95.53	91.96	95.90	4.45	4.45	0.03	0.29
2009	8878.54	7217	1330	80.49	81.76	76.21	82.39	1.22	1.36	16.87	1.28
2010	6627.27	5280	1330	59.23	60.38	56.88	60.27	32.32	30.00	9.62	1.15
2011	7976.85	6332	1330	71.30	71.41	68.47	72.28	0.85	3.00	25.59	0.11
2012	10476.99	8525	1330	95.85	96.05	89.68	97.05	3.88	3.88	0.07	0.19
2013	9001.96	7536	1330	84.12	85.74	77.26	86.03	0.67	6.26	7.99	1.63
2014	8406.70	6939	1330	77.63	78.26	72.16	79.21	0.78	1.15	20.59	0.63
2015	10162.55	8623	1330	97.69	98.37	87.23	98.44	1.54	1.54	0.09	0.68
2016	9489.07	7812	1330	83.87	85.65	81.22	88.93	1.56	1.36	12.99	1.78
2017	7829.20	6376	1330	69.30	71.90	67.20	72.79	1.56	8.37	19.73	2.60
2018	8796.74	7044	1330	78.37	79.72	75.50	80.41	2.90	10.61	9.67	1.35
2019	10462.26	8383	1330	93.91	94.57	89.80	95.70	1.07	4.91	0.53	0.66
2020	6249.27	5120	1330	53.91	56.99	53.49	58.29	3.42	11.92	31.09	3.08
2021	8310.67	6387	1330	71.39	72.54	71.33	72.91	3.21	2.41	25.05	1.15
2022	0.00	0	1330	0.00	0.27	0.00	0.00	99.65	78.09	21.63	0.27
2023	4916.24	3978	1330	43.15	46.45	42.20	45.41	53.08	52.56	1.00	3.30
2024	7966.36	6258	1330	69.75	69.92	68.19	71.24	1.01	0.71	29.37	0.17

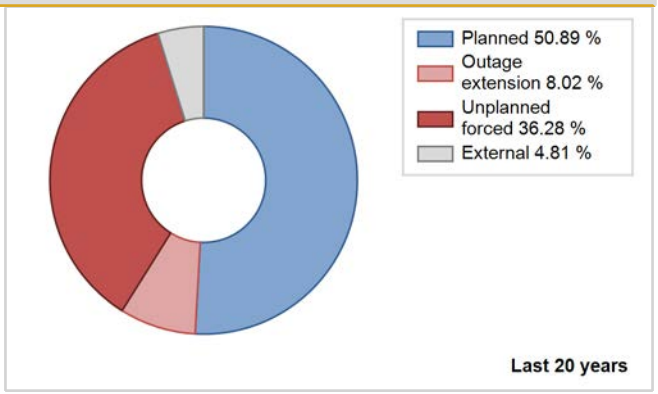
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1990 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		9			692	0
B. Refuelling without maintenance				99		
C. Inspection, maintenance or repair combined with refuelling	2517			938	1	
D. Inspection, maintenance or repair without refuelling				114		
E. Testing of plant systems or components				13		0
H. Nuclear regulatory requirements					1	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L. Human factor related					3	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						3
O. Load dispatching, prioritization						0
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						15
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						1
Z. Other					4	2
Subtotal	2517	9		1164	701	22
Total	**2526**			**1887**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1990 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		24
12. Reactor I&C Systems		21
13. Reactor Auxiliary Systems		23
14. Safety Systems		332
15. Reactor Cooling Systems		27
16. Steam generation systems		26
17. Safety I&C Systems (excluding reactor I&C)		3
21. Fuel Handling and Storage Facilities		3
31. Turbine and auxiliaries	9	32
32. Feedwater and Main Steam System		21
33. Circulating Water System		1
34. Miscellaneous Systems		85
35. All other I&C Systems		1
41. Main Generator Systems		80
42. Electrical Power Supply Systems		6
Total	**9**	**685**

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2024 Operating Experience

FR-64 PENLY-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1382 MWe
Reference unit power (net)	:	1330 MWe

Key Dates

Construction Date	:	1984-08-01
Grid Date	:	1992-02-04
Commercial Date	:	1992-11-01
Age at end of year	:	32 years

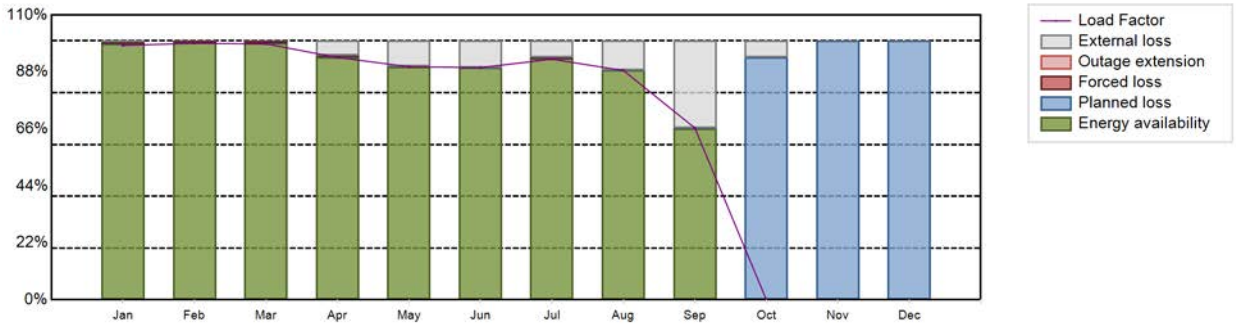
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.7
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	804	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7943.73 GW(e).h	Forced Loss Rate (FLR)	:	0.33 %
Energy Availability Factor (EAF)	:	68.1 %	Unplanned Capability Loss Factor (UCL)	:	0.25 %
Unit Capability Factor (UCF)	:	75.1 %	Planned Unavailability Factor (PUF)	:	24.65 %
Load Factor (LF)	:	68 %	Externally cause unavailability (XUF)	:	7 %
Operating Factor (OF)	:	73.49 %	Total off-line time	:	2329 hours

Annual Summary



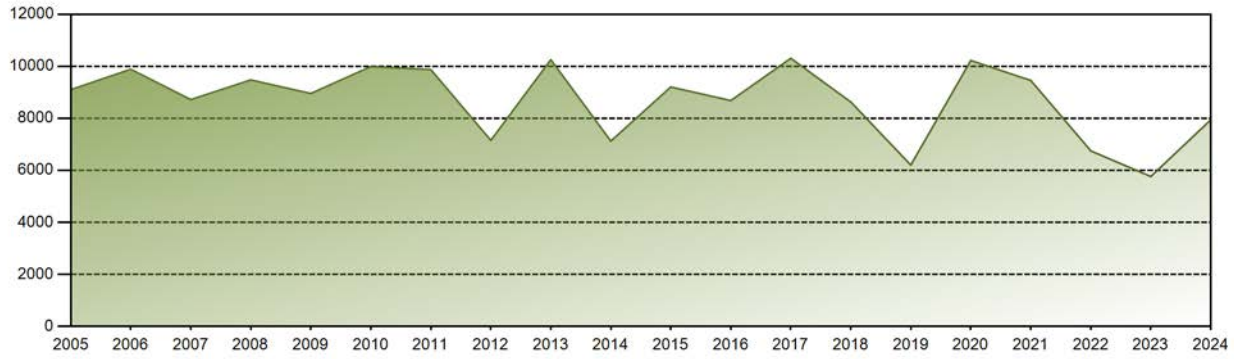
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	972.37	916.99	976.72	896.38	891.00	858.79	919.60	876.43	635.46	0.00	0.00	0.00	7943.73
EAF [%]	98.81	99.34	99.10	93.69	90.03	89.68	93.16	88.58	66.22	0.00	0.00	0.00	68.10
UCF [%]	99.23	99.34	99.10	99.40	99.89	99.90	99.57	99.98	99.96	6.44	0.00	0.00	75.10
LF [%]	98.27	99.06	98.84	93.61	90.04	89.68	92.93	88.57	66.36	0.00	0.00	0.00	68.00
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	83.33	0.00	0.00	0.00	73.49
FLR [%]	0.68	0.61	0.84	0.51	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.33
UCL [%]	0.68	0.61	0.84	0.51	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.25
PUF [%]	0.08	0.05	0.06	0.09	0.11	0.10	0.07	0.02	0.04	93.56	100.00	100.00	24.65
XUF [%]	0.42	0.00	0.00	5.71	9.86	10.21	6.41	11.40	33.74	6.44	0.00	0.00	7.00

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Historical Summary

Lifetime energy generation	:	284173.18 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.65 %
Cumulative Energy Availability Factor (EAF)	:	80.29 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.4 %
Cumulative Unit Capability Factor (UCF)	:	81.79 %	Cumulative Planned Unavailability Factor (PUF)	:	11.81 %
Cumulative Load Factor (LF)	:	74.88 %	Cumulative Externally cause unavailability (XUF)	:	1.5 %
Cumulative Operating Factor (OF)	:	82.17 %			

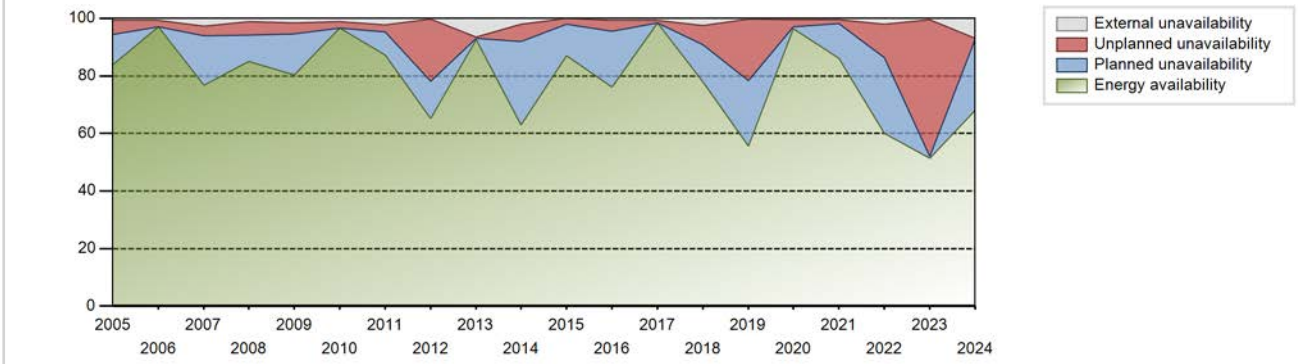
Electricity Production (net) [GWh]



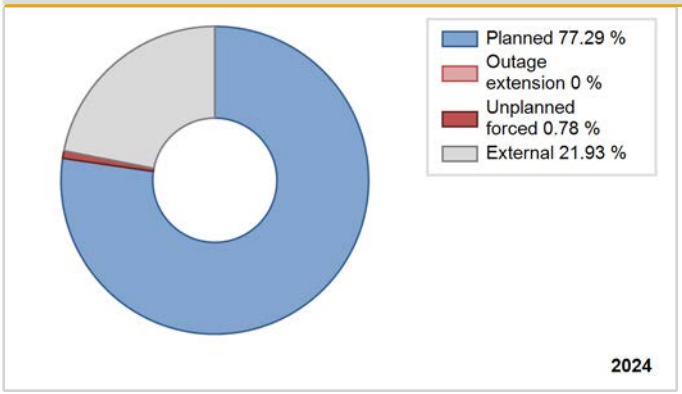
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1992	5149.77	4796	1330	99.98	99.98	101.22	100.00	0.00	0.00	0.02	0.00
1993	8611.76	6658	1330	74.40	75.16	73.92	76.00	0.54	0.41	24.43	0.76
1994	8759.66	7228	1330	77.57	81.28	75.19	82.51	3.58	3.01	15.71	3.70
1995	8169.73	6574	1330	73.77	73.98	70.12	75.05	16.06	14.16	11.86	0.21
1996	9757.97	8025	1330	89.29	91.33	83.52	91.36	8.62	8.61	0.06	2.04
1997	8068.94	7186	1330	82.95	84.26	69.26	82.03	4.09	3.60	12.14	1.32
1998	8877.52	7318	1330	81.07	82.94	76.20	83.54	4.74	4.12	12.93	1.87
1999	8636.97	7203	1330	79.35	81.27	74.13	82.23	5.19	4.45	14.28	1.92
2000	9584.47	8393	1330	96.84	97.11	82.04	95.55	2.85	2.85	0.04	0.27
2001	8816.23	7333	1330	80.24	82.09	75.67	83.71	4.63	3.98	13.93	1.85
2002	8464.26	6890	1330	78.98	79.07	72.65	78.65	9.06	7.88	13.06	0.09
2003	10207.81	8603	1330	97.65	97.65	87.61	98.21	1.90	1.89	0.47	0.00
2004	7225.85	6231	1330	69.09	69.21	61.85	70.94	2.04	1.44	29.35	0.12
2005	9102.59	7546	1330	84.01	84.78	78.13	86.14	2.96	4.86	10.36	0.78
2006	9885.16	8447	1330	96.99	97.73	84.85	96.43	2.24	2.23	0.03	0.74
2007	8718.65	7081	1330	76.70	79.44	74.83	80.83	4.06	3.36	17.20	2.73
2008	9474.85	7590	1330	85.00	86.11	81.10	86.41	1.39	4.70	9.18	1.11
2009	8954.23	7258	1330	80.32	81.97	76.86	82.85	1.70	3.81	14.22	1.64
2010	9986.96	8571	1330	96.52	97.72	85.72	97.84	2.25	2.25	0.03	1.20
2011	9873.06	7931	1330	87.16	89.53	84.74	90.54	1.03	2.42	8.05	2.37
2012	7151.26	5802	1330	65.28	65.59	61.21	66.05	19.48	21.64	12.76	0.31
2013	10253.29	8413	1330	92.59	99.11	88.00	96.04	0.46	0.45	0.43	6.52
2014	7123.77	5722	1330	62.89	64.90	61.14	65.32	2.68	5.99	29.11	2.01
2015	9204.63	7743	1330	87.14	87.26	79.00	88.39	0.94	1.91	10.83	0.12
2016	8682.34	6925	1330	76.22	77.01	74.32	78.84	1.05	3.70	19.30	0.78
2017	10308.82	8697	1330	98.33	99.03	88.48	99.28	0.91	0.91	0.05	0.70
2018	8627.09	7065	1330	77.84	80.27	74.05	80.65	1.78	6.64	13.09	2.43
2019	6201.08	4943	1330	55.63	55.93	53.22	56.43	1.31	21.30	22.78	0.30
2020	10224.76	8609	1330	96.37	96.76	87.52	98.01	1.17	2.65	0.59	0.39
2021	9455.83	7694	1330	86.14	86.61	81.16	87.83	1.42	1.25	12.14	0.47
2022	6747.56	5359	1330	60.12	62.23	57.92	61.18	2.63	11.63	26.14	2.11
2023	5763.76	4733	1330	51.29	51.74	49.47	54.03	3.89	47.52	0.75	0.44
2024	7943.73	6455	1330	68.10	75.10	68.00	73.49	0.33	0.25	24.65	7.00

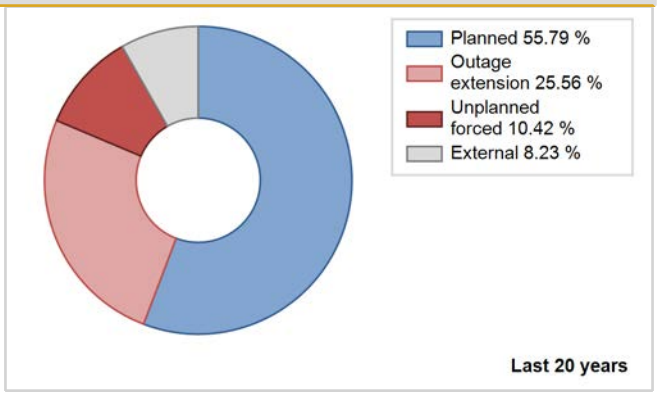
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1992 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					572	
B.	Refuelling without maintenance				138		
C.	Inspection, maintenance or repair combined with refuelling	2161			836		
E.	Testing of plant systems or components				26		
H.	Nuclear regulatory requirements					10	
I.	Grid capacity limitation						1
J.	Grid limitation, failure or grid unavailability						2
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L.	Human factor related					4	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						3
O.	Load dispatching, prioritization						1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					2	5
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			168			16
Z.	Other					2	2
Subtotal		2161		168	1000	590	31
Total		**2329**			**1621**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1992 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		22
12. Reactor I&C Systems		15
13. Reactor Auxiliary Systems		16
14. Safety Systems		19
15. Reactor Cooling Systems		68
16. Steam generation systems		10
21. Fuel Handling and Storage Facilities		8
31. Turbine and auxiliaries		33
32. Feedwater and Main Steam System		15
33. Circulating Water System		2
34. Miscellaneous Systems		249
35. All other I&C Systems		1
41. Main Generator Systems		5
42. Electrical Power Supply Systems		96
Total		**559**

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2024 Operating Experience

FR-48 ST. ALBAN-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1381 MWe
Reference unit power (net)	:	1335 MWe

Key Dates

Construction Date	:	1979-01-29
Grid Date	:	1985-08-30
Commercial Date	:	1986-05-01
Age at end of year	:	39 years

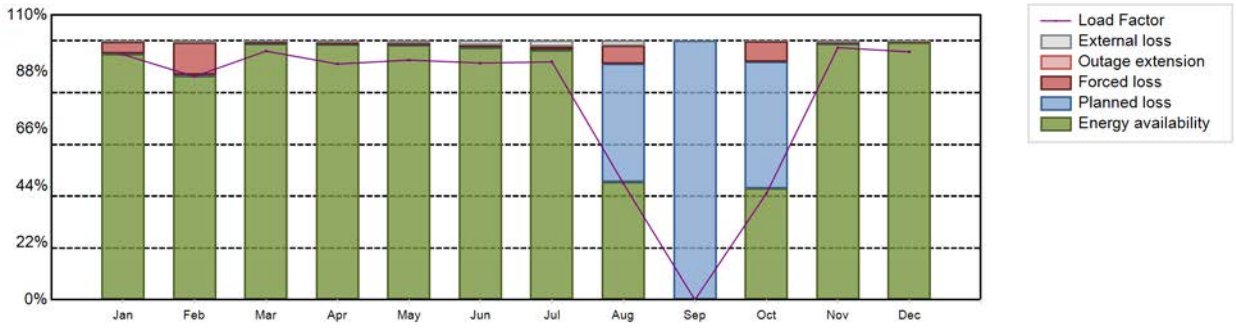
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.3
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9024.78 GW(e).h	Forced Loss Rate (FLR)	:	3.61 %
Energy Availability Factor (EAF)	:	79.84 %	Unplanned Capability Loss Factor (UCL)	:	3.02 %
Unit Capability Factor (UCF)	:	80.65 %	Planned Unavailability Factor (PUF)	:	16.32 %
Load Factor (LF)	:	76.96 %	Externally cause unavailability (XUF)	:	0.82 %
Operating Factor (OF)	:	82.25 %	Total off-line time	:	1559 hours

Annual Summary



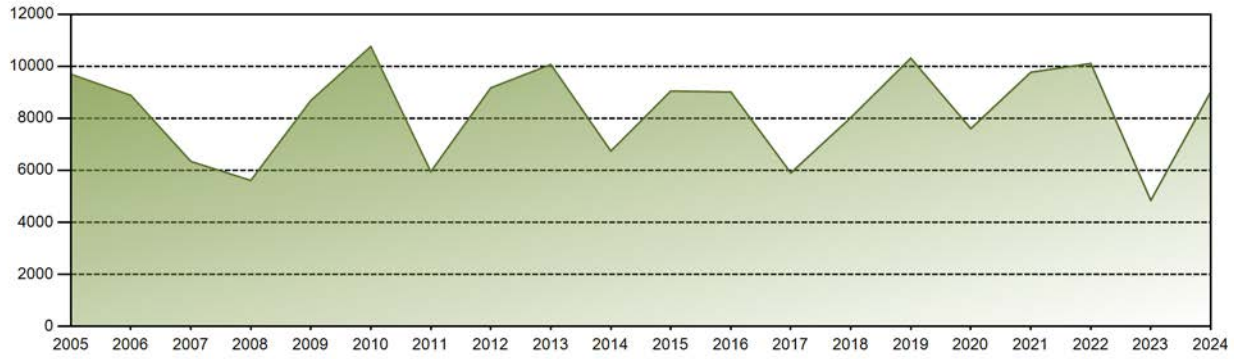
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	941.21	801.21	952.88	875.55	919.73	879.08	912.81	446.36	0.00	408.44	936.06	951.44	9024.78
EAF [%]	94.92	86.54	98.78	98.60	98.37	97.43	96.45	45.44	0.00	42.95	98.87	99.42	79.84
UCF [%]	95.40	87.06	99.24	99.16	99.25	99.12	98.61	47.27	0.00	43.14	99.46	99.82	80.65
LF [%]	94.76	86.23	96.07	91.09	92.60	91.46	91.90	44.94	0.00	41.07	97.38	95.79	76.96
OF [%]	100.00	88.51	100.00	100.00	100.00	100.00	99.33	48.12	0.00	50.60	100.00	100.00	82.25
FLR [%]	4.50	12.57	0.63	0.72	0.66	0.78	1.31	13.05	0.00	15.34	0.41	0.09	3.61
UCL [%]	4.49	12.52	0.63	0.72	0.66	0.78	1.31	7.09	0.00	7.82	0.41	0.09	3.02
PUF [%]	0.11	0.42	0.13	0.11	0.09	0.10	0.08	45.64	100.00	49.04	0.13	0.08	16.32
XUF [%]	0.47	0.52	0.46	0.56	0.88	1.70	2.16	1.83	0.00	0.19	0.60	0.40	0.82

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Historical Summary

Lifetime energy generation	:	312740.94 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.94 %
Cumulative Energy Availability Factor (EAF)	:	74.75 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.77 %
Cumulative Unit Capability Factor (UCF)	:	77.36 %	Cumulative Planned Unavailability Factor (PUF)	:	13.86 %
Cumulative Load Factor (LF)	:	68.26 %	Cumulative Externally cause unavailability (XUF)	:	2.61 %
Cumulative Operating Factor (OF)	:	75.09 %			

Electricity Production (net) [GWh]

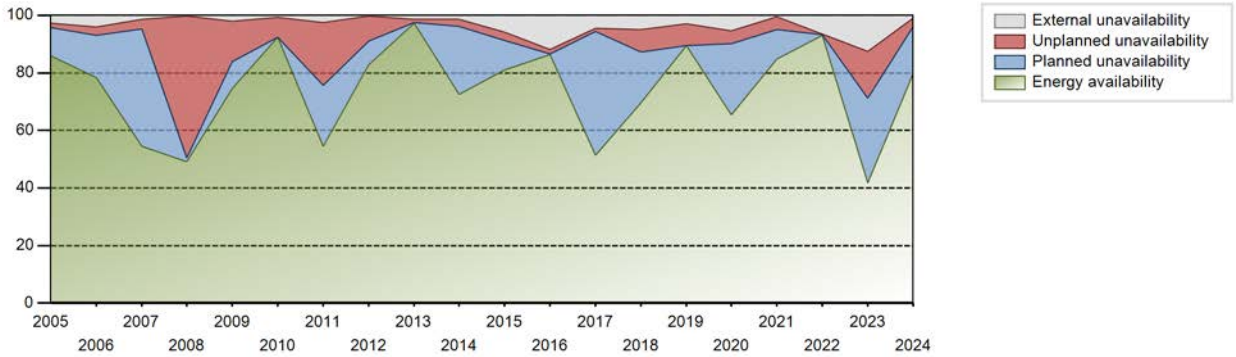


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	6722.90	5449	1300	66.38	67.62	51.14	54.11	17.05	13.90	18.48	1.24
1987	6101.60	4944	1300	56.16	56.61	53.58	56.44	20.02	14.17	29.21	0.45
1988	4562.00	3721	1335	82.37	83.39	38.90	42.36	11.01	10.32	6.29	1.01
1989	6781.29	5907	1335	63.54	70.68	57.99	67.43	10.17	8.00	21.32	7.14
1990	7799.06	6295	1335	68.64	70.38	66.69	71.86	15.39	12.81	16.81	1.74
1991	7935.34	6380	1335	73.32	74.44	67.85	72.83	12.62	10.75	14.82	1.11
1992	4812.15	3775	1335	42.11	42.12	41.04	42.98	45.73	35.50	22.38	0.01
1993	7376.03	6010	1335	65.75	68.18	63.07	68.61	17.44	14.40	17.42	2.43
1994	7575.62	6777	1335	93.82	94.52	64.78	77.36	5.46	5.45	0.02	0.70
1995	8535.72	7197	1335	78.17	81.11	72.99	82.16	2.27	1.88	17.00	2.95
1996	8126.62	6950	1335	83.10	83.67	69.30	79.12	3.91	3.40	12.92	0.57
1997	7112.76	5833	1335	63.62	65.48	60.82	66.59	12.82	9.63	24.89	1.86
1998	8255.92	6802	1335	89.95	90.64	70.60	77.65	8.95	8.91	0.45	0.69
1999	9240.59	7656	1335	85.68	86.27	79.02	87.40	2.52	2.23	11.50	0.59
2000	8027.83	6494	1335	71.39	72.16	68.46	73.93	12.97	10.76	17.08	0.77
2001	9298.49	7843	1335	89.61	89.84	79.51	89.53	9.55	9.49	0.68	0.23
2002	8768.82	7275	1335	79.60	81.04	74.98	83.05	6.57	5.70	13.26	1.44
2003	8691.94	7029	1335	78.00	80.58	74.32	80.24	2.24	1.85	17.58	2.57
2004	10127.42	8283	1335	95.28	96.62	86.36	94.30	3.37	3.37	0.02	1.33
2005	9697.02	7949	1335	85.96	88.64	82.91	90.73	1.71	1.54	9.81	2.69
2006	8882.10	7342	1335	78.35	82.46	75.95	83.81	3.41	2.91	14.63	4.11
2007	6342.04	4987	1335	54.55	55.89	54.23	56.93	5.08	3.40	40.71	1.34
2008	5610.15	4577	1335	49.16	49.33	47.84	52.11	46.41	49.43	1.25	0.17
2009	8681.78	6881	1335	74.60	76.69	74.24	78.55	7.66	13.97	9.34	2.09
2010	10759.91	8465	1335	92.33	93.10	92.01	96.63	6.86	6.86	0.03	0.77
2011	5946.79	5202	1335	54.57	57.07	50.85	59.38	7.51	21.77	21.15	2.50
2012	9171.05	7422	1335	82.81	83.11	78.21	84.49	2.45	8.60	8.29	0.30
2013	10069.65	8498	1335	97.38	98.71	86.11	97.01	1.26	1.26	0.03	1.34
2014	6739.26	5918	1335	72.44	73.89	57.63	67.56	2.82	2.42	23.69	1.45
2015	9047.80	7538	1335	81.10	86.97	77.37	86.05	3.07	2.76	10.27	5.88
2016	9010.70	8069	1335	86.46	98.38	76.84	91.86	1.55	1.55	0.07	11.93
2017	5900.57	5100	1335	51.39	55.80	50.46	58.22	1.92	1.09	43.11	4.41
2018	8028.05	6361	1335	69.66	74.70	68.65	72.61	6.39	7.74	17.56	5.04
2019	10312.99	8456	1335	89.47	92.44	88.19	96.53	7.47	7.46	0.10	2.97
2020	7603.38	6035	1335	65.52	70.88	64.84	68.70	0.63	4.51	24.61	5.36
2021	9770.53	7586	1335	84.88	85.43	83.55	86.60	4.84	4.34	10.23	0.55
2022	10111.34	8662	1335	93.12	99.53	86.46	98.88	0.38	0.37	0.09	6.41

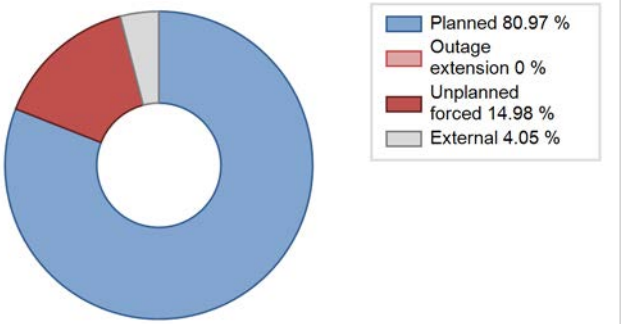
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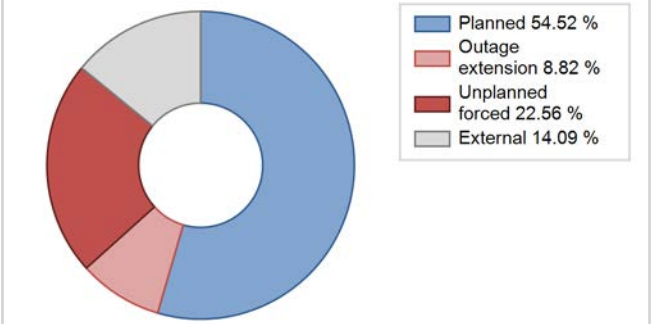
2023	4843.46	3939	1335	41.80	54.23	41.42	44.97	23.23	16.41	29.36	12.43
2024	9024.78	7225	1335	79.84	80.65	76.96	82.25	3.61	3.02	16.32	0.82

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1986 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		118			634	
B.	Refuelling without maintenance	1361			169		
C.	Inspection, maintenance or repair combined with refuelling				950	6	
D.	Inspection, maintenance or repair without refuelling				42	0	
E.	Testing of plant systems or components				23		
H.	Nuclear regulatory requirements					37	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						17
L.	Human factor related		65			6	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						20
O.	Load dispatching, prioritization			14			1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					7	30
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					0	37
Z.	Other					12	0
Subtotal		1361	183	14	1184	702	105
Total			**1558**			**1991**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		37
12. Reactor I&C Systems		24
13. Reactor Auxiliary Systems		17
14. Safety Systems	54	12
15. Reactor Cooling Systems		73
16. Steam generation systems		4
21. Fuel Handling and Storage Facilities		9
31. Turbine and auxiliaries	64	105
32. Feedwater and Main Steam System		86
33. Circulating Water System		2
34. Miscellaneous Systems		64
35. All other I&C Systems		5
41. Main Generator Systems		146
42. Electrical Power Supply Systems		45
Total	**118**	**629**

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2024 Operating Experience

FR-49 ST. ALBAN-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / P4 REP 1300
Thermal power	:	3817 MWth
Gross electrical power	:	1381 MWe
Reference unit power (net)	:	1335 MWe

Key Dates

Construction Date	:	1979-07-31
Grid Date	:	1986-07-03
Commercial Date	:	1987-03-01
Age at end of year	:	38 years

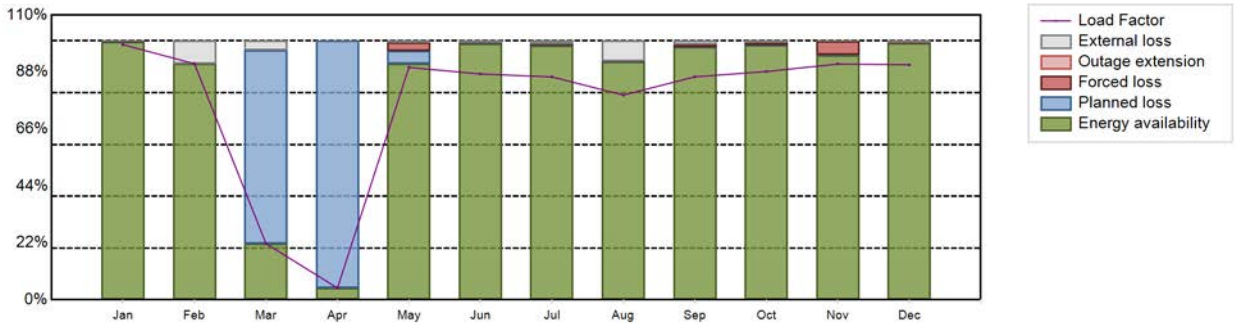
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	328.3
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.1
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	16	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.95
Active core height/length [m]	:	4.267	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8938.09 GW(e).h	Forced Loss Rate (FLR)	:	1.12 %
Energy Availability Factor (EAF)	:	82.28 %	Unplanned Capability Loss Factor (UCL)	:	0.96 %
Unit Capability Factor (UCF)	:	84.4 %	Planned Unavailability Factor (PUF)	:	14.64 %
Load Factor (LF)	:	76.22 %	Externally cause unavailability (XUF)	:	2.12 %
Operating Factor (OF)	:	85.3 %	Total off-line time	:	1291 hours

Annual Summary



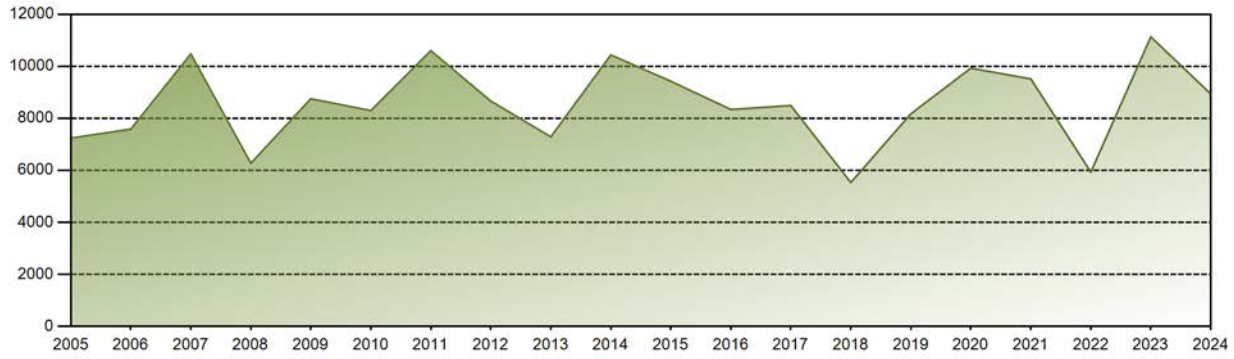
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	978.78	847.12	215.65	44.00	891.62	838.41	855.15	785.39	827.88	876.90	875.41	901.76	8938.09
EAF [%]	99.54	91.17	21.74	4.58	91.17	98.87	98.06	91.82	97.70	98.38	94.51	99.19	82.28
UCF [%]	99.77	100.00	25.46	4.58	91.70	99.56	99.31	99.55	98.98	98.97	94.66	99.88	84.40
LF [%]	98.54	91.17	21.74	4.58	89.77	87.23	86.10	79.07	86.13	88.17	91.08	90.79	76.22
OF [%]	100.00	100.00	25.84	10.69	97.04	95.69	95.83	100.00	100.00	99.87	98.33	100.00	85.30
FLR [%]	0.18	0.00	0.00	0.00	3.41	0.23	0.28	0.37	0.98	0.98	5.21	0.04	1.12
UCL [%]	0.18	0.00	0.00	0.00	3.24	0.22	0.28	0.37	0.98	0.98	5.20	0.04	0.96
PUF [%]	0.05	0.00	74.54	95.42	5.06	0.21	0.41	0.09	0.04	0.05	0.13	0.08	14.64
XUF [%]	0.23	8.83	3.72	0.00	0.53	0.69	1.25	7.72	1.28	0.59	0.15	0.69	2.12

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Historical Summary

Lifetime energy generation	:	309047 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.42 %
Cumulative Energy Availability Factor (EAF)	:	75.69 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.06 %
Cumulative Unit Capability Factor (UCF)	:	78.49 %	Cumulative Planned Unavailability Factor (PUF)	:	13.45 %
Cumulative Load Factor (LF)	:	69.29 %	Cumulative Externally cause unavailability (XUF)	:	2.8 %
Cumulative Operating Factor (OF)	:	77.39 %			

Electricity Production (net) [GWh]

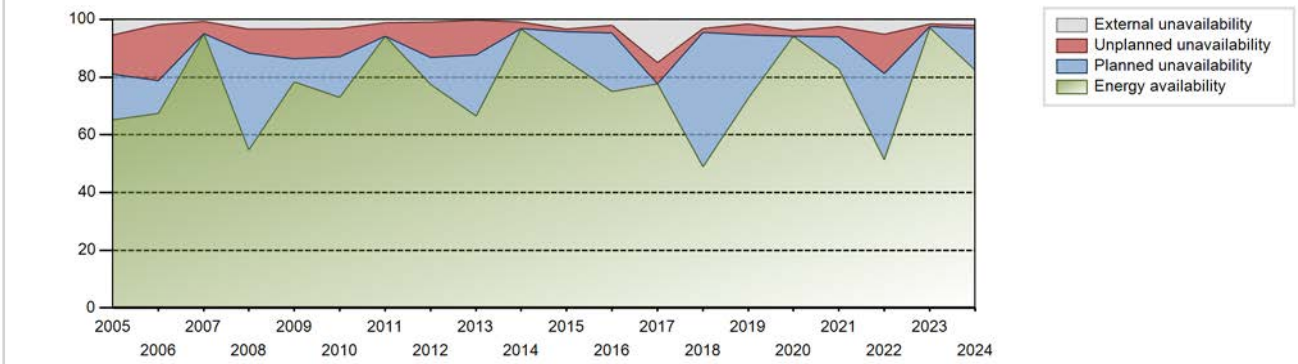


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	6952.20	6094	1300	79.01	79.06	59.07	68.27	20.94	20.94	0.00	0.05
1988	5185.00	4308	1335	46.48	47.29	44.22	49.04	31.63	21.88	30.83	0.81
1989	6126.50	4806	1335	56.23	57.46	52.39	54.86	33.18	28.53	14.01	1.23
1990	6070.64	5146	1335	56.52	60.26	51.91	58.74	23.59	18.60	21.14	3.74
1991	7962.55	6484	1335	71.13	73.29	68.09	74.02	8.73	7.01	19.70	2.16
1992	6375.15	5405	1335	62.34	64.33	54.36	61.53	20.15	16.23	19.44	1.99
1993	6433.10	6121	1335	83.07	90.86	55.01	69.87	8.11	8.02	1.12	7.78
1994	7125.76	6074	1335	73.00	74.87	60.93	69.34	6.29	5.02	20.11	1.86
1995	7751.41	6763	1335	72.69	76.09	66.28	77.20	10.39	8.82	15.09	3.40
1996	8344.63	7247	1335	79.67	81.54	71.16	82.50	3.68	3.11	15.34	1.88
1997	8049.72	7072	1335	91.80	92.33	68.83	80.73	7.25	7.21	0.46	0.53
1998	6555.74	5654	1335	63.23	66.72	56.06	64.54	11.90	9.02	24.26	3.49
1999	8606.97	7188	1335	79.30	80.33	73.60	82.05	8.76	7.71	11.96	1.03
2000	8729.60	7202	1335	79.03	86.47	74.44	81.99	3.56	3.19	10.34	7.45
2001	8654.77	7657	1335	91.30	91.41	74.01	87.41	2.03	1.89	6.69	0.11
2002	8290.64	6950	1335	75.20	77.33	70.89	79.34	6.52	5.39	17.28	2.13
2003	9254.77	7558	1335	83.01	87.77	79.14	86.28	0.52	0.45	11.77	4.76
2004	10476.49	8709	1335	97.73	97.77	89.34	99.15	1.74	1.73	0.49	0.04
2005	7237.98	6361	1335	65.22	70.61	61.88	72.61	16.03	13.68	15.71	5.38
2006	7584.24	6292	1335	67.40	69.14	64.85	71.83	21.25	19.57	11.28	1.74
2007	10476.05	8660	1335	95.02	95.65	89.58	98.86	4.33	4.33	0.02	0.62
2008	6270.91	5320	1335	54.70	58.09	53.48	60.56	5.25	8.33	33.58	3.39
2009	8753.18	7052	1335	78.37	81.82	74.85	80.50	9.69	10.26	7.92	3.45
2010	8297.53	6659	1335	73.03	76.19	70.95	76.02	2.30	9.78	14.03	3.16
2011	10599.69	8474	1335	94.13	95.33	90.64	96.74	4.55	4.55	0.12	1.20
2012	8662.28	7044	1335	77.41	78.39	73.87	80.19	1.24	12.13	9.47	0.98
2013	7287.87	6032	1335	66.54	66.80	62.32	68.86	9.50	11.95	21.25	0.26
2014	10438.17	8684	1335	96.57	97.45	89.26	99.13	2.36	2.35	0.19	0.89
2015	9426.74	7930	1335	85.74	89.08	80.61	90.53	1.02	0.92	10.00	3.34
2016	8339.93	7056	1335	75.04	77.18	71.12	80.33	3.19	2.56	20.26	2.14
2017	8493.06	7023	1335	77.61	92.52	72.62	80.17	7.37	7.36	0.13	14.91
2018	5530.66	4805	1335	48.84	51.97	47.29	54.85	2.44	1.42	46.61	3.13
2019	8171.02	6622	1335	72.77	74.32	69.87	75.59	4.87	3.81	21.87	1.55
2020	9928.37	8649	1335	94.16	97.94	84.67	98.46	2.00	2.00	0.06	3.78
2021	9517.07	7697	1335	82.78	85.22	81.38	87.87	3.99	3.55	11.24	2.44
2022	5931.74	4727	1335	51.44	56.62	50.72	53.96	19.30	13.54	29.84	5.19
2023	11131.59	8759	1335	97.05	98.74	95.19	99.99	0.76	0.76	0.50	1.69

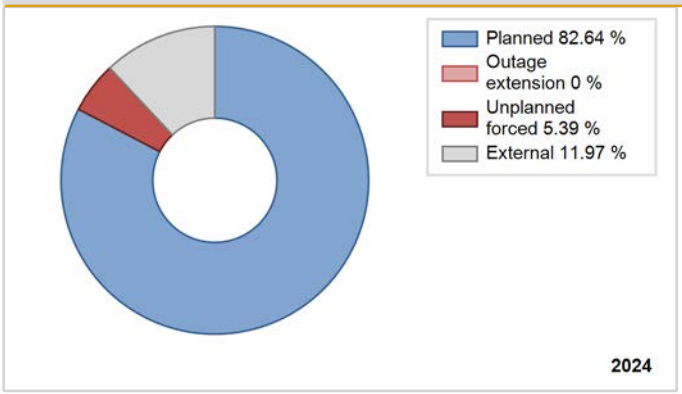
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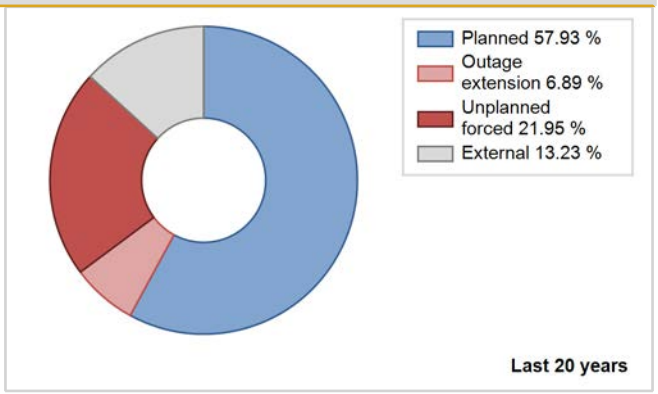
2024	8938.09	7493	1335	82.28	84.40	76.22	85.30	1.12	0.96	14.64	2.12

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		12			602	
B.	Refuelling without maintenance	1179			116		
C.	Inspection, maintenance or repair combined with refuelling				937	18	
D.	Inspection, maintenance or repair without refuelling				52		
E.	Testing of plant systems or components				38	1	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						4
L.	Human factor related		33			19	0
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						22
O.	Load dispatching, prioritization			67			2
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					1	25
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						30
Z.	Other					9	0
Subtotal		1179	45	67	1143	650	83
Total		**1291**			**1876**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		36
12. Reactor I&C Systems		57
13. Reactor Auxiliary Systems		10
14. Safety Systems		14
15. Reactor Cooling Systems		33
16. Steam generation systems		73
17. Safety I&C Systems (excluding reactor I&C)		2
21. Fuel Handling and Storage Facilities		18
31. Turbine and auxiliaries		91
32. Feedwater and Main Steam System		77
33. Circulating Water System		1
34. Miscellaneous Systems		49
35. All other I&C Systems		5
41. Main Generator Systems		102
42. Electrical Power Supply Systems	12	28
Total	**12**	**596**

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2024 Operating Experience

FR-17 ST. LAURENT B-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP2
Thermal power	:	2785 MWth
Gross electrical power	:	956 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1976-05-01
Grid Date	:	1981-01-21
Commercial Date	:	1983-08-01
Age at end of year	:	43 years

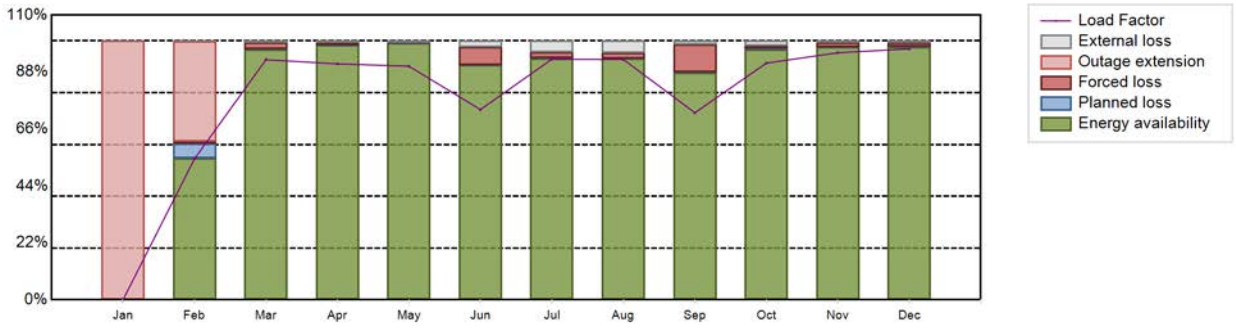
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	41	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6328.39 GW(e).h	Forced Loss Rate (FLR)	:	2.87 %
Energy Availability Factor (EAF)	:	83.8 %	Unplanned Capability Loss Factor (UCL)	:	14.06 %
Unit Capability Factor (UCF)	:	85.32 %	Planned Unavailability Factor (PUF)	:	0.62 %
Load Factor (LF)	:	78.74 %	Externally cause unavailability (XUF)	:	1.53 %
Operating Factor (OF)	:	86.42 %	Total off-line time	:	1193 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	346.82	630.46	600.36	614.27	484.09	632.82	631.84	476.00	623.12	628.74	659.85	6328.39
EAF [%]	0.00	54.58	96.72	98.28	99.04	90.57	93.16	93.07	87.59	96.74	97.52	97.65	83.80
UCF [%]	0.00	54.75	97.44	98.99	99.68	93.02	97.54	97.59	88.99	98.64	98.27	98.20	85.32
LF [%]	0.00	54.46	92.74	91.13	90.23	73.48	92.96	92.81	72.25	91.41	95.44	96.93	78.74
OF [%]	0.00	61.21	98.12	100.00	100.00	83.75	100.00	100.00	93.47	99.87	100.00	100.00	86.42
FLR [%]	0.00	1.08	2.46	0.82	0.19	6.95	2.32	2.30	10.68	0.88	1.66	1.66	2.87
UCL [%]	100.00	39.37	2.46	0.82	0.19	6.95	2.32	2.30	10.64	0.87	1.66	1.65	14.06
PUF [%]	0.00	5.88	0.11	0.19	0.13	0.03	0.14	0.10	0.37	0.49	0.06	0.15	0.62
XUF [%]	0.00	0.17	0.72	0.71	0.64	2.45	4.38	4.52	1.40	1.90	0.76	0.55	1.53

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Historical Summary

Lifetime energy generation	:	242120.2 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.23 %
Cumulative Energy Availability Factor (EAF)	:	75.4 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.56 %
Cumulative Unit Capability Factor (UCF)	:	77.54 %	Cumulative Planned Unavailability Factor (PUF)	:	13.9 %
Cumulative Load Factor (LF)	:	72.52 %	Cumulative Externally cause unavailability (XUF)	:	2.14 %
Cumulative Operating Factor (OF)	:	77.9 %			

Electricity Production (net) [GWh]

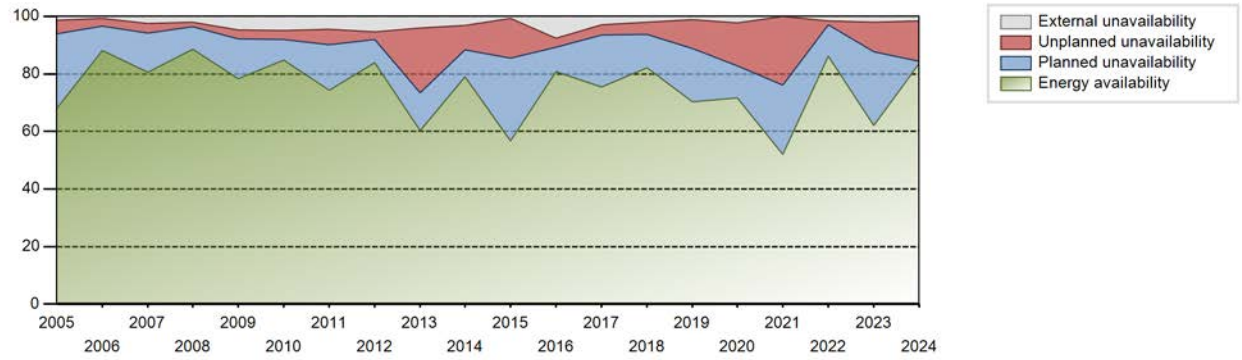


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	3670.00	4382	880	91.99	91.99	91.89	93.85	8.01	8.01	0.00	0.00
1984	4401.00	5042	880	55.95	55.95	56.93	57.40	22.37	16.12	27.92	0.00
1985	5630.40	6827	880	75.00	76.09	73.04	77.93	10.66	9.08	14.83	1.09
1986	5476.40	7144	880	79.72	79.78	71.04	81.55	10.61	9.47	10.75	0.06
1987	5171.30	6667	880	76.14	76.83	67.08	76.11	9.98	8.51	14.66	0.69
1988	5721.00	6464	915	75.95	76.30	71.18	73.59	15.48	13.97	9.73	0.35
1989	6609.76	7699	915	82.69	85.43	82.46	87.89	9.30	8.76	5.81	2.73
1990	6113.67	7089	915	84.12	86.26	76.27	80.92	7.98	7.48	6.26	2.15
1991	4005.40	4736	915	52.29	53.65	49.97	54.06	32.18	25.46	20.89	1.36
1992	5621.12	6690	915	74.05	75.42	69.94	76.16	9.59	8.00	16.58	1.37
1993	5668.51	6821	915	72.38	75.27	70.72	77.87	11.93	10.20	14.54	2.89
1994	6095.73	7252	915	85.11	87.05	76.05	82.79	1.53	1.35	11.60	1.93
1995	4442.99	5211	915	60.27	64.30	55.43	59.49	0.89	0.58	35.13	4.03
1996	5541.09	6888	915	78.78	79.06	68.94	78.42	17.99	17.34	3.60	0.27
1997	5132.60	6404	915	75.43	76.15	64.03	73.11	14.88	13.31	10.54	0.72
1998	6030.71	7366	915	82.11	84.57	75.24	84.09	0.83	0.71	14.72	2.45
1999	5062.64	6207	915	67.92	69.71	63.16	70.86	21.66	19.28	11.02	1.78
2000	5086.74	5957	915	65.97	66.43	63.29	67.82	22.62	19.42	14.15	0.46
2001	6814.76	7735	915	86.40	86.84	85.02	88.30	2.69	2.40	10.76	0.44
2002	6637.03	7592	915	83.36	85.56	82.80	86.67	1.31	1.13	13.31	2.20
2003	6630.44	7658	915	82.81	86.53	82.72	87.42	2.33	2.06	11.40	3.73
2004	6364.19	7356	915	80.41	82.41	79.18	83.74	1.06	0.88	16.71	2.00
2005	5384.07	6186	915	68.11	69.53	67.16	70.61	0.86	4.54	25.93	1.43
2006	6914.14	7973	915	88.21	88.91	86.26	91.02	2.53	2.75	8.34	0.70
2007	6426.68	7380	915	80.55	83.06	80.18	84.25	2.74	3.35	13.58	2.52
2008	6894.13	8034	915	88.62	90.77	85.78	91.46	0.51	1.36	7.87	2.15
2009	6241.46	7298	915	78.42	83.22	77.87	83.31	2.19	3.01	13.77	4.79
2010	6802.10	7967	915	84.89	89.81	84.86	90.95	1.61	3.07	7.13	4.91
2011	5947.96	7000	915	74.24	78.71	74.21	79.91	3.25	5.47	15.82	4.47
2012	6577.57	7708	915	83.89	89.34	81.84	87.75	0.48	2.61	8.06	5.45
2013	4822.46	5662	915	60.34	64.38	60.16	64.63	0.07	22.44	13.18	4.05
2014	6259.24	7417	915	79.08	82.18	78.09	84.67	8.07	8.52	9.30	3.10
2015	4480.02	5185	915	56.68	57.45	55.89	59.19	4.48	13.81	28.74	0.77
2016	6385.17	7366	915	80.74	88.45	79.44	83.86	1.44	3.03	8.52	7.71
2017	5955.70	6794	915	75.48	78.39	74.30	77.56	1.75	3.53	18.07	2.92
2018	6516.26	7535	915	82.17	84.33	81.30	86.02	4.55	4.02	11.66	2.16
2019	5581.31	6561	915	70.25	71.36	69.63	74.90	8.72	10.03	18.61	1.11

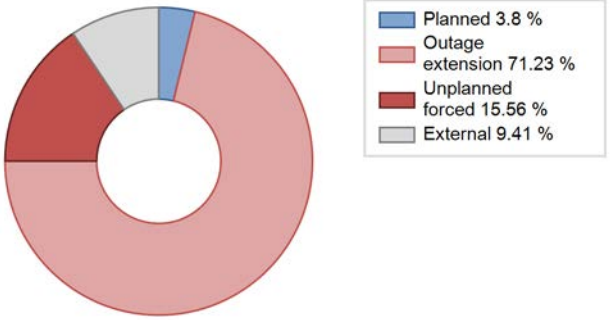
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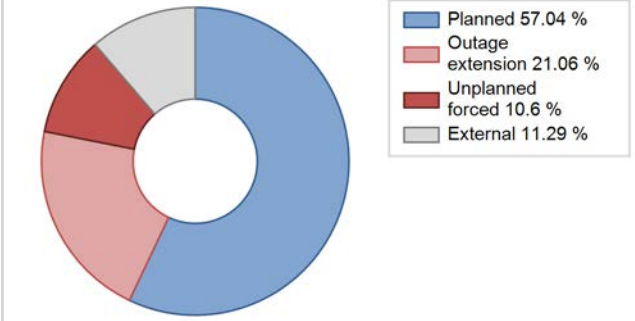
2020	5698.35	6792	915	71.59	73.83	70.90	77.32	9.56	15.06	11.12	2.24
2021	4157.53	4788	915	52.02	52.02	51.87	54.66	7.87	23.85	24.13	0.00
2022	6616.63	7711	915	86.12	87.65	82.55	88.03	1.56	1.39	10.96	1.53
2023	4734.88	5669	915	62.10	64.18	59.07	64.71	0.73	10.12	25.70	2.09
2024	6328.39	7591	915	83.80	85.32	78.74	86.42	2.87	14.06	0.62	1.53

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1983 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		1095			577	
B.	Refuelling without maintenance				145		
C.	Inspection, maintenance or repair combined with refuelling				1112	13	
E.	Testing of plant systems or components				7	2	
H.	Nuclear regulatory requirements					1	
J.	Grid limitation, failure or grid unavailability						0
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			0			6
L.	Human factor related					15	
O.	Load dispatching, prioritization			101			5
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					22	36
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					216	1
Z.	Other					6	1
Subtotal			1095	101	1264	852	49
Total			**1196**			**2165**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		10
12. Reactor I&C Systems		27
13. Reactor Auxiliary Systems		15
14. Safety Systems		27
15. Reactor Cooling Systems		8
16. Steam generation systems		70
21. Fuel Handling and Storage Facilities		8
31. Turbine and auxiliaries	36	52
32. Feedwater and Main Steam System		14
33. Circulating Water System		2
34. Miscellaneous Systems	1014	225
35. All other I&C Systems		3
41. Main Generator Systems	45	107
42. Electrical Power Supply Systems		8
Total	**1095**	**576**

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2024 Operating Experience

FR-23 ST. LAURENT B-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)

Reactor Unit Details

Reactor type and model	:	PWR / CP2
Thermal power	:	2785 MWth
Gross electrical power	:	956 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1976-07-01
Grid Date	:	1981-06-01
Commercial Date	:	1983-08-01
Age at end of year	:	43 years

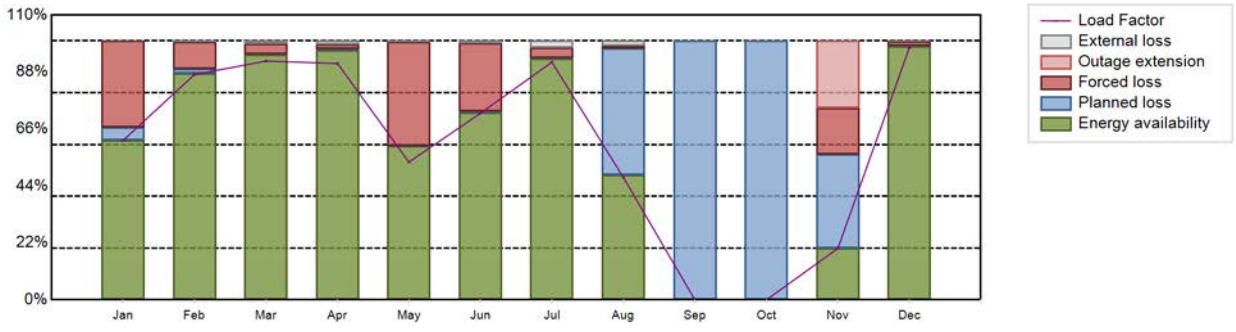
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	41	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4778.58 GW(e).h	Forced Loss Rate (FLR)	:	15.98 %
Energy Availability Factor (EAF)	:	60.88 %	Unplanned Capability Loss Factor (UCL)	:	13.86 %
Unit Capability Factor (UCF)	:	61.62 %	Planned Unavailability Factor (PUF)	:	24.53 %
Load Factor (LF)	:	59.45 %	Externally cause unavailability (XUF)	:	0.74 %
Operating Factor (OF)	:	70.34 %	Total off-line time	:	2605 hours

Annual Summary



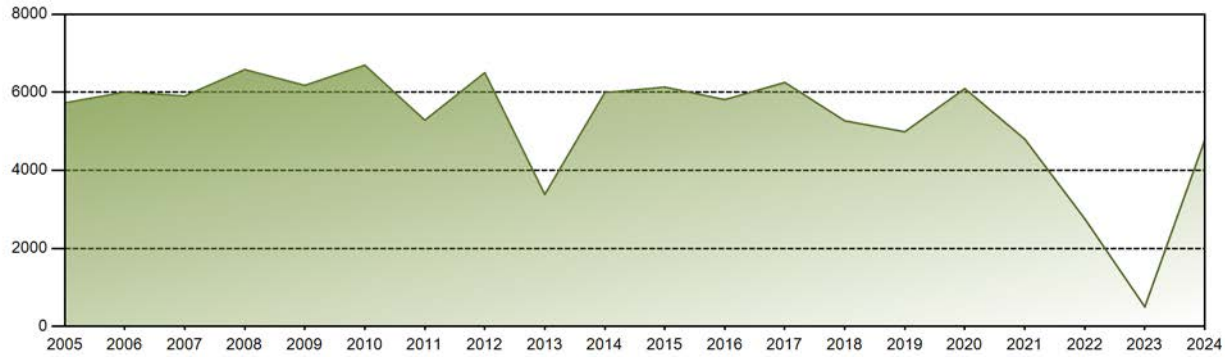
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	418.86	554.03	626.96	601.47	362.24	474.63	624.94	321.81	0.00	0.00	130.81	662.82	4778.58
EAF [%]	61.53	87.37	94.62	96.40	59.34	72.34	93.11	48.20	0.00	0.00	19.86	97.81	60.88
UCF [%]	61.53	87.81	95.63	97.77	59.82	73.25	95.71	50.03	0.00	0.00	19.86	98.03	61.62
LF [%]	61.53	87.00	92.22	91.30	53.21	72.04	91.80	47.27	0.00	0.00	19.86	97.37	59.45
OF [%]	90.59	100.00	100.00	100.00	83.87	87.50	100.00	51.48	0.00	0.00	30.69	100.00	70.34
FLR [%]	35.11	10.64	4.19	1.83	40.17	26.46	3.92	1.83	0.00	0.00	47.09	1.78	15.98
UCL [%]	33.30	10.45	4.18	1.82	40.17	26.36	3.90	0.93	0.00	0.00	43.71	1.77	13.86
PUF [%]	5.17	1.73	0.19	0.41	0.02	0.39	0.39	49.04	100.00	100.00	36.43	0.20	24.53
XUF [%]	0.00	0.45	1.01	1.37	0.48	0.91	2.60	1.83	0.00	0.00	0.00	0.21	0.74

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Historical Summary

Lifetime energy generation	:	230022.56 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.43 %
Cumulative Energy Availability Factor (EAF)	:	71.96 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.55 %
Cumulative Unit Capability Factor (UCF)	:	75.61 %	Cumulative Planned Unavailability Factor (PUF)	:	15.84 %
Cumulative Load Factor (LF)	:	67.9 %	Cumulative Externally cause unavailability (XUF)	:	3.65 %
Cumulative Operating Factor (OF)	:	75.01 %			

Electricity Production (net) [GWh]

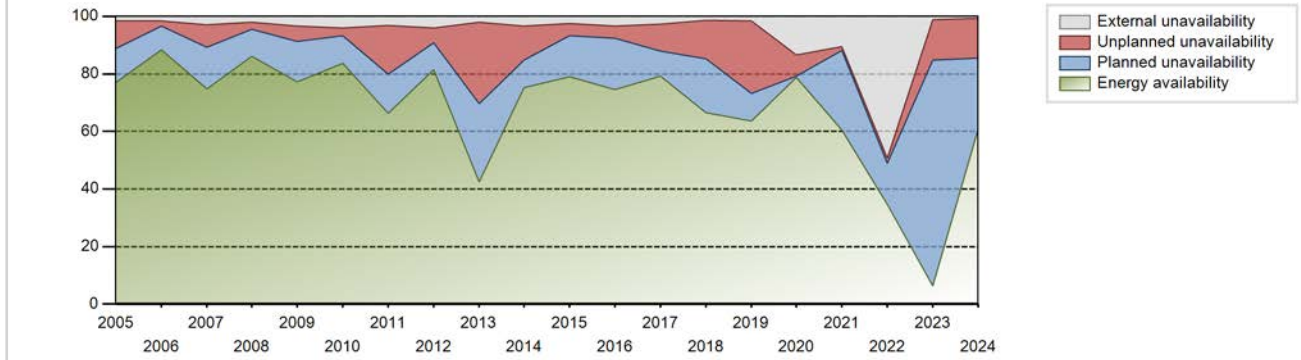


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	4123.00	4839	880	16.06	16.06	15.84	16.74	34.68	8.53	75.41	0.00
1984	5724.00	7237	880	88.88	88.88	74.05	82.39	11.08	11.07	0.05	0.00
1985	5295.60	6806	880	75.70	77.55	68.70	77.69	9.43	8.08	14.37	1.86
1986	5662.80	7337	880	79.78	81.74	73.46	83.76	9.65	8.73	9.53	1.96
1987	5060.20	6798	880	79.41	79.86	65.64	77.60	10.75	9.62	10.52	0.45
1988	5108.00	6262	880	69.57	69.61	66.08	71.29	12.35	9.81	20.58	0.04
1989	5034.03	6490	880	75.92	81.39	65.30	74.09	8.36	7.42	11.19	5.47
1990	5165.86	6212	915	71.29	73.78	64.45	70.91	15.77	13.81	12.41	2.49
1991	6043.04	7374	915	84.25	86.09	75.39	84.18	4.84	4.38	9.53	1.84
1992	5490.13	6982	915	79.41	80.61	68.31	79.49	10.42	9.38	10.01	1.20
1993	5042.24	6149	915	64.11	68.73	62.91	70.19	9.30	7.04	24.23	4.61
1994	6322.70	7406	915	81.17	83.73	78.88	84.54	5.20	4.60	11.67	2.56
1995	5311.31	6720	915	72.12	72.87	66.26	76.71	17.25	15.19	11.94	0.75
1996	6057.67	7303	915	80.85	82.22	75.37	83.14	5.77	5.04	12.74	1.37
1997	5960.69	7147	915	78.13	80.78	74.37	81.59	1.01	0.82	18.39	2.66
1998	6415.27	7585	915	83.15	85.68	80.04	86.59	4.51	4.05	10.27	2.52
1999	5845.85	7013	915	77.25	79.00	72.93	80.06	7.64	6.54	14.47	1.74
2000	5134.00	6069	915	66.99	67.63	63.88	69.09	21.60	18.64	13.74	0.64
2001	6046.65	7226	915	80.11	81.74	75.44	82.49	3.42	2.89	15.37	1.63
2002	6215.02	7434	915	82.66	82.67	77.54	84.86	5.88	5.17	12.16	0.01
2003	4702.44	5580	915	61.64	61.64	58.67	63.70	9.15	6.21	32.14	0.00
2004	6468.60	7838	915	85.64	87.62	80.48	89.23	5.79	5.38	7.00	1.99
2005	5728.05	7038	915	76.98	78.63	71.45	80.33	8.53	9.59	11.77	1.66
2006	6004.32	7580	915	88.27	89.77	74.91	86.53	1.61	1.96	8.27	1.51
2007	5906.81	6949	915	74.73	77.72	73.69	79.33	4.74	7.85	14.43	2.99
2008	6581.43	7784	915	86.07	88.03	81.89	88.62	0.97	2.59	9.37	1.97
2009	6175.76	7086	915	77.33	80.73	77.05	80.89	1.94	5.29	13.98	3.40
2010	6694.83	7737	915	83.59	87.63	83.52	88.32	1.99	2.77	9.60	4.03
2011	5285.01	6171	915	66.20	69.40	65.94	70.45	13.86	16.81	13.78	3.20
2012	6501.97	7591	915	81.35	85.32	80.90	86.42	0.76	5.18	9.50	3.98
2013	3380.08	3990	915	42.44	44.40	42.17	45.55	3.05	28.42	27.18	1.97
2014	5991.68	7035	915	75.25	78.52	74.75	80.31	5.04	11.92	9.56	3.26
2015	6132.94	7188	915	79.00	81.43	76.51	82.05	0.84	4.22	14.35	2.42
2016	5812.80	6867	915	74.58	77.94	72.32	78.18	1.21	4.26	17.79	3.37
2017	6252.54	7246	915	79.24	82.02	78.01	82.72	1.47	9.23	8.74	2.78
2018	5268.72	6257	915	66.58	67.98	65.73	71.43	6.91	13.35	18.67	1.40
2019	4987.68	6030	915	63.60	65.28	62.23	68.84	15.74	25.18	9.54	1.68

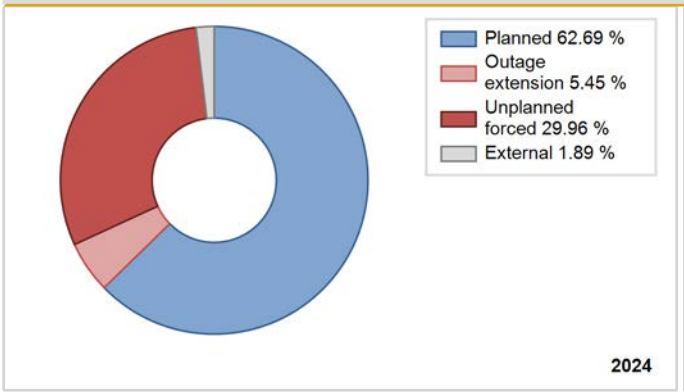
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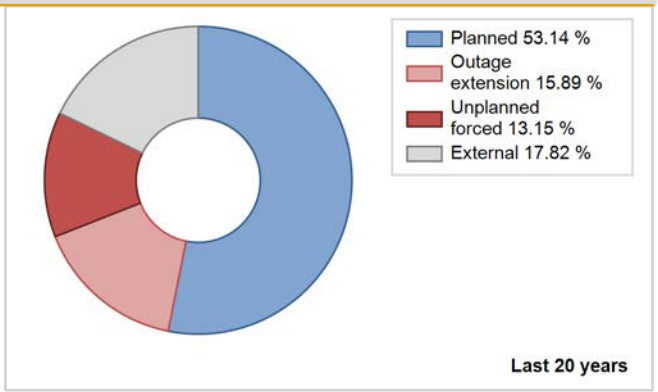
2020	6094.77	7807	915	78.83	92.29	75.83	88.88	7.26	7.23	0.48	13.46
2021	4799.08	5972	915	60.50	70.99	59.87	68.17	1.90	1.37	27.64	10.49
2022	2756.21	3256	915	34.55	83.82	34.39	37.17	2.03	1.74	14.44	49.27
2023	500.78	1019	915	6.25	7.42	6.25	11.63	52.33	14.10	78.47	1.17
2024	4778.58	6179	915	60.88	61.62	59.45	70.34	15.98	13.86	24.53	0.74

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1983 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		536			669	
B.	Refuelling without maintenance				86		
C.	Inspection, maintenance or repair combined with refuelling	2042			1223	10	
D.	Inspection, maintenance or repair without refuelling				5		
E.	Testing of plant systems or components				11	1	
H.	Nuclear regulatory requirements					10	
J.	Grid limitation, failure or grid unavailability						3
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L.	Human factor related					12	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
O.	Load dispatching, prioritization			26			1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						13
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					77	136
Z.	Other					28	
Subtotal		2042	536	26	1325	807	154
Total		**2604**			**2286**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		11
12. Reactor I&C Systems		14
13. Reactor Auxiliary Systems		15
14. Safety Systems		42
15. Reactor Cooling Systems		32
16. Steam generation systems	97	38
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		17
31. Turbine and auxiliaries	67	197
32. Feedwater and Main Steam System	185	29
33. Circulating Water System		5
34. Miscellaneous Systems	187	187
35. All other I&C Systems		2
41. Main Generator Systems		51
42. Electrical Power Supply Systems		14
Total	**536**	**655**

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2024 Operating Experience

FR-18 TRICASTIN-1 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)



Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	955 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1974-11-01
Grid Date	:	1980-05-31
Commercial Date	:	1980-12-01
Age at end of year	:	44 years

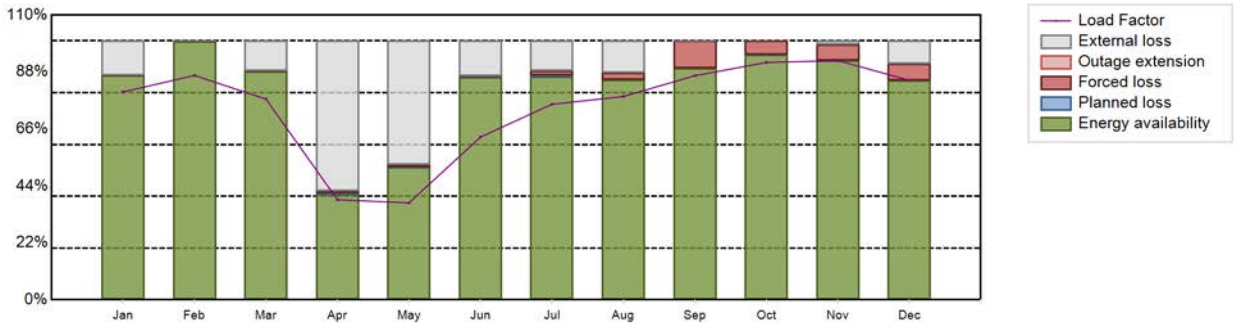
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2/MOX	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	42000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	45	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5979 GW(e).h	Forced Loss Rate (FLR)	:	2.94 %
Energy Availability Factor (EAF)	:	82.08 %	Unplanned Capability Loss Factor (UCL)	:	2.94 %
Unit Capability Factor (UCF)	:	96.98 %	Planned Unavailability Factor (PUF)	:	0.08 %
Load Factor (LF)	:	74.39 %	Externally cause unavailability (XUF)	:	14.9 %
Operating Factor (OF)	:	85.71 %	Total off-line time	:	1255 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	546.54	551.93	527.07	254.69	254.93	413.96	514.19	534.62	570.23	624.96	608.69	577.19	5979.00
EAF [%]	86.62	99.79	88.29	40.91	51.24	85.96	86.32	85.10	89.32	94.59	92.43	84.85	82.08
UCF [%]	99.90	99.83	99.84	98.88	99.00	99.58	97.98	97.40	89.32	94.59	93.72	93.70	96.98
LF [%]	80.28	86.67	77.53	38.66	37.45	62.83	75.53	78.53	86.56	91.68	92.39	84.79	74.39
OF [%]	87.10	100.00	89.10	45.00	53.36	84.86	89.78	85.48	100.00	99.87	100.00	94.49	85.71
FLR [%]	0.04	0.14	0.12	0.86	0.92	0.24	1.73	2.60	10.68	5.41	6.28	6.30	2.94
UCL [%]	0.04	0.14	0.12	0.86	0.92	0.24	1.72	2.60	10.68	5.41	6.28	6.30	2.94
PUF [%]	0.06	0.04	0.04	0.26	0.08	0.18	0.30	0.00	0.00	0.01	0.00	0.00	0.08
XUF [%]	13.28	0.04	11.55	57.97	47.76	13.62	11.65	12.31	0.00	0.00	1.29	8.86	14.90

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Historical Summary

Lifetime energy generation	:	255800.3 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.65 %
Cumulative Energy Availability Factor (EAF)	:	75.45 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.69 %
Cumulative Unit Capability Factor (UCF)	:	78.67 %	Cumulative Planned Unavailability Factor (PUF)	:	13.65 %
Cumulative Load Factor (LF)	:	71.71 %	Cumulative Externally cause unavailability (XUF)	:	3.22 %
Cumulative Operating Factor (OF)	:	79.1 %			

Electricity Production (net) [GWh]

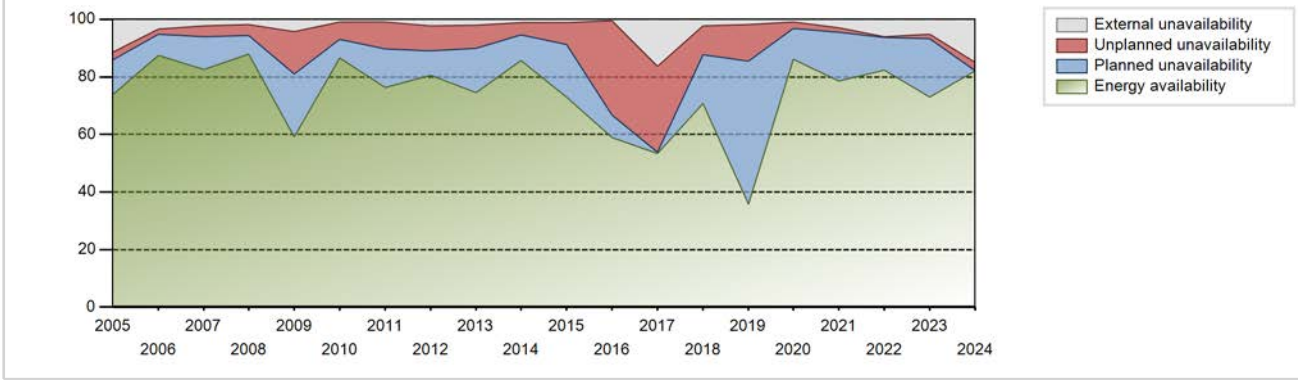


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	2468.00	3412	918	56.60	56.60	95.84	97.04	43.40	43.40	0.00	0.00
1981	4416.00	5176	920	56.33	56.33	54.79	59.09	20.34	14.39	29.28	0.00
1982	5909.80	8151	915	81.86	82.78	73.73	93.05	17.22	17.22	0.00	0.92
1983	5111.00	6097	915	67.24	67.24	63.76	69.60	12.27	9.41	23.35	0.00
1984	6468.00	7662	915	86.67	86.67	80.47	87.23	2.06	1.82	11.51	0.00
1985	6217.90	7560	915	81.64	85.97	77.57	86.30	2.01	1.77	12.27	4.33
1986	5880.30	7188	915	77.05	79.44	73.36	82.05	7.60	6.54	14.02	2.39
1987	5978.10	7360	915	78.15	83.46	74.58	84.02	6.66	5.96	10.58	5.31
1988	5836.00	7200	915	76.70	79.77	72.61	81.97	5.40	4.55	15.68	3.07
1989	5830.15	7550	915	83.17	83.31	72.74	86.19	4.50	3.92	12.76	0.14
1990	5099.69	6377	915	65.08	68.77	63.62	72.80	6.40	4.70	26.53	3.69
1991	5909.12	7262	915	77.01	83.18	73.72	82.90	4.86	4.25	12.57	6.17
1992	5659.31	7573	915	82.99	85.27	70.41	86.21	2.21	1.92	12.81	2.27
1993	6134.82	7393	915	77.71	83.93	76.54	84.39	4.55	4.00	12.07	6.22
1994	5008.42	6458	915	70.27	75.44	62.48	73.72	13.11	11.39	13.17	5.17
1995	5372.68	6374	915	70.60	71.28	67.03	72.76	17.56	15.19	13.53	0.68
1996	7302.13	8448	915	93.78	94.47	90.85	96.17	4.85	4.82	0.71	0.69
1997	5548.30	6711	915	72.49	73.13	69.22	76.61	9.22	7.42	19.45	0.64
1998	5503.66	7075	915	71.03	71.03	68.66	80.76	16.38	13.92	15.05	0.00
1999	3426.65	4016	915	44.51	44.90	42.75	45.84	41.81	32.27	22.83	0.40
2000	6644.86	7842	915	87.15	87.68	82.67	89.28	2.36	2.12	10.21	0.53
2001	6053.29	7261	915	82.03	83.19	75.52	82.89	0.83	0.69	16.12	1.15
2002	6384.56	7778	915	86.67	87.67	79.65	88.79	1.48	1.32	11.01	1.01
2003	5670.06	7029	915	73.02	85.15	70.74	80.24	1.26	1.08	13.76	12.13
2004	6832.46	8049	915	89.00	91.54	85.01	91.63	0.18	0.16	8.30	2.54
2005	5830.97	7007	915	73.98	85.33	72.74	79.98	2.29	2.64	12.02	11.35
2006	6466.79	7989	915	87.40	90.66	80.68	91.20	0.04	1.97	7.36	3.26
2007	6344.72	7496	915	82.55	84.84	79.16	85.57	1.43	3.66	11.49	2.29
2008	6808.19	7950	915	87.86	89.74	84.71	90.51	0.20	3.68	6.58	1.88
2009	4655.39	5435	915	59.21	63.45	58.08	62.04	8.56	14.84	21.71	4.24
2010	6688.43	7755	915	86.65	87.51	83.44	88.53	2.34	6.00	6.49	0.86
2011	5580.09	6483	915	76.43	77.39	69.62	74.01	0.25	9.31	13.30	0.96
2012	6339.05	7345	915	80.56	82.92	78.87	83.62	4.22	8.55	8.54	2.36
2013	5868.42	6741	915	74.66	76.70	73.21	76.95	1.82	7.97	15.33	2.04
2014	6743.76	7683	915	85.74	86.92	84.14	87.71	3.18	4.24	8.84	1.18
2015	5751.37	6557	915	73.07	74.21	71.75	74.85	2.79	7.58	18.20	1.14
2016	4576.92	5400	915	58.84	59.37	56.95	61.48	3.78	32.71	7.91	0.53

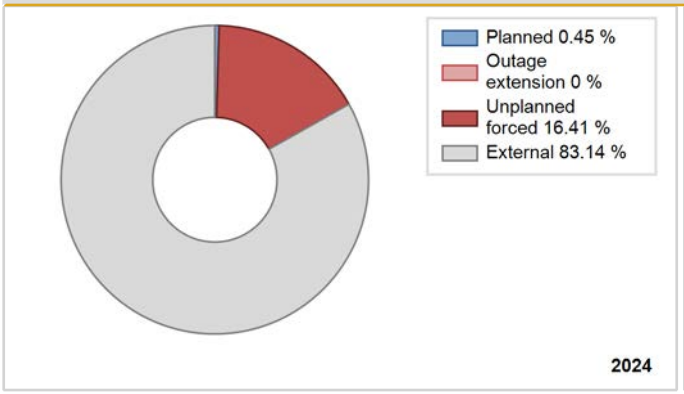
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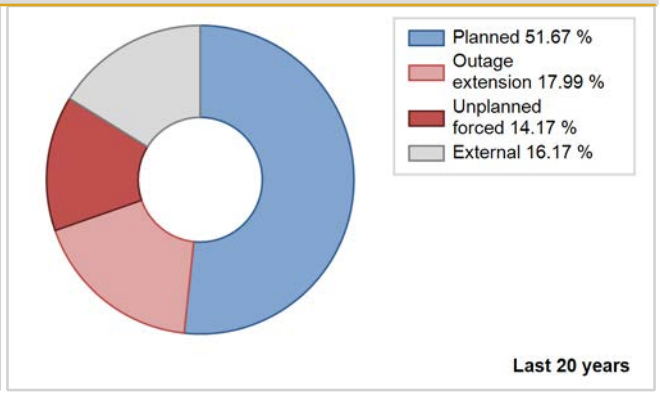
2017	4029.83	4975	915	53.33	69.61	50.28	56.79	29.14	29.98	0.40	16.28
2018	5586.73	6477	915	70.79	73.09	69.70	73.94	4.87	9.93	16.98	2.30
2019	2843.84	3231	915	35.70	37.49	35.48	36.88	16.76	12.76	49.75	1.79
2020	6655.75	7846	915	86.13	87.16	82.81	89.32	2.43	2.17	10.67	1.03
2021	6052.10	7270	915	78.53	81.44	75.51	82.99	1.92	1.59	16.96	2.91
2022	6479.64	7555	915	82.40	88.49	80.84	86.24	0.32	0.28	11.23	6.09
2023	5453.03	6633	915	73.09	78.29	68.03	75.72	1.85	1.47	20.23	5.20
2024	5979.00	7529	915	82.08	96.98	74.39	85.71	2.94	2.94	0.08	14.90

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1980 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		46			371	1
B.	Refuelling without maintenance				112		
C.	Inspection, maintenance or repair combined with refuelling				1027	7	
D.	Inspection, maintenance or repair without refuelling				14	1	
E.	Testing of plant systems or components				4	0	
H.	Nuclear regulatory requirements					113	
J.	Grid limitation, failure or grid unavailability						11
L.	Human factor related					10	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			0			2
O.	Load dispatching, prioritization			43			3
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					15	14
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)			1183			64
Z.	Other					24	1
Subtotal			46	1226	1157	541	96
Total			**1272**			**1794**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	18	66
12. Reactor I&C Systems	23	10
13. Reactor Auxiliary Systems	5	2
14. Safety Systems		59
15. Reactor Cooling Systems		18
16. Steam generation systems		84
21. Fuel Handling and Storage Facilities		7
31. Turbine and auxiliaries		42
32. Feedwater and Main Steam System		7
33. Circulating Water System		4
34. Miscellaneous Systems		84
35. All other I&C Systems		1
41. Main Generator Systems		61
42. Electrical Power Supply Systems		35
Total	**46**	**480**

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2024 Operating Experience

FR-19 TRICASTIN-2 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)



Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	955 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1974-12-01
Grid Date	:	1980-08-07
Commercial Date	:	1980-12-01
Age at end of year	:	44 years

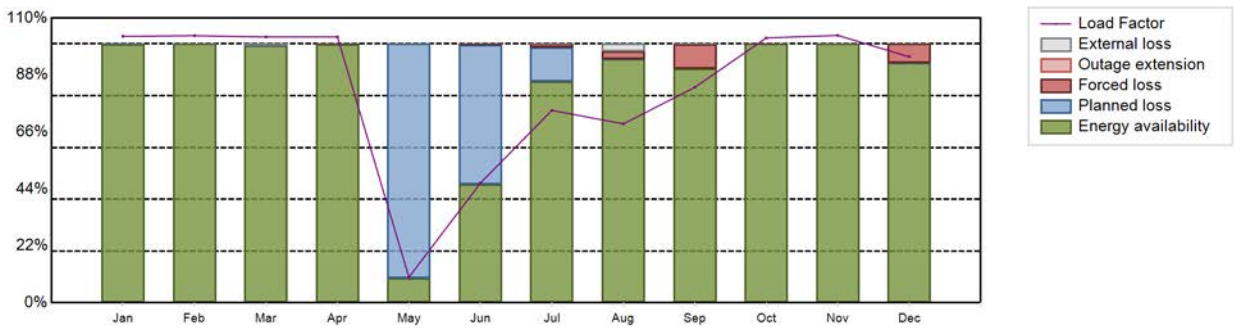
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2/MOX	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	45	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6654.49 GW(e).h	Forced Loss Rate (FLR)	:	2.12 %
Energy Availability Factor (EAF)	:	84.69 %	Unplanned Capability Loss Factor (UCL)	:	1.84 %
Unit Capability Factor (UCF)	:	84.99 %	Planned Unavailability Factor (PUF)	:	13.17 %
Load Factor (LF)	:	82.79 %	Externally cause unavailability (XUF)	:	0.29 %
Operating Factor (OF)	:	86 %	Total off-line time	:	1230 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	700.55	657.19	697.98	676.67	67.40	304.88	506.04	470.53	548.39	697.53	680.42	646.89	6654.49
EAF [%]	99.98	100.00	99.29	99.91	9.59	45.74	85.55	94.04	90.50	99.99	100.00	92.62	84.69
UCF [%]	99.98	100.00	99.99	99.91	9.59	45.74	85.56	96.80	90.52	99.99	100.00	92.62	84.99
LF [%]	102.91	103.20	102.67	102.71	9.90	46.28	74.34	69.12	83.24	102.33	103.28	95.02	82.79
OF [%]	100.00	100.00	100.00	100.00	9.81	53.47	100.00	87.63	88.89	99.87	100.00	93.15	86.00
FLR [%]	0.00	0.00	0.00	0.09	0.00	1.01	1.68	3.18	9.48	0.01	0.00	7.36	2.12
UCL [%]	0.00	0.00	0.00	0.09	0.00	0.47	1.46	3.18	9.48	0.01	0.00	7.35	1.84
PUF [%]	0.02	0.00	0.01	0.00	90.41	53.79	12.98	0.02	0.00	0.00	0.00	0.03	13.17
XUF [%]	0.00	0.00	0.70	0.00	0.00	0.00	0.01	2.75	0.02	0.00	0.00	0.00	0.29

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Historical Summary

Lifetime energy generation	:	256947.59 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.08 %
Cumulative Energy Availability Factor (EAF)	:	75.34 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.89 %
Cumulative Unit Capability Factor (UCF)	:	78.72 %	Cumulative Planned Unavailability Factor (PUF)	:	14.39 %
Cumulative Load Factor (LF)	:	72.26 %	Cumulative Externally cause unavailability (XUF)	:	3.38 %
Cumulative Operating Factor (OF)	:	78.33 %			

Electricity Production (net) [GWh]

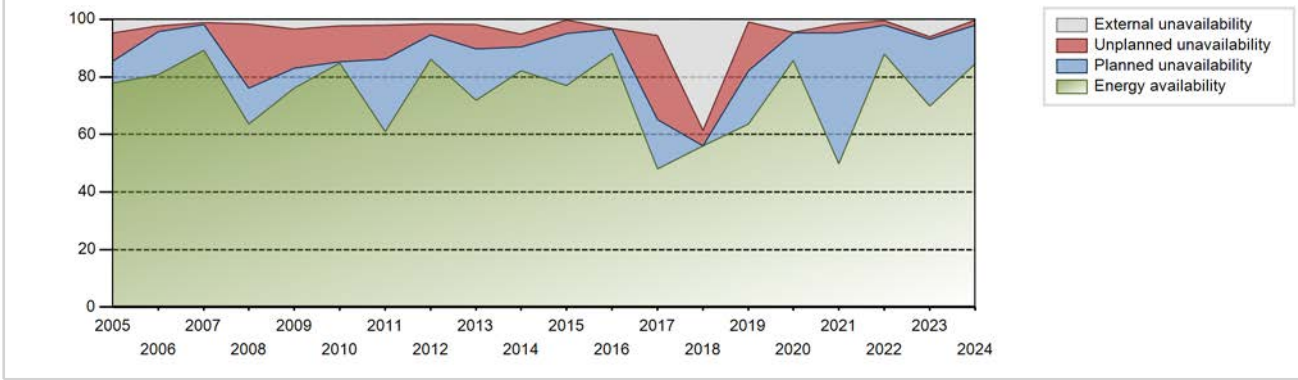


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	1614.00	2559	917	68.70	68.70	68.08	76.34	9.91	7.56	23.74	0.00
1981	6155.10	7819	920	82.33	82.33	76.37	89.26	4.42	3.81	13.87	0.00
1982	4056.20	5932	915	63.03	63.03	50.61	67.72	11.83	8.46	28.51	0.00
1983	5624.00	7245	915	81.92	81.92	70.16	82.71	1.75	1.46	16.62	0.00
1984	6603.00	7684	915	87.18	87.18	82.15	87.48	4.50	4.11	8.72	0.00
1985	6261.70	7375	915	79.37	86.02	78.12	84.19	4.24	3.81	10.17	6.64
1986	6286.60	7631	915	82.60	85.78	78.43	87.11	4.14	3.71	10.51	3.18
1987	5302.30	6500	915	69.61	73.17	66.15	74.20	10.08	8.20	18.63	3.56
1988	4896.00	6628	915	73.08	76.03	60.92	75.46	13.58	11.95	12.02	2.95
1989	5164.73	6650	915	71.40	74.33	64.44	75.91	25.15	24.97	0.70	2.93
1990	5614.37	7177	915	72.54	80.90	70.04	81.93	2.87	2.39	16.70	8.36
1991	4459.14	5429	915	58.16	60.81	55.63	61.97	15.63	11.26	27.93	2.65
1992	6099.10	7118	915	78.72	79.95	75.88	81.03	8.45	7.38	12.67	1.24
1993	5777.08	6876	915	72.92	77.31	72.07	78.49	12.48	11.03	11.66	4.39
1994	6216.70	7222	915	79.09	81.66	77.56	82.44	6.02	5.24	13.10	2.57
1995	6312.32	7504	915	81.63	84.62	78.75	85.66	3.01	2.63	12.75	2.99
1996	6391.27	7615	915	82.08	84.90	79.52	86.69	1.18	1.02	14.08	2.83
1997	5218.84	6107	915	66.82	68.49	65.11	69.71	1.07	0.74	30.77	1.67
1998	6293.90	7354	915	81.20	83.02	78.52	83.95	7.01	6.26	10.72	1.82
1999	5661.49	6674	915	73.01	74.99	70.63	76.19	11.30	9.55	15.45	1.98
2000	4293.76	5092	915	55.29	56.70	53.42	57.97	23.28	17.20	26.10	1.41
2001	6710.46	7779	915	87.14	87.24	83.72	88.80	2.49	2.23	10.54	0.10
2002	6593.92	7714	915	86.87	87.14	82.27	88.06	0.23	0.20	12.66	0.28
2003	6195.95	7521	915	84.36	88.44	77.30	85.86	0.76	0.68	10.88	4.07
2004	5684.23	7271	915	80.68	86.42	70.72	82.78	2.15	1.90	11.67	5.74
2005	5878.67	7128	915	77.85	82.60	73.33	81.36	9.85	9.87	7.53	4.75
2006	6221.30	7366	915	80.69	83.01	77.62	84.09	1.78	1.91	15.09	2.31
2007	6910.13	7989	915	89.26	90.37	86.20	91.19	0.27	0.82	8.81	1.10
2008	4884.40	5768	915	63.59	65.13	60.77	65.66	1.42	22.37	12.50	1.54
2009	6083.60	7028	915	76.12	79.58	75.90	80.23	1.98	13.57	6.85	3.46
2010	6467.47	7629	915	84.84	87.15	80.69	87.09	12.52	12.47	0.38	2.31
2011	4690.91	5560	915	60.94	62.96	58.52	63.47	1.11	11.80	25.23	2.03
2012	6847.18	7806	915	86.09	87.67	85.19	88.87	0.98	3.71	8.63	1.58
2013	5664.14	6607	915	71.85	73.76	70.67	75.42	6.53	8.27	17.96	1.91
2014	6417.13	7593	915	82.09	87.19	80.06	86.68	0.54	4.44	8.38	5.10
2015	6224.43	6828	915	77.05	77.38	77.66	77.95	0.21	4.59	18.02	0.33
2016	7208.49	7948	915	88.24	91.29	89.69	90.48	0.43	0.39	8.32	3.05

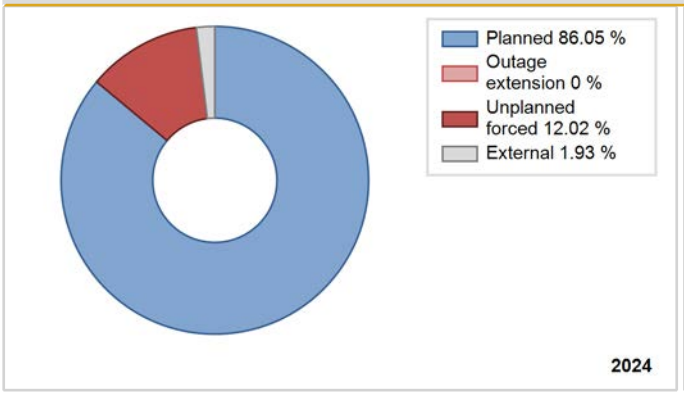
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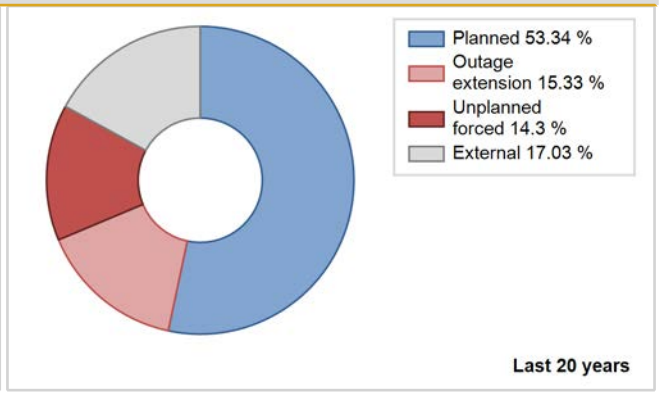
2017	3839.11	4529	915	47.96	53.48	47.90	51.70	32.46	29.21	17.30	5.52
2018	4365.93	5046	915	56.03	94.64	54.47	57.60	5.35	5.35	0.01	38.61
2019	5126.60	5725	915	63.55	64.50	63.96	65.35	3.01	16.84	18.66	0.95
2020	6937.00	7615	915	85.66	90.26	86.31	86.69	0.12	0.11	9.63	4.61
2021	4051.53	4413	915	49.71	51.40	50.55	50.38	5.68	3.09	45.51	1.69
2022	7074.48	7808	915	87.99	88.55	88.26	89.13	1.61	1.45	10.00	0.56
2023	5664.11	6272	915	69.98	76.13	70.67	71.60	0.90	0.69	23.17	6.15
2024	6654.49	7554	915	84.69	84.99	82.79	86.00	2.12	1.84	13.17	0.29

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1980 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		155			423	
B.	Refuelling without maintenance	1004			120		
C.	Inspection, maintenance or repair combined with refuelling				1054	24	
D.	Inspection, maintenance or repair without refuelling				23		
E.	Testing of plant systems or components				3	1	
H.	Nuclear regulatory requirements					35	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L.	Human factor related					20	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			24			19
O.	Load dispatching, prioritization			47			1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						51
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						76
Z.	Other					26	2
Subtotal		1004	155	71	1200	529	149
Total		**1230**			**1878**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		61
12. Reactor I&C Systems	51	28
13. Reactor Auxiliary Systems		6
14. Safety Systems		53
15. Reactor Cooling Systems		34
16. Steam generation systems		25
21. Fuel Handling and Storage Facilities		3
31. Turbine and auxiliaries	3	60
32. Feedwater and Main Steam System		12
33. Circulating Water System		8
34. Miscellaneous Systems	101	117
41. Main Generator Systems		28
42. Electrical Power Supply Systems		29
Total	**155**	**464**

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2024 Operating Experience

FR-25 TRICASTIN-3 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)



Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	955 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1975-04-01
Grid Date	:	1981-02-10
Commercial Date	:	1981-05-11
Age at end of year	:	43 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2/MOX
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	25
Average discharge burnup [MWd/t]	:	33735
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	45
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

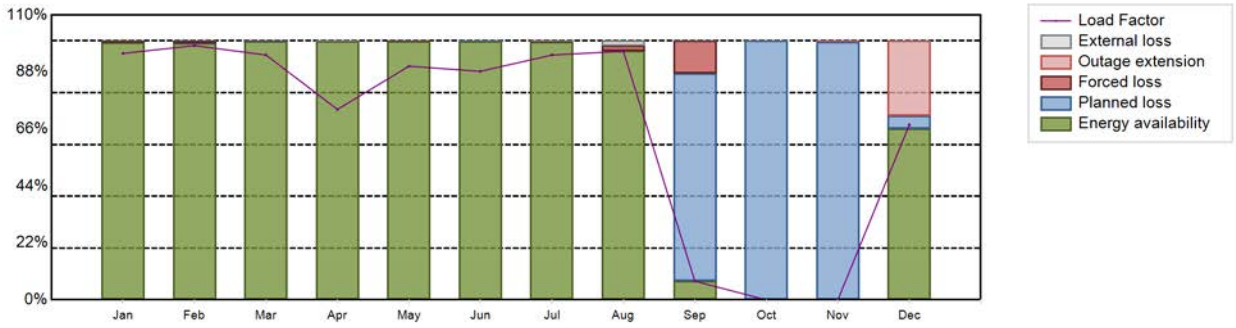
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.45
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5400.84 GW(e).h
Energy Availability Factor (EAF)	:	72.33 %
Unit Capability Factor (UCF)	:	72.49 %
Load Factor (LF)	:	67.2 %
Operating Factor (OF)	:	73.19 %

Forced Loss Rate (FLR)	:	1.85 %
Unplanned Capability Loss Factor (UCL)	:	3.84 %
Planned Unavailability Factor (PUF)	:	23.67 %
Externally cause unavailability (XUF)	:	0.15 %
Total off-line time	:	2355 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	647.94	625.11	642.85	484.55	614.16	581.42	643.58	653.55	47.42	0.00	0.00	460.27	5400.84
EAF [%]	99.47	99.06	99.94	99.93	99.81	99.91	99.73	96.04	7.20	0.00	0.00	66.10	72.33
UCF [%]	99.47	99.06	99.94	99.93	99.81	99.91	99.79	97.79	7.20	0.00	0.00	66.10	72.49
LF [%]	95.18	98.16	94.56	73.55	90.22	88.26	94.54	96.00	7.20	0.00	0.00	67.61	67.20
OF [%]	100.00	98.99	100.00	95.42	100.00	100.00	100.00	97.85	14.17	0.00	0.00	70.97	73.19
FLR [%]	0.53	0.92	0.02	0.07	0.19	0.00	0.02	2.21	63.67	0.00	0.00	0.00	1.85
UCL [%]	0.53	0.92	0.02	0.07	0.19	0.00	0.02	2.21	12.62	0.00	0.31	28.98	3.84
PUF [%]	0.00	0.02	0.05	0.00	0.00	0.09	0.19	0.00	80.17	100.00	99.69	4.92	23.67
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.06	1.75	0.00	0.00	0.00	0.00	0.15

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Historical Summary

Lifetime energy generation	:	256767.57 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.31 %
Cumulative Energy Availability Factor (EAF)	:	75.73 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.55 %
Cumulative Unit Capability Factor (UCF)	:	79.22 %	Cumulative Planned Unavailability Factor (PUF)	:	14.23 %
Cumulative Load Factor (LF)	:	73.19 %	Cumulative Externally cause unavailability (XUF)	:	3.49 %
Cumulative Operating Factor (OF)	:	78.35 %			

Electricity Production (net) [GWh]

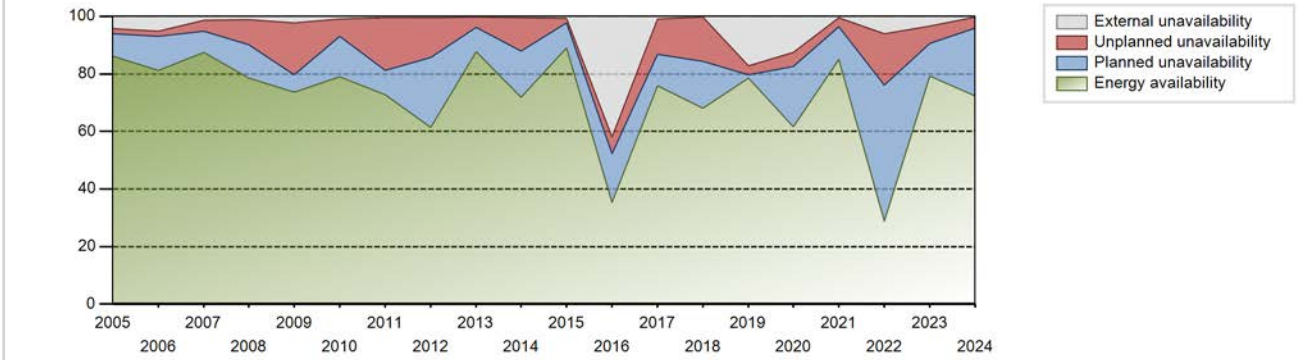


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	4917.60	6463	919	78.00	78.00	73.91	81.89	0.00	0.00	22.00	0.00
1982	5067.30	5966	915	65.83	65.83	63.22	68.11	7.17	5.08	29.09	0.00
1983	6342.00	7544	915	82.77	82.77	79.12	86.12	4.29	3.71	13.52	0.00
1984	6682.00	7668	915	85.11	85.11	83.14	87.30	2.01	1.74	13.14	0.00
1985	7166.00	8518	915	94.29	97.06	89.40	97.24	0.89	0.87	2.06	2.77
1986	6230.40	7704	915	83.48	86.83	77.73	87.95	3.18	2.85	10.32	3.34
1987	5654.30	6810	915	75.37	76.85	70.54	77.74	8.05	6.73	16.42	1.48
1988	5722.00	7106	915	77.98	80.29	71.19	80.90	8.35	7.32	12.39	2.31
1989	5834.63	7188	915	75.88	80.92	72.79	82.05	2.34	1.94	17.14	5.04
1990	6457.21	7671	915	84.62	85.77	80.56	87.57	2.00	1.75	12.48	1.15
1991	4746.80	5941	915	62.06	66.50	59.22	67.82	23.92	20.91	12.59	4.43
1992	5198.98	6010	915	66.63	67.55	64.69	68.42	6.11	4.39	28.06	0.92
1993	6423.91	7373	915	81.39	83.29	80.14	84.17	5.63	4.97	11.74	1.89
1994	6496.49	7641	915	83.59	86.27	81.05	87.23	2.85	2.53	11.20	2.68
1995	6494.69	7675	915	85.14	86.97	81.03	87.61	2.11	1.88	11.15	1.83
1996	5806.69	7172	915	76.16	79.30	72.25	81.65	7.59	6.51	14.19	3.13
1997	6192.76	7331	915	79.06	82.57	77.26	83.69	8.25	7.42	10.01	3.51
1998	6359.54	7375	915	80.49	82.28	79.34	84.19	6.55	5.77	11.96	1.79
1999	5731.67	6828	915	74.01	76.65	71.51	77.95	11.85	10.31	13.04	2.64
2000	5985.21	7325	915	78.99	82.30	74.47	83.39	8.50	7.65	10.05	3.32
2001	4929.48	5777	915	65.18	65.77	61.50	65.95	15.73	12.27	21.96	0.59
2002	5976.06	7140	915	80.19	80.44	74.56	81.51	1.24	1.01	18.55	0.25
2003	6144.89	7607	915	79.71	86.93	76.66	86.84	4.69	4.28	8.79	7.23
2004	6377.15	7455	915	82.86	84.34	79.34	84.87	3.69	3.23	12.43	1.47
2005	6563.04	7981	915	86.14	90.44	81.87	91.10	0.74	1.69	7.87	4.30
2006	6006.89	7488	915	81.28	86.47	74.94	85.48	1.44	1.78	11.75	5.18
2007	6775.03	7862	915	87.57	88.96	84.53	89.75	2.62	3.78	7.26	1.39
2008	6185.23	7030	915	78.59	79.66	76.96	80.03	0.32	8.87	11.48	1.06
2009	5750.65	6608	915	73.61	75.88	71.74	75.43	16.37	18.01	6.11	2.27
2010	6257.49	7089	915	79.10	80.07	78.07	80.92	1.30	5.87	14.05	0.98
2011	5827.60	6507	915	72.83	73.42	72.71	74.28	17.38	18.27	8.31	0.59
2012	4959.82	5534	915	61.47	61.93	61.71	63.00	1.39	13.77	24.31	0.45
2013	6912.58	7765	915	87.60	87.87	86.24	88.64	0.83	3.52	8.61	0.28
2014	5763.72	6369	915	71.84	72.39	71.91	72.71	7.95	11.53	16.08	0.55
2015	7186.07	7928	915	89.05	89.64	89.65	90.50	0.48	1.58	8.77	0.59
2016	2863.03	3168	915	35.34	77.34	35.62	36.07	0.00	5.73	16.94	42.00
2017	6042.82	6785	915	75.80	76.75	75.39	77.45	2.57	12.33	10.91	0.95

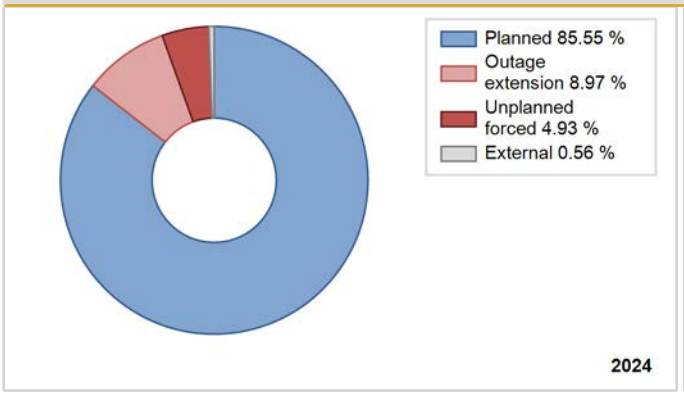
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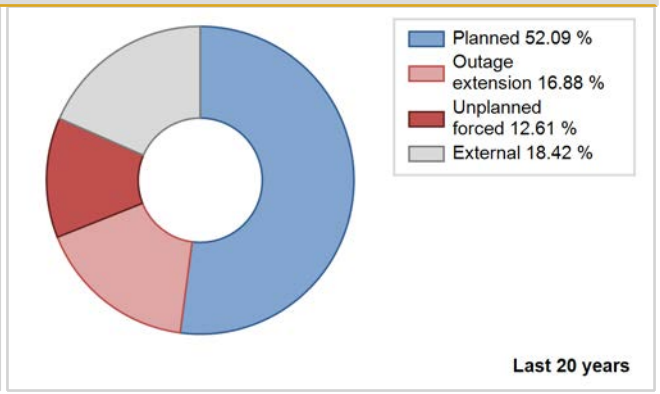
2018	5453.10	6019	915	68.17	68.32	68.03	68.71	18.45	15.46	16.21	0.16
2019	6032.36	7059	915	78.63	95.75	75.26	80.58	1.18	3.13	1.12	17.13
2020	4987.94	5578	915	61.67	74.21	62.06	63.50	2.40	4.82	20.97	12.54
2021	6884.54	7514	915	85.10	85.49	85.89	85.78	1.68	3.21	11.30	0.39
2022	2357.63	2566	915	28.75	34.91	29.41	29.29	3.33	17.80	47.29	6.16
2023	6179.71	7040	915	79.26	82.61	77.10	80.37	0.22	6.06	11.33	3.35
2024	5400.84	6429	915	72.33	72.49	67.20	73.19	1.85	3.84	23.67	0.15

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		282			440	
B.	Refuelling without maintenance				124		
C.	Inspection, maintenance or repair combined with refuelling	2038			1040	6	
D.	Inspection, maintenance or repair without refuelling				22		
E.	Testing of plant systems or components		1		4	1	
H.	Nuclear regulatory requirements					22	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L.	Human factor related					22	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						31
O.	Load dispatching, prioritization			34			1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					14	102
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						32
Z.	Other					22	
Subtotal		2038	283	34	1190	527	166
Total		**2355**			**1883**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		12
12. Reactor I&C Systems	60	32
13. Reactor Auxiliary Systems		18
14. Safety Systems		43
15. Reactor Cooling Systems		35
16. Steam generation systems		85
17. Safety I&C Systems (excluding reactor I&C)		3
21. Fuel Handling and Storage Facilities		5
31. Turbine and auxiliaries		91
32. Feedwater and Main Steam System		5
34. Miscellaneous Systems	218	123
35. All other I&C Systems		2
41. Main Generator Systems	5	81
42. Electrical Power Supply Systems		8
Total	**283**	**543**

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2024 Operating Experience

FR-26 TRICASTIN-4 FRANCE

Status at end of year	:	**Operational**
Operator	:	EDF (ÉLECTRICITÉ DE FRANCE)
Owner	:	EDF (ÉLECTRICITÉ DE FRANCE)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)



Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2785 MWth
Gross electrical power	:	955 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1975-05-01
Grid Date	:	1981-06-12
Commercial Date	:	1981-11-01
Age at end of year	:	43 years

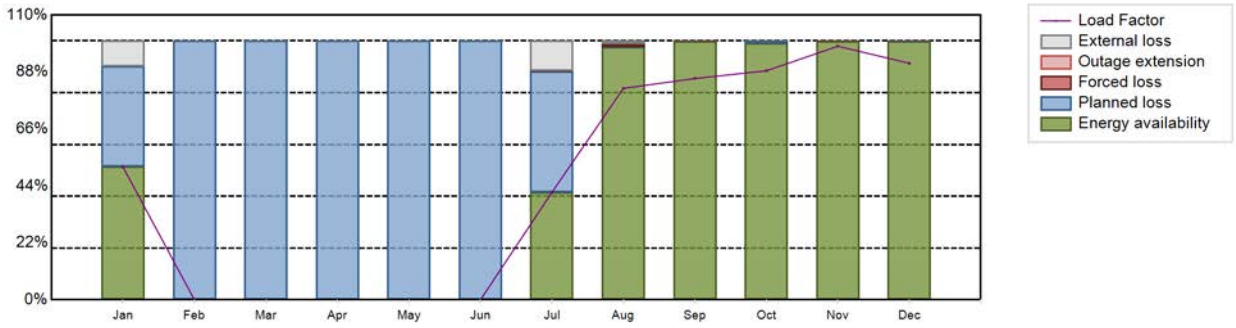
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2/MOX	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	33735	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.45
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	45	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	3621.04 GW(e).h	Forced Loss Rate (FLR)	:	0.29 %
Energy Availability Factor (EAF)	:	49.37 %	Unplanned Capability Loss Factor (UCL)	:	0.15 %
Unit Capability Factor (UCF)	:	51.27 %	Planned Unavailability Factor (PUF)	:	48.58 %
Load Factor (LF)	:	45.05 %	Externally cause unavailability (XUF)	:	1.9 %
Operating Factor (OF)	:	51.09 %	Total off-line time	:	4296 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	349.31	0.00	0.00	0.00	0.00	0.00	282.53	556.01	563.08	602.95	645.24	621.93	3621.04
EAF [%]	51.36	0.00	0.00	0.00	0.00	0.00	41.44	97.52	99.93	99.21	99.91	99.82	49.37
UCF [%]	61.09	0.00	0.00	0.00	0.00	0.00	52.93	98.71	99.93	99.21	99.91	99.82	51.27
LF [%]	51.31	0.00	0.00	0.00	0.00	0.00	41.50	81.67	85.47	88.45	97.94	91.36	45.05
OF [%]	61.16	0.00	0.00	0.00	0.00	0.00	48.52	100.00	100.00	99.87	100.00	100.00	51.09
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.62	1.20	0.07	0.00	0.01	0.13	0.29
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.33	1.20	0.07	0.00	0.01	0.13	0.15
PUF [%]	38.91	100.00	100.00	100.00	100.00	100.00	46.74	0.09	0.00	0.79	0.08	0.05	48.58
XUF [%]	9.74	0.00	0.00	0.00	0.00	0.00	11.49	1.19	0.00	0.00	0.00	0.00	1.90

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Historical Summary

Lifetime energy generation	:	255993.62 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.54 %
Cumulative Energy Availability Factor (EAF)	:	77.83 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.28 %
Cumulative Unit Capability Factor (UCF)	:	81.06 %	Cumulative Planned Unavailability Factor (PUF)	:	13.66 %
Cumulative Load Factor (LF)	:	73.71 %	Cumulative Externally cause unavailability (XUF)	:	3.24 %
Cumulative Operating Factor (OF)	:	80.2 %			

Electricity Production (net) [GWh]

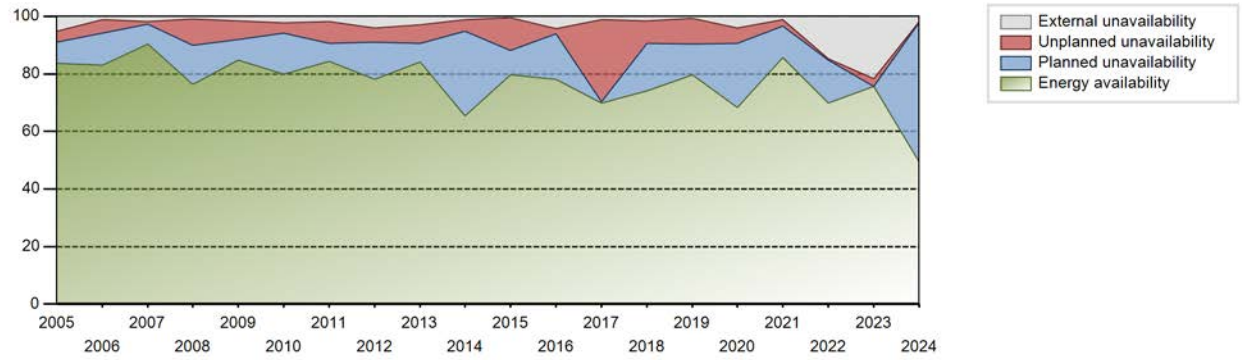


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	2480.00	3883	917	97.21	97.21	95.30	99.86	0.00	0.00	2.79	0.00
1982	5470.50	6311	915	69.85	69.85	68.25	72.04	5.62	4.16	25.99	0.00
1983	6170.00	7386	915	80.67	80.67	76.98	84.32	3.68	3.08	16.25	0.00
1984	5446.00	7587	915	87.08	87.08	67.76	86.37	4.70	4.30	8.62	0.00
1985	6161.70	7816	915	84.80	91.35	76.87	89.22	0.51	0.47	8.19	6.54
1986	5873.90	7568	915	81.78	85.70	73.28	86.39	0.52	0.45	13.85	3.92
1987	5725.70	7257	915	80.12	84.16	71.43	82.84	5.52	4.92	10.93	4.04
1988	3770.00	4772	915	66.25	67.65	46.91	54.33	19.52	16.41	15.94	1.41
1989	5729.11	7335	915	79.80	82.94	71.48	83.73	3.98	3.44	13.62	3.14
1990	5201.58	7329	915	77.42	82.72	64.89	83.66	5.39	4.71	12.57	5.30
1991	5742.81	6838	915	74.55	77.09	71.65	78.06	11.76	10.27	12.64	2.54
1992	6459.26	7968	915	86.69	90.20	80.37	90.71	0.54	0.49	9.31	3.51
1993	5302.81	6842	915	70.89	80.08	66.16	78.11	2.01	1.64	18.27	9.19
1994	5952.97	7049	915	77.80	80.87	74.27	80.47	7.76	6.81	12.33	3.06
1995	6208.92	7562	915	81.99	85.67	77.46	86.32	4.77	4.29	10.04	3.69
1996	6700.35	7774	915	86.55	87.59	83.37	88.50	1.75	1.56	10.85	1.04
1997	6488.77	7595	915	84.84	86.00	80.95	86.70	1.26	1.09	12.90	1.17
1998	5912.98	7138	915	76.19	80.45	73.77	81.48	9.79	8.73	10.82	4.25
1999	5887.87	7158	915	77.95	80.49	73.46	81.71	11.36	10.31	9.20	2.53
2000	5780.25	6873	915	75.76	77.41	71.92	78.24	5.60	4.59	18.00	1.65
2001	6036.95	7138	915	81.25	83.00	75.32	81.48	6.39	5.67	11.34	1.75
2002	6260.60	7168	915	81.89	83.97	78.11	81.83	4.25	3.73	12.31	2.08
2003	6387.89	7399	915	79.89	82.88	79.70	84.46	5.91	5.20	11.92	2.99
2004	4724.06	5359	915	58.84	59.83	58.78	61.01	2.24	1.37	38.80	0.99
2005	6501.37	7728	915	83.63	88.80	81.10	88.21	4.04	3.74	7.46	5.16
2006	6410.44	7412	915	82.98	84.10	79.98	84.61	2.81	4.73	11.17	1.12
2007	7046.97	8096	915	90.42	92.18	87.91	92.41	0.13	0.96	6.86	1.75
2008	6016.61	6867	915	76.42	77.35	74.86	78.18	2.16	9.14	13.51	0.93
2009	6536.71	7630	915	84.80	86.48	81.55	87.10	0.89	6.30	7.23	1.67
2010	6263.83	7275	915	79.97	82.28	78.15	83.05	0.31	3.51	14.21	2.31
2011	6477.78	7589	915	84.30	86.18	80.82	86.63	4.34	7.46	6.36	1.87
2012	5937.33	7062	915	78.04	82.15	73.87	80.40	0.43	4.83	13.02	4.10
2013	6556.13	7607	915	84.21	87.24	81.79	86.84	1.34	6.41	6.35	3.03
2014	5218.80	5828	915	65.48	66.62	65.11	66.53	0.01	3.98	29.40	1.14
2015	6538.75	7080	915	79.60	80.15	81.58	80.82	2.51	11.24	8.61	0.55
2016	6420.53	6914	915	78.13	82.46	79.88	78.71	1.98	1.67	15.88	4.33
2017	5531.81	6267	915	69.86	70.95	69.01	71.54	25.20	28.63	0.42	1.09

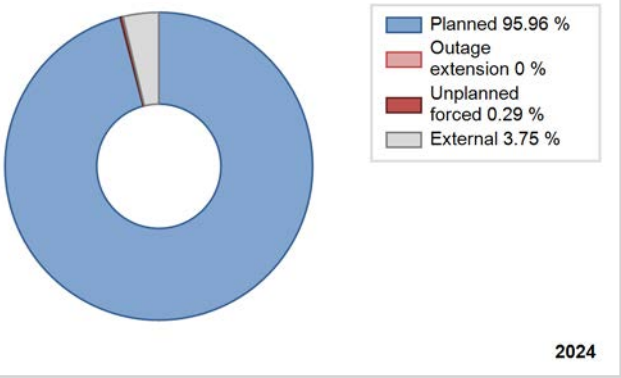
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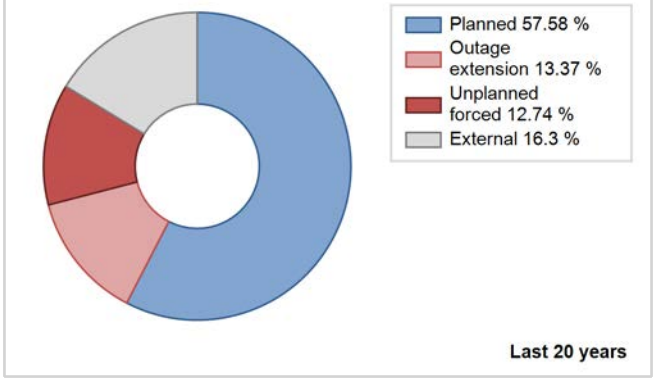
2018	5916.77	6699	915	74.10	75.71	73.82	76.47	3.43	7.69	16.60	1.61
2019	6228.37	7130	915	79.65	80.42	77.71	81.39	3.51	8.92	10.65	0.77
2020	5432.69	6235	915	68.40	72.47	67.59	70.98	6.78	5.27	22.26	4.07
2021	6792.92	7554	915	85.63	86.67	84.75	86.23	2.61	2.32	11.00	1.04
2022	5407.68	6467	915	69.85	84.59	67.47	73.82	0.63	0.53	14.88	14.74
2023	5694.38	6859	915	75.69	97.40	71.04	78.30	2.55	2.55	0.05	21.71
2024	3621.04	4488	915	49.37	51.27	45.05	51.09	0.29	0.15	48.58	1.90

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					285	1
B.	Refuelling without maintenance				82		
C.	Inspection, maintenance or repair combined with refuelling	4209			1048	7	
D.	Inspection, maintenance or repair without refuelling				14		
E.	Testing of plant systems or components	0			2	0	
H.	Nuclear regulatory requirements					42	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						17
L.	Human factor related					19	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						5
O.	Load dispatching, prioritization						2
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)			17		20	37
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						60
Z.	Other			68		30	2
Subtotal		4209		85	1146	403	124
Total		**4294**			**1673**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		19
12. Reactor I&C Systems		15
13. Reactor Auxiliary Systems		10
14. Safety Systems		68
15. Reactor Cooling Systems		15
16. Steam generation systems		29
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		4
31. Turbine and auxiliaries		22
32. Feedwater and Main Steam System		14
33. Circulating Water System		1
34. Miscellaneous Systems		88
35. All other I&C Systems		0
41. Main Generator Systems		35
42. Electrical Power Supply Systems		16
Total		**336**

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2024 Operating Experience

HU-1 PAKS-1 HUNGARY

Status at end of year	:	**Operational**
Operator	:	PAKS Zrt (PAKS NUCLEAR POWER PLANT, LTD.)
Owner	:	MVM Zrt. (HUNGARIAN POWER COMPANIES LTD.)
Reactor Supplier	:	AEE (ATOMENERGOEXPORT)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")



Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1485 MWth
Gross electrical power	:	509 MWe
Reference unit power (net)	:	479 MWe

Key Dates

Construction Date	:	1974-08-01
Grid Date	:	1982-12-28
Commercial Date	:	1983-08-10
Age at end of year	:	42 years

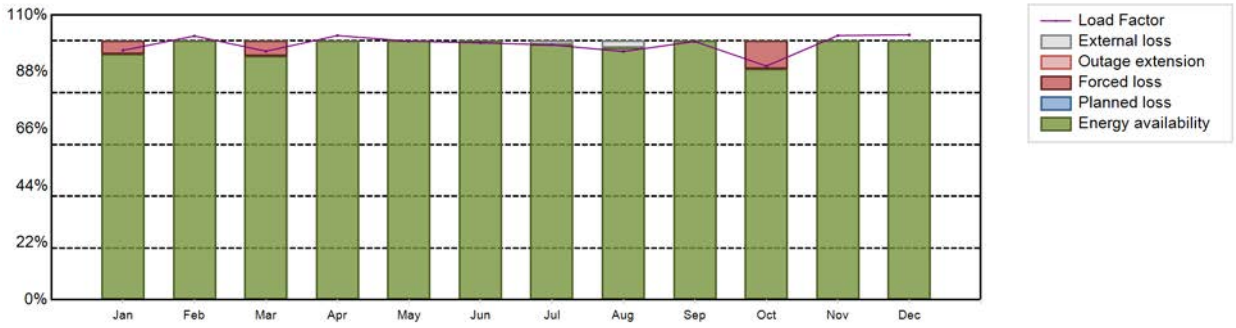
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	12.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	297
Fuel material	:	UO2	Number of SG	:	6
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.15
Average fuel enrichment [% of U235]	:	3.6	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	30	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	37000	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	2.88	HP cylinder inlet steam pressure [MPa]	:	4.2
Active core height/length [m]	:	2.42	Output voltage [kV]	:	15.75
Number of fissile fuel assemblies/bundles	:	349	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	13.1	Number of main condensate pumps	:	3
Number of control rod assemblies	:	37	Number of FW pumps for full power operation	:	4
Number of external reactor coolant loops	:	6	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4150.92 GW(e).h	Forced Loss Rate (FLR)	:	1.83 %
Energy Availability Factor (EAF)	:	97.83 %	Unplanned Capability Loss Factor (UCL)	:	1.83 %
Unit Capability Factor (UCF)	:	98.17 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	98.65 %	Externally cause unavailability (XUF)	:	0.34 %
Operating Factor (OF)	:	99.58 %	Total off-line time	:	37 hours

Annual Summary



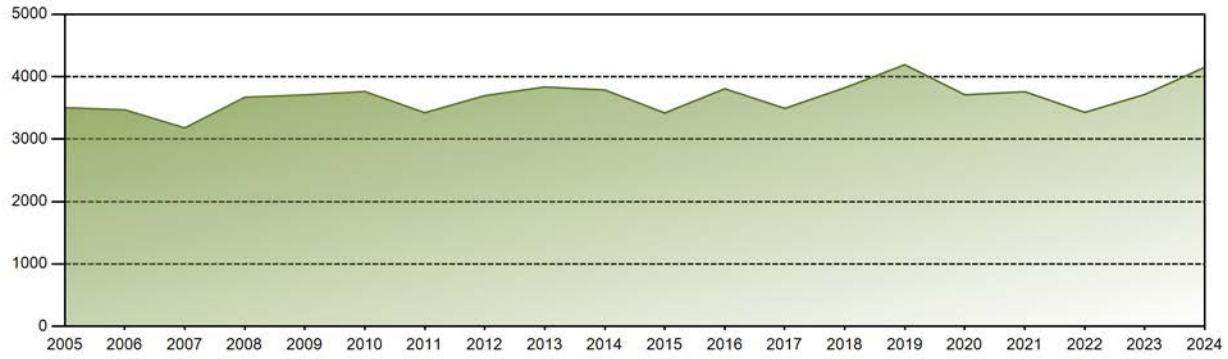
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	343.33	339.73	341.70	351.99	356.02	342.38	350.82	341.81	344.16	322.24	352.05	364.71	4150.92
EAF [%]	94.96	100.00	94.12	100.00	100.00	100.00	98.51	97.49	100.00	89.29	100.00	100.00	97.83
UCF [%]	94.96	100.00	94.12	100.00	100.00	100.00	100.00	100.00	100.00	89.29	100.00	100.00	98.17
LF [%]	96.34	101.90	96.01	102.06	99.90	99.27	98.44	95.91	99.79	90.30	102.08	102.34	98.65
OF [%]	100.00	100.00	95.02	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.58
FLR [%]	5.04	0.00	5.88	0.00	0.00	0.00	0.00	0.00	0.00	10.71	0.00	0.00	1.83
UCL [%]	5.04	0.00	5.88	0.00	0.00	0.00	0.00	0.00	0.00	10.71	0.00	0.00	1.83
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	1.49	2.51	0.00	0.00	0.00	0.00	0.34

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Historical Summary

Lifetime energy generation	:	142940.2 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.71 %
Cumulative Energy Availability Factor (EAF)	:	87.01 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.06 %
Cumulative Unit Capability Factor (UCF)	:	87.18 %	Cumulative Planned Unavailability Factor (PUF)	:	10.76 %
Cumulative Load Factor (LF)	:	87.87 %	Cumulative Externally cause unavailability (XUF)	:	0.17 %
Cumulative Operating Factor (OF)	:	88.16 %			

Electricity Production (net) [GWh]

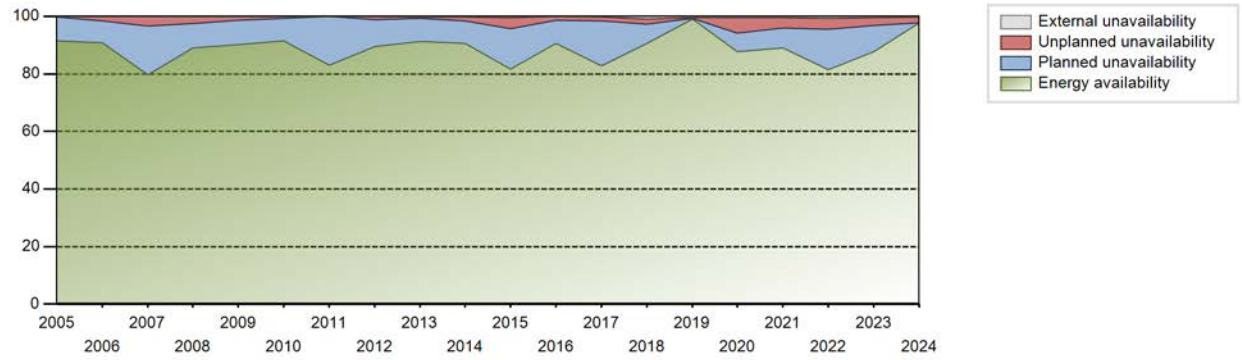


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	2299.70	7106	410	91.00	91.00	91.00	99.73	9.00	9.00	0.00	0.00
1984	2595.30	6901	403	75.63	75.73	73.25	78.56	1.28	0.98	23.29	0.10
1985	2997.30	7491	410	84.15	84.15	83.45	85.51	1.01	0.86	14.99	0.00
1986	3114.64	7718	410	87.11	87.11	86.72	88.11	0.69	0.61	12.28	0.00
1987	2883.09	7107	415	79.20	79.20	79.31	81.13	0.56	0.45	20.35	0.00
1988	3076.94	7737	415	85.83	85.83	84.41	88.08	3.88	3.47	10.70	0.00
1989	3182.18	7929	415	87.68	87.68	87.53	90.51	1.00	0.88	11.44	0.00
1990	3216.83	7837	415	87.22	87.22	88.49	89.46	3.83	3.48	9.31	0.00
1991	2883.91	6823	410	75.08	75.08	80.30	77.89	7.82	6.37	18.55	0.00
1992	3498.85	7629	430	84.92	84.94	92.63	86.85	5.50	4.95	10.11	0.02
1993	3512.43	7637	430	85.80	85.80	93.25	87.18	4.98	4.50	9.70	0.00
1994	3441.51	8031	430	89.81	89.86	91.36	91.68	1.34	1.22	8.92	0.05
1995	3056.32	7088	430	79.54	79.64	81.14	80.91	3.61	2.98	17.38	0.10
1996	3472.68	8033	430	90.62	90.74	91.94	91.45	0.76	0.70	8.57	0.11
1997	3328.48	7646	430	86.95	87.04	88.36	87.28	1.24	1.09	11.87	0.09
1998	3487.73	8095	430	92.37	92.41	92.59	92.41	0.39	0.36	7.23	0.04
1999	3117.54	7240	430	81.25	81.61	82.76	82.65	1.21	1.00	17.39	0.36
2000	3192.12	7268	430	82.27	82.53	84.51	82.74	4.10	3.53	13.95	0.26
2001	3514.87	8069	437	91.61	91.77	91.82	92.11	0.18	0.17	8.07	0.15
2002	3330.66	7909	437	90.08	90.21	87.01	90.29	0.07	0.07	9.72	0.13
2003	3097.84	7197	437	80.96	80.96	80.91	82.15	3.43	3.04	16.00	0.00
2004	3342.33	7692	437	87.07	87.07	87.07	87.57	0.21	2.70	10.23	0.00
2005	3503.53	8029	437	91.52	91.52	91.52	91.66	0.18	0.25	8.23	0.00
2006	3468.50	7979	437	90.83	90.83	90.61	91.08	0.26	1.48	7.68	0.00
2007	3179.36	6933	470	79.71	79.71	79.74	79.14	0.52	3.33	16.96	0.00
2008	3670.29	7824	470	88.94	88.94	88.90	89.07	2.35	2.59	8.47	0.00
2009	3708.04	7926	470	90.19	90.19	90.06	90.48	0.34	1.34	8.47	0.00
2010	3762.00	8031	470	91.46	91.46	91.37	91.68	0.00	0.67	7.87	0.00
2011	3422.07	7291	470	83.12	83.12	83.12	83.23	0.09	0.08	16.80	0.00
2012	3697.01	7881	470	89.57	89.57	89.55	89.72	0.47	1.24	9.19	0.00
2013	3834.70	8009	470	91.29	91.45	93.14	91.43	0.02	0.59	7.97	0.16
2014	3787.47	8022	470	90.51	90.69	91.99	91.58	0.82	1.48	7.83	0.18
2015	3418.04	7194	470	81.59	82.00	83.02	82.12	0.00	3.94	14.06	0.41
2016	3806.89	8056	470	90.69	90.80	92.21	91.71	0.95	1.17	8.03	0.10
2017	3492.07	7421	470	82.88	83.23	84.82	84.71	1.38	1.17	15.60	0.35
2018	3822.70	8103	479	90.59	91.46	91.10	92.50	0.68	1.83	6.71	0.87
2019	4192.05	8760	479	99.16	99.73	99.90	100.00	0.19	0.19	0.08	0.57

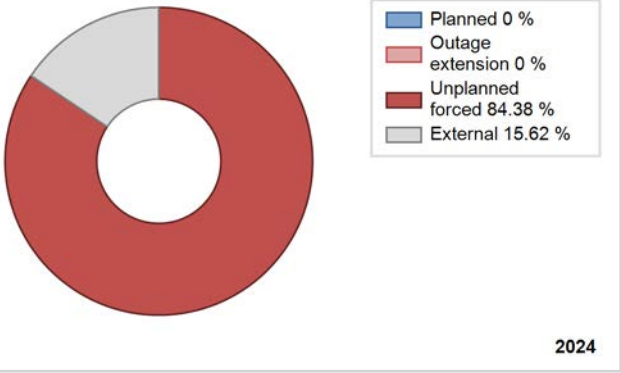
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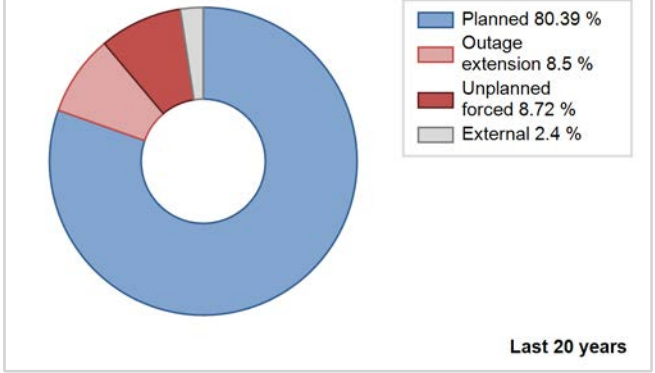
2020	3709.65	8151	479	87.60	88.11	88.17	92.79	4.97	5.28	6.61	0.51
2021	3759.42	7926	479	88.95	89.43	89.59	90.48	3.17	3.54	7.03	0.48
2022	3428.09	7197	479	81.41	82.17	81.70	82.16	1.38	3.69	14.14	0.76
2023	3715.12	7880	479	87.81	88.37	88.54	89.95	1.52	2.68	8.95	0.56
2024	4150.92	8747	479	97.83	98.17	98.65	99.58	1.83	1.83	0.00	0.34

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1983 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		37			95	
C. Inspection, maintenance or repair combined with refuelling				913	16	
D. Inspection, maintenance or repair without refuelling				14		
E. Testing of plant systems or components					0	
J. Grid limitation, failure or grid unavailability						0
L. Human factor related					1	
Z. Other					9	
Subtotal		37		927	121	0
Total		**37**			**1048**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		0
12. Reactor I&C Systems		20
13. Reactor Auxiliary Systems		4
14. Safety Systems		11
15. Reactor Cooling Systems		8
16. Steam generation systems		13
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		9
32. Feedwater and Main Steam System		7
33. Circulating Water System		7
34. Miscellaneous Systems		9
35. All other I&C Systems		0
41. Main Generator Systems	37	4
42. Electrical Power Supply Systems		4
Total	**37**	**97**

Highlights (2024)

Operation at full power in base load mode

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2024 Operating Experience

HU-2 PAKS-2 HUNGARY



Status at end of year	:	**Operational**
Operator	:	PAKS Zrt (PAKS NUCLEAR POWER PLANT, LTD.)
Owner	:	MVM Zrt. (HUNGARIAN POWER COMPANIES LTD.)
Reactor Supplier	:	AEE (ATOMENERGOEXPORT)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1485 MWth
Gross electrical power	:	506 MWe
Reference unit power (net)	:	479 MWe

Key Dates

Construction Date	:	1974-08-01
Grid Date	:	1984-09-06
Commercial Date	:	1984-11-14
Age at end of year	:	40 years

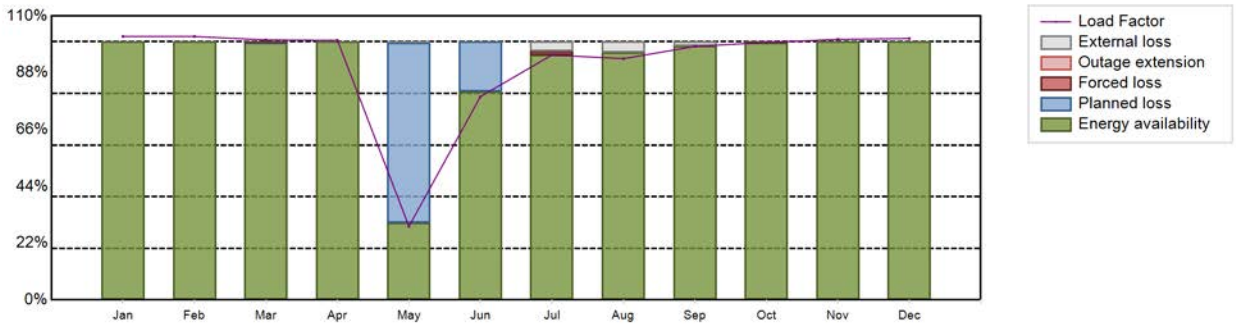
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.82
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	30
Average discharge burnup [MWd/t]	:	37000
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.42
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.1
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.5
Reactor outlet temperature [°C]	:	297
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.15
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.315
Output voltage [kV]	:	15.75
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	3857.1 GW(e).h
Energy Availability Factor (EAF)	:	91.5 %
Unit Capability Factor (UCF)	:	92.33 %
Load Factor (LF)	:	91.67 %
Operating Factor (OF)	:	92.94 %
Equivalent non-electrical energy generated (NEG)	:	0 GW(e).h
Forced Loss Rate (FLR)	:	0.19 %
Unplanned Capability Loss Factor (UCL)	:	0.18 %
Planned Unavailability Factor (PUF)	:	7.5 %
Externally cause unavailability (XUF)	:	0.82 %
Total off-line time	:	620 hours

Annual Summary



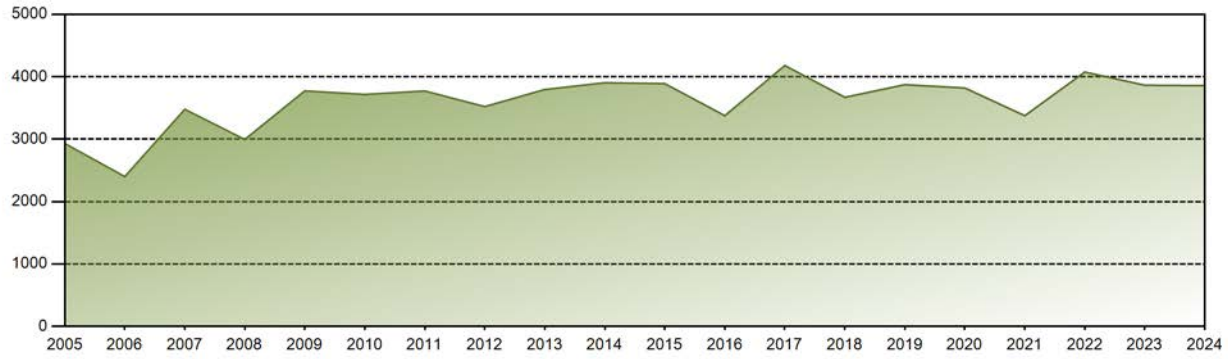
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	363.73	340.18	358.49	346.77	101.60	271.58	338.13	333.06	338.65	355.99	348.05	360.88	3857.10
EAF [%]	100.00	100.00	99.70	100.00	29.93	80.68	94.99	95.78	98.40	99.53	100.00	100.00	91.50
UCF [%]	100.00	100.00	99.70	100.00	30.20	80.68	98.66	100.00	100.00	99.53	100.00	100.00	92.33
LF [%]	102.06	102.04	100.73	100.55	28.51	78.75	94.88	93.46	98.19	99.76	100.92	101.26	91.67
OF [%]	100.00	100.00	100.00	100.00	32.66	83.47	100.00	100.00	100.00	100.00	100.00	100.00	92.94
FLR [%]	0.00	0.00	0.29	0.00	0.00	0.00	1.34	0.00	0.00	0.47	0.00	0.00	0.19
UCL [%]	0.00	0.00	0.29	0.00	0.00	0.00	1.34	0.00	0.00	0.47	0.00	0.00	0.18
PUF [%]	0.00	0.00	0.00	0.00	69.80	19.32	0.00	0.00	0.00	0.00	0.00	0.00	7.50
XUF [%]	0.00	0.00	0.00	0.00	0.27	0.00	3.68	4.22	1.60	0.00	0.00	0.00	0.82

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Historical Summary

Lifetime energy generation	:	133461.46 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.93 %
Cumulative Energy Availability Factor (EAF)	:	83.57 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.11 %
Cumulative Unit Capability Factor (UCF)	:	83.8 %	Cumulative Planned Unavailability Factor (PUF)	:	11.09 %
Cumulative Load Factor (LF)	:	84.42 %	Cumulative Externally cause unavailability (XUF)	:	0.23 %
Cumulative Operating Factor (OF)	:	84.42 %			

Electricity Production (net) [GWh]

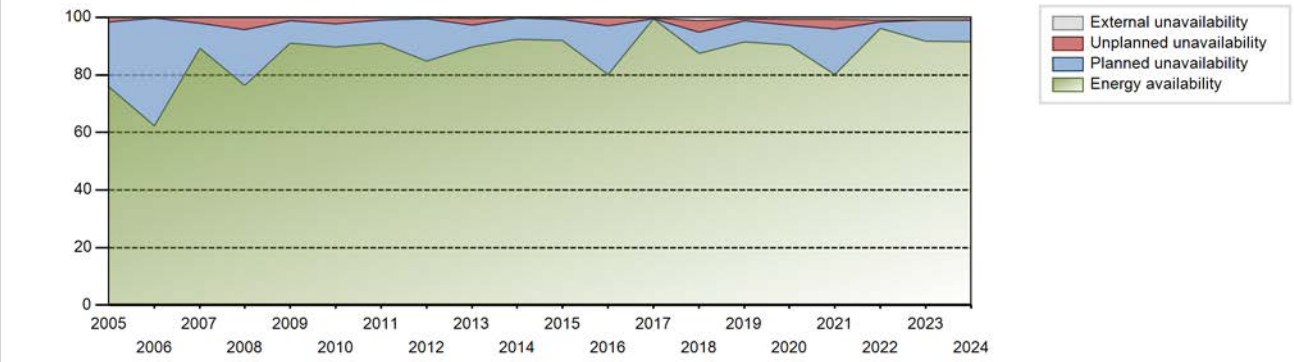


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	921.75	2659	425	94.06	94.06	97.33	99.45	1.21	1.15	4.78	0.00
1985	3101.62	7695	415	85.11	85.11	85.32	87.84	0.75	0.64	14.25	0.00
1986	3148.27	7643	415	86.01	86.01	86.60	87.25	2.11	1.85	12.14	0.00
1987	3193.95	7770	415	85.33	85.33	87.86	88.70	3.06	2.69	11.98	0.00
1988	3046.30	7352	415	81.93	81.93	83.57	83.70	0.20	0.17	17.90	0.00
1989	3300.66	7962	415	88.63	88.63	90.79	90.89	1.01	0.91	10.46	0.00
1990	3338.22	7845	425	87.99	87.99	89.66	89.55	3.12	2.83	9.18	0.00
1991	3421.60	7912	415	88.63	88.63	94.12	90.32	2.25	2.04	9.32	0.00
1992	3174.93	6829	433	76.00	76.01	83.47	77.74	6.63	5.40	18.59	0.02
1993	3568.98	7731	433	87.00	87.00	94.09	88.25	0.43	0.38	12.62	0.00
1994	3440.38	8000	433	89.44	89.50	90.70	91.32	0.18	0.16	10.34	0.06
1995	3309.08	7657	433	86.45	86.63	87.24	87.41	5.62	5.16	8.21	0.18
1996	3019.89	7011	433	79.41	79.50	79.40	79.82	5.89	4.98	15.52	0.09
1997	3267.61	7807	433	88.20	88.26	86.15	89.12	6.15	5.78	5.96	0.06
1998	3206.72	7717	433	88.21	88.27	84.54	88.09	2.83	2.57	9.16	0.06
1999	3246.62	7780	433	89.23	90.18	85.59	88.81	2.10	1.93	7.88	0.95
2000	3059.33	7073	433	79.99	80.08	80.44	80.52	0.89	0.72	19.19	0.10
2001	3266.89	7484	441	84.76	84.94	84.57	85.43	6.50	5.91	9.15	0.18
2002	3338.46	7644	441	86.54	86.71	86.42	87.26	1.93	2.19	11.10	0.17
2003	918.84	2089	441	23.80	23.80	23.78	23.85	0.00	65.27	10.94	0.00
2004	1137.22	2620	441	29.36	29.36	29.36	29.83	4.66	66.93	3.71	0.00
2005	2929.48	6669	441	75.84	75.84	75.83	76.13	1.92	1.54	22.63	0.00
2006	2399.56	5493	441	62.34	62.59	62.11	62.71	0.03	0.02	37.39	0.25
2007	3477.05	7887	443	89.16	89.16	89.60	90.03	2.24	2.05	8.79	0.00
2008	2993.79	6669	473	76.24	76.26	76.50	75.92	0.70	4.25	19.50	0.02
2009	3772.51	7985	473	91.14	91.14	91.05	91.15	1.13	1.04	7.82	0.00
2010	3715.76	7892	473	89.74	89.74	89.68	90.09	1.99	2.31	7.95	0.00
2011	3770.49	7978	473	91.02	91.02	91.00	91.07	0.22	0.84	8.15	0.00
2012	3521.36	7456	473	84.77	84.77	84.75	84.88	0.48	0.41	14.82	0.00
2013	3794.73	7905	473	89.72	90.25	91.58	90.24	2.28	2.11	7.64	0.53
2014	3903.00	8127	473	92.41	92.50	94.20	92.77	0.12	0.11	7.39	0.09
2015	3889.01	8118	473	91.91	92.25	93.86	92.67	0.47	0.44	7.31	0.34
2016	3375.14	7132	473	80.09	80.16	81.23	81.19	0.47	2.87	16.96	0.07
2017	4178.74	8760	473	99.46	99.83	100.85	100.00	0.14	0.14	0.03	0.37
2018	3670.36	7798	477	87.44	88.51	87.84	89.02	4.43	4.10	7.38	1.07
2019	3872.20	8127	477	91.47	92.04	92.67	92.77	0.40	0.57	7.39	0.56
2020	3819.36	8175	477	90.36	91.00	91.15	93.07	2.07	2.05	6.95	0.65

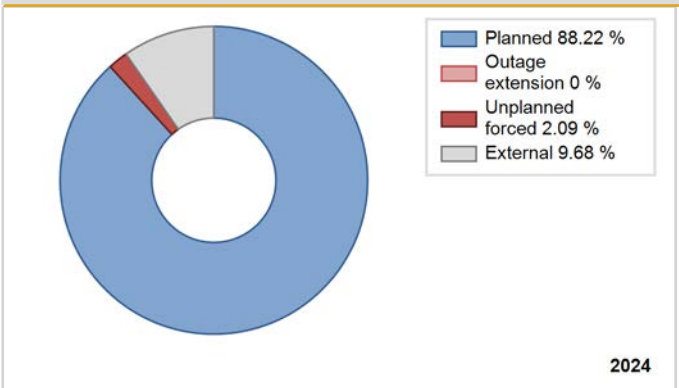
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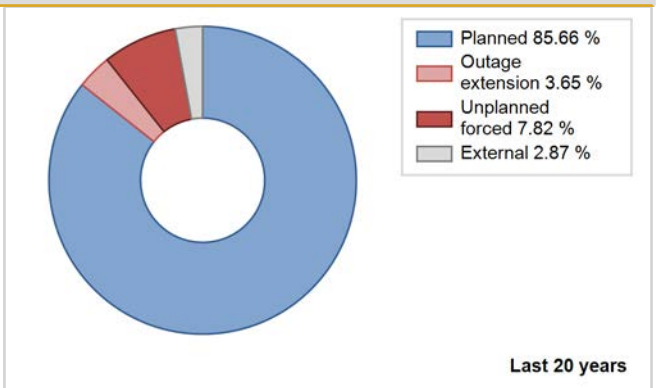
2021	3375.40	7175	479	80.05	80.73	80.50	81.91	2.78	3.33	15.94	0.68
2022	4074.98	8504	479	96.19	97.05	97.11	97.08	0.13	0.79	2.16	0.86
2023	3863.62	8170	479	91.63	92.50	92.08	93.26	0.16	0.15	7.35	0.87
2024	3857.10	8164	479	91.50	92.33	91.67	92.94	0.19	0.18	7.50	0.82

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					376	
C. Inspection, maintenance or repair combined with refuelling	620			885	11	
D. Inspection, maintenance or repair without refuelling				68		
E. Testing of plant systems or components				1	0	
J. Grid limitation, failure or grid unavailability						0
L. Human factor related					14	
Z. Other					16	
Subtotal	620			954	417	0
Total	**620**			**1371**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		142
12. Reactor I&C Systems		18
13. Reactor Auxiliary Systems		0
14. Safety Systems		4
15. Reactor Cooling Systems		21
16. Steam generation systems		14
17. Safety I&C Systems (excluding reactor I&C)		12
21. Fuel Handling and Storage Facilities		144
31. Turbine and auxiliaries		13
32. Feedwater and Main Steam System		0
34. Miscellaneous Systems		3
41. Main Generator Systems		10
42. Electrical Power Supply Systems		2
Total		**383**

Highlights (2024)

Operation at full power in base load mode

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2024 Operating Experience

HU-3 PAKS-3 HUNGARY



Status at end of year	:	**Operational**
Operator	:	PAKS Zrt (PAKS NUCLEAR POWER PLANT, LTD.)
Owner	:	MVM Zrt. (HUNGARIAN POWER COMPANIES LTD.)
Reactor Supplier	:	AEE (ATOMENERGOEXPORT)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1485 MWth
Gross electrical power	:	506 MWe
Reference unit power (net)	:	479 MWe

Key Dates

Construction Date	:	1979-10-01
Grid Date	:	1986-09-28
Commercial Date	:	1986-12-01
Age at end of year	:	38 years

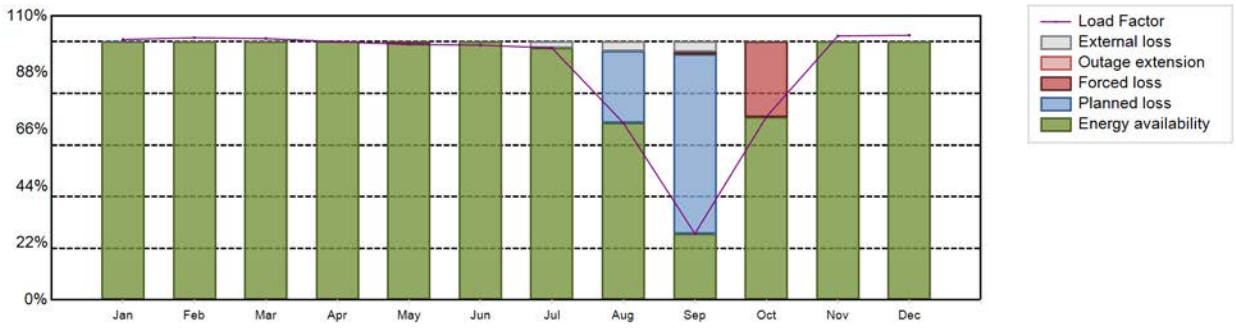
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.82
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	30
Average discharge burnup [MWd/t]	:	37000
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.42
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.1
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.5
Reactor outlet temperature [°C]	:	297
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.15
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.4
Output voltage [kV]	:	15.75
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	3747.98 GW(e).h
Energy Availability Factor (EAF)	:	88.56 %
Unit Capability Factor (UCF)	:	89.39 %
Load Factor (LF)	:	89.08 %
Operating Factor (OF)	:	89.47 %
Equivalent non-electrical energy generated (NEG)	:	6.88 GW(e).h
Forced Loss Rate (FLR)	:	2.79 %
Unplanned Capability Loss Factor (UCL)	:	2.57 %
Planned Unavailability Factor (PUF)	:	8.04 %
Externally cause unavailability (XUF)	:	0.83 %
Total off-line time	:	925 hours

Annual Summary



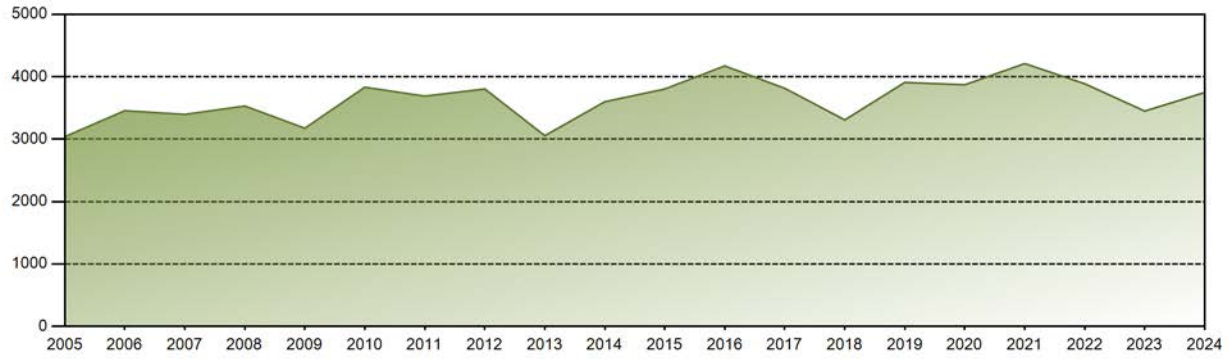
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	359.52	338.64	360.26	344.95	352.59	340.36	347.86	244.40	88.49	253.03	352.63	365.27	3747.98
EAF [%]	100.00	100.00	100.00	100.00	99.73	100.00	97.72	68.58	25.66	70.85	100.00	100.00	88.56
UCF [%]	100.00	100.00	100.00	100.00	99.73	100.00	100.00	72.25	29.63	70.85	100.00	100.00	89.39
LF [%]	100.88	101.58	101.23	100.02	98.94	98.69	97.61	68.58	25.66	70.90	102.25	102.49	89.08
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	71.24	29.86	72.35	100.00	100.00	89.47
FLR [%]	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	2.97	29.15	0.00	0.00	2.79
UCL [%]	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.91	29.15	0.00	0.00	2.57
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.75	69.46	0.00	0.00	0.00	8.04
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	2.28	3.67	3.97	0.00	0.00	0.00	0.83

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Historical Summary

Lifetime energy generation	:	132260.28 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.62 %
Cumulative Energy Availability Factor (EAF)	:	87.47 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.01 %
Cumulative Unit Capability Factor (UCF)	:	87.86 %	Cumulative Planned Unavailability Factor (PUF)	:	10.13 %
Cumulative Load Factor (LF)	:	88.31 %	Cumulative Externally cause unavailability (XUF)	:	0.39 %
Cumulative Operating Factor (OF)	:	88.51 %			

Electricity Production (net) [GWh]

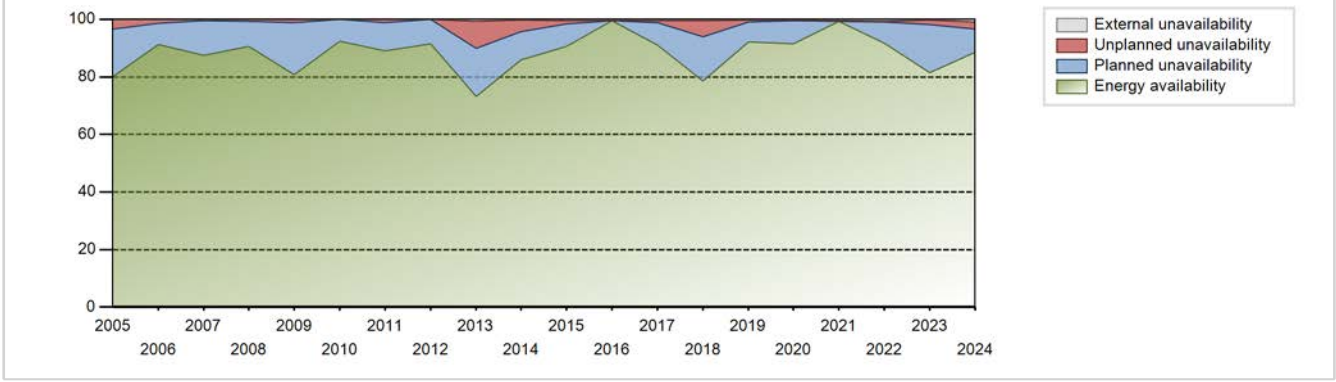


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	718.54	2109	427	99.65	99.65	101.72	100.00	0.00	0.00	0.35	0.00
1987	3209.58	7648	415	86.95	86.95	88.29	87.31	0.92	0.81	12.24	0.00
1988	3300.93	7874	415	88.09	88.09	90.55	89.64	1.12	0.99	10.92	0.00
1989	3140.52	7343	415	82.41	82.41	86.39	83.82	2.15	1.81	15.78	0.00
1990	3273.39	7755	435	85.64	85.64	85.90	88.53	4.39	3.93	10.43	0.00
1991	3256.00	7580	410	84.19	84.19	90.66	86.53	6.82	6.16	9.65	0.00
1992	3587.32	7852	433	87.47	87.70	94.32	89.39	3.49	3.17	9.13	0.23
1993	3177.93	6950	433	77.40	77.63	83.78	79.34	1.05	0.82	21.55	0.23
1994	3375.99	7884	433	88.53	88.64	89.00	90.00	0.41	0.36	11.00	0.11
1995	3392.81	7911	433	88.99	89.16	89.45	90.31	3.29	3.03	7.80	0.17
1996	3429.38	8136	433	90.84	90.91	90.16	92.62	2.04	1.89	7.20	0.07
1997	3066.09	7136	433	80.91	81.10	80.83	81.46	5.11	4.37	14.53	0.19
1998	3294.11	7566	433	87.98	88.02	86.85	86.37	6.17	5.79	6.20	0.04
1999	3445.71	8058	433	92.19	92.28	90.84	91.99	0.47	0.43	7.29	0.09
2000	3517.25	8163	433	92.76	93.04	92.47	92.93	0.73	0.68	6.28	0.28
2001	3040.40	7159	433	80.31	80.72	80.16	81.72	2.68	2.22	17.06	0.42
2002	3256.84	7900	433	90.36	90.48	85.86	90.18	0.38	0.35	9.17	0.12
2003	3008.34	7746	433	80.47	87.85	79.31	88.42	0.85	0.88	11.27	7.37
2004	3333.25	7732	433	87.64	87.64	87.64	88.02	1.86	4.45	7.91	0.00
2005	3038.71	7088	433	80.10	80.10	80.11	80.91	3.96	3.39	16.50	0.00
2006	3454.91	8007	433	91.18	91.18	91.08	91.40	0.25	1.40	7.42	0.00
2007	3396.00	7691	443	87.53	87.53	87.51	87.80	0.45	0.40	12.07	0.00
2008	3530.43	7962	443	90.63	90.69	90.73	90.64	0.72	0.65	8.65	0.06
2009	3174.02	7078	473	80.88	80.88	80.88	80.80	0.12	1.21	17.91	0.00
2010	3831.50	8123	473	92.48	92.48	92.47	92.73	0.04	0.04	7.49	0.00
2011	3688.74	7823	473	89.04	89.04	89.03	89.30	0.58	1.10	9.86	0.00
2012	3803.60	8080	473	91.56	91.56	91.55	91.99	0.00	0.00	8.44	0.00
2013	3054.56	6480	473	73.20	73.92	73.72	73.97	0.05	9.35	16.73	0.72
2014	3598.71	7620	473	86.02	86.30	86.85	86.99	0.00	4.01	9.70	0.28
2015	3803.38	8032	473	90.61	91.15	91.79	91.69	0.52	1.01	7.84	0.55
2016	4172.78	8784	473	99.46	99.96	100.43	100.00	0.04	0.04	0.00	0.50
2017	3813.11	8073	473	90.95	91.43	92.03	92.16	0.06	0.79	7.79	0.48
2018	3307.59	7032	473	78.50	78.93	79.83	80.27	6.62	5.60	15.47	0.44
2019	3908.46	8133	473	92.20	92.38	94.33	92.84	0.77	0.72	6.90	0.18
2020	3871.06	8156	473	91.55	91.75	93.17	92.85	0.37	0.34	7.92	0.19
2021	4210.62	8752	479	99.24	99.71	100.55	99.91	0.29	0.29	0.00	0.47
2022	3886.48	8178	479	91.78	92.38	92.62	93.36	0.00	0.37	7.25	0.60

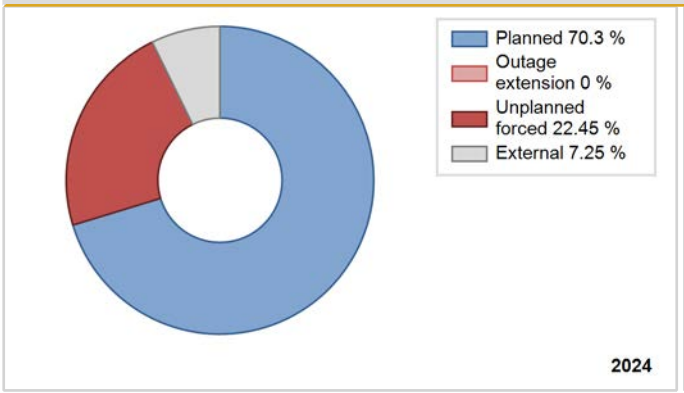
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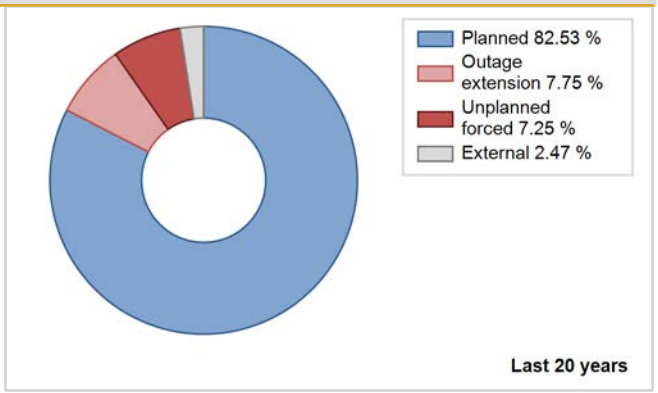
2023	3449.13	7400	479	81.47	81.80	82.20	84.47	1.83	1.53	16.68	0.32
2024	3747.98	7859	479	88.56	89.39	89.08	89.47	2.79	2.57	8.04	0.83

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		206			131	
C. Inspection, maintenance or repair combined with refuelling	719			835	70	
D. Inspection, maintenance or repair without refuelling				28		
E. Testing of plant systems or components				1	3	
L. Human factor related					0	
Z. Other					6	
Subtotal	719	206		864	210	
Total		**925**			**1074**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1986 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		8
12. Reactor I&C Systems		28
13. Reactor Auxiliary Systems		2
14. Safety Systems		6
15. Reactor Cooling Systems	206	6
16. Steam generation systems		1
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		28
31. Turbine and auxiliaries		6
32. Feedwater and Main Steam System		13
34. Miscellaneous Systems		6
42. Electrical Power Supply Systems		30
Total	**206**	**134**

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Highlights (2024)

Operation at full power in base load mode

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2024 Operating Experience

HU-4 PAKS-4 HUNGARY



Status at end of year	:	**Operational**
Operator	:	PAKS Zrt (PAKS NUCLEAR POWER PLANT, LTD.)
Owner	:	MVM Zrt. (HUNGARIAN POWER COMPANIES LTD.)
Reactor Supplier	:	AEE (ATOMENERGOEXPORT)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1485 MWth
Gross electrical power	:	506 MWe
Reference unit power (net)	:	479 MWe

Key Dates

Construction Date	:	1979-10-01
Grid Date	:	1987-08-16
Commercial Date	:	1987-11-01
Age at end of year	:	37 years

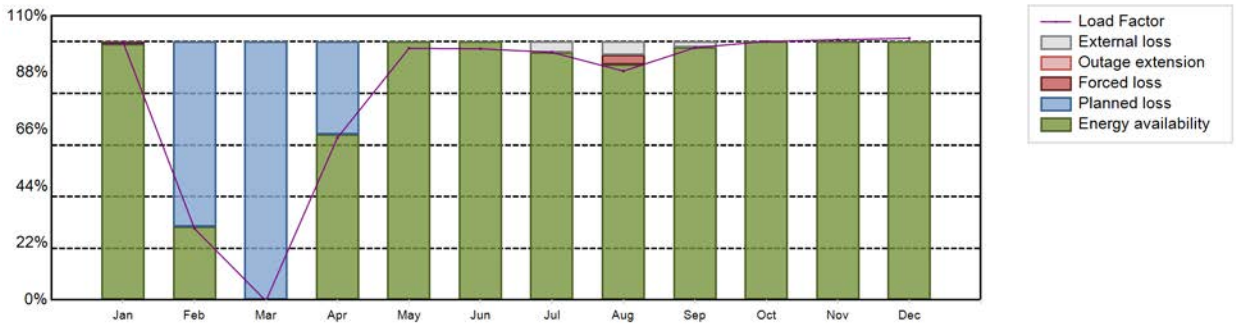
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.82
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	30
Average discharge burnup [MWd/t]	:	37000
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.42
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.1
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.5
Reactor outlet temperature [°C]	:	297
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.15
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.4
Output voltage [kV]	:	15.75
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	3407.28 GW(e).h
Energy Availability Factor (EAF)	:	81.58 %
Unit Capability Factor (UCF)	:	82.53 %
Load Factor (LF)	:	80.98 %
Operating Factor (OF)	:	83.11 %
Equivalent non-electrical energy generated (NEG)	:	3.08 GW(e).h
Forced Loss Rate (FLR)	:	0.48 %
Unplanned Capability Loss Factor (UCL)	:	0.4 %
Planned Unavailability Factor (PUF)	:	17.07 %
Externally cause unavailability (XUF)	:	0.95 %
Total off-line time	:	1484 hours

Annual Summary



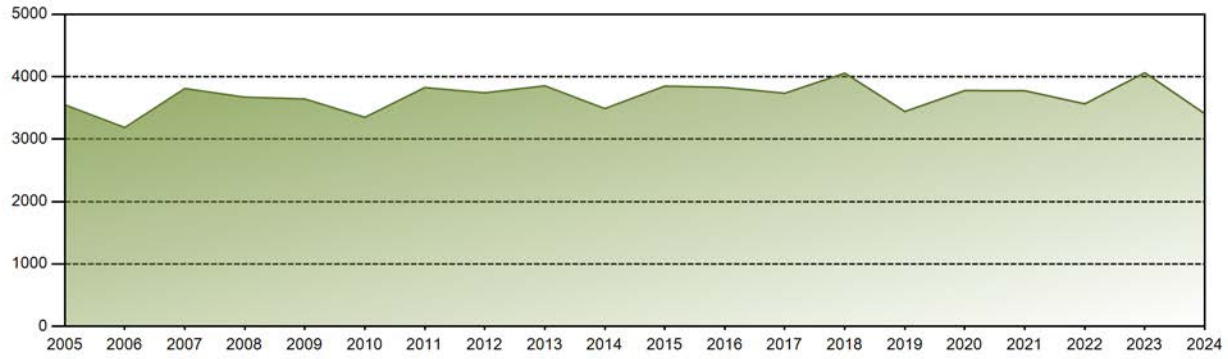
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	356.14	92.24	-1.31	216.62	347.31	335.50	341.75	315.91	336.89	357.46	347.60	361.17	3407.28
EAF [%]	99.01	28.28	0.00	64.23	100.00	100.00	96.00	91.27	97.80	100.00	100.00	100.00	81.58
UCF [%]	99.01	28.28	0.00	64.23	100.00	100.00	100.00	96.31	100.00	100.00	100.00	100.00	82.53
LF [%]	99.93	27.67	-0.37	62.81	97.46	97.28	95.90	88.64	97.68	100.17	100.79	101.35	80.98
OF [%]	100.00	27.87	0.00	66.81	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	83.11
FLR [%]	0.99	0.00	0.00	0.00	0.00	0.00	0.00	3.69	0.00	0.00	0.00	0.00	0.48
UCL [%]	0.99	0.00	0.00	0.00	0.00	0.00	0.00	3.69	0.00	0.00	0.00	0.00	0.40
PUF [%]	0.01	71.72	100.00	35.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.07
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	4.00	5.04	2.20	0.00	0.00	0.00	0.95

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Historical Summary

Lifetime energy generation	:	131790.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.19 %
Cumulative Energy Availability Factor (EAF)	:	88.27 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.33 %
Cumulative Unit Capability Factor (UCF)	:	88.68 %	Cumulative Planned Unavailability Factor (PUF)	:	9.99 %
Cumulative Load Factor (LF)	:	89.24 %	Cumulative Externally cause unavailability (XUF)	:	0.41 %
Cumulative Operating Factor (OF)	:	89.55 %			

Electricity Production (net) [GWh]

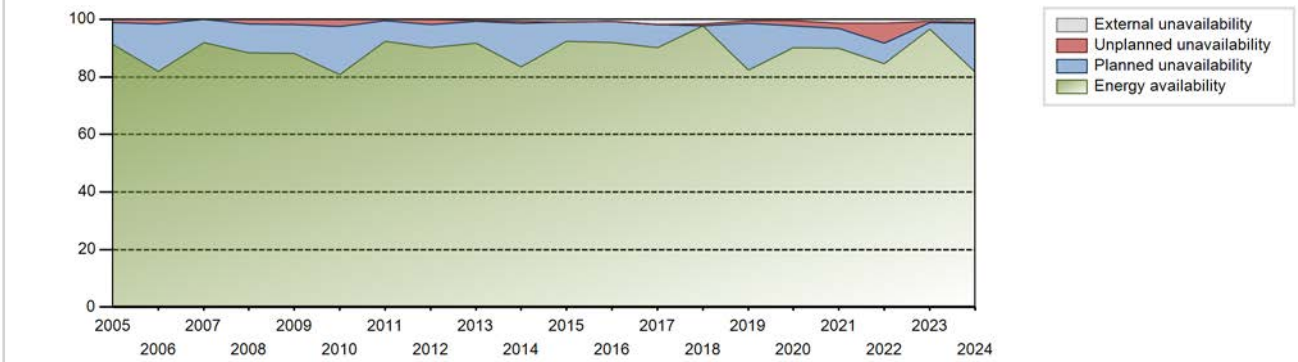


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	1039.12	2936	425	100.00	100.00	101.77	100.00	0.00	0.00	0.00	0.00
1988	3200.89	7564	415	85.65	85.65	87.81	86.11	3.21	2.84	11.51	0.00
1989	3425.34	7974	415	89.67	89.67	94.22	91.03	1.27	1.15	9.17	0.00
1990	3064.45	7253	435	76.69	76.69	80.42	82.80	4.04	3.23	20.08	0.00
1991	3342.95	7787	410	86.54	86.54	93.08	88.89	3.48	3.12	10.34	0.00
1992	3702.82	8082	433	90.69	90.86	97.35	92.01	0.41	0.37	8.77	0.18
1993	3537.22	7767	430	87.05	87.48	93.91	88.66	2.37	2.12	10.40	0.44
1994	2971.22	7019	433	78.06	78.13	78.33	80.13	1.51	1.20	20.67	0.07
1995	3443.81	8049	433	90.45	90.77	90.79	91.88	0.89	0.82	8.41	0.33
1996	3487.53	8087	433	90.71	91.31	91.69	92.07	1.06	0.97	7.72	0.60
1997	3487.08	8098	433	91.61	92.04	91.93	92.44	0.74	0.69	7.27	0.43
1998	3136.11	7389	433	83.72	84.26	82.68	84.35	1.18	1.00	14.73	0.54
1999	3464.00	8046	433	89.27	89.33	91.32	91.85	3.95	3.68	6.99	0.06
2000	3578.42	8116	433	92.20	92.31	94.08	92.40	0.24	0.22	7.47	0.11
2001	3471.72	7916	444	89.98	90.14	89.26	90.37	1.63	1.50	8.36	0.16
2002	3182.88	7287	444	83.14	83.35	81.83	83.18	0.94	0.79	15.86	0.21
2003	3607.64	8119	444	92.75	92.99	92.75	92.68	0.03	0.62	6.40	0.23
2004	3396.64	7878	444	87.09	87.09	87.09	89.69	0.30	0.48	12.43	0.00
2005	3548.78	8046	444	91.24	91.24	91.24	91.85	1.10	1.08	7.68	0.00
2006	3185.19	7196	444	81.91	81.91	81.89	82.15	0.55	1.67	16.42	0.00
2007	3810.43	8078	473	91.99	91.99	91.96	92.21	0.05	0.04	7.97	0.00
2008	3671.44	7854	473	88.40	88.40	88.37	89.41	0.51	1.70	9.91	0.00
2009	3643.09	7715	473	88.04	88.04	87.92	88.07	0.33	1.89	10.06	0.00
2010	3348.24	7091	473	80.85	80.85	80.81	80.95	2.92	2.43	16.71	0.00
2011	3825.62	8103	473	92.34	92.34	92.33	92.50	0.42	0.39	7.27	0.00
2012	3741.44	7961	473	90.07	90.07	90.05	90.63	2.03	1.86	8.07	0.00
2013	3853.52	8076	473	91.68	92.06	93.00	92.19	0.32	0.29	7.65	0.38
2014	3488.55	7430	473	83.52	84.28	84.19	84.82	0.65	0.55	15.17	0.76
2015	3849.34	8174	473	92.33	93.24	92.90	93.31	0.04	0.04	6.72	0.92
2016	3828.20	8153	473	91.92	92.69	92.14	92.82	0.04	0.04	7.27	0.77
2017	3735.00	8064	473	90.14	91.86	90.14	92.05	0.17	0.16	7.98	1.72
2018	4056.61	8722	473	97.84	99.36	97.90	99.57	0.64	0.64	0.00	1.53
2019	3442.12	7315	473	82.37	82.83	83.07	83.50	0.79	0.94	16.23	0.46
2020	3778.60	8053	473	90.19	90.70	90.94	91.68	1.49	1.76	7.55	0.51
2021	3775.68	8027	479	89.83	91.11	90.16	91.63	0.50	1.89	7.00	1.28
2022	3564.70	7968	479	84.66	86.10	84.95	90.96	4.76	6.77	7.13	1.44
2023	4063.77	8558	479	96.58	97.26	96.85	97.69	0.53	0.52	2.22	0.68

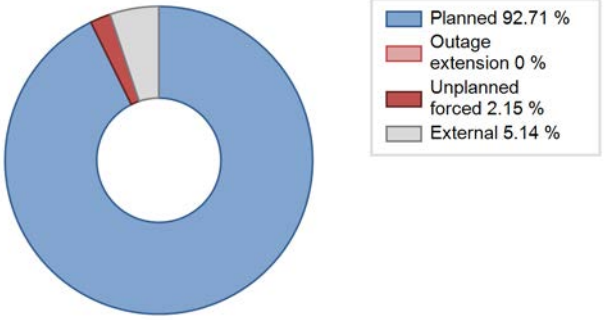
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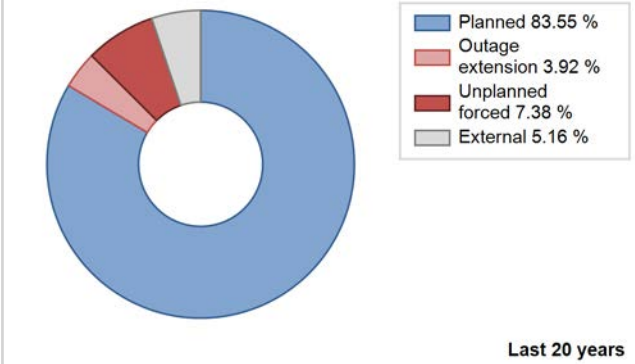
2024	3407.28	7300	479	81.58	82.53	80.98	83.11	0.48	0.40	17.07	0.95

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					63	
C. Inspection, maintenance or repair combined with refuelling	1485			833	15	
D. Inspection, maintenance or repair without refuelling				9		
E. Testing of plant systems or components				1		
L. Human factor related					2	
Z. Other				2	2	
Subtotal	1485			845	82	
Total	**1485**			**927**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1987 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		10
15. Reactor Cooling Systems		18
16. Steam generation systems		13
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		11
32. Feedwater and Main Steam System		4
34. Miscellaneous Systems		4
41. Main Generator Systems		0
42. Electrical Power Supply Systems		2
Total		**63**

Highlights (2024)

Operation at full power in base load mode

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2024 Operating Experience

IN-13 KAIGA-1 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	1989-09-01
Grid Date	:	2000-10-12
Commercial Date	:	2000-11-16
Age at end of year	:	24 years

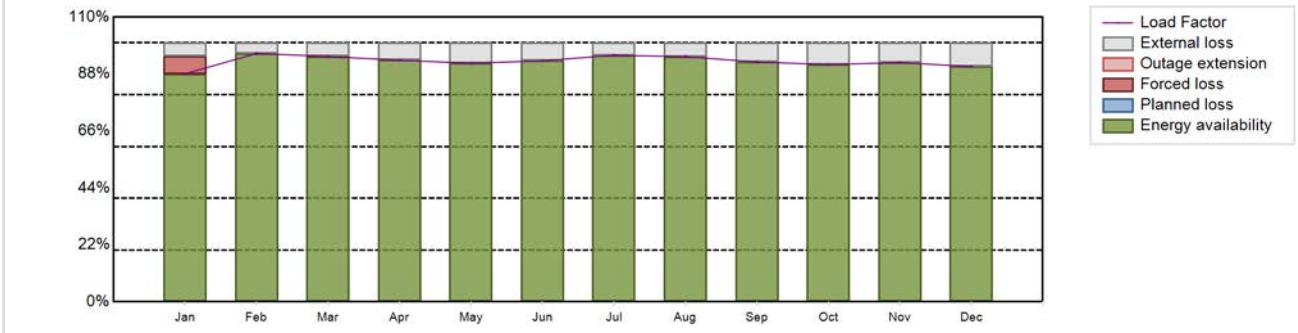
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	8.7
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	293
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	Double
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.73
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	6700	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.5	HP cylinder inlet steam pressure [MPa]	:	3.972
Active core height/length [m]	:	5	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	3672	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	35.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	4	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	1	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	1648.02 GW(e).h	Forced Loss Rate (FLR)	:	0.59 %
Energy Availability Factor (EAF)	:	92.88 %	Unplanned Capability Loss Factor (UCL)	:	0.59 %
Unit Capability Factor (UCF)	:	99.41 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	92.88 %	Externally cause unavailability (XUF)	:	6.53 %
Operating Factor (OF)	:	99.4 %	Total off-line time	:	53 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	132.31	134.88	142.43	135.68	138.51	135.36	143.15	142.28	134.73	137.72	134.41	136.56	1648.02
EAF [%]	88.04	95.94	94.77	93.29	92.16	93.07	95.25	94.67	92.64	91.64	92.41	90.86	92.88
UCF [%]	93.21	100.00	99.79	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.41
LF [%]	88.04	95.94	94.77	93.29	92.16	93.07	95.25	94.67	92.64	91.64	92.41	90.86	92.88
OF [%]	93.15	100.00	99.73	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.40
FLR [%]	6.79	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59
UCL [%]	6.79	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	5.17	4.06	5.02	6.71	7.84	6.93	4.75	5.33	7.36	8.36	7.59	9.14	6.53

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Historical Summary

Lifetime energy generation	:	33423.44 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.56 %
Cumulative Energy Availability Factor (EAF)	:	79.15 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.62 %
Cumulative Unit Capability Factor (UCF)	:	92.32 %	Cumulative Planned Unavailability Factor (PUF)	:	4.06 %
Cumulative Load Factor (LF)	:	78.48 %	Cumulative Externally cause unavailability (XUF)	:	13.17 %
Cumulative Operating Factor (OF)	:	91.71 %			

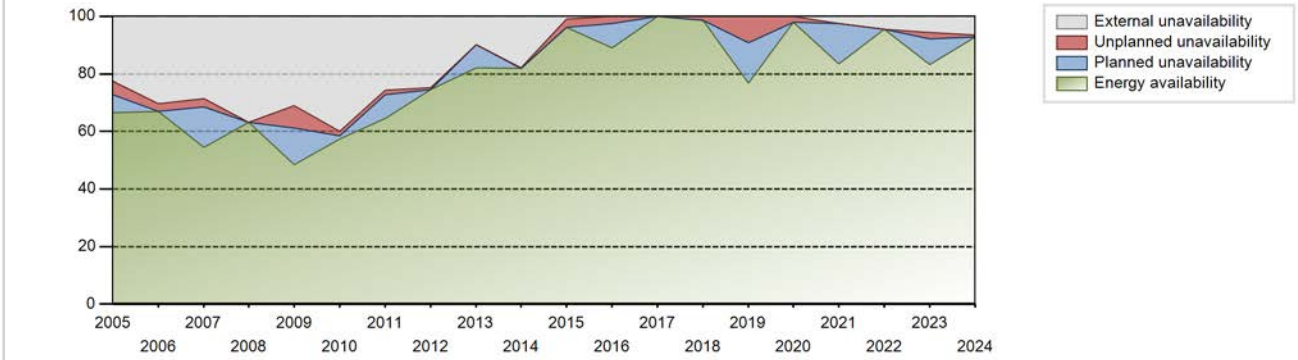
Electricity Production (net) [GWh]



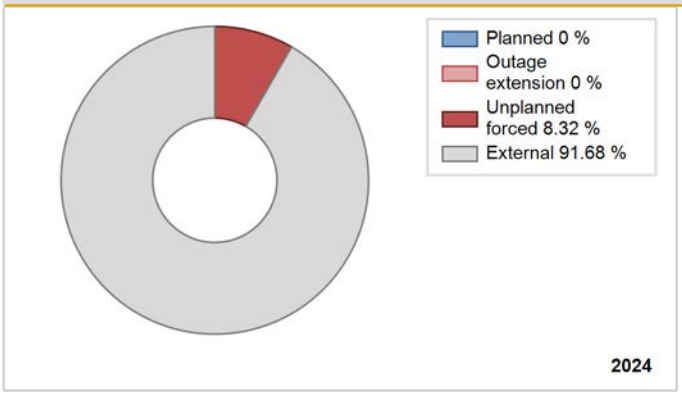
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2000	192.32	1173	200	100.00	100.00	74.50	75.94	0.00	0.00	0.00	0.00
2001	1241.14	6316	200	70.41	75.78	70.84	72.10	23.82	23.70	0.53	5.37
2002	1692.93	8082	202	92.36	95.62	95.67	92.26	3.11	3.06	1.31	3.26
2003	1336.02	7255	202	83.44	87.54	75.50	82.82	12.46	12.46	0.00	4.09
2004	1344.92	8181	202	77.78	94.57	75.80	93.14	5.43	5.43	0.00	16.79
2005	1183.58	7580	202	66.47	88.93	66.89	86.53	2.98	4.67	6.40	22.47
2006	1167.31	8524	202	66.96	97.37	65.97	97.31	2.35	2.63	0.00	30.41
2007	946.25	7250	202	54.40	82.86	53.48	82.76	0.04	2.91	14.23	28.46
2008	1103.03	8784	202	63.15	100.00	62.16	100.00	0.00	0.00	0.00	36.85
2009	842.14	6953	202	48.57	79.58	47.59	79.37	8.88	7.75	12.67	31.01
2010	998.55	8535	202	57.42	97.46	56.43	97.43	1.59	1.57	0.97	40.04
2011	1124.79	7900	202	64.55	90.30	63.56	90.18	1.73	1.59	8.11	25.75
2012	1303.28	8719	202	74.44	99.29	73.45	99.26	0.71	0.71	0.00	24.85
2013	1440.99	8049	202	82.22	91.96	81.43	91.88	0.00	0.00	8.04	9.74
2014	1433.14	8751	202	81.98	99.90	80.99	99.90	0.10	0.10	0.00	17.92
2015	1740.46	8492	202	96.13	96.97	98.36	96.94	3.03	3.03	0.00	0.84
2016	1589.32	7904	202	88.99	88.99	89.57	89.98	2.76	2.53	8.48	0.00
2017	1758.47	8760	202	99.92	99.92	99.38	100.00	0.08	0.08	0.00	0.00
2018	1748.63	8759	202	98.68	98.68	98.82	99.99	1.31	1.31	0.01	0.00
2019	1360.54	6811	202	76.82	76.82	76.89	77.75	10.60	9.11	14.07	0.00
2020	1736.35	8639	202	97.98	97.98	97.86	98.35	2.02	2.02	0.00	0.00
2021	1460.86	7530	202	83.55	86.10	82.56	85.96	0.04	0.03	13.87	2.55
2022	1671.76	8760	202	95.47	100.00	94.48	100.00	0.00	0.00	0.00	4.53
2023	1472.23	7787	202	83.20	88.90	83.20	88.89	2.25	2.05	9.05	5.70
2024	1648.02	8731	202	92.88	99.41	92.88	99.40	0.59	0.59	0.00	6.53

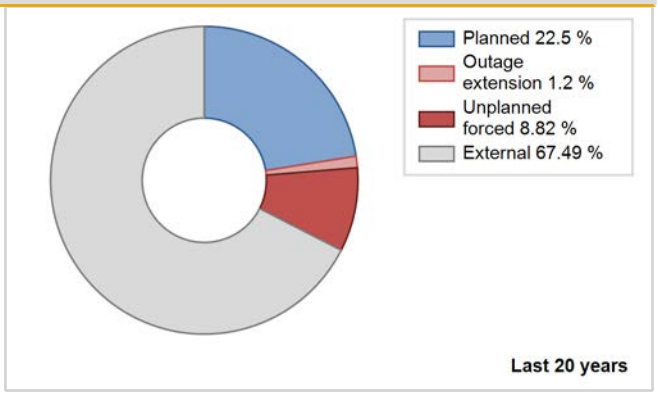
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2000 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		52			261	
D. Inspection, maintenance or repair without refuelling				351		
E. Testing of plant systems or components				5	7	
H. Nuclear regulatory requirements					10	
J. Grid limitation, failure or grid unavailability						66
L. Human factor related					9	
Z. Other					37	
Subtotal		52		356	324	66
Total		**52**			**746**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2000 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		49
12. Reactor I&C Systems		19
13. Reactor Auxiliary Systems		8
14. Safety Systems		14
15. Reactor Cooling Systems		11
17. Safety I&C Systems (excluding reactor I&C)		9
21. Fuel Handling and Storage Facilities		3
31. Turbine and auxiliaries	2	50
32. Feedwater and Main Steam System		13
34. Miscellaneous Systems		8
35. All other I&C Systems		0
41. Main Generator Systems		107
42. Electrical Power Supply Systems	51	19
Total	**53**	**310**

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Highlights (2024)

During the year Unit achieved Availabilty factor of 99.41% and Capacity factor of 94.88%.

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2024 Operating Experience

IN-14 KAIGA-2 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	1989-12-01
Grid Date	:	1999-12-02
Commercial Date	:	2000-03-16
Age at end of year	:	25 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	6700
Active core diameter [m]	:	4.5
Active core height/length [m]	:	5
Number of fissile fuel assemblies/bundles	:	3672
Fuel linear heat generation rate [kW/m]	:	35.3
Number of control rod assemblies	:	4
Number of external reactor coolant loops	:	1
Coolant type	:	D2O

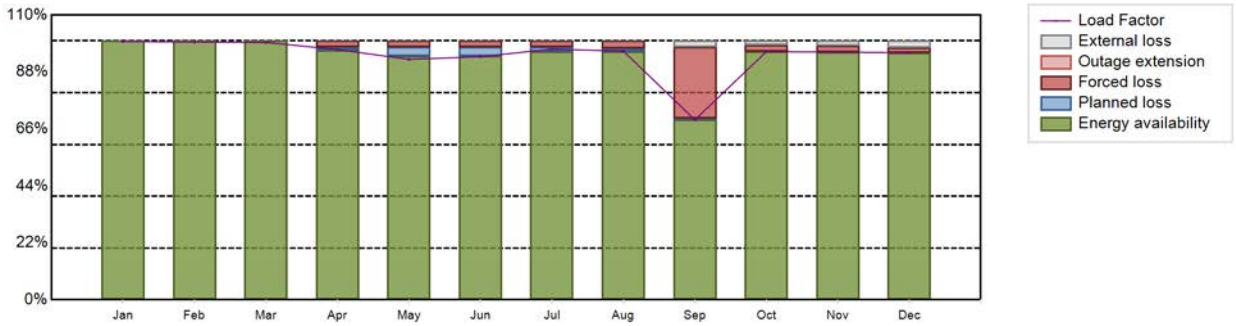
Operating coolant pressure [MPa]	:	8.7
Reactor outlet temperature [°C]	:	293
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	1.73
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	3.972
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	1673.7 GW(e).h
Energy Availability Factor (EAF)	:	94.43 %
Unit Capability Factor (UCF)	:	95.15 %
Load Factor (LF)	:	94.33 %
Operating Factor (OF)	:	97.92 %

Forced Loss Rate (FLR)	:	3.93 %
Unplanned Capability Loss Factor (UCL)	:	3.89 %
Planned Unavailability Factor (PUF)	:	0.96 %
Externally cause unavailability (XUF)	:	0.72 %
Total off-line time	:	183 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	149.94	139.99	149.40	140.59	139.55	136.57	145.55	144.35	101.14	144.04	139.14	143.44	1673.70
EAF [%]	100.00	100.00	100.00	96.40	94.19	94.18	95.78	95.77	69.54	95.84	95.67	95.44	94.43
UCF [%]	100.00	100.00	100.00	96.40	94.19	94.18	95.78	95.77	72.01	97.52	97.52	98.13	95.15
LF [%]	99.77	99.57	99.41	96.67	92.86	93.90	96.85	96.05	69.54	95.84	95.67	95.44	94.33
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.60	75.00	100.00	100.00	100.00	97.92
FLR [%]	0.00	0.00	0.00	2.51	2.56	2.56	2.52	2.89	27.59	2.48	2.48	1.87	3.93
UCL [%]	0.00	0.00	0.00	2.48	2.48	2.48	2.48	2.85	27.44	2.48	2.48	1.87	3.89
PUF [%]	0.00	0.00	0.00	1.12	3.33	3.34	1.74	1.38	0.55	0.00	0.00	0.00	0.96
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.46	1.68	1.85	2.68	0.72

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Historical Summary

Lifetime energy generation	:	34310.74 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.48 %
Cumulative Energy Availability Factor (EAF)	:	78.8 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.39 %
Cumulative Unit Capability Factor (UCF)	:	91.21 %	Cumulative Planned Unavailability Factor (PUF)	:	4.4 %
Cumulative Load Factor (LF)	:	78.38 %	Cumulative Externally cause unavailability (XUF)	:	12.42 %
Cumulative Operating Factor (OF)	:	90.45 %			

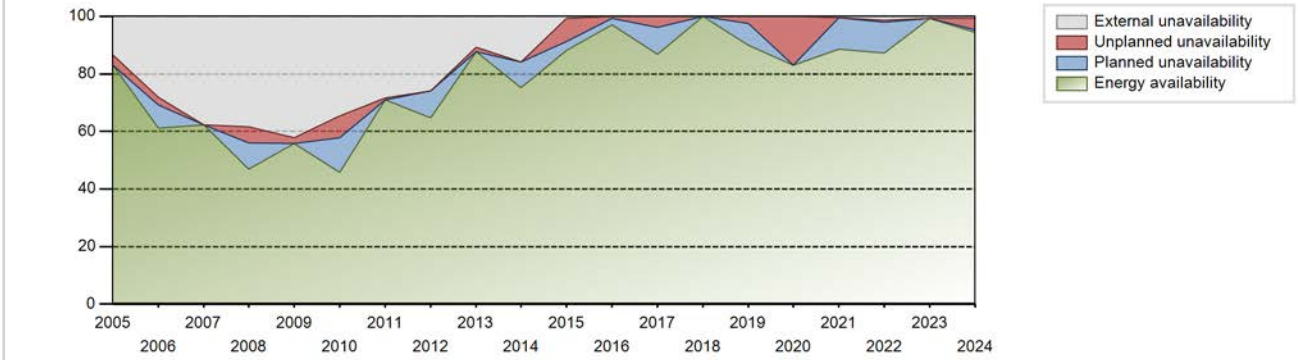
Electricity Production (net) [GWh]



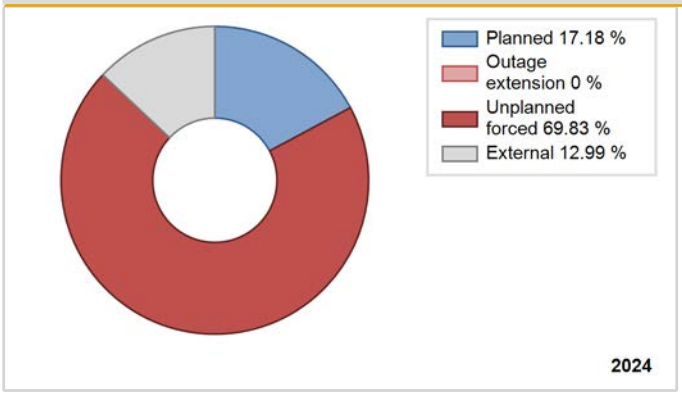
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2000	1086.47	5975	200	80.61	80.61	76.35	79.40	19.39	19.39	0.00	0.00
2001	1308.57	6670	200	74.24	82.08	74.69	76.14	6.84	6.03	11.89	7.83
2002	1559.24	7455	202	85.78	87.53	88.12	85.10	12.47	12.47	0.00	1.75
2003	1412.99	7535	202	86.91	88.75	79.85	86.02	11.25	11.25	0.00	1.84
2004	1290.24	7732	202	74.70	91.01	72.72	88.02	3.83	3.63	5.36	16.32
2005	1509.37	8428	202	82.92	96.41	85.30	96.21	3.37	3.59	0.00	13.49
2006	1064.23	7806	202	61.13	89.24	60.14	89.11	2.73	2.73	8.03	28.11
2007	1083.13	8757	202	62.20	99.97	61.21	99.97	0.03	0.03	0.00	37.77
2008	816.51	7040	202	47.01	85.49	46.02	80.15	3.92	5.58	8.93	38.49
2009	969.97	8589	202	55.81	98.07	54.82	98.05	1.93	1.93	0.00	42.26
2010	794.66	7031	202	45.90	80.48	44.91	80.26	8.66	7.63	11.89	34.58
2011	1193.28	8466	202	70.97	99.22	67.44	96.64	0.78	0.78	0.00	28.26
2012	1129.23	7940	202	64.63	90.49	63.64	90.39	0.11	0.10	9.41	25.86
2013	1533.50	8613	202	87.65	98.35	86.66	98.32	1.65	1.65	0.00	10.69
2014	1313.47	7979	202	75.22	91.18	74.23	91.08	0.00	0.00	8.82	15.96
2015	1592.28	7788	202	88.21	89.02	89.98	88.90	8.23	7.99	3.00	0.80
2016	1784.91	8585	202	97.16	97.16	100.59	97.73	0.62	0.60	2.24	0.00
2017	1530.48	7792	202	86.90	86.90	86.49	88.95	4.28	3.88	9.21	0.00
2018	1777.58	8759	202	99.98	99.98	100.46	99.99	0.02	0.02	0.00	0.00
2019	1618.54	7860	202	89.83	89.83	91.47	89.73	2.72	2.51	7.66	0.00
2020	1500.83	7291	202	82.93	82.93	84.58	83.00	17.07	17.07	0.00	0.00
2021	1574.62	7799	202	88.59	89.13	88.99	89.03	0.06	0.05	10.82	0.54
2022	1532.82	7752	202	87.27	88.60	86.62	88.49	0.75	0.67	10.73	1.33
2023	1759.87	8760	202	99.37	100.00	99.45	100.00	0.00	0.00	0.00	0.63
2024	1673.70	8601	202	94.43	95.15	94.33	97.92	3.93	3.89	0.96	0.72

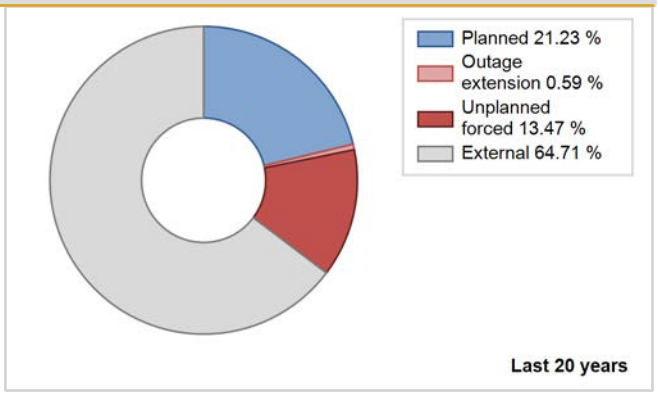
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2000 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		183			390	
D. Inspection, maintenance or repair without refuelling				384	1	
E. Testing of plant systems or components					1	
H. Nuclear regulatory requirements				8		
J. Grid limitation, failure or grid unavailability						73
L. Human factor related					7	
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						18
Z. Other					5	
Subtotal		183		392	404	91
Total		**183**			**887**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2000 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		22
12. Reactor I&C Systems		69
13. Reactor Auxiliary Systems		9
14. Safety Systems		2
15. Reactor Cooling Systems		35
16. Steam generation systems		3
17. Safety I&C Systems (excluding reactor I&C)		15
31. Turbine and auxiliaries		139
32. Feedwater and Main Steam System		17
34. Miscellaneous Systems		2
41. Main Generator Systems		68
42. Electrical Power Supply Systems	183	45
Total	**183**	**426**

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Highlights (2024)

During the year Unit achieved Availability factor of 97.92% and Capacity factor of 95.45%. Till 15th September before trip, unit completed 707 days of continuous operarion.

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2024 Operating Experience

IN-15 KAIGA-3 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	TURBOATO (TURBOATOM Kharkiv Turbine Manufacture Plant)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	800 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	2002-03-30
Grid Date	:	2007-04-11
Commercial Date	:	2007-05-06
Age at end of year	:	17 years

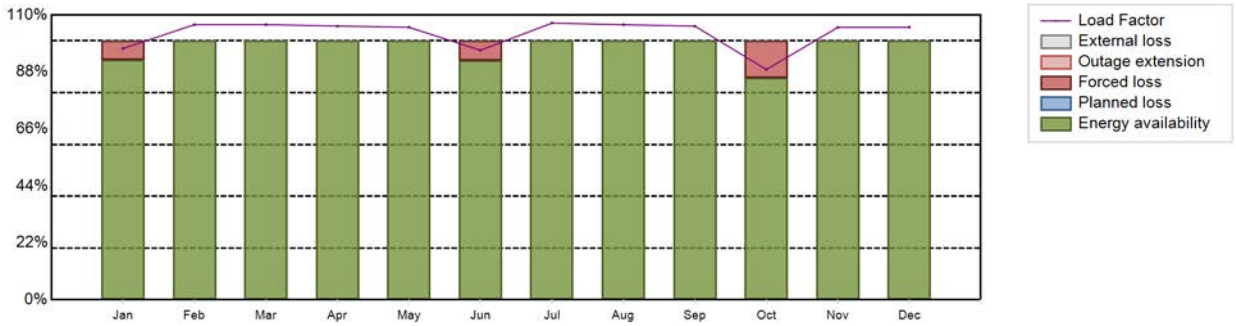
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	1.5
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	-
Fuel material	:	UO2	Number of SG	:	-
Refuelling type	:	ON-line	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	1826.25 GW(e).h	Forced Loss Rate (FLR)	:	2.44 %
Energy Availability Factor (EAF)	:	97.56 %	Unplanned Capability Loss Factor (UCL)	:	2.44 %
Unit Capability Factor (UCF)	:	97.56 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	102.92 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	97.55 %	Total off-line time	:	215 hours

Annual Summary



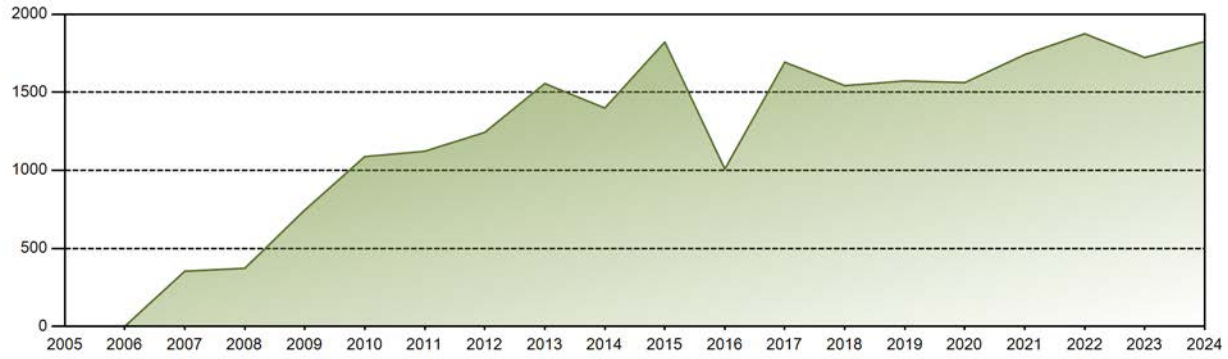
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	145.86	149.43	159.75	153.79	158.19	140.18	160.64	159.70	153.76	133.69	153.05	158.21	1826.25
EAF [%]	92.73	100.00	100.00	100.00	100.00	92.37	100.00	100.00	100.00	85.79	100.00	100.00	97.56
UCF [%]	92.73	100.00	100.00	100.00	100.00	92.37	100.00	100.00	100.00	85.79	100.00	100.00	97.56
LF [%]	97.05	106.28	106.29	105.74	105.26	96.38	106.89	106.26	105.72	88.95	105.24	105.27	102.92
OF [%]	92.74	100.00	100.00	100.00	100.00	92.36	100.00	100.00	100.00	85.75	100.00	100.00	97.55
FLR [%]	7.27	0.00	0.00	0.00	0.00	7.63	0.00	0.00	0.00	14.21	0.00	0.00	2.44
UCL [%]	7.27	0.00	0.00	0.00	0.00	7.63	0.00	0.00	0.00	14.21	0.00	0.00	2.44
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

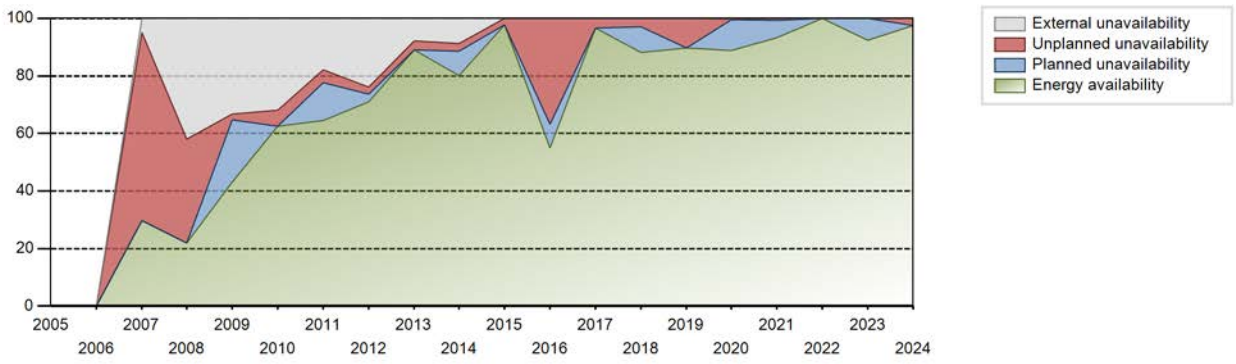
Lifetime energy generation	:	24246.49 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.68 %
Cumulative Energy Availability Factor (EAF)	:	76.46 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	9.02 %
Cumulative Unit Capability Factor (UCF)	:	86.04 %	Cumulative Planned Unavailability Factor (PUF)	:	4.94 %
Cumulative Load Factor (LF)	:	77.46 %	Cumulative Externally cause unavailability (XUF)	:	9.59 %
Cumulative Operating Factor (OF)	:	84.42 %			

Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2007	353.34	2181	202	29.85	34.82	29.33	34.14	65.18	65.18	0.00	4.97
2008	372.04	2532	202	21.96	63.85	20.97	28.83	36.15	36.15	0.00	41.89
2009	745.45	6677	202	43.12	76.46	42.13	76.22	2.50	1.96	21.58	33.35
2010	1087.76	8267	202	62.46	94.43	61.47	94.37	5.57	5.57	0.00	31.97
2011	1122.31	7145	202	64.41	82.29	63.42	81.56	5.20	4.51	13.20	17.88
2012	1243.34	8342	202	71.06	95.03	70.07	94.97	2.42	2.36	2.61	23.97
2013	1556.25	8477	202	88.94	96.81	87.95	96.77	3.18	3.18	0.02	7.87
2014	1398.93	7768	202	80.05	88.79	79.06	88.68	3.02	2.76	8.45	8.74
2015	1821.94	8551	202	97.64	97.64	102.96	97.61	2.36	2.36	0.00	0.00
2016	1008.42	4996	202	54.94	54.94	56.83	56.88	6.83	36.88	8.19	0.00
2017	1692.70	8712	202	96.65	96.65	95.66	99.45	3.35	3.35	0.00	0.00
2018	1542.62	7966	202	88.17	88.17	87.18	90.94	3.22	2.94	8.89	0.00
2019	1572.91	7935	202	89.66	89.66	88.89	90.58	10.34	10.34	0.00	0.00
2020	1562.14	7816	202	88.79	89.10	88.04	88.98	0.10	0.09	10.82	0.31
2021	1741.94	8179	202	93.34	93.44	98.44	93.37	0.65	0.61	5.95	0.09
2022	1875.28	8760	202	100.00	100.00	105.98	100.00	0.00	0.00	0.00	0.00
2023	1722.86	8090	202	92.42	92.42	97.36	92.35	0.00	0.00	7.58	0.00
2024	1826.25	8569	202	97.56	97.56	102.92	97.55	2.44	2.44	0.00	0.00

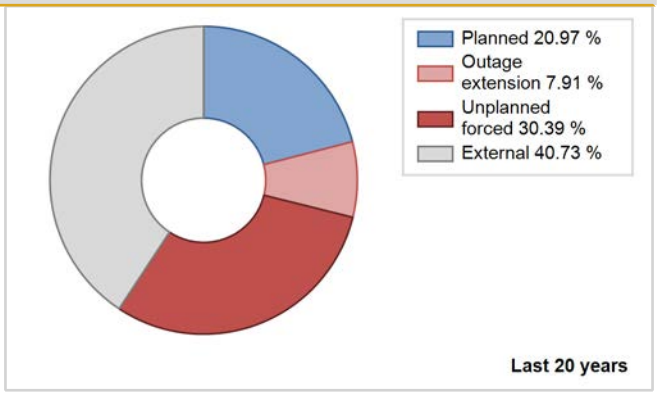
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2007 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		215			708	
D. Inspection, maintenance or repair without refuelling				125		
E. Testing of plant systems or components					27	
H. Nuclear regulatory requirements				205		
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					18	
P. Fire					16	
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)				108		172
Z. Other					0	
Subtotal		215		438	769	175
Total		**215**			**1382**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2007 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		202
12. Reactor I&C Systems	54	6
13. Reactor Auxiliary Systems		18
14. Safety Systems		3
15. Reactor Cooling Systems	106	6
16. Steam generation systems		11
21. Fuel Handling and Storage Facilities		12
31. Turbine and auxiliaries		45
32. Feedwater and Main Steam System	55	3
35. All other I&C Systems		3
41. Main Generator Systems		588
42. Electrical Power Supply Systems		40
Total	**215**	**937**

Highlights (2024)

During the year Unit achieved an Availability factor of 97.56%.

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2024 Operating Experience

IN-16 KAIGA-4 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	TURBOATO (TURBOATOM Kharkiv Turbine Manufacture Plant)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	800 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	2002-05-10
Grid Date	:	2011-01-19
Commercial Date	:	2011-01-20
Age at end of year	:	13 years

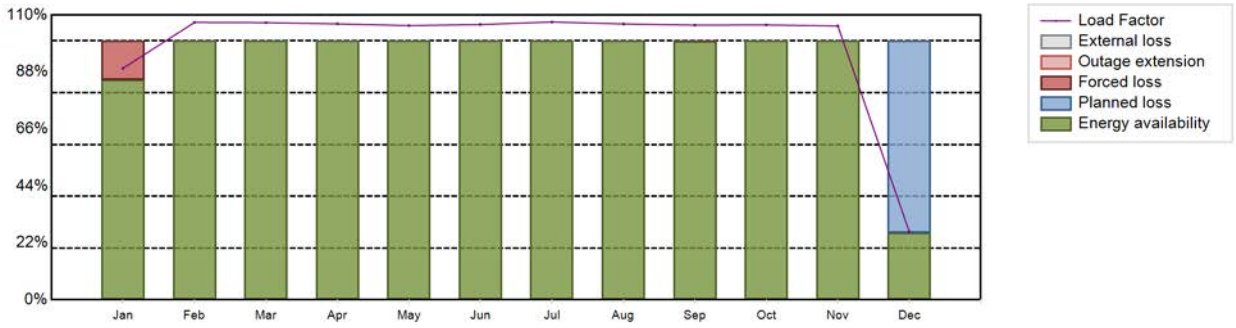
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	1.05
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	-
Fuel material	:	UO2	Number of SG	:	-
Refuelling type	:	ON-line	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	1743.24 GW(e).h	Forced Loss Rate (FLR)	:	1.36 %
Energy Availability Factor (EAF)	:	92.44 %	Unplanned Capability Loss Factor (UCL)	:	1.28 %
Unit Capability Factor (UCF)	:	92.44 %	Planned Unavailability Factor (PUF)	:	6.28 %
Load Factor (LF)	:	98.25 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	92.44 %	Total off-line time	:	664 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	134.39	150.64	160.89	154.99	159.18	154.63	161.26	160.14	154.31	159.55	153.85	39.42	1743.24
EAF [%]	84.93	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.97	100.00	100.00	25.85	92.44
UCF [%]	84.93	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.97	100.00	100.00	25.85	92.44
LF [%]	89.42	107.14	107.05	106.57	105.92	106.32	107.30	106.55	106.10	106.17	105.79	26.23	98.25
OF [%]	84.95	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	25.81	92.44
FLR [%]	15.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.36
UCL [%]	15.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.28
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74.15	6.28
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

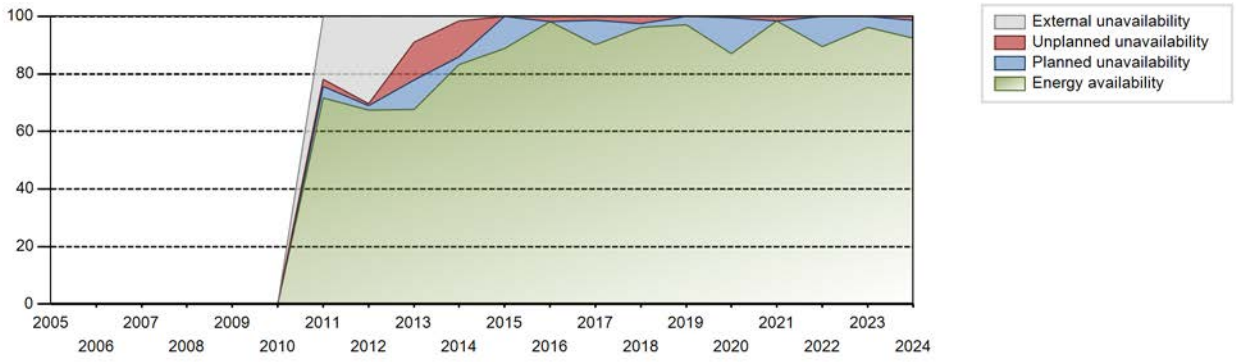
Lifetime energy generation	:	22479.18 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.78 %
Cumulative Energy Availability Factor (EAF)	:	87.5 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.74 %
Cumulative Unit Capability Factor (UCF)	:	91.88 %	Cumulative Planned Unavailability Factor (PUF)	:	5.38 %
Cumulative Load Factor (LF)	:	91.12 %	Cumulative Externally cause unavailability (XUF)	:	4.38 %
Cumulative Operating Factor (OF)	:	91.75 %			

Electricity Production (net) [GWh]



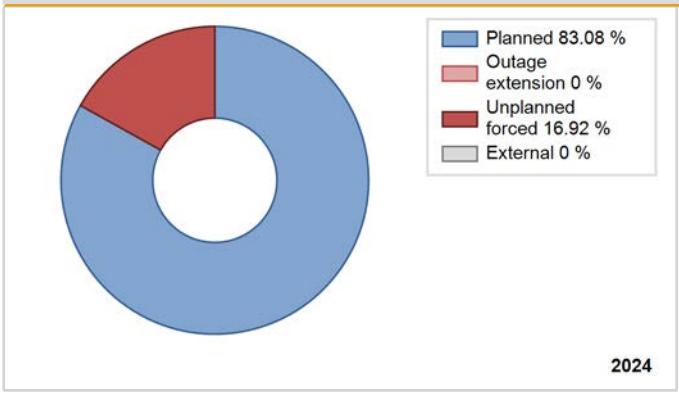
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2011	1166.35	7720	202	71.67	93.49	70.52	92.58	2.53	2.56	3.95	21.82
2012	1180.55	8585	202	67.52	97.77	66.53	97.73	0.82	0.81	1.42	30.25
2013	1187.63	6706	202	67.73	76.78	67.12	76.55	14.60	13.13	10.09	9.06
2014	1465.78	7411	202	83.17	84.74	82.84	84.60	12.84	12.48	2.78	1.57
2015	1662.23	7770	202	88.80	88.80	93.94	88.70	0.00	0.00	11.20	0.00
2016	1847.31	8618	202	98.12	98.12	104.11	98.11	1.88	1.88	0.00	0.00
2017	1682.54	7896	202	90.23	90.23	95.08	90.14	0.00	1.38	8.39	0.00
2018	1799.01	8415	202	96.11	96.11	101.67	96.06	2.51	2.59	1.30	0.00
2019	1813.17	8494	202	97.00	97.00	102.47	96.96	0.00	0.00	3.00	0.00
2020	1619.09	7637	202	87.07	87.07	91.25	86.94	0.63	0.55	12.37	0.00
2021	1830.05	8609	202	98.30	98.30	103.42	98.28	1.70	1.70	0.00	0.00
2022	1670.85	7829	202	89.41	89.48	94.42	89.37	0.03	0.03	10.49	0.07
2023	1811.38	8413	202	96.07	96.07	102.37	96.04	0.00	0.00	3.93	0.00
2024	1743.24	8120	202	92.44	92.44	98.25	92.44	1.36	1.28	6.28	0.00

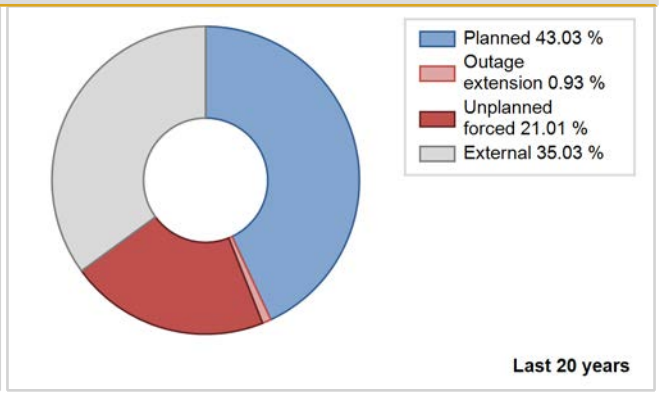
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2011 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		112			205	
D. Inspection, maintenance or repair without refuelling				152		
E. Testing of plant systems or components				14		
H. Nuclear regulatory requirements	552			310	10	
J. Grid limitation, failure or grid unavailability						5
Z. Other					28	
Subtotal	552	112		476	243	5
Total		**664**			**724**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2011 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		13
12. Reactor I&C Systems		7
16. Steam generation systems	0	23
21. Fuel Handling and Storage Facilities	112	16
31. Turbine and auxiliaries		51
32. Feedwater and Main Steam System		0
35. All other I&C Systems		5
41. Main Generator Systems		118
42. Electrical Power Supply Systems		8
Total	**112**	**241**

Highlights (2024)

During the year Unit achieved an Availability factor of 92.44%.
This is the 5th instance of unit completeing more than 300 days of continuous operation.

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2024 Operating Experience

IN-9 KAKRAPAR-1 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	1984-12-01
Grid Date	:	1992-11-24
Commercial Date	:	1993-05-06
Age at end of year	:	32 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	6500
Active core diameter [m]	:	4.5
Active core height/length [m]	:	5
Number of fissile fuel assemblies/bundles	:	3672
Fuel linear heat generation rate [kW/m]	:	29.57
Number of control rod assemblies	:	4
Number of external reactor coolant loops	:	1
Coolant type	:	D2O

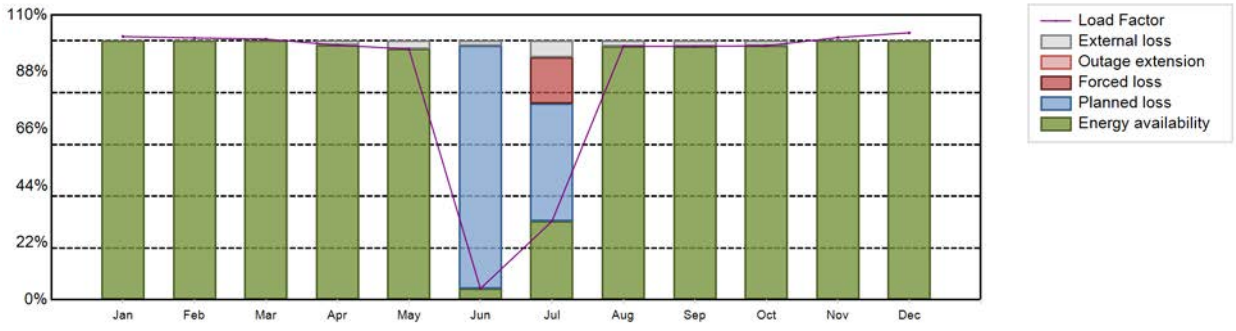
Operating coolant pressure [MPa]	:	8.7
Reactor outlet temperature [°C]	:	293
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	1.25
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	3.972
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	1526.18 GW(e).h
Energy Availability Factor (EAF)	:	85.35 %
Unit Capability Factor (UCF)	:	86.96 %
Load Factor (LF)	:	86.01 %
Operating Factor (OF)	:	86.95 %

Forced Loss Rate (FLR)	:	1.71 %
Unplanned Capability Loss Factor (UCL)	:	1.51 %
Planned Unavailability Factor (PUF)	:	11.53 %
Externally cause unavailability (XUF)	:	1.61 %
Total off-line time	:	1146 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	152.80	142.21	151.36	143.03	145.56	6.31	45.56	147.18	142.35	147.49	147.32	155.02	1526.18
EAF [%]	100.00	100.00	100.00	98.34	96.85	4.34	30.31	97.93	97.87	98.14	100.00	100.00	85.35
UCF [%]	100.00	100.00	100.00	100.00	100.00	6.30	36.69	100.00	100.00	100.00	100.00	100.00	86.96
LF [%]	101.67	101.15	100.71	98.34	96.85	4.34	30.31	97.93	97.87	98.14	101.29	103.15	86.01
OF [%]	100.00	100.00	100.00	100.00	100.00	6.25	36.69	100.00	100.00	100.00	100.00	100.00	86.95
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	32.71	0.00	0.00	0.00	0.00	0.00	1.71
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	17.83	0.00	0.00	0.00	0.00	0.00	1.51
PUF [%]	0.00	0.00	0.00	0.00	0.00	93.70	45.48	0.00	0.00	0.00	0.00	0.00	11.53
XUF [%]	0.00	0.00	0.00	1.66	3.15	1.96	6.38	2.07	2.13	1.86	0.00	0.00	1.61

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Historical Summary

Lifetime energy generation	:	34516.79 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.96 %
Cumulative Energy Availability Factor (EAF)	:	65.12 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.79 %
Cumulative Unit Capability Factor (UCF)	:	69.59 %	Cumulative Planned Unavailability Factor (PUF)	:	23.62 %
Cumulative Load Factor (LF)	:	62.93 %	Cumulative Externally cause unavailability (XUF)	:	4.47 %
Cumulative Operating Factor (OF)	:	69.18 %			

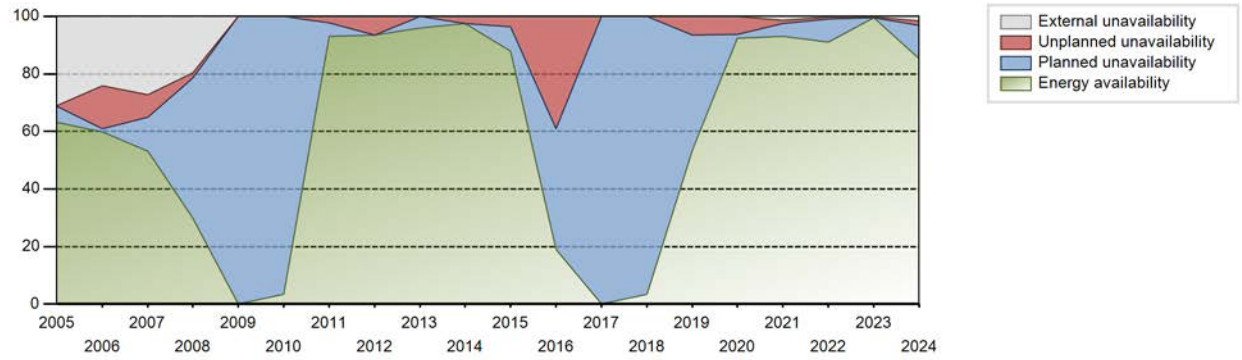
Electricity Production (net) [GWh]



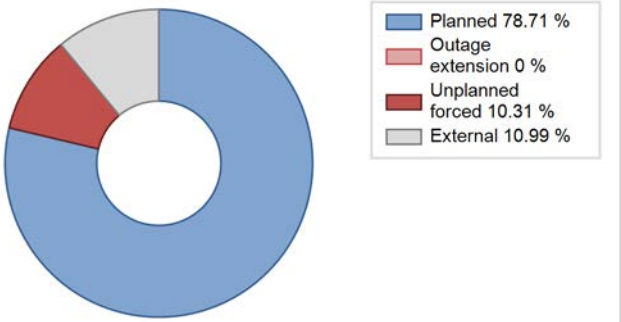
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1993	Data not provided										
1994	130.28	1049	194	11.98	13.24	7.67	11.97	52.21	14.46	72.30	1.25
1995	1089.07	6225	195	66.46	70.51	63.76	71.06	26.77	25.77	3.71	4.05
1996	1295.82	7539	195	75.65	84.61	75.65	85.83	15.39	15.39	0.00	8.96
1997	906.72	5140	195	52.87	58.36	53.08	58.68	20.52	15.07	26.57	5.50
1998	1090.62	5987	195	63.10	67.03	63.85	68.34	18.11	14.83	18.14	3.93
1999	1407.12	7450	195	85.08	87.72	82.37	85.05	5.30	4.91	7.37	2.64
2000	1645.42	8445	195	94.53	95.18	96.06	96.14	4.82	4.82	0.00	0.64
2001	1517.45	7690	195	86.46	86.49	88.83	87.79	6.72	6.23	7.28	0.03
2002	1697.79	8488	202	96.74	96.79	95.95	96.89	3.21	3.21	0.00	0.04
2003	1419.43	7622	202	81.93	87.47	80.22	87.01	1.80	1.60	10.93	5.54
2004	1064.42	7416	202	89.06	89.06	59.99	84.43	10.94	10.94	0.00	0.00
2005	1089.40	7969	202	63.14	94.21	61.56	90.97	0.00	0.17	5.62	31.06
2006	985.55	7316	202	59.76	83.85	55.70	83.53	3.24	14.91	1.24	24.09
2007	828.70	6867	202	53.26	80.48	46.83	78.39	0.00	7.78	11.75	27.21
2008	438.12	4210	202	29.97	49.70	24.69	47.93	3.44	1.77	48.53	19.73
2009	0.00	0	202	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2010	0.00	0	202	3.47	3.47	0.00	0.00	0.00	0.00	96.53	0.00
2011	1621.39	8177	202	93.05	93.05	91.63	93.34	2.31	2.20	4.75	0.00
2012	1640.69	8186	202	93.42	93.42	92.47	93.19	6.58	6.58	0.00	0.00
2013	1711.81	8387	202	95.89	95.89	96.74	95.74	0.00	0.00	4.11	0.00
2014	1719.70	8543	202	97.61	97.61	97.18	97.52	2.39	2.39	0.00	0.00
2015	1541.28	7699	202	87.92	87.92	87.10	87.89	0.00	3.66	8.41	0.00
2016	337.72	1676	202	19.09	19.09	19.03	19.08	67.20	39.11	41.80	0.00
2017	0.00	0	202	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2018	0.00	0	202	3.47	3.47	0.00	0.00	0.00	0.00	96.53	0.00
2019	887.73	4723	202	53.63	53.63	50.17	53.92	10.95	6.59	39.77	0.00
2020	1600.12	8417	202	92.29	92.29	90.18	95.82	6.27	6.17	1.54	0.00
2021	1655.51	8370	202	93.01	94.43	93.56	95.55	1.18	1.12	4.44	1.42
2022	1617.43	8009	202	91.14	91.43	91.41	91.43	0.77	0.71	7.87	0.29
2023	1764.71	8760	202	99.55	99.87	99.73	100.00	0.13	0.13	0.00	0.32
2024	1526.18	7638	202	85.35	86.96	86.01	86.95	1.71	1.51	11.53	1.61

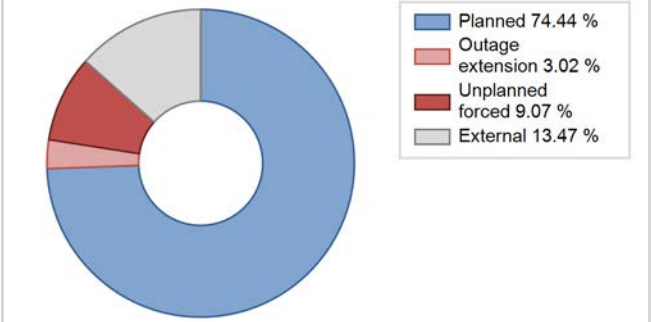
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1993 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		133			479	
D. Inspection, maintenance or repair without refuelling	1013			508		
E. Testing of plant systems or components				38	33	
F. Major backfitting, refurbishment or upgrading activities with refuelling				717		
G. Major backfitting, refurbishment or upgrading activities without refuelling				795		
H. Nuclear regulatory requirements					36	
J. Grid limitation, failure or grid unavailability						33
L. Human factor related					5	
P. Fire					4	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						11
Z. Other				13	2	5
Subtotal	1013	133		2071	559	49
Total	**1146**			**2679**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1993 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		144
12. Reactor I&C Systems		28
13. Reactor Auxiliary Systems		8
14. Safety Systems		5
15. Reactor Cooling Systems		78
16. Steam generation systems		29
17. Safety I&C Systems (excluding reactor I&C)		9
21. Fuel Handling and Storage Facilities		15
31. Turbine and auxiliaries		61
32. Feedwater and Main Steam System		8
35. All other I&C Systems		32
41. Main Generator Systems	66	74
42. Electrical Power Supply Systems	67	44
Total	**133**	**535**

Highlights (2024)

During the year 2024, KAPS-1 achieved an Availability factor of 86.96% and Capability factor of 88%.

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2024 Operating Experience

IN-10 KAKRAPAR-2 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	1985-04-01
Grid Date	:	1995-03-04
Commercial Date	:	1995-09-01
Age at end of year	:	29 years

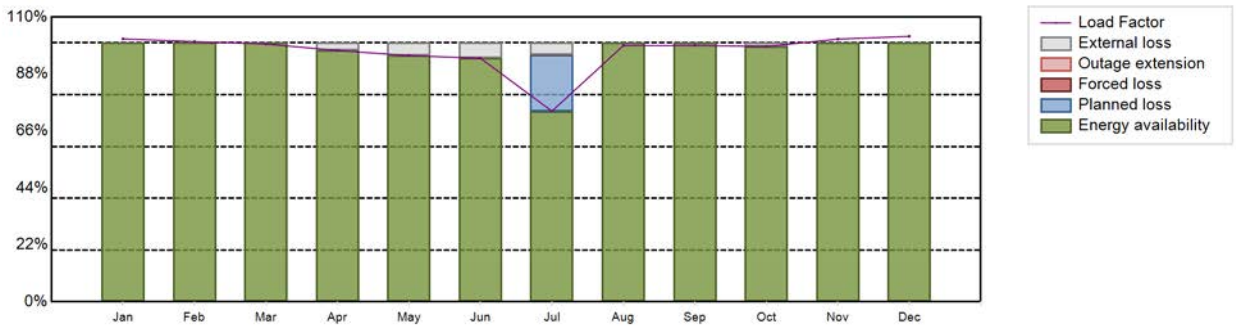
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	8.7
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	293
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	Double
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.25
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	6500	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.5	HP cylinder inlet steam pressure [MPa]	:	3.972
Active core height/length [m]	:	5	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	3672	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	29.57	Number of main condensate pumps	:	-
Number of control rod assemblies	:	4	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	1	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	1717.82 GW(e).h	Forced Loss Rate (FLR)	:	0.01 %
Energy Availability Factor (EAF)	:	96.51 %	Unplanned Capability Loss Factor (UCL)	:	0.01 %
Unit Capability Factor (UCF)	:	98.16 %	Planned Unavailability Factor (PUF)	:	1.83 %
Load Factor (LF)	:	96.81 %	Externally cause unavailability (XUF)	:	1.65 %
Operating Factor (OF)	:	98.16 %	Total off-line time	:	162 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	152.63	141.29	149.64	141.18	142.92	136.84	110.69	148.75	143.98	148.22	147.58	154.11	1717.82
EAF [%]	100.00	100.00	100.00	97.07	95.10	94.09	73.65	100.00	100.00	98.62	100.00	100.00	96.51
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	78.25	100.00	100.00	100.00	100.00	100.00	98.16
LF [%]	101.56	100.50	99.57	97.07	95.10	94.09	73.65	98.98	99.00	98.62	101.47	102.54	96.81
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	78.23	100.00	100.00	100.00	100.00	100.00	98.16
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.01
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.01
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	21.64	0.00	0.00	0.00	0.00	0.00	1.83
XUF [%]	0.00	0.00	0.00	2.93	4.90	5.91	4.60	0.00	0.00	1.38	0.00	0.00	1.65

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Historical Summary

Lifetime energy generation	:	36443.84 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.29 %
Cumulative Energy Availability Factor (EAF)	:	72.61 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.92 %
Cumulative Unit Capability Factor (UCF)	:	80.46 %	Cumulative Planned Unavailability Factor (PUF)	:	11.62 %
Cumulative Load Factor (LF)	:	70.3 %	Cumulative Externally cause unavailability (XUF)	:	7.85 %
Cumulative Operating Factor (OF)	:	80.32 %			

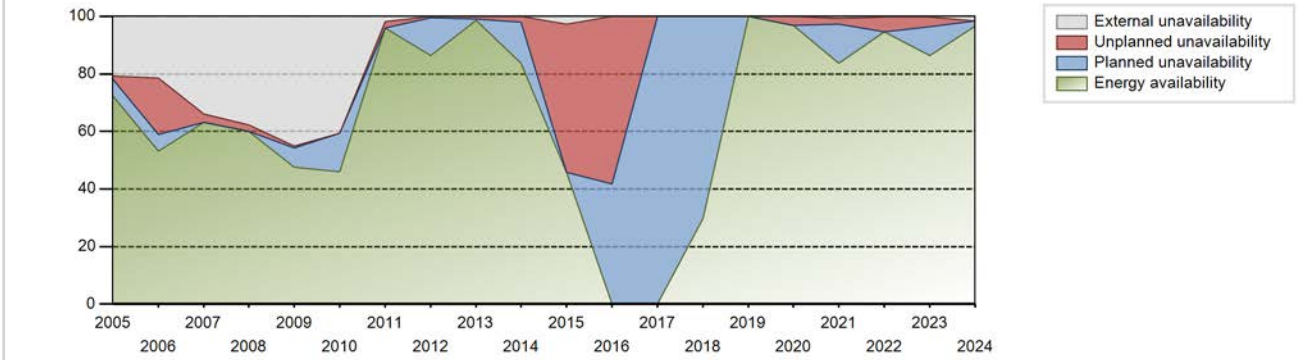
Electricity Production (net) [GWh]



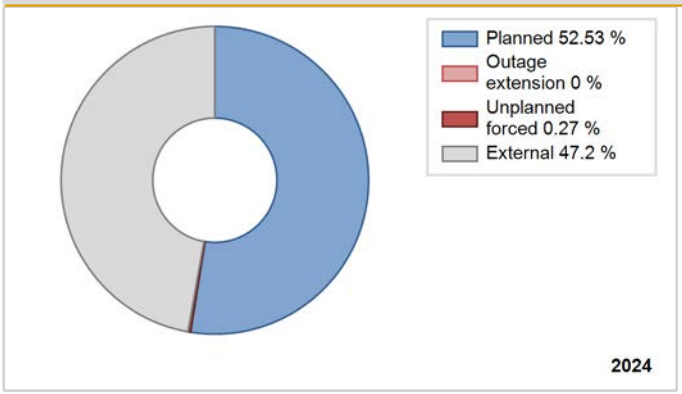
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1995	825.53	5401	196	88.25	91.95	79.29	85.83	1.15	1.07	6.98	3.70
1996	1326.81	7663	195	77.46	86.25	77.46	87.24	12.65	12.50	1.25	8.79
1997	1093.45	6139	195	63.81	66.70	64.01	70.08	27.13	24.83	8.47	2.89
1998	1291.62	6932	195	76.62	78.67	75.61	79.13	12.18	10.91	10.41	2.06
1999	1512.28	7955	195	91.14	92.38	88.53	90.81	5.08	4.94	2.67	1.25
2000	1489.85	7697	195	85.60	85.81	86.98	87.63	6.83	6.29	7.90	0.21
2001	1685.44	8500	195	95.26	95.97	98.67	97.03	4.03	4.03	0.00	0.71
2002	1597.13	7940	202	89.19	89.49	90.26	90.64	2.50	2.65	7.87	0.29
2003	1613.17	8515	202	92.29	97.32	91.16	97.20	2.68	2.68	0.00	5.03
2004	1142.04	7658	202	90.87	90.87	64.36	87.18	8.17	8.08	1.05	0.00
2005	1255.04	7979	202	72.25	92.94	70.93	91.08	1.36	1.28	5.78	20.69
2006	865.76	6473	202	53.10	74.59	48.93	73.89	3.12	19.66	5.75	21.49
2007	1011.68	8447	202	63.15	97.04	57.17	96.43	2.96	2.96	0.00	33.90
2008	938.12	8596	202	60.10	97.83	52.87	97.86	2.17	2.17	0.00	37.72
2009	780.39	7506	202	47.57	92.53	44.10	85.68	0.77	0.72	6.75	44.96
2010	751.12	7530	202	45.91	86.46	42.45	85.96	0.00	0.00	13.54	40.55
2011	1641.96	8568	202	95.98	97.82	92.79	97.81	2.18	2.18	0.00	1.83
2012	1517.71	7639	202	86.43	86.43	85.54	86.96	0.02	0.51	13.05	0.00
2013	1689.37	8682	202	98.63	98.63	95.47	99.11	0.86	0.85	0.52	0.00
2014	1439.30	7748	202	83.65	83.65	81.34	88.45	1.51	1.97	14.38	0.00
2015	780.65	4259	202	45.80	48.62	44.12	48.62	51.38	51.38	0.00	2.82
2016	0.00	0	202	0.00	0.00	0.00	0.00	100.00	58.20	41.80	0.00
2017	0.00	0	202	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2018	456.84	2411	202	29.68	29.68	25.82	27.52	0.32	0.09	70.23	0.00
2019	1777.01	8760	202	100.00	100.00	100.42	100.00	0.00	0.00	0.00	0.00
2020	1709.80	8546	202	96.90	96.90	96.36	97.29	3.10	3.10	0.00	0.00
2021	1490.01	7383	202	83.62	84.28	84.20	84.28	2.27	1.96	13.77	0.66
2022	1685.86	8315	202	94.64	94.92	95.27	94.92	5.08	5.08	0.00	0.28
2023	1533.03	7583	202	86.29	86.56	86.64	86.56	3.78	3.40	10.04	0.27
2024	1717.82	8622	202	96.51	98.16	96.81	98.16	0.01	0.01	1.83	1.65

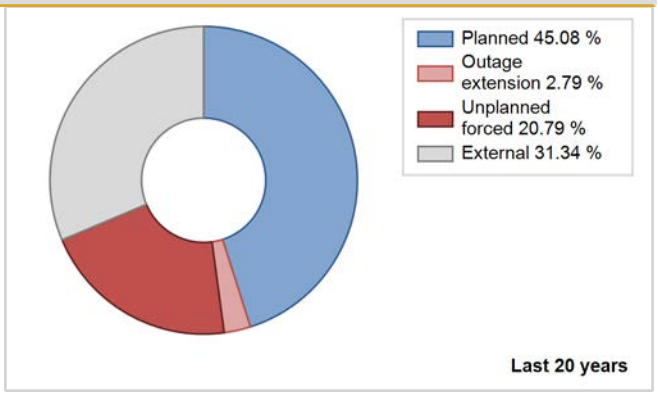
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1995 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		1			625	
D. Inspection, maintenance or repair without refuelling	161			366	25	
E. Testing of plant systems or components				5	12	
G. Major backfitting, refurbishment or upgrading activities without refuelling				640		
H. Nuclear regulatory requirements					30	
J. Grid limitation, failure or grid unavailability						17
L. Human factor related					5	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						2
Z. Other					4	
Subtotal	161	1		1011	701	19
Total	**162**			**1731**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1995 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		324
12. Reactor I&C Systems		36
13. Reactor Auxiliary Systems		5
14. Safety Systems		6
15. Reactor Cooling Systems		19
16. Steam generation systems	1	10
17. Safety I&C Systems (excluding reactor I&C)		18
21. Fuel Handling and Storage Facilities		8
31. Turbine and auxiliaries		79
32. Feedwater and Main Steam System		50
35. All other I&C Systems		2
41. Main Generator Systems		37
42. Electrical Power Supply Systems		50
Total	**1**	**644**

Highlights (2024)

During the year , KAPS-2 achieved Availabilty factor of 98.16% and Capacity factor of 98.16%.

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2024 Operating Experience

IN-30 KAKRAPAR-3 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / PHWR-700
Thermal power	:	2166 MWth
Gross electrical power	:	700 MWe
Reference unit power (net)	:	630 MWe

Key Dates

Construction Date	:	2010-11-22
Grid Date	:	2021-01-10
Commercial Date	:	2023-06-30
Age at end of year	:	3 years

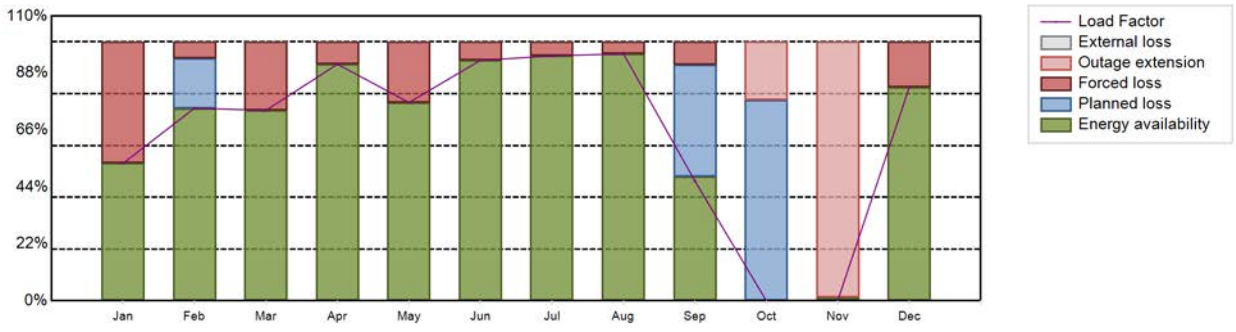
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	3603.32 GW(e).h	Forced Loss Rate (FLR)	:	16.62 %
Energy Availability Factor (EAF)	:	65.36 %	Unplanned Capability Loss Factor (UCL)	:	23.02 %
Unit Capability Factor (UCF)	:	65.36 %	Planned Unavailability Factor (PUF)	:	11.62 %
Load Factor (LF)	:	65.11 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	72.09 %	Total off-line time	:	2452 hours

Annual Summary



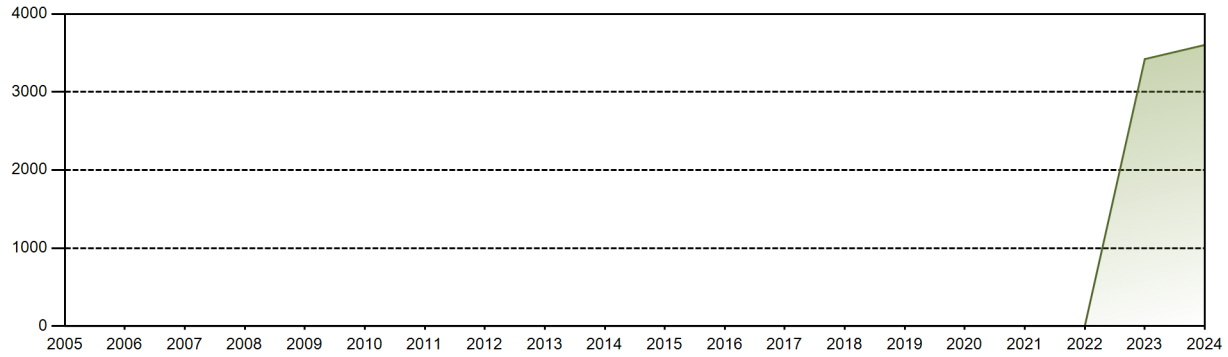
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	248.84	326.17	344.82	414.44	359.12	421.28	443.35	447.21	210.04	0.00	1.18	386.87	3603.31
EAF [%]	53.23	74.39	73.57	91.37	76.62	92.88	94.59	95.41	48.02	0.00	1.39	82.54	65.36
UCF [%]	53.23	74.39	73.57	91.37	76.62	92.88	94.59	95.41	48.02	0.00	1.39	82.54	65.36
LF [%]	53.09	74.39	73.57	91.37	76.62	92.88	94.59	95.41	46.30	0.00	0.26	82.54	65.11
OF [%]	59.95	80.89	81.32	99.31	86.56	100.00	100.00	100.00	55.14	0.00	1.39	100.00	72.09
FLR [%]	46.77	7.96	26.43	8.63	23.38	7.13	5.41	4.59	15.44	0.00	0.00	17.46	16.62
UCL [%]	46.77	6.44	26.43	8.63	23.38	7.13	5.41	4.59	8.77	22.58	98.61	17.46	23.02
PUF [%]	0.00	19.18	0.00	0.00	0.00	0.00	0.00	0.00	43.20	77.42	0.00	0.00	11.62
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

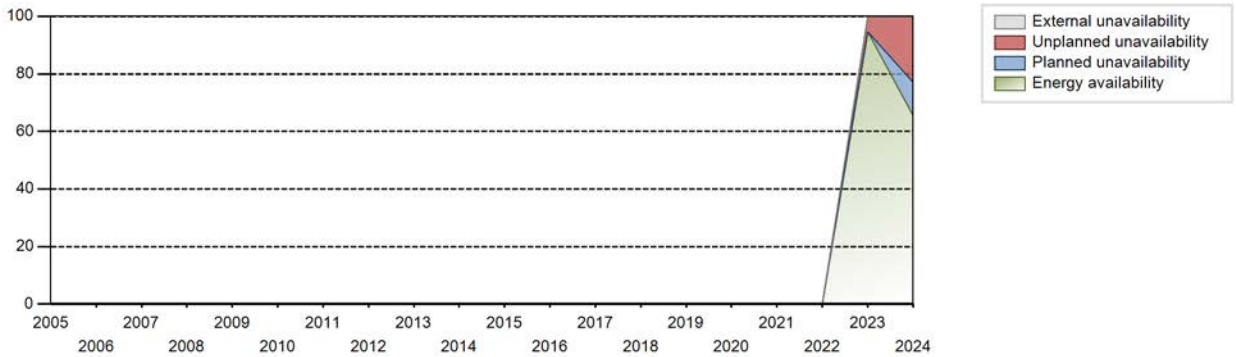
Lifetime energy generation	:	7026.67 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	12.22 %
Cumulative Energy Availability Factor (EAF)	:	75.13 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	17.11 %
Cumulative Unit Capability Factor (UCF)	:	75.13 %	Cumulative Planned Unavailability Factor (PUF)	:	7.76 %
Cumulative Load Factor (LF)	:	75.1 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	81.39 %			

Electricity Production (net) [GWh]

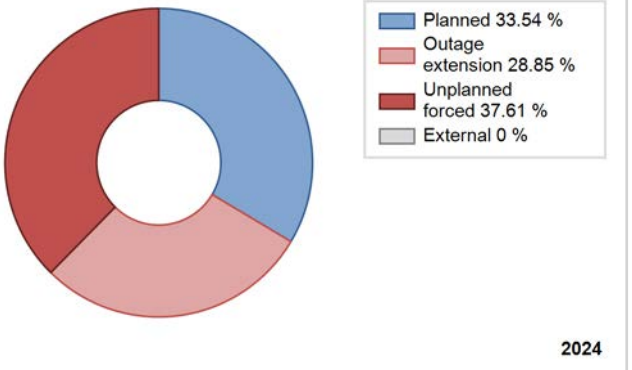


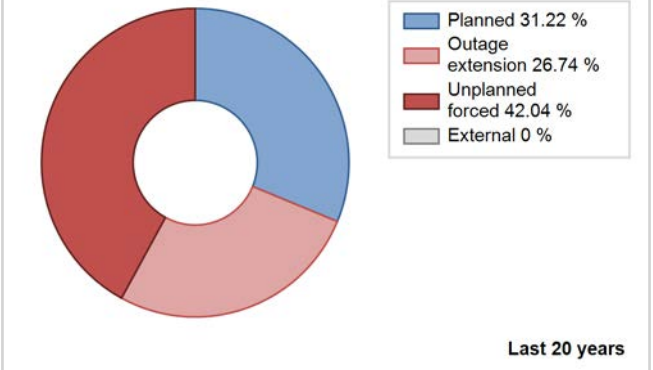
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2023	3422.13	6443	630	94.55	94.55	94.95	99.89	5.35	5.35	0.10	0.00
2024	3603.32	6332	630	65.36	65.36	65.11	72.09	16.62	23.02	11.62	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2023 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		245			171	
D. Inspection, maintenance or repair without refuelling	887			2630		
E. Testing of plant systems or components	133	297		92	198	
J. Grid limitation, failure or grid unavailability			13			9
Z. Other		878			585	
Subtotal	1020	1420	13	2722	954	9
Total	**2453**			**3685**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2023 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		1
12. Reactor I&C Systems	100	33
16. Steam generation systems		1
31. Turbine and auxiliaries	1	1
32. Feedwater and Main Steam System	297	99
35. All other I&C Systems	140	47
41. Main Generator Systems	5	4
42. Electrical Power Supply Systems	12	4
Total	**555**	**190**

Highlights (2024)

Presently reactor is operating at 90% FP and TG output is 638MWe.

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2024 Operating Experience

IN-31 KAKRAPAR-4 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / PHWR-700
Thermal power	:	2166 MWth
Gross electrical power	:	700 MWe
Reference unit power (net)	:	630 MWe

Key Dates

Construction Date	:	2010-11-22
Grid Date	:	2024-02-20
Commercial Date	:	2024-03-31
Age at end of year	:	0 years

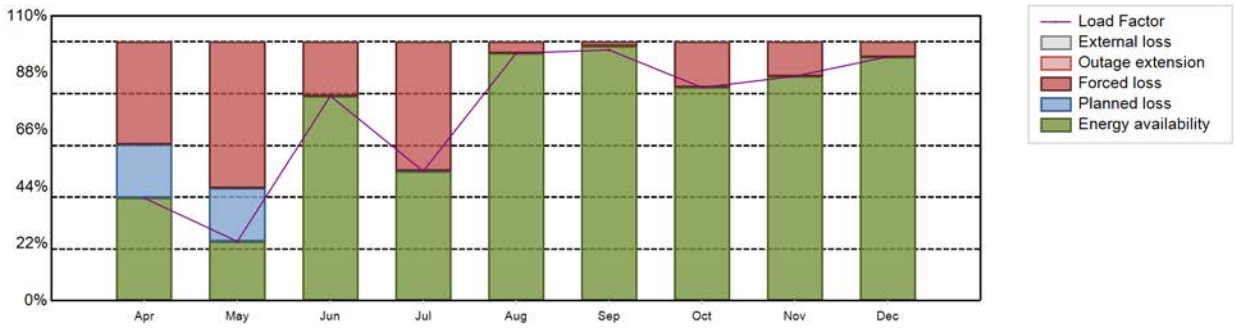
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	3065.42 GW(e).h	Forced Loss Rate (FLR)	:	24.45 %
Energy Availability Factor (EAF)	:	72.09 %	Unplanned Capability Loss Factor (UCL)	:	23.33 %
Unit Capability Factor (UCF)	:	72.09 %	Planned Unavailability Factor (PUF)	:	4.59 %
Load Factor (LF)	:	71.92 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	83.91 %	Total off-line time	:	1611 hours

Annual Summary



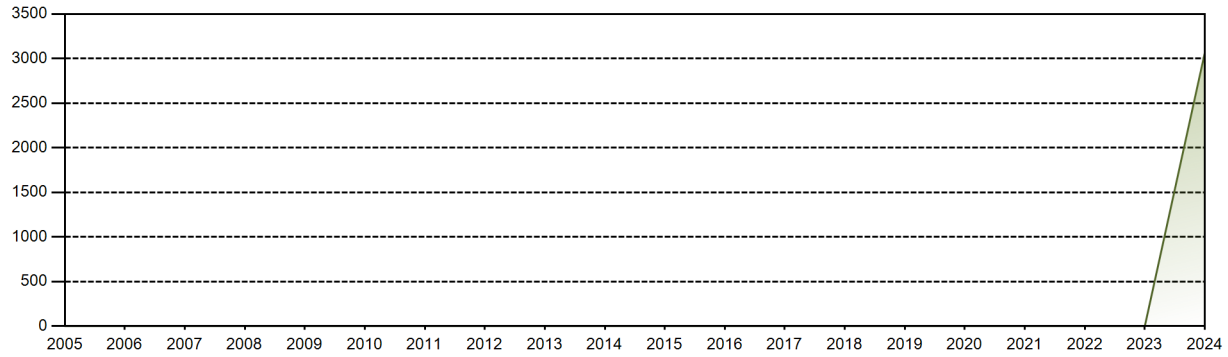
	Mar	Jan	Feb	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h				180.05	107.38	358.92	234.81	448.34	439.51	386.13	393.39	441.89	2990.43
EAF [%]				39.69	22.91	79.13	50.10	95.65	98.43	82.38	86.73	94.28	72.09
UCF [%]				39.69	22.91	79.13	50.10	95.65	98.43	82.38	86.73	94.28	72.09
LF [%]				39.69	22.91	79.13	50.10	95.65	96.89	82.38	86.73	94.28	71.92
OF [%]				72.92	35.62	100.00	59.54	100.00	96.94	93.55	98.89	98.79	83.91
FLR [%]				49.99	71.12	20.87	49.88	4.35	1.57	17.62	13.27	5.72	24.45
UCL [%]				39.67	56.42	20.87	49.85	4.35	1.57	17.62	13.27	5.72	23.33
PUF [%]				20.64	20.67	0.00	0.05	0.00	0.00	0.00	0.00	0.00	4.59
XUF [%]				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

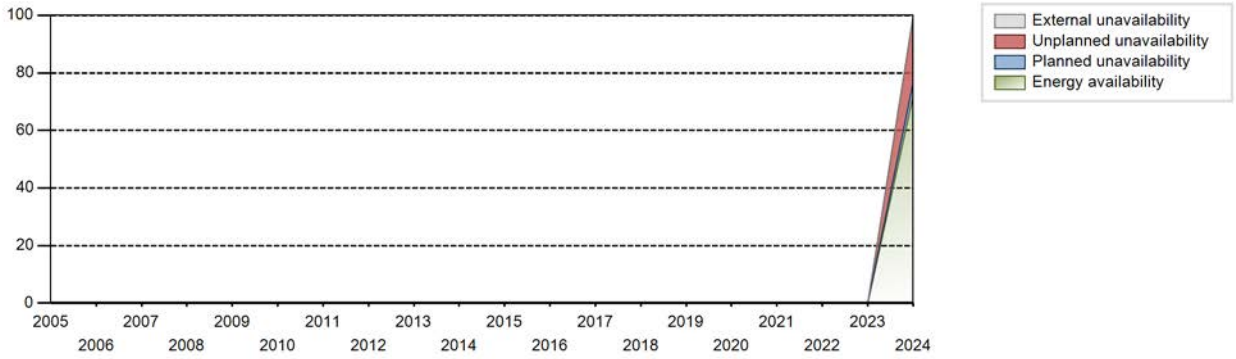
Lifetime energy generation	:	3065.42 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	24.45 %
Cumulative Energy Availability Factor (EAF)	:	72.09 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	23.33 %
Cumulative Unit Capability Factor (UCF)	:	72.09 %	Cumulative Planned Unavailability Factor (PUF)	:	4.59 %
Cumulative Load Factor (LF)	:	71.92 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	83.91 %			

Electricity Production (net) [GWh]

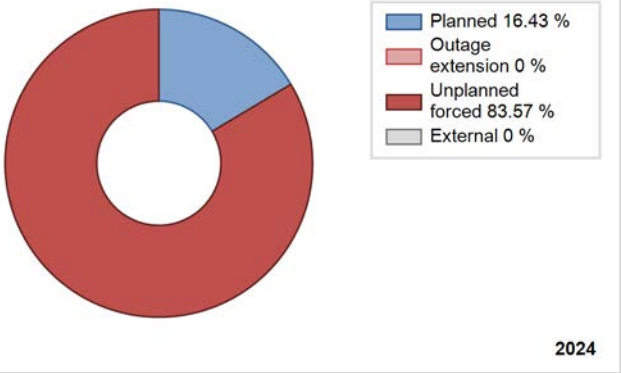


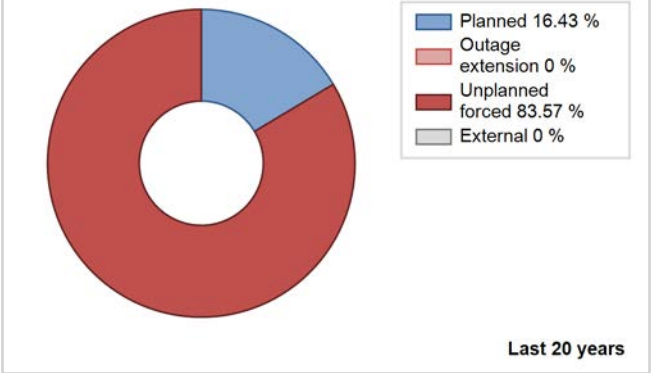
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2024	3065.42	5973	630	72.09	72.09	71.92	83.91	24.45	23.33	4.59	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2024 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		583			777	
D. Inspection, maintenance or repair without refuelling	302			403		
E. Testing of plant systems or components	406	297		542	396	
J. Grid limitation, failure or grid unavailability			10			14
Subtotal	708	880	10	945	1173	14
Total		**1598**			**2132**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2024 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems	99	108
31. Turbine and auxiliaries	325	354
32. Feedwater and Main Steam System	25	27
41. Main Generator Systems	60	65
42. Electrical Power Supply Systems	382	416
Total	**891**	**970**

Highlights (2024)

KAPP-4 TG synchronization with National Power Grid with effect from 11:38hrs on 20/02/2024.
KAPP-4 was declared "Commercial operation" with effect from 00:00hrs on 31/03/2024.

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2024 Operating Experience

IN-25 KUDANKULAM-1 INDIA



Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	MAEP (MINATOMENERGOPROM, MINISTRY OF NUCLEAR POWER AND INDUSTRY)
Turbine Supplier	:	JSC ASE (JSC "Atomstroyexport")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-412
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	932 MWe

Key Dates

Construction Date	:	2002-03-31
Grid Date	:	2013-10-22
Commercial Date	:	2014-12-31
Age at end of year	:	11 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	10
Part of the core refuelled [%]	:	30
Average discharge burnup [MWd/t]	:	42000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	121
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

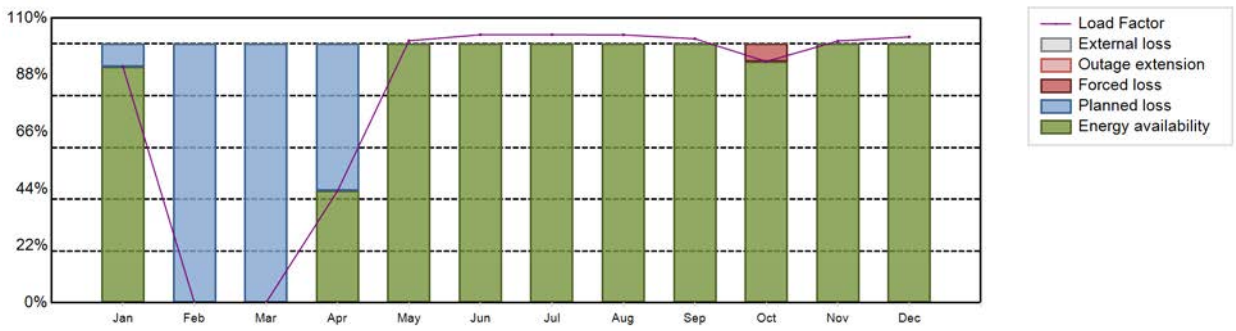
Operating coolant pressure [MPa]	:	2.7
Reactor outlet temperature [°C]	:	321
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	5.6
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6475.05 GW(e).h
Energy Availability Factor (EAF)	:	77.62 %
Unit Capability Factor (UCF)	:	77.62 %
Load Factor (LF)	:	79.09 %
Operating Factor (OF)	:	78.03 %

Forced Loss Rate (FLR)	:	0.74 %
Unplanned Capability Loss Factor (UCL)	:	0.58 %
Planned Unavailability Factor (PUF)	:	21.8 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1930 hours

Annual Summary



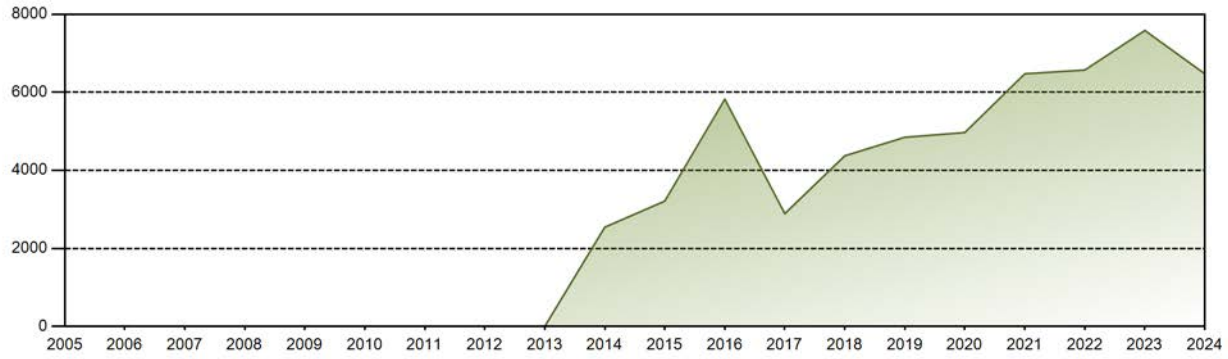
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	631.80	0.00	0.00	289.63	701.77	694.87	718.10	717.65	684.31	646.29	678.55	712.09	6475.05
EAF [%]	91.12	0.00	0.00	43.16	100.00	100.00	100.00	100.00	100.00	93.20	100.00	100.00	77.62
UCF [%]	91.12	0.00	0.00	43.16	100.00	100.00	100.00	100.00	100.00	93.20	100.00	100.00	77.62
LF [%]	91.12	0.00	0.00	43.16	101.21	103.55	103.56	103.50	101.98	93.20	101.12	102.69	79.09
OF [%]	91.13	0.00	0.00	49.03	100.00	100.00	100.00	100.00	100.00	92.34	100.00	100.00	78.03
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.80	0.00	0.00	0.74
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.80	0.00	0.00	0.58
PUF [%]	8.88	100.00	100.00	56.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.80
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

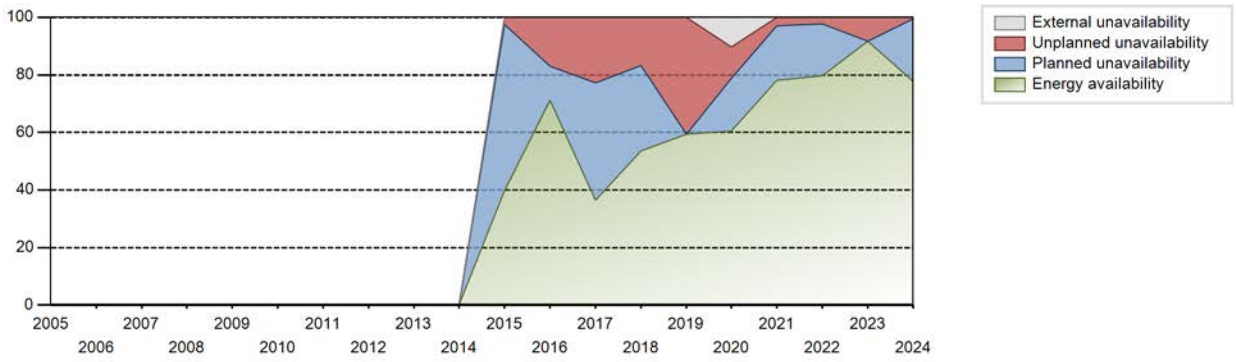
Lifetime energy generation	:	55764.34 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	15.19 %
Cumulative Energy Availability Factor (EAF)	:	64.87 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.45 %
Cumulative Unit Capability Factor (UCF)	:	65.9 %	Cumulative Planned Unavailability Factor (PUF)	:	21.65 %
Cumulative Load Factor (LF)	:	65.24 %	Cumulative Externally cause unavailability (XUF)	:	1.03 %
Cumulative Operating Factor (OF)	:	69.21 %			

Electricity Production (net) [GWh]



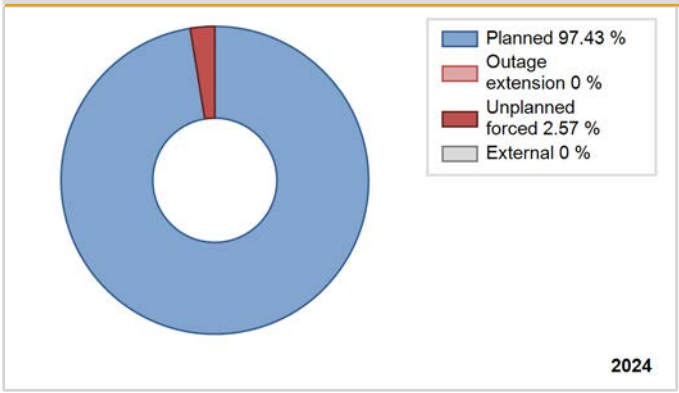
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2014	2542.23	4212	917	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	3212.83	3993	917	39.74	39.74	40.00	45.58	5.74	2.42	57.84	0.00
2016	5823.01	6828	932	71.21	71.21	71.13	77.73	19.30	17.03	11.76	0.00
2017	2889.26	3937	932	36.53	36.53	35.39	44.94	38.43	22.80	40.67	0.00
2018	4372.96	4997	932	53.56	53.56	53.56	57.04	23.73	16.67	29.77	0.00
2019	4847.99	5349	932	59.48	59.48	59.38	61.06	40.52	40.52	0.00	0.00
2020	4968.80	6369	932	60.49	70.74	60.69	72.51	6.86	10.92	18.34	10.25
2021	6475.11	6982	932	78.11	78.11	79.31	79.70	2.75	2.97	18.91	0.00
2022	6572.07	7228	932	79.74	79.74	80.50	82.51	2.78	2.28	17.98	0.00
2023	7584.74	8141	932	91.82	91.82	92.90	92.93	8.18	8.18	0.00	0.00
2024	6475.05	6854	932	77.62	77.62	79.09	78.03	0.74	0.58	21.80	0.00

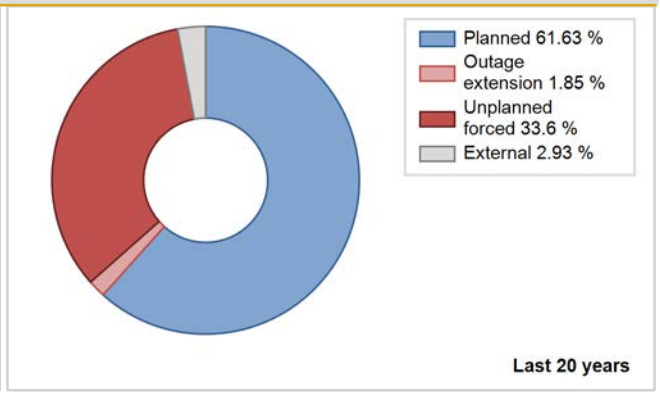
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2014 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		46			862	
C. Inspection, maintenance or repair combined with refuelling	1874			1779		
E. Testing of plant systems or components				3		
Z. Other					53	
Subtotal	1874	46		1782	915	
Total	**1920**			**2697**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2014 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		8
13. Reactor Auxiliary Systems	46	5
15. Reactor Cooling Systems		7
16. Steam generation systems		43
21. Fuel Handling and Storage Facilities		5
31. Turbine and auxiliaries		508
32. Feedwater and Main Steam System		30
33. Circulating Water System		2
35. All other I&C Systems		16
41. Main Generator Systems		201
42. Electrical Power Supply Systems		38
Total	**46**	**870**

Highlights (2024)

During the year, KKNPP-1 achieved Availability factor of 78.02% and Capacity factor of 78.95%.

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2024 Operating Experience

IN-26 KUDANKULAM-2 INDIA



Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	MAEP (MINATOMENERGOPROM, MINISTRY OF NUCLEAR POWER AND INDUSTRY)
Turbine Supplier	:	JSC ASE (JSC "Atomstroyexport")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-412
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	932 MWe

Key Dates

Construction Date	:	2002-07-04
Grid Date	:	2016-08-29
Commercial Date	:	2017-03-31
Age at end of year	:	8 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	42000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	121
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

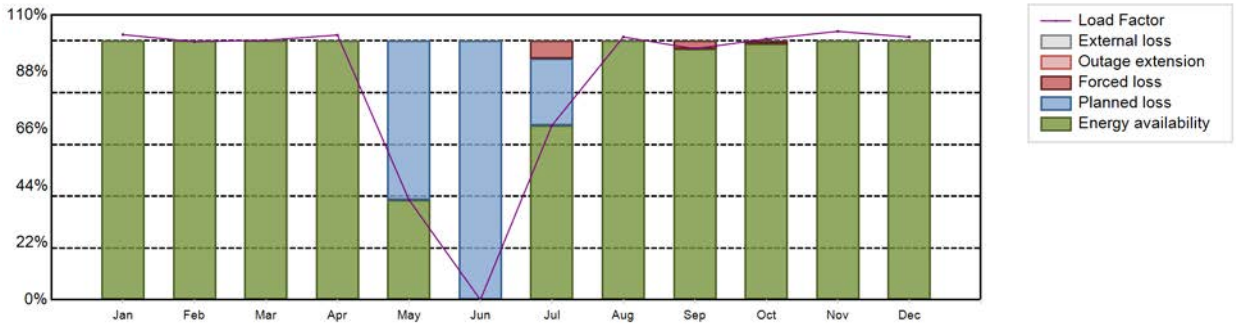
Operating coolant pressure [MPa]	:	1.27
Reactor outlet temperature [°C]	:	320.1
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	5.6
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6926.29 GW(e).h
Energy Availability Factor (EAF)	:	83.5 %
Unit Capability Factor (UCF)	:	83.5 %
Load Factor (LF)	:	84.6 %
Operating Factor (OF)	:	84.16 %

Forced Loss Rate (FLR)	:	1.1 %
Unplanned Capability Loss Factor (UCL)	:	0.93 %
Planned Unavailability Factor (PUF)	:	15.58 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1391 hours

Annual Summary



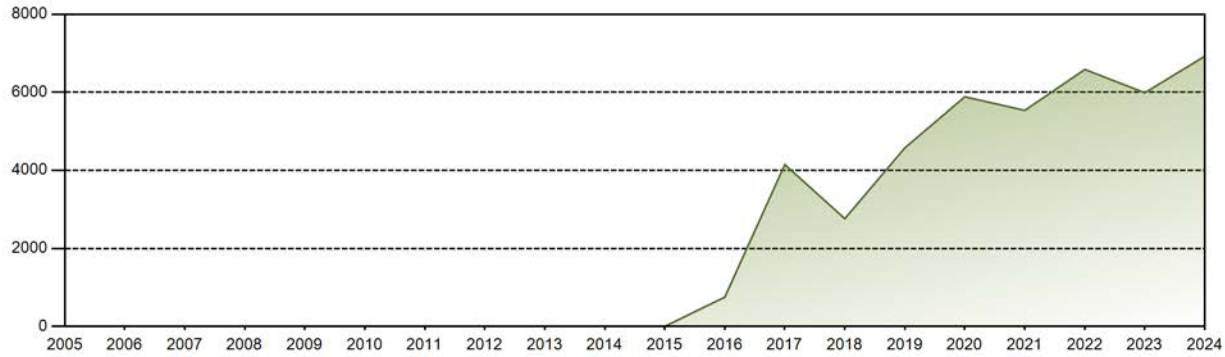
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	710.22	646.63	695.03	686.29	268.18	0.00	467.07	703.95	650.77	698.68	695.75	703.72	6926.29
EAF [%]	100.00	100.00	100.00	100.00	38.68	0.00	67.36	100.00	96.98	98.84	100.00	100.00	83.50
UCF [%]	100.00	100.00	100.00	100.00	38.68	0.00	67.36	100.00	96.98	98.84	100.00	100.00	83.50
LF [%]	102.42	99.68	100.23	102.27	38.68	0.00	67.36	101.52	96.98	100.76	103.68	101.49	84.60
OF [%]	100.00	100.00	100.00	100.00	39.52	0.00	71.51	100.00	100.00	98.79	100.00	100.00	84.16
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	9.23	0.00	3.02	1.16	0.00	0.00	1.10
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	6.85	0.00	3.02	1.16	0.00	0.00	0.93
PUF [%]	0.00	0.00	0.00	0.00	61.32	100.00	25.80	0.00	0.00	0.00	0.00	0.00	15.58
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

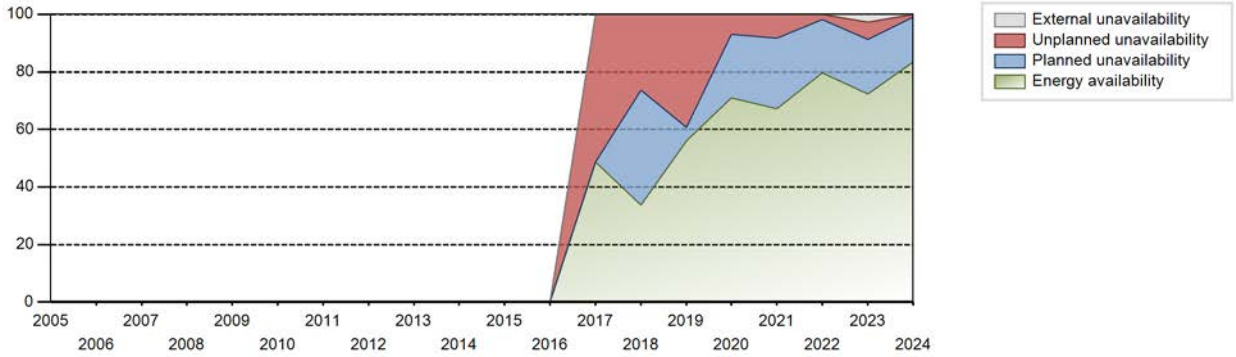
Lifetime energy generation	:	43161.32 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	19.61 %
Cumulative Energy Availability Factor (EAF)	:	64.51 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	16.51 %
Cumulative Unit Capability Factor (UCF)	:	64.87 %	Cumulative Planned Unavailability Factor (PUF)	:	18.62 %
Cumulative Load Factor (LF)	:	64.84 %	Cumulative Externally cause unavailability (XUF)	:	0.36 %
Cumulative Operating Factor (OF)	:	72.26 %			

Electricity Production (net) [GWh]

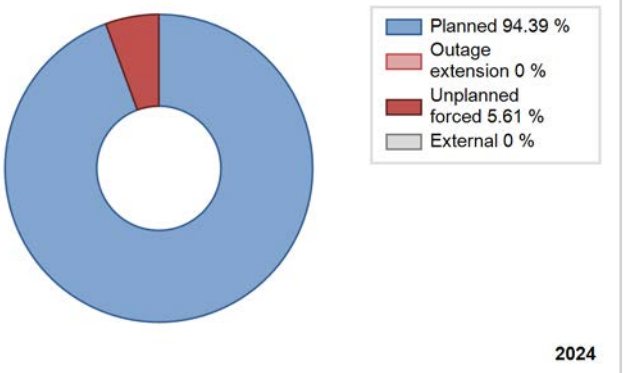


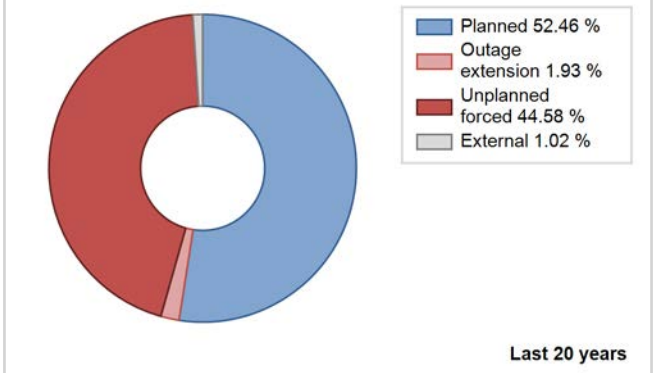
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2017	4147.80	4991	932	48.64	48.64	45.81	50.17	51.32	51.29	0.07	0.00
2018	2761.23	3846	932	33.82	33.82	33.82	43.90	43.78	26.34	39.84	0.00
2019	4573.82	8217	932	56.12	56.12	56.02	93.80	41.19	39.31	4.57	0.00
2020	5885.37	6446	932	70.90	70.90	71.89	73.38	8.84	6.88	22.23	0.00
2021	5537.43	6105	932	67.24	67.24	67.82	69.69	8.98	8.29	24.47	0.00
2022	6586.51	7079	932	79.60	79.60	80.67	80.81	2.27	1.85	18.55	0.00
2023	5988.25	6714	932	72.24	75.06	73.35	76.64	2.82	5.85	19.09	2.82
2024	6926.29	7393	932	83.50	83.50	84.60	84.16	1.10	0.93	15.58	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2017 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		48			785	
C. Inspection, maintenance or repair combined with refuelling	1344			1562		
D. Inspection, maintenance or repair without refuelling				15		
E. Testing of plant systems or components				12	19	
Z. Other					41	
Subtotal	1344	48		1589	845	
Total	**1392**			**2434**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2017 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		18
12. Reactor I&C Systems	17	9
15. Reactor Cooling Systems		52
31. Turbine and auxiliaries		60
32. Feedwater and Main Steam System	31	53
33. Circulating Water System		1
35. All other I&C Systems		15
41. Main Generator Systems		572
Total	**48**	**780**

Highlights (2024)

During the year KKNPP-2 achieved Availability factor of 84.16% and Capacity factor of 84.29%.

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2024 Operating Experience

IN-6 MADRAS-2 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	205 MWe

Key Dates

Construction Date	:	1972-10-01
Grid Date	:	1985-09-20
Commercial Date	:	1986-03-21
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	6700
Active core diameter [m]	:	4.5
Active core height/length [m]	:	5
Number of fissile fuel assemblies/bundles	:	3672
Fuel linear heat generation rate [kW/m]	:	35.3
Number of control rod assemblies	:	-
Number of external reactor coolant loops	:	1
Coolant type	:	D2O

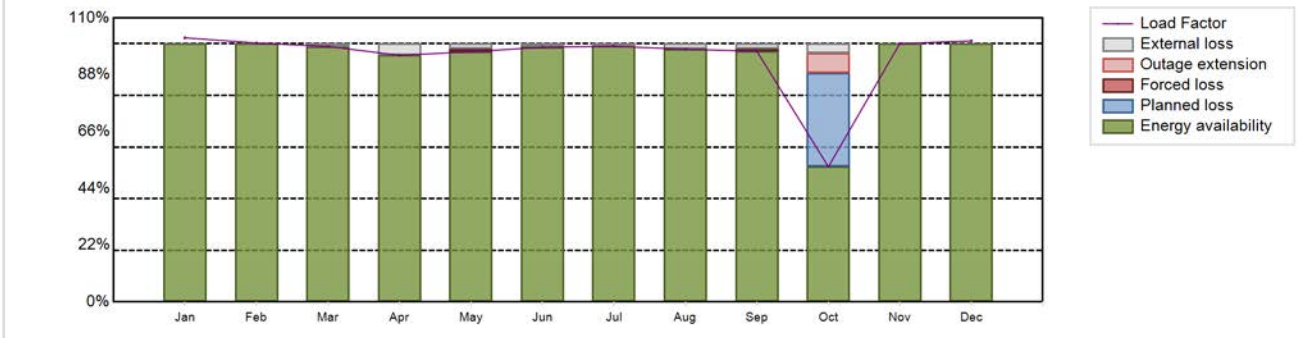
Operating coolant pressure [MPa]	:	8.5
Reactor outlet temperature [°C]	:	293
Number of SG	:	8
Containment type	:	Confinement
Containment design pressure [MPa]	:	1.16
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	3.972
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DS

Annual Production Results (2024)

Net Energy Production	:	1709.95 GW(e).h
Energy Availability Factor (EAF)	:	94.64 %
Unit Capability Factor (UCF)	:	96.04 %
Load Factor (LF)	:	94.96 %
Operating Factor (OF)	:	96.25 %
Equivalent non-electrical energy generated (NEG)	:	12.86 GW(e).h

Forced Loss Rate (FLR)	:	0.24 %
Unplanned Capability Loss Factor (UCL)	:	0.89 %
Planned Unavailability Factor (PUF)	:	3.07 %
Externally cause unavailability (XUF)	:	1.4 %
Total off-line time	:	329 hours

Annual Summary



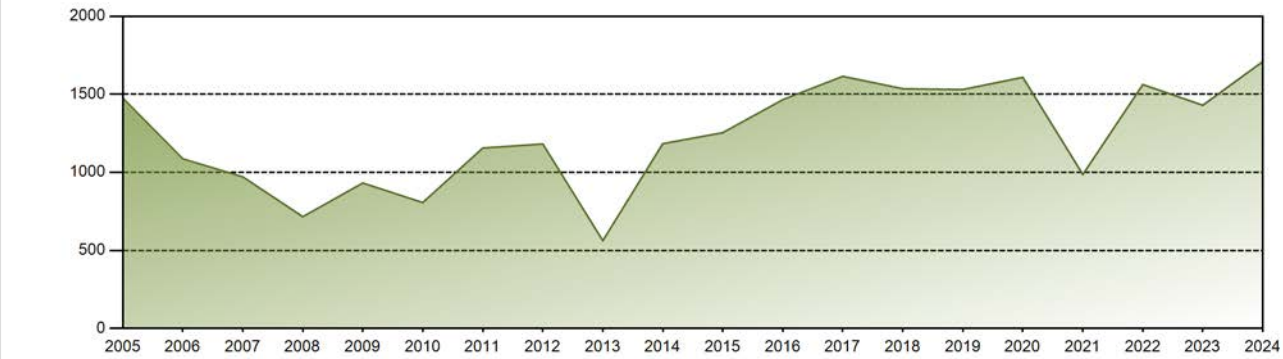
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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	156.04	143.11	150.93	140.99	147.81	145.62	151.01	149.29	143.33	79.87	147.73	154.21	1709.95
EAF [%]	100.00	100.00	98.96	95.52	96.91	98.66	99.01	97.88	97.11	52.37	100.00	100.00	94.64
UCF [%]	100.00	100.00	100.00	100.00	98.75	99.83	100.00	99.74	98.90	55.93	100.00	100.00	96.04
LF [%]	102.31	100.30	98.96	95.52	96.91	98.66	99.01	97.88	97.11	52.37	100.09	101.10	94.96
OF [%]	100.00	100.00	100.00	100.00	100.00	99.86	100.00	100.00	100.00	55.91	100.00	100.00	96.25
FLR [%]	0.00	0.00	0.00	0.00	1.25	0.17	0.00	0.26	1.10	0.00	0.00	0.00	0.24
UCL [%]	0.00	0.00	0.00	0.00	1.25	0.17	0.00	0.26	1.10	7.79	0.00	0.00	0.89
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.28	0.00	0.00	3.07
XUF [%]	0.00	0.00	1.04	4.48	1.84	1.17	0.99	1.86	1.79	3.56	0.00	0.00	1.40

Historical Summary

Lifetime energy generation	:	41188 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	14.63 %
Cumulative Energy Availability Factor (EAF)	:	64.53 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	13.28 %
Cumulative Unit Capability Factor (UCF)	:	74.79 %	Cumulative Planned Unavailability Factor (PUF)	:	11.93 %
Cumulative Load Factor (LF)	:	62.42 %	Cumulative Externally cause unavailability (XUF)	:	10.26 %
Cumulative Operating Factor (OF)	:	76.63 %			

Electricity Production (net) [GWh]

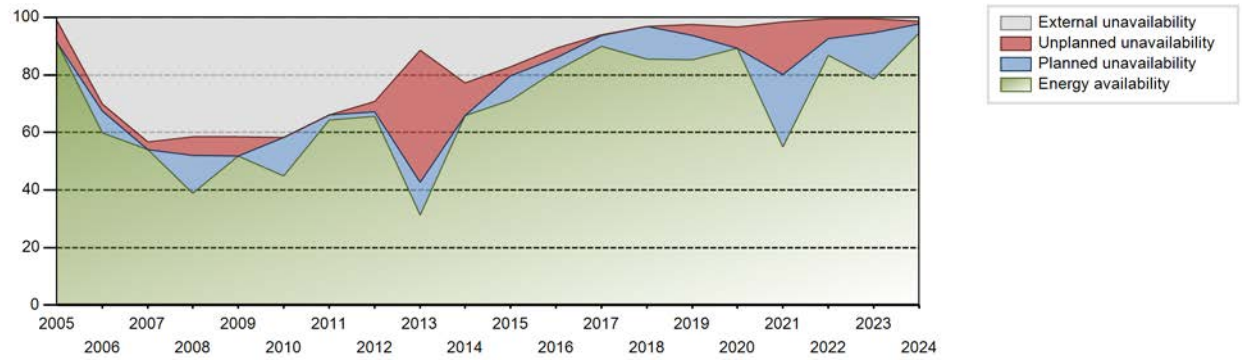


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	783.74	5303	220	36.50	36.50	36.50	56.27	63.49	63.49	0.01	0.00
1987	1066.00	6382	220	55.47	62.45	55.31	72.85	32.66	30.29	7.26	6.99
1988	642.00	3535	220	33.22	33.22	33.22	40.24	53.14	37.68	29.10	0.00
1989	438.21	4350	220	22.74	22.75	22.74	49.66	76.53	74.17	3.08	0.01
1990	1082.36	7726	215	57.19	61.60	57.47	88.20	37.09	36.32	2.08	4.41
1991	1082.97	7642	215	86.63	87.16	57.50	87.24	12.84	12.84	0.00	0.54
1992	665.18	4751	194	54.21	55.22	39.03	54.09	6.84	4.06	40.72	1.01
1993	950.33	6625	205	77.07	80.20	52.92	75.63	13.59	12.62	7.18	3.13
1994	1032.14	7071	194	80.88	85.49	60.73	80.72	14.51	14.51	0.00	4.61
1995	274.66	1871	194	21.39	22.73	16.16	21.36	7.29	1.79	75.48	1.34
1996	1061.91	7256	161	82.17	84.72	75.12	82.60	9.73	9.13	6.15	2.55
1997	958.20	6464	150	72.41	75.58	72.92	73.79	24.42	24.42	0.00	3.16
1998	1104.22	7478	150	85.39	86.96	84.04	85.37	13.04	13.04	0.00	1.57
1999	879.94	5755	150	65.71	68.04	66.97	65.70	7.02	5.14	26.81	2.33
2000	1273.39	8304	150	94.56	95.72	96.64	94.54	4.28	4.28	0.00	1.15
2001	1119.14	7671	150	87.58	88.45	85.17	87.57	9.59	9.38	2.17	0.87
2002	22.71	183	155	1.67	1.67	1.67	2.09	0.00	0.00	98.33	0.00
2003	589.13	3135	155	39.98	39.98	43.39	35.79	10.48	10.43	49.59	0.00
2004	1274.31	7970	155	90.92	92.36	93.59	90.73	7.64	7.64	0.00	1.44
2005	1475.77	8165	155	91.25	92.47	108.69	93.21	7.53	7.53	0.00	1.22
2006	1086.59	7894	202	59.92	89.97	61.41	90.11	2.75	2.54	7.49	30.05
2007	971.07	8537	202	54.06	97.42	54.88	97.45	2.58	2.58	0.00	43.36
2008	715.69	7080	202	38.98	80.44	40.34	80.60	7.59	6.60	12.96	41.46
2009	931.47	8178	205	51.87	93.36	51.87	93.36	6.64	6.64	0.00	41.49
2010	806.13	7596	205	44.89	86.72	44.89	86.71	0.01	0.01	13.28	41.83
2011	1155.83	8600	205	64.36	98.17	64.36	98.17	0.01	0.01	1.81	33.81
2012	1181.56	8339	205	65.62	94.97	65.62	94.93	3.43	3.37	1.66	29.35

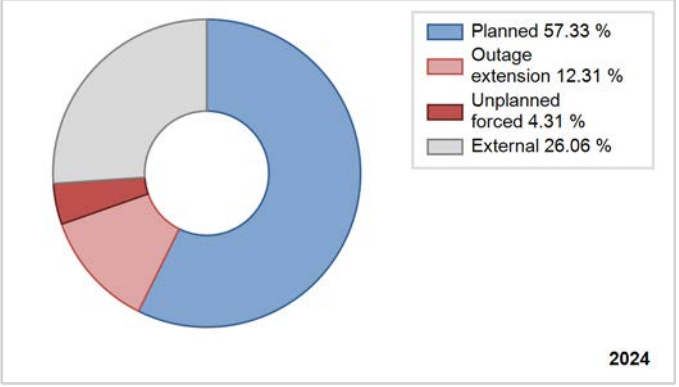
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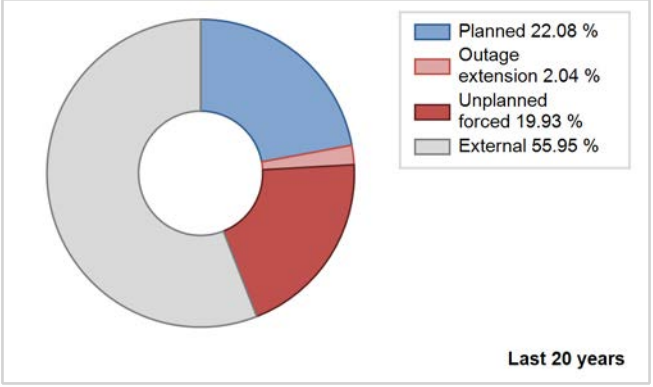
2013	561.74	3735	205	31.28	42.64	31.28	42.64	51.93	46.06	11.30	11.36
2014	1183.61	7755	205	65.91	88.66	65.91	88.53	11.34	11.34	0.00	22.75
2015	1254.20	7739	205	71.13	88.34	69.84	88.34	3.45	3.15	8.50	17.21
2016	1465.58	7865	205	81.39	92.09	81.39	89.54	3.45	3.29	4.62	10.70
2017	1615.20	8400	205	89.94	95.89	89.94	95.89	0.37	0.36	3.75	5.95
2018	1535.80	7772	205	85.52	88.74	85.52	88.72	0.02	0.02	11.24	3.22
2019	1530.73	7681	205	85.22	87.61	85.24	87.68	4.34	3.97	8.42	2.39
2020	1608.90	8151	205	89.35	92.68	89.35	92.79	7.32	7.32	0.00	3.34
2021	986.16	5628	205	54.91	56.44	54.91	64.25	15.25	18.38	25.18	1.52
2022	1562.47	7909	205	86.88	87.31	87.01	90.29	7.36	6.94	5.75	0.44
2023	1429.96	6960	205	78.59	78.97	79.63	79.45	1.86	5.05	15.97	0.38
2024	1709.95	8455	205	94.64	96.04	94.96	96.25	0.24	0.89	3.07	1.40

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					754	
D. Inspection, maintenance or repair without refuelling				638		
E. Testing of plant systems or components				37	5	
H. Nuclear regulatory requirements	269	59		70	19	
J. Grid limitation, failure or grid unavailability						67
L. Human factor related					6	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						6
P. Fire					3	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				348		
Z. Other		1		26	7	
Subtotal	269	60		1119	794	73
Total	**329**			**1986**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		161
12. Reactor I&C Systems		41
13. Reactor Auxiliary Systems		11
14. Safety Systems		3
15. Reactor Cooling Systems		107
16. Steam generation systems		63
17. Safety I&C Systems (excluding reactor I&C)		9
21. Fuel Handling and Storage Facilities		57
31. Turbine and auxiliaries		89
32. Feedwater and Main Steam System		25
33. Circulating Water System		6
34. Miscellaneous Systems		8
35. All other I&C Systems		2
41. Main Generator Systems		40
42. Electrical Power Supply Systems	1	146
Total	**1**	**768**

Highlights (2024)

During the year Unit achieved Availability factor of 96.25% and Capacity factor of 96.77%.

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2024 Operating Experience

IN-7 NARORA-1 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	1976-12-01
Grid Date	:	1989-07-29
Commercial Date	:	1991-01-01
Age at end of year	:	35 years

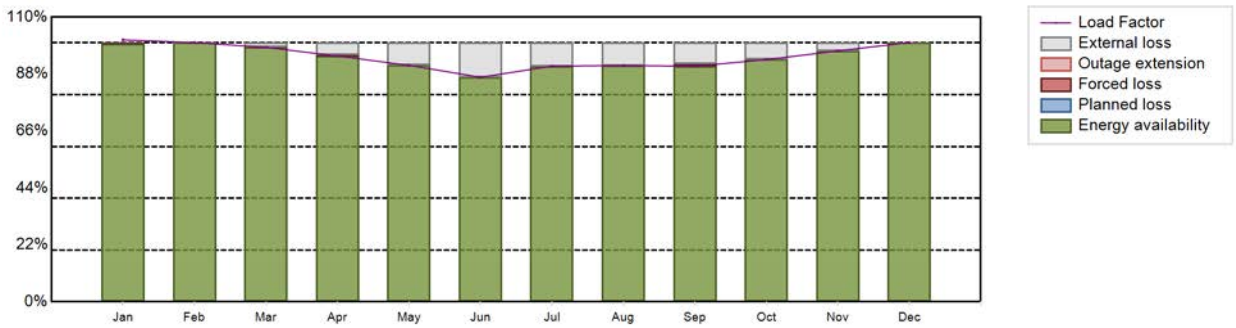
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	8.7
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	293.4
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	Double
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.25
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	15000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.5	HP cylinder inlet steam pressure [MPa]	:	3.972
Active core height/length [m]	:	5	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	3672	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	35.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	4	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	1680.44 GW(e).h	Forced Loss Rate (FLR)	:	0.16 %
Energy Availability Factor (EAF)	:	94.54 %	Unplanned Capability Loss Factor (UCL)	:	0.16 %
Unit Capability Factor (UCF)	:	99.84 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	94.71 %	Externally cause unavailability (XUF)	:	5.3 %
Operating Factor (OF)	:	100 %	Total off-line time	:	0 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	152.05	140.79	147.70	138.09	137.26	126.17	136.78	137.19	132.33	140.60	140.95	150.53	1680.44
EAF [%]	99.50	100.00	98.30	94.93	91.33	86.75	91.01	91.28	90.99	93.55	96.91	100.00	94.54
UCF [%]	99.50	100.00	99.90	99.47	100.00	100.00	100.00	100.00	99.15	100.00	100.00	100.00	99.84
LF [%]	101.17	100.14	98.28	94.95	91.33	86.75	91.01	91.28	90.99	93.55	96.91	100.16	94.71
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.50	0.00	0.10	0.53	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.16
UCL [%]	0.50	0.00	0.10	0.53	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.16
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	1.61	4.54	8.67	13.25	8.99	8.72	8.16	6.45	3.09	0.00	5.30

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Historical Summary

Lifetime energy generation	:	38096.48 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.58 %
Cumulative Energy Availability Factor (EAF)	:	65.13 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.35 %
Cumulative Unit Capability Factor (UCF)	:	75.44 %	Cumulative Planned Unavailability Factor (PUF)	:	17.21 %
Cumulative Load Factor (LF)	:	62.99 %	Cumulative Externally cause unavailability (XUF)	:	10.31 %
Cumulative Operating Factor (OF)	:	75.58 %			

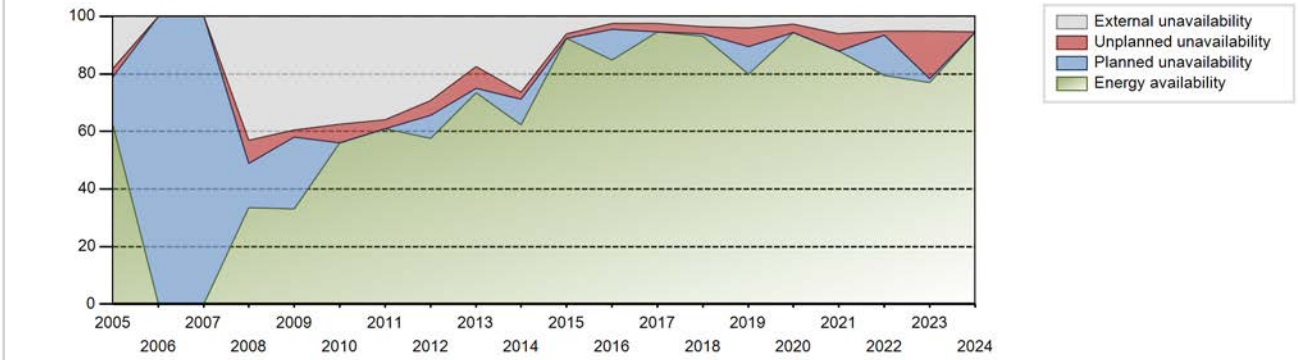
Electricity Production (net) [GWh]



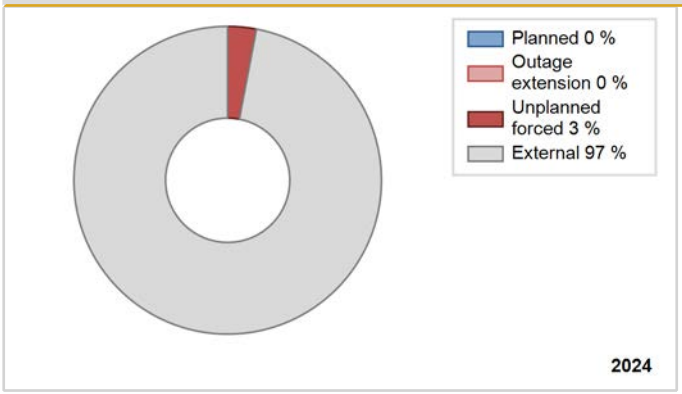
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1991	449.26	4331	210	42.32	42.80	24.42	49.44	36.61	24.72	32.49	0.48
1992	742.66	5514	200	42.27	42.77	42.27	62.77	57.23	57.23	0.00	0.50
1993	339.57	2032	200	19.38	19.38	19.38	23.20	40.05	12.95	67.67	0.00
1994	0.00	0	200	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1995	944.42	5740	200	65.98	68.31	53.91	65.53	19.31	16.35	15.34	2.32
1996	1162.26	6407	200	66.16	76.93	66.16	72.94	14.44	12.98	10.08	10.78
1997	1585.20	8128	200	89.28	92.83	90.48	92.79	5.35	5.25	1.93	3.55
1998	1485.61	7986	200	83.85	90.84	84.79	91.16	7.01	6.84	2.32	6.98
1999	1128.61	6703	200	76.54	76.84	64.42	76.52	13.32	11.81	11.35	0.30
2000	1386.34	7452	200	83.36	87.21	78.91	84.84	8.32	7.92	4.88	3.85
2001	1562.99	8157	200	89.21	91.94	89.21	93.12	8.06	8.06	0.00	2.73
2002	1574.49	7912	202	87.98	89.30	88.98	90.32	2.92	2.73	7.97	1.32
2003	1528.24	8254	202	85.99	95.12	86.36	94.22	2.88	2.82	2.06	9.13
2004	1120.61	6860	202	64.80	82.54	63.16	78.10	0.34	0.28	17.18	17.74
2005	1064.75	6924	202	62.38	80.52	60.17	79.04	3.32	2.77	16.71	18.14
2006	0.00	0	202	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2007	0.00	0	202	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2008	567.17	5963	202	33.64	76.77	31.96	67.88	9.46	8.02	15.21	43.13
2009	551.08	6298	202	33.12	72.53	31.14	71.89	3.41	2.56	24.91	39.41
2010	956.95	8191	202	56.06	93.63	54.08	93.50	6.37	6.37	0.00	37.57
2011	1044.57	8494	202	61.01	97.04	59.03	96.96	2.96	2.96	0.00	36.02
2012	987.24	7611	202	57.62	86.90	55.64	86.65	3.27	5.07	8.03	29.28
2013	1223.62	7739	202	73.39	90.84	69.15	88.34	7.67	7.55	1.61	17.45
2014	1067.58	7750	202	62.31	88.69	60.33	88.47	2.58	2.35	8.96	26.38
2015	1568.35	8449	202	92.30	98.33	88.63	96.45	1.67	1.67	0.00	6.02
2016	1479.92	7649	202	84.76	87.24	83.41	87.08	0.00	2.07	10.70	2.48
2017	1658.28	8520	202	94.72	97.30	93.71	97.26	2.70	2.70	0.00	2.58
2018	1624.80	8462	202	93.06	96.66	91.82	96.60	2.53	2.51	0.83	3.60
2019	1411.63	7459	202	79.88	83.91	79.77	85.15	1.80	6.45	9.65	4.02
2020	1655.65	8543	202	94.46	97.23	93.31	97.26	2.77	2.77	0.00	2.78
2021	1556.37	8269	202	87.95	94.02	87.95	94.39	5.98	5.98	0.00	6.07
2022	1394.87	7444	202	79.44	84.51	78.83	84.98	1.57	1.35	14.15	5.07
2023	1355.97	7241	202	77.11	82.30	76.63	82.66	16.65	16.44	1.26	5.19
2024	1680.44	8784	202	94.54	99.84	94.71	100.00	0.16	0.16	0.00	5.30

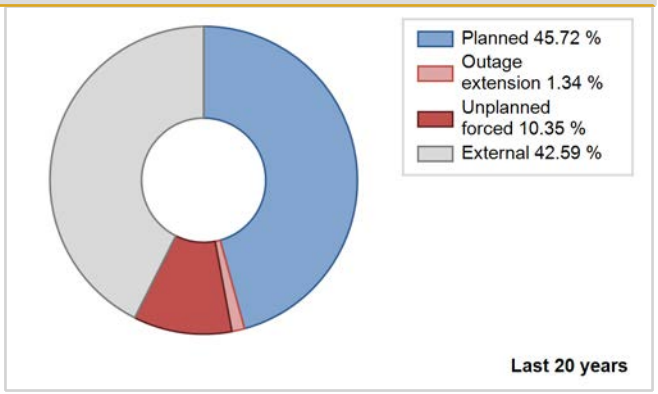
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1991 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					664	
C. Inspection, maintenance or repair combined with refuelling				58		
D. Inspection, maintenance or repair without refuelling				561	18	
E. Testing of plant systems or components				14	24	
F. Major backfitting, refurbishment or upgrading activities with refuelling				82		
G. Major backfitting, refurbishment or upgrading activities without refuelling				515		
H. Nuclear regulatory requirements				60	6	
J. Grid limitation, failure or grid unavailability						50
L. Human factor related					5	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						7
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						18
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				25	10	
Z. Other					8	2
Subtotal				1315	735	77
Total		**0**			**2127**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1991 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		38
12. Reactor I&C Systems		48
13. Reactor Auxiliary Systems		17
15. Reactor Cooling Systems		95
16. Steam generation systems		11
17. Safety I&C Systems (excluding reactor I&C)		18
21. Fuel Handling and Storage Facilities		27
31. Turbine and auxiliaries		268
32. Feedwater and Main Steam System		13
33. Circulating Water System		8
34. Miscellaneous Systems		8
41. Main Generator Systems		104
42. Electrical Power Supply Systems		90
Total		**745**

Highlights (2024)

NAPS-1 achieved an Availabilty factor of 100% and Capacity factor of 95.64% during the year.

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2024 Operating Experience

IN-8 NARORA-2 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	1977-11-01
Grid Date	:	1992-01-05
Commercial Date	:	1992-07-01
Age at end of year	:	32 years

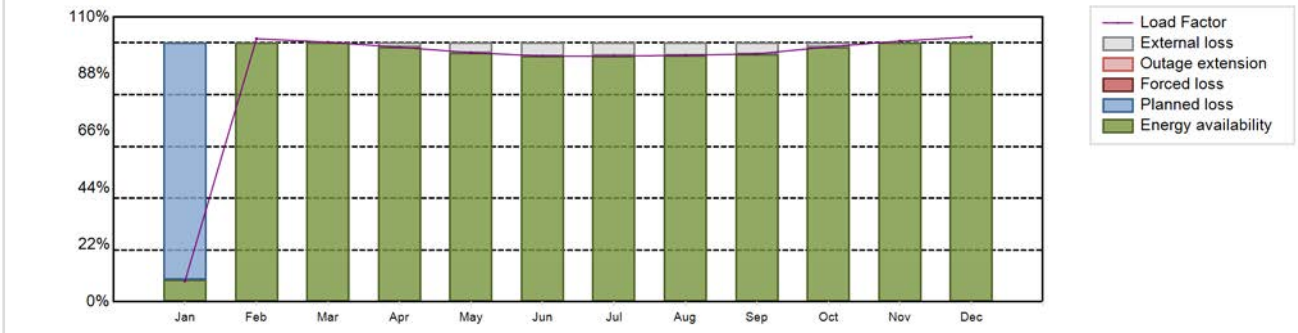
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	8.7
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	293.4
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	Double
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.25
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	15000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.5	HP cylinder inlet steam pressure [MPa]	:	3.972
Active core height/length [m]	:	5	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	3672	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	35.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	4	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	D2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	1604.61 GW(e).h	Forced Loss Rate (FLR)	:	0.03 %
Energy Availability Factor (EAF)	:	90.08 %	Unplanned Capability Loss Factor (UCL)	:	0.02 %
Unit Capability Factor (UCF)	:	92.24 %	Planned Unavailability Factor (PUF)	:	7.74 %
Load Factor (LF)	:	90.43 %	Externally cause unavailability (XUF)	:	2.16 %
Operating Factor (OF)	:	92.43 %	Total off-line time	:	665 hours

Annual Summary



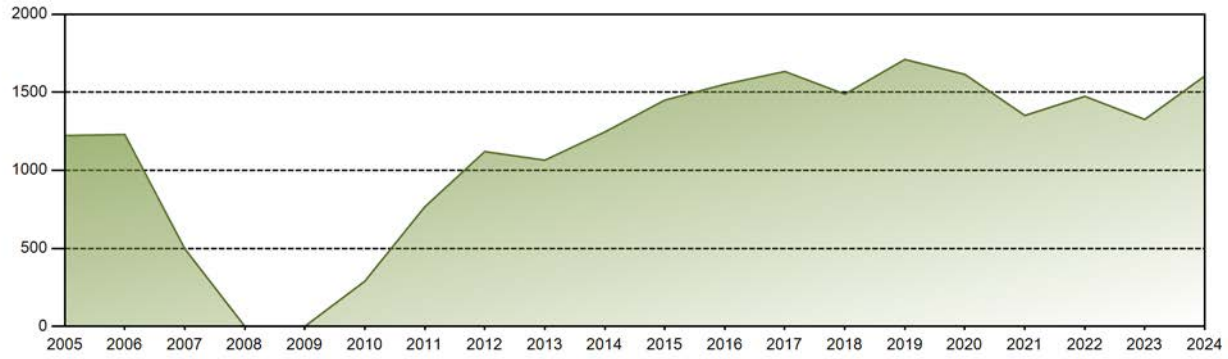
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	12.12	142.85	150.72	143.01	144.63	138.06	142.57	143.16	139.27	148.00	146.48	153.74	1604.61
EAF [%]	8.62	100.00	100.00	98.33	96.24	94.93	94.86	95.26	95.76	98.48	100.00	100.00	90.08
UCF [%]	8.62	100.00	100.00	100.00	100.00	100.00	99.72	100.00	100.00	100.00	100.00	100.00	92.24
LF [%]	8.06	101.61	100.29	98.33	96.24	94.93	94.86	95.26	95.76	98.48	100.72	102.30	90.43
OF [%]	10.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.43
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.03
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.02
PUF [%]	91.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.74
XUF [%]	0.00	0.00	0.00	1.67	3.76	5.07	4.86	4.74	4.24	1.52	0.00	0.00	2.16

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Historical Summary

Lifetime energy generation	:	37679.13 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.39 %
Cumulative Energy Availability Factor (EAF)	:	66.76 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.19 %
Cumulative Unit Capability Factor (UCF)	:	76.31 %	Cumulative Planned Unavailability Factor (PUF)	:	17.5 %
Cumulative Load Factor (LF)	:	65.64 %	Cumulative Externally cause unavailability (XUF)	:	9.55 %
Cumulative Operating Factor (OF)	:	76.58 %			

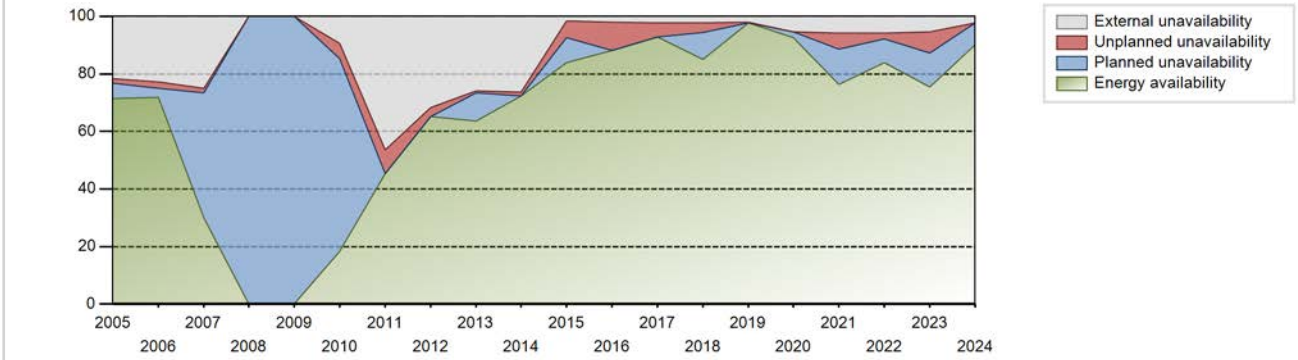
Electricity Production (net) [GWh]



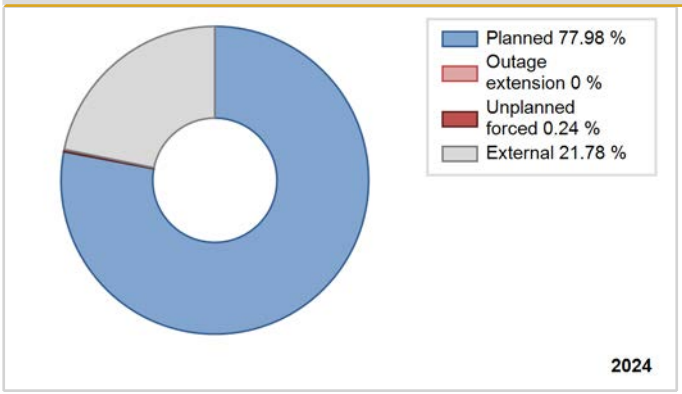
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1992	567.04	3553	201	64.20	65.16	64.20	80.46	34.83	34.83	0.00	0.96
1993	83.31	548	200	4.85	4.85	4.76	6.26	60.06	7.29	87.87	0.00
1994	761.66	5494	200	43.47	53.14	43.47	62.72	33.96	27.33	19.53	9.67
1995	1036.81	5798	200	66.13	68.60	59.18	66.19	31.40	31.40	0.00	2.46
1996	1227.52	6572	200	69.87	79.42	69.87	74.82	11.54	10.36	10.22	9.55
1997	1568.71	8121	200	89.22	91.43	89.54	92.71	5.51	5.33	3.24	2.21
1998	1333.24	6829	200	75.05	80.05	76.10	77.96	5.41	4.58	15.37	5.00
1999	1425.94	7468	200	85.78	86.98	81.39	85.25	5.44	5.01	8.01	1.19
2000	1340.76	7182	200	79.90	80.61	76.32	81.76	10.09	9.05	10.34	0.72
2001	1343.01	6897	200	74.53	75.39	76.66	78.73	13.51	11.78	12.84	0.86
2002	1692.79	8416	202	94.75	95.71	95.66	96.07	3.12	3.17	1.11	0.96
2003	1287.09	7458	202	70.67	85.43	72.74	85.14	4.68	4.20	10.38	14.75
2004	1364.55	8447	202	78.88	96.71	76.90	96.16	1.78	1.76	1.54	17.83
2005	1222.91	7907	202	71.49	93.25	69.11	90.26	1.63	1.55	5.21	21.75
2006	1229.43	8278	202	71.86	94.62	69.48	94.50	2.33	2.26	3.12	22.76
2007	496.85	4808	202	29.99	54.90	28.08	54.89	2.99	1.69	43.41	24.91
2008	0.00	0	202	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2009	0.00	0	202	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2010	289.19	2282	202	18.32	27.79	16.34	26.05	16.16	5.36	66.86	9.46
2011	765.97	8014	202	45.27	91.65	43.29	91.48	8.35	8.35	0.00	46.39
2012	1120.09	8495	202	65.11	96.77	63.13	96.71	3.23	3.23	0.00	31.66
2013	1064.99	7697	202	63.57	89.51	60.19	87.87	0.60	0.54	9.95	25.94
2014	1245.70	8646	202	72.38	98.73	70.40	98.70	1.27	1.27	0.00	26.35
2015	1449.83	7467	202	83.93	85.54	81.93	85.24	4.12	5.86	8.60	1.61
2016	1551.47	7906	202	88.09	90.19	87.44	90.00	9.81	9.81	0.00	2.10
2017	1633.27	8327	202	92.86	95.08	92.30	95.06	4.92	4.92	0.00	2.22
2018	1488.42	7629	202	85.01	87.34	84.11	87.09	2.44	3.26	9.40	2.33
2019	1710.41	8760	202	97.81	99.83	96.66	100.00	0.17	0.17	0.00	2.02
2020	1615.02	8613	202	92.68	97.97	91.02	98.05	0.12	0.12	1.91	5.29
2021	1351.53	7331	202	76.42	82.32	76.38	83.69	6.24	5.48	12.20	5.90
2022	1474.35	8063	202	83.95	89.83	83.32	92.04	2.03	1.86	8.31	5.88
2023	1326.28	7085	202	75.44	80.85	74.95	80.88	8.36	7.37	11.78	5.41
2024	1604.61	8119	202	90.08	92.24	90.43	92.43	0.03	0.02	7.74	2.16

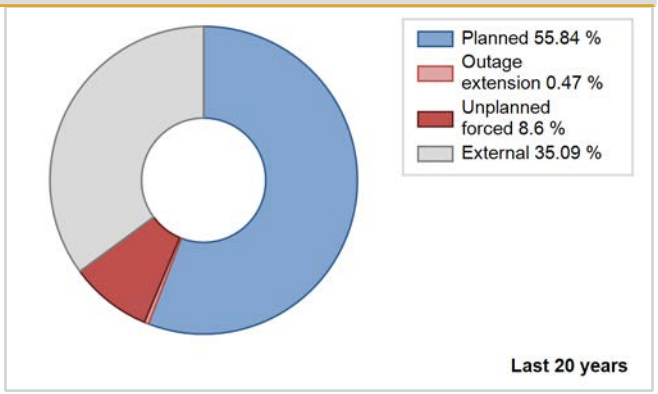
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1992 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					346	
C. Inspection, maintenance or repair combined with refuelling				40		
D. Inspection, maintenance or repair without refuelling	665			711	9	
E. Testing of plant systems or components				14	32	
F. Major backfitting, refurbishment or upgrading activities with refuelling				733		
H. Nuclear regulatory requirements					14	
J. Grid limitation, failure or grid unavailability						55
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						3
L. Human factor related					5	
P. Fire					14	
Z. Other					40	
Subtotal	665			1498	460	58
Total	**665**			**2016**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1992 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		46
12. Reactor I&C Systems		44
13. Reactor Auxiliary Systems		3
14. Safety Systems		2
15. Reactor Cooling Systems		31
16. Steam generation systems		20
17. Safety I&C Systems (excluding reactor I&C)		7
21. Fuel Handling and Storage Facilities		18
31. Turbine and auxiliaries		111
32. Feedwater and Main Steam System		14
33. Circulating Water System		1
34. Miscellaneous Systems		14
41. Main Generator Systems		20
42. Electrical Power Supply Systems		85
Total		**416**

Highlights (2024)

During the year NAPS-2 achieved Availability factor of 92.43% and Capacity factor of 91.73%.

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2024 Operating Experience

IN-4 RAJASTHAN-2 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	AECL/DAE (ATOMIC ENERGY OF CANADA Ltda AND DEPARTMENT OF ATOMIC ENERGY (INDIA))
Turbine Supplier	:	EE (THE ENGLISH ELECTRIC CO., LTD.)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	693 MWth
Gross electrical power	:	200 MWe
Reference unit power (net)	:	187 MWe

Key Dates

Construction Date	:	1968-04-01
Grid Date	:	1980-11-01
Commercial Date	:	1981-04-01
Age at end of year	:	44 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	6700
Active core diameter [m]	:	4.5
Active core height/length [m]	:	5
Number of fissile fuel assemblies/bundles	:	3672
Fuel linear heat generation rate [kW/m]	:	35.3
Number of control rod assemblies	:	-
Number of external reactor coolant loops	:	2
Coolant type	:	D2O

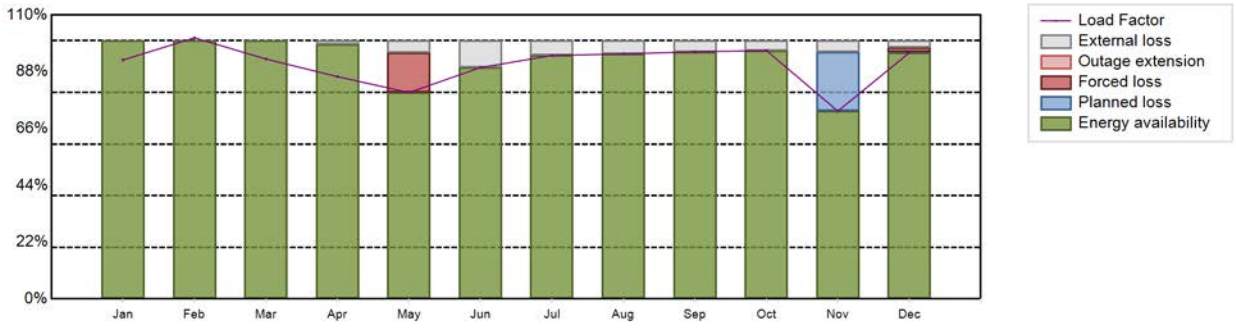
Operating coolant pressure [MPa]	:	11.6
Reactor outlet temperature [°C]	:	304
Number of SG	:	8
Containment type	:	Confinement
Containment design pressure [MPa]	:	1.44
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	4.1
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	PH

Annual Production Results (2024)

Net Energy Production	:	1494.25 GW(e).h
Energy Availability Factor (EAF)	:	93.13 %
Unit Capability Factor (UCF)	:	96.66 %
Load Factor (LF)	:	90.97 %
Operating Factor (OF)	:	94.56 %
Equivalent non-electrical energy generated (NEG)	:	29.27 GW(e).h

Forced Loss Rate (FLR)	:	1.47 %
Unplanned Capability Loss Factor (UCL)	:	1.45 %
Planned Unavailability Factor (PUF)	:	1.9 %
Externally cause unavailability (XUF)	:	3.53 %
Total off-line time	:	478 hours

Annual Summary



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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	128.75	131.64	129.29	115.94	111.24	120.66	131.21	132.05	128.89	133.88	97.96	132.72	1494.25
EAF [%]	100.00	100.00	100.00	98.61	79.96	89.62	94.31	94.91	95.73	96.23	72.75	95.40	93.13
UCF [%]	100.00	100.00	100.00	100.00	84.59	100.00	100.00	100.00	100.00	100.00	77.18	98.04	96.66
LF [%]	92.54	101.15	92.93	86.11	79.96	89.62	94.31	94.91	95.73	96.23	72.75	95.40	90.97
OF [%]	92.20	100.00	93.15	87.78	84.54	100.00	100.00	100.00	100.00	100.00	77.22	99.73	94.56
FLR [%]	0.00	0.00	0.00	0.00	15.41	0.00	0.00	0.00	0.00	0.00	0.00	1.66	1.47
UCL [%]	0.00	0.00	0.00	0.00	15.41	0.00	0.00	0.00	0.00	0.00	0.00	1.66	1.45
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.82	0.30	1.90
XUF [%]	0.00	0.00	0.00	1.39	4.63	10.38	5.69	5.09	4.27	3.77	4.43	2.65	3.53

Historical Summary

Lifetime energy generation	:	40345.21 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	17.58 %
Cumulative Energy Availability Factor (EAF)	:	60.37 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	13.76 %
Cumulative Unit Capability Factor (UCF)	:	63.87 %	Cumulative Planned Unavailability Factor (PUF)	:	22.38 %
Cumulative Load Factor (LF)	:	57.77 %	Cumulative Externally cause unavailability (XUF)	:	3.49 %
Cumulative Operating Factor (OF)	:	67.15 %			

Electricity Production (net) [GWh]

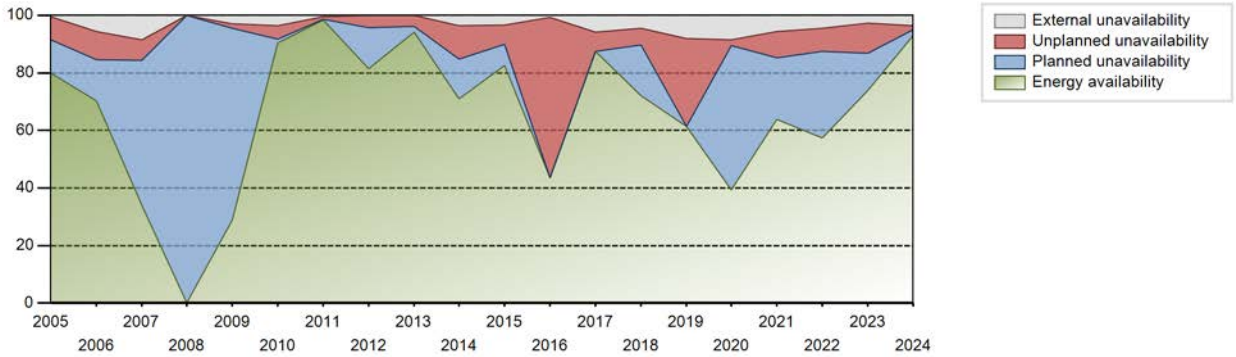


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	686.00	7068	220	38.37	38.37	38.01	80.55	33.17	19.05	42.58	0.00
1982	372.90	3651	206	20.67	20.67	20.66	41.68	79.33	79.33	0.00	0.00
1983	957.20	6673	202	54.11	54.11	54.09	76.18	45.89	45.89	0.00	0.00
1984	908.73	5870	185	49.14	56.12	55.92	66.83	35.88	31.40	12.48	6.98
1985	959.92	6243	184	71.30	73.35	59.55	71.27	26.65	26.65	0.00	2.05
1986	1080.48	6743	207	59.59	65.24	59.59	76.97	18.09	14.41	20.35	5.65
1987	1031.10	6277	207	56.86	63.17	56.86	71.66	19.33	15.14	21.69	6.31
1988	1233.98	7935	207	67.86	70.14	67.86	90.33	25.53	24.05	5.82	2.27
1989	1084.21	6980	207	59.79	60.49	59.79	79.68	33.04	29.85	9.66	0.70
1990	1173.83	7151	192	68.70	68.70	69.79	81.63	19.43	16.57	14.73	0.00
1991	895.11	5416	192	62.95	62.95	53.22	61.83	24.58	20.51	16.54	0.00
1992	874.35	5297	184	58.10	90.30	54.10	60.30	9.70	9.70	0.00	32.20
1993	1153.48	6983	184	71.15	74.22	71.56	79.71	25.78	25.78	0.00	3.08
1994	519.42	3244	184	32.23	39.37	32.23	37.03	11.39	5.06	55.58	7.14
1995	0.00	0	184	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1996	0.00	0	184	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1997	0.00	0	184	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1998	512.37	3728	184	49.60	49.60	31.79	42.56	10.00	5.51	44.89	0.00
1999	1162.33	7264	184	83.11	87.62	72.11	82.92	8.14	7.77	4.61	4.51
2000	1308.11	8104	184	92.26	92.26	80.93	92.26	7.74	7.74	0.00	0.00
2001	1348.28	7486	184	85.48	86.86	83.65	85.46	3.40	3.06	10.08	1.38
2002	1430.87	7768	187	88.99	90.67	87.35	88.68	5.26	5.03	4.30	1.68
2003	1391.45	8018	187	84.70	92.31	84.94	91.53	4.62	4.47	3.23	7.60
2004	1047.75	6806	187	77.84	77.84	63.79	77.48	8.89	7.60	14.56	0.00
2005	1134.78	7581	187	80.01	80.55	69.27	86.54	9.05	8.01	11.44	0.54
2006	1026.82	7207	187	70.37	75.92	62.68	82.27	10.32	9.85	14.23	5.55
2007	508.69	3758	187	33.98	42.38	31.05	42.90	14.53	7.21	50.41	8.40

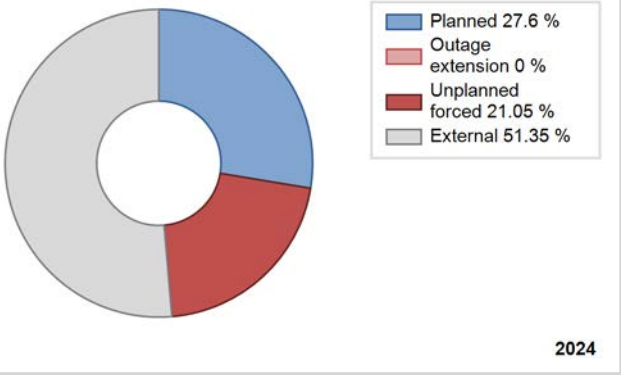
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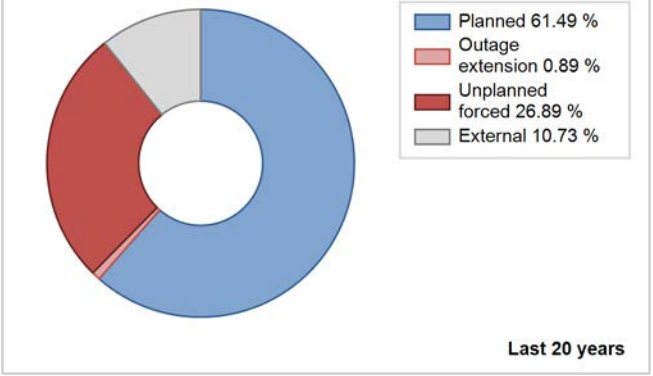
2008	0.00	0	187	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2009	470.72	2795	187	28.74	31.73	28.74	31.91	4.49	1.49	66.77	3.00
2010	1449.01	8286	187	90.47	94.16	88.46	94.59	4.56	4.50	1.34	3.69
2011	1528.78	8518	187	98.34	98.92	93.33	97.24	0.75	0.75	0.33	0.58
2012	1304.66	7265	187	81.50	81.50	79.43	82.71	5.07	4.36	14.14	0.00
2013	1498.71	8327	187	94.13	94.13	91.49	95.06	4.01	3.93	1.94	0.00
2014	1129.42	6534	187	70.92	74.59	68.95	74.59	13.48	11.62	13.79	3.67
2015	1304.85	8067	187	82.55	85.91	79.66	92.09	7.23	6.70	7.39	3.36
2016	711.15	4360	187	43.57	44.22	43.29	49.64	55.78	55.78	0.00	0.65
2017	1424.74	8171	187	87.51	93.32	86.97	93.28	6.68	6.68	0.00	5.81
2018	1187.27	6734	187	72.06	76.45	72.48	76.87	7.19	5.92	17.63	4.38
2019	998.12	6208	187	61.40	69.38	60.93	70.87	30.62	30.62	0.00	7.98
2020	644.59	4201	187	39.24	47.83	39.24	47.83	3.83	1.90	50.27	8.58
2021	1047.41	6093	187	63.94	69.57	63.94	69.55	11.52	9.06	21.38	5.63
2022	940.72	5424	187	57.39	61.93	57.43	61.92	11.39	7.96	30.12	4.54
2023	1211.09	6764	187	73.87	76.66	73.93	77.21	6.53	10.30	13.04	2.79
2024	1494.25	8306	187	93.13	96.66	90.97	94.56	1.47	1.45	1.90	3.53

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1981 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		115			832	
C. Inspection, maintenance or repair combined with refuelling				101		
D. Inspection, maintenance or repair without refuelling	167			1321	2	
E. Testing of plant systems or components					9	
G. Major backfitting, refurbishment or upgrading activities without refuelling				435		
H. Nuclear regulatory requirements					3	
J. Grid limitation, failure or grid unavailability			197			126
L. Human factor related					8	
P. Fire					8	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						10
Z. Other				31	27	1
Subtotal	167	115	197	1888	889	137
Total		**479**			**2914**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		54
12. Reactor I&C Systems		124
13. Reactor Auxiliary Systems		23
14. Safety Systems		18
15. Reactor Cooling Systems	115	145
16. Steam generation systems		106
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		21
31. Turbine and auxiliaries		184
32. Feedwater and Main Steam System		64
33. Circulating Water System		2
34. Miscellaneous Systems		7
35. All other I&C Systems		11
41. Main Generator Systems		46
42. Electrical Power Supply Systems	197	57
Total	**312**	**863**

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2024 Operating Experience

IN-11 RAJASTHAN-3 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	1990-02-01
Grid Date	:	2000-03-10
Commercial Date	:	2000-06-01
Age at end of year	:	24 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	6700
Active core diameter [m]	:	4.5
Active core height/length [m]	:	5
Number of fissile fuel assemblies/bundles	:	3672
Fuel linear heat generation rate [kW/m]	:	35.3
Number of control rod assemblies	:	4
Number of external reactor coolant loops	:	1
Coolant type	:	D2O

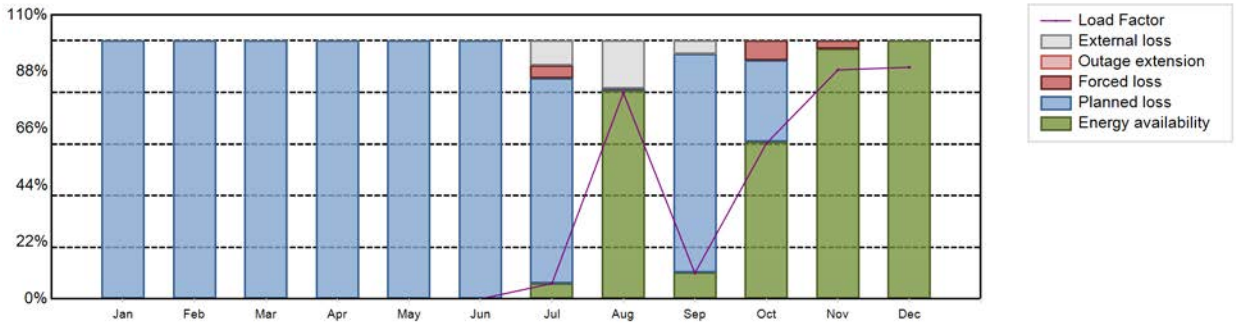
Operating coolant pressure [MPa]	:	8.7
Reactor outlet temperature [°C]	:	293
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	0.42
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	3.972
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	PH

Annual Production Results (2024)

Net Energy Production	:	497.86 GW(e).h
Energy Availability Factor (EAF)	:	29.74 %
Unit Capability Factor (UCF)	:	32.55 %
Load Factor (LF)	:	28.06 %
Operating Factor (OF)	:	33.88 %
Equivalent non-electrical energy generated (NEG)	:	28.36 GW(e).h

Forced Loss Rate (FLR)	:	3.89 %
Unplanned Capability Loss Factor (UCL)	:	1.32 %
Planned Unavailability Factor (PUF)	:	66.13 %
Externally cause unavailability (XUF)	:	2.81 %
Total off-line time	:	5808 hours

Annual Summary



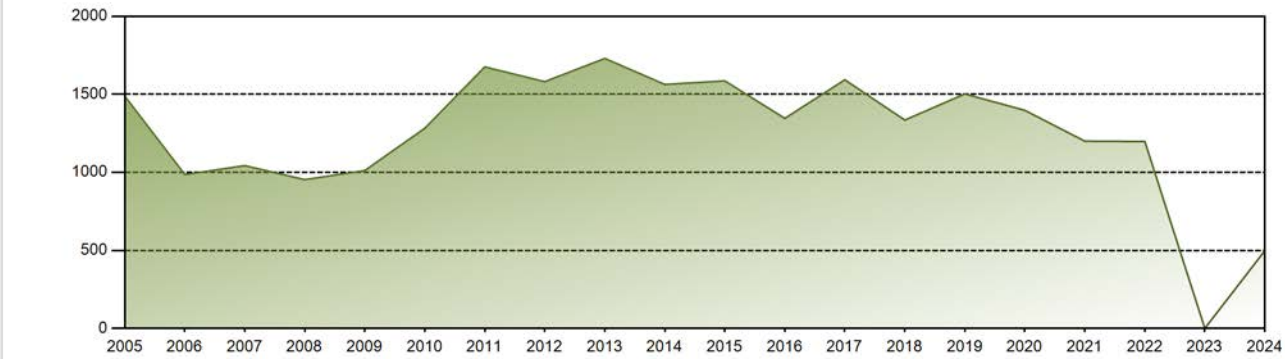
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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	0.00	0.00	0.00	0.00	9.01	119.89	14.53	90.55	129.00	134.88	497.86
EAF [%]	0.00	0.00	0.00	0.00	0.00	0.00	5.99	80.76	10.16	60.93	96.79	100.00	29.74
UCF [%]	0.00	0.00	0.00	0.00	0.00	0.00	15.64	99.22	15.36	60.93	96.79	100.00	32.55
LF [%]	0.00	0.00	0.00	0.00	0.00	0.00	6.00	79.77	9.99	60.25	88.70	89.75	28.06
OF [%]	0.00	0.00	0.00	0.00	0.00	0.00	18.55	99.87	17.08	68.41	99.86	100.00	33.88
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	23.40	0.14	0.00	11.01	3.21	0.00	3.89
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	4.78	0.14	0.00	7.54	3.21	0.00	1.32
PUF [%]	100.00	100.00	100.00	100.00	100.00	100.00	79.58	0.64	84.64	31.53	0.00	0.00	66.13
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	9.65	18.46	5.20	0.00	0.00	0.00	2.81

Historical Summary

Lifetime energy generation	:	31524.11 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.45 %
Cumulative Energy Availability Factor (EAF)	:	74.88 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.92 %
Cumulative Unit Capability Factor (UCF)	:	84.06 %	Cumulative Planned Unavailability Factor (PUF)	:	12.02 %
Cumulative Load Factor (LF)	:	71.6 %	Cumulative Externally cause unavailability (XUF)	:	9.18 %
Cumulative Operating Factor (OF)	:	84.14 %			

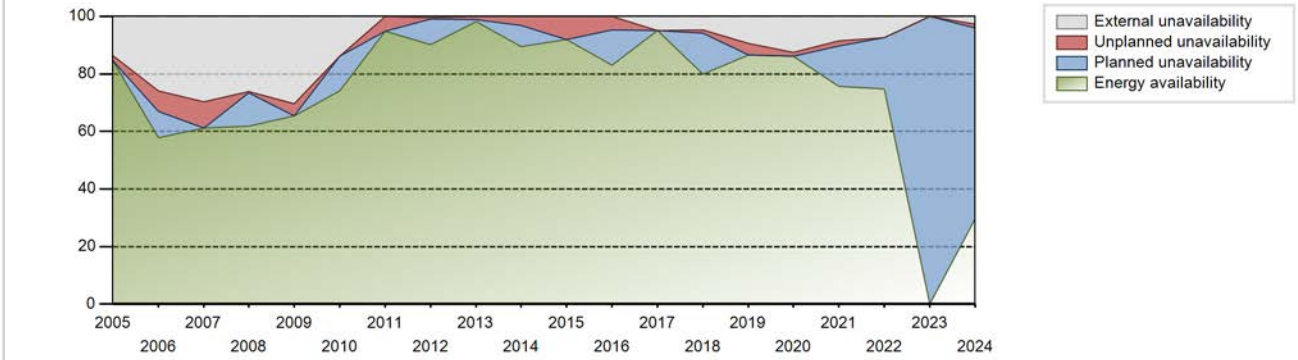
Electricity Production (net) [GWh]



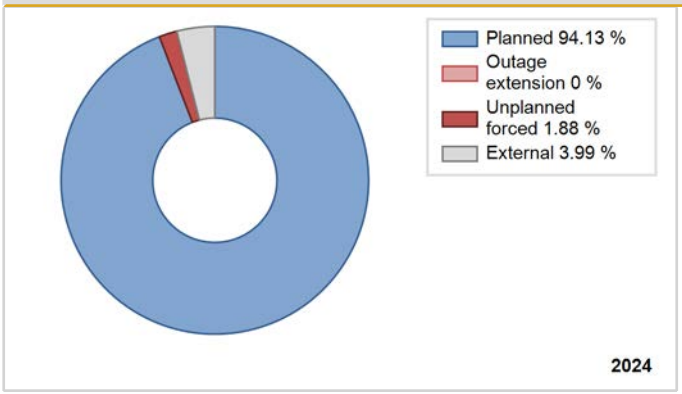
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2000	893.76	4794	200	76.36	76.36	77.64	77.59	23.64	23.64	0.00	0.00
2001	1366.08	7317	200	83.58	84.85	77.97	83.53	15.15	15.15	0.00	1.27
2002	1317.95	6715	202	75.54	81.17	74.48	76.66	5.31	4.55	14.28	5.63
2003	1442.06	8285	202	84.53	95.29	81.49	94.58	4.71	4.71	0.00	10.77
2004	1260.33	7711	202	72.28	90.02	71.03	87.78	3.17	2.94	7.04	17.74
2005	1487.92	8581	202	84.56	98.27	84.09	97.96	1.73	1.73	0.00	13.71
2006	985.60	7323	202	57.83	83.76	55.70	83.60	7.87	7.15	9.09	25.93
2007	1043.01	7934	202	61.07	90.67	58.94	90.57	9.33	9.33	0.00	29.59
2008	952.90	7707	202	61.80	87.86	53.70	87.74	0.60	0.53	11.61	26.06
2009	1011.51	8338	202	65.49	95.78	57.16	95.18	4.22	4.22	0.00	30.29
2010	1282.09	7699	202	74.20	88.01	72.45	87.89	0.00	0.00	11.99	13.80
2011	1675.45	8307	202	94.89	94.89	94.68	94.83	5.11	5.11	0.00	0.00
2012	1581.04	7932	202	90.23	90.77	89.10	90.30	0.45	0.41	8.82	0.54
2013	1729.79	8603	202	98.23	98.23	97.75	98.21	1.23	1.23	0.55	0.00
2014	1563.28	7991	202	89.54	89.54	88.35	91.22	3.38	3.13	7.33	0.00
2015	1585.87	8431	202	92.04	92.04	89.62	96.24	7.96	7.96	0.00	0.00
2016	1345.94	7519	202	82.99	82.99	75.85	85.60	5.36	4.70	12.31	0.00
2017	1592.74	8758	202	95.03	99.98	90.01	99.98	0.02	0.02	0.00	4.95
2018	1335.05	7489	202	79.86	84.52	75.45	85.49	1.47	1.26	14.22	4.66
2019	1502.33	8514	202	86.53	95.93	84.90	97.19	4.07	4.07	0.00	9.40
2020	1397.32	8662	202	86.17	98.63	78.75	98.61	1.37	1.37	0.00	12.46
2021	1199.71	7362	202	75.60	84.04	67.80	84.04	2.15	1.85	14.11	8.45
2022	1197.78	7198	202	74.75	82.17	67.69	82.17	0.00	0.00	17.83	7.42
2023	0.00	0	202	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2024	497.86	2976	202	29.74	32.55	28.06	33.88	3.89	1.32	66.13	2.81

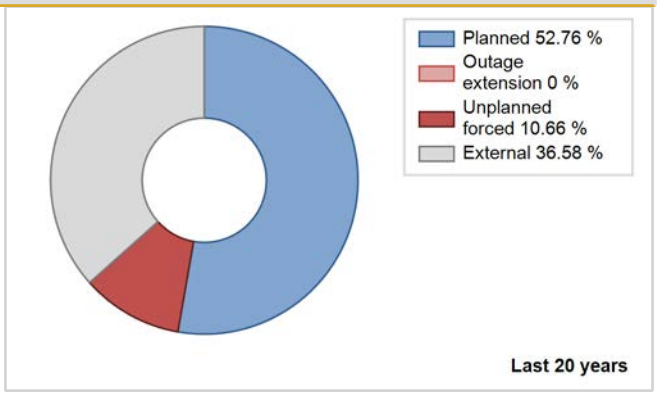
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2000 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		38			297	
D. Inspection, maintenance or repair without refuelling	832			442		
E. Testing of plant systems or components					15	
G. Major backfitting, refurbishment or upgrading activities without refuelling	4939			621		
J. Grid limitation, failure or grid unavailability						30
L. Human factor related					5	
Subtotal	5771	38		1063	317	30
Total		**5809**			**1410**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2000 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		11
12. Reactor I&C Systems		68
13. Reactor Auxiliary Systems		20
15. Reactor Cooling Systems		26
16. Steam generation systems		17
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		15
31. Turbine and auxiliaries	38	46
32. Feedwater and Main Steam System		36
33. Circulating Water System		2
34. Miscellaneous Systems		2
41. Main Generator Systems		31
42. Electrical Power Supply Systems		38
Total	**38**	**313**

Highlights (2024)

During the year Unit achieved Availability factor of 77.38% and Capacity factor of 71,54%.

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2024 Operating Experience

IN-12 RAJASTHAN-4 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	1990-10-01
Grid Date	:	2000-11-17
Commercial Date	:	2000-12-23
Age at end of year	:	24 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	6700
Active core diameter [m]	:	4.5
Active core height/length [m]	:	5
Number of fissile fuel assemblies/bundles	:	3672
Fuel linear heat generation rate [kW/m]	:	20.6
Number of control rod assemblies	:	4
Number of external reactor coolant loops	:	1
Coolant type	:	D2O

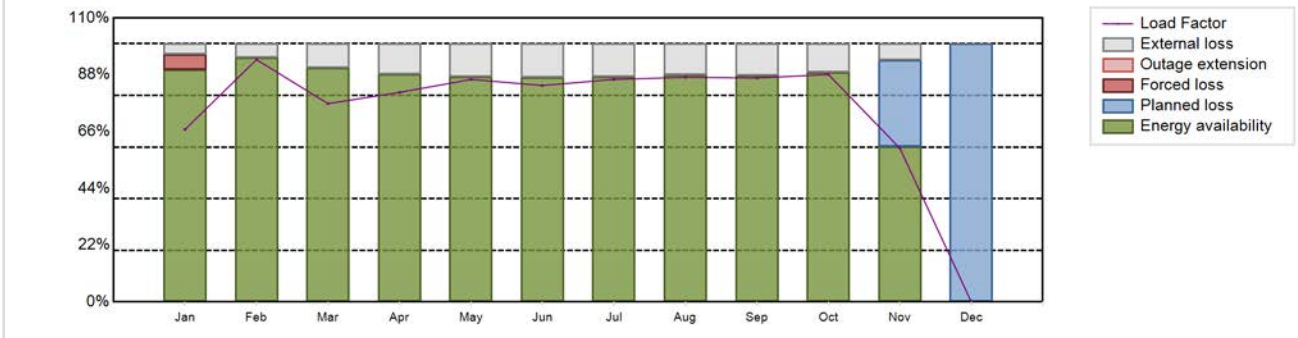
Operating coolant pressure [MPa]	:	8.7
Reactor outlet temperature [°C]	:	293
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	0.42
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	3.972
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	PH

Annual Production Results (2024)

Net Energy Production	:	1322.76 GW(e).h
Energy Availability Factor (EAF)	:	79.03 %
Unit Capability Factor (UCF)	:	88.29 %
Load Factor (LF)	:	74.55 %
Operating Factor (OF)	:	85.91 %
Equivalent non-electrical energy generated (NEG)	:	28.31 GW(e).h

Forced Loss Rate (FLR)	:	0.57 %
Unplanned Capability Loss Factor (UCL)	:	0.5 %
Planned Unavailability Factor (PUF)	:	11.21 %
Externally cause unavailability (XUF)	:	9.26 %
Total off-line time	:	1238 hours

Annual Summary



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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	100.40	131.94	115.46	118.05	129.50	121.96	129.54	130.76	126.15	132.41	86.60	0.00	1322.76
EAF [%]	90.04	94.60	90.63	88.21	87.11	87.04	87.13	87.95	87.68	89.04	60.17	0.00	79.03
UCF [%]	94.05	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	66.61	0.00	88.29
LF [%]	66.81	93.85	76.83	81.16	86.17	83.85	86.19	87.01	86.74	88.10	59.54	0.00	74.55
OF [%]	74.19	100.00	93.01	98.61	100.00	100.00	100.00	100.00	100.00	100.00	66.67	0.00	85.91
FLR [%]	5.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57
UCL [%]	5.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.39	100.00	11.21
XUF [%]	4.00	5.40	9.37	11.79	12.89	12.96	12.87	12.05	12.32	10.96	6.44	0.00	9.26

Historical Summary

Lifetime energy generation	:	34061.93 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.69 %
Cumulative Energy Availability Factor (EAF)	:	81.74 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.85 %
Cumulative Unit Capability Factor (UCF)	:	90.91 %	Cumulative Planned Unavailability Factor (PUF)	:	5.25 %
Cumulative Load Factor (LF)	:	79.32 %	Cumulative Externally cause unavailability (XUF)	:	9.17 %
Cumulative Operating Factor (OF)	:	90.24 %			

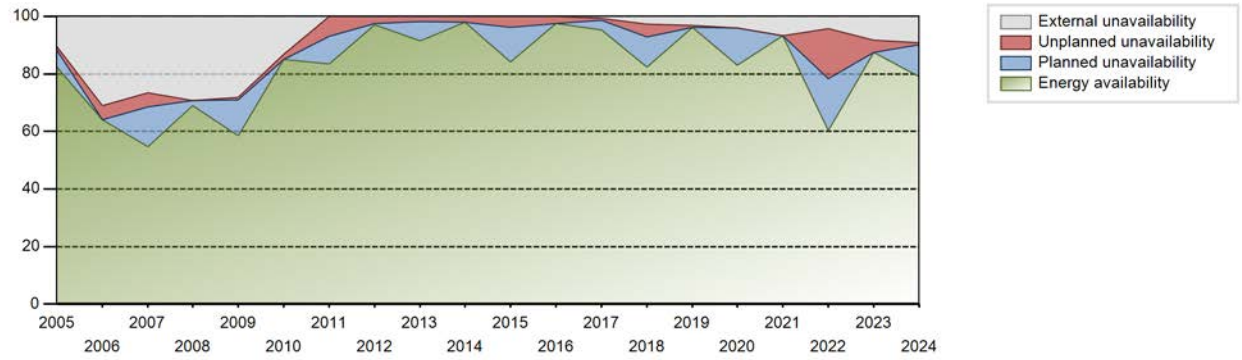
Electricity Production (net) [GWh]



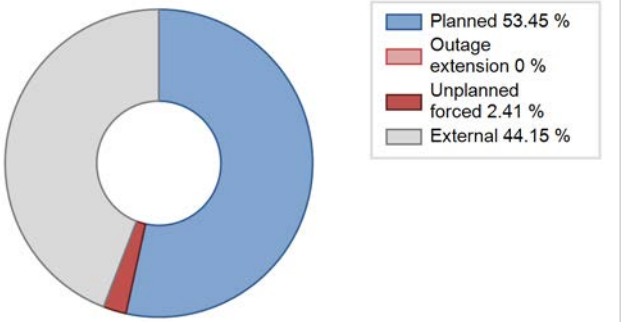
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2000	57.46	518	200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	1200.83	6214	200	71.01	81.99	68.54	70.94	18.01	18.01	0.00	10.98
2002	1671.49	8255	202	94.30	96.52	94.46	94.24	3.48	3.48	0.00	2.22
2003	1318.22	7633	202	74.78	87.55	74.50	87.13	5.77	5.36	7.09	12.77
2004	1447.74	8329	202	79.49	95.78	81.59	94.82	4.22	4.22	0.00	16.29
2005	1461.94	8074	202	82.29	92.77	82.62	92.17	1.52	1.43	5.80	10.49
2006	1128.13	8334	202	64.10	95.18	63.75	95.14	4.82	4.82	0.00	31.08
2007	943.36	7101	202	54.68	81.17	53.31	81.06	5.74	4.94	13.89	26.49
2008	1041.60	8626	202	69.05	98.21	58.70	98.20	0.00	0.00	1.79	29.17
2009	859.80	7542	202	58.54	86.76	48.59	86.10	0.83	0.72	12.52	28.22
2010	1490.50	8598	202	84.93	98.17	84.23	98.15	1.83	1.83	0.00	13.24
2011	1435.59	7299	202	83.49	83.49	81.13	83.32	7.68	6.94	9.57	0.00
2012	1734.64	8512	202	97.09	97.09	97.76	96.90	2.51	2.50	0.42	0.00
2013	1651.99	7999	202	91.40	91.40	93.36	91.31	1.90	1.77	6.83	0.00
2014	1778.77	8575	202	97.91	97.91	100.52	97.89	2.09	2.09	0.00	0.00
2015	1484.17	7362	202	84.20	84.20	83.87	84.04	4.38	3.85	11.95	0.00
2016	1682.21	8559	202	97.46	97.46	94.81	97.44	2.54	2.54	0.00	0.00
2017	1653.11	8399	202	95.19	95.93	93.42	95.88	0.57	0.55	3.53	0.74
2018	1450.03	7441	202	82.41	85.03	81.94	84.94	5.02	4.49	10.48	2.61
2019	1542.80	8701	202	96.26	99.33	87.19	99.33	0.67	0.67	0.00	3.07
2020	1452.54	7641	202	83.07	87.12	81.86	86.99	0.00	0.00	12.88	4.05
2021	1542.54	8760	202	93.18	100.00	87.17	100.00	0.00	0.00	0.00	6.82
2022	1039.61	5959	202	60.33	64.55	58.75	68.03	12.01	17.49	17.96	4.22
2023	1360.73	8390	202	87.42	95.74	76.90	95.78	4.26	4.26	0.00	8.32
2024	1322.76	7546	202	79.03	88.29	74.55	85.91	0.57	0.50	11.21	9.26

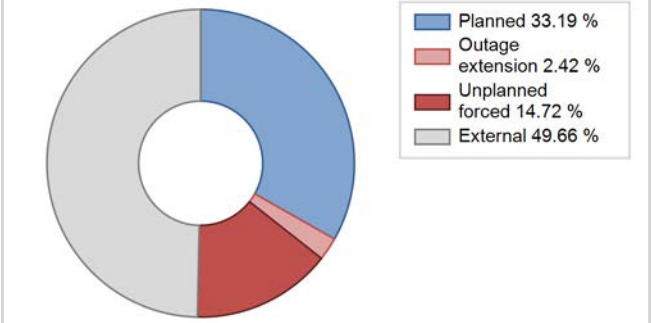
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2000 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		40			244	
D. Inspection, maintenance or repair without refuelling	984			462		
E. Testing of plant systems or components					0	
J. Grid limitation, failure or grid unavailability			213			57
L. Human factor related					8	
Z. Other					32	
Subtotal	984	40	213	462	284	57
Total	**1237**			**803**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2000 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		24
13. Reactor Auxiliary Systems		7
14. Safety Systems		13
15. Reactor Cooling Systems		44
16. Steam generation systems		42
21. Fuel Handling and Storage Facilities		7
31. Turbine and auxiliaries		12
32. Feedwater and Main Steam System		27
34. Miscellaneous Systems		4
41. Main Generator Systems		20
42. Electrical Power Supply Systems	253	51
Total	**253**	**258**

Highlights (2024)

During the year Unit achieved Availabity factor of 85.91% and Capacity factor of 78.64%.

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2024 Operating Experience

IN-19 RAJASTHAN-5 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	TURBOATO (TURBOATOM Kharkiv Turbine Manufacture Plant)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	2002-09-18
Grid Date	:	2009-12-22
Commercial Date	:	2010-02-04
Age at end of year	:	15 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	7000
Active core diameter [m]	:	6.38
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	5096
Fuel linear heat generation rate [kW/m]	:	20.18
Number of control rod assemblies	:	4
Number of external reactor coolant loops	:	1
Coolant type	:	D2O

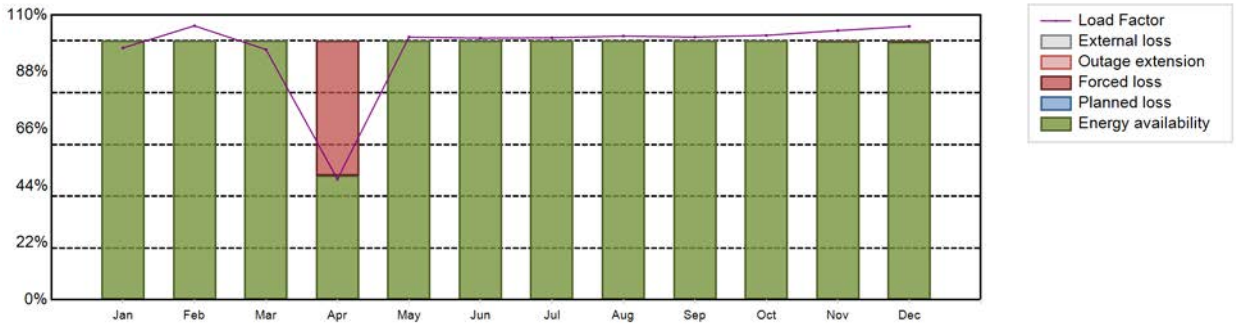
Operating coolant pressure [MPa]	:	1.034
Reactor outlet temperature [°C]	:	293
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	1.73
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	3.972
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	1723.82 GW(e).h
Energy Availability Factor (EAF)	:	95.69 %
Unit Capability Factor (UCF)	:	95.69 %
Load Factor (LF)	:	97.15 %
Operating Factor (OF)	:	94.5 %

Forced Loss Rate (FLR)	:	4.31 %
Unplanned Capability Loss Factor (UCL)	:	4.31 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	483 hours

Annual Summary



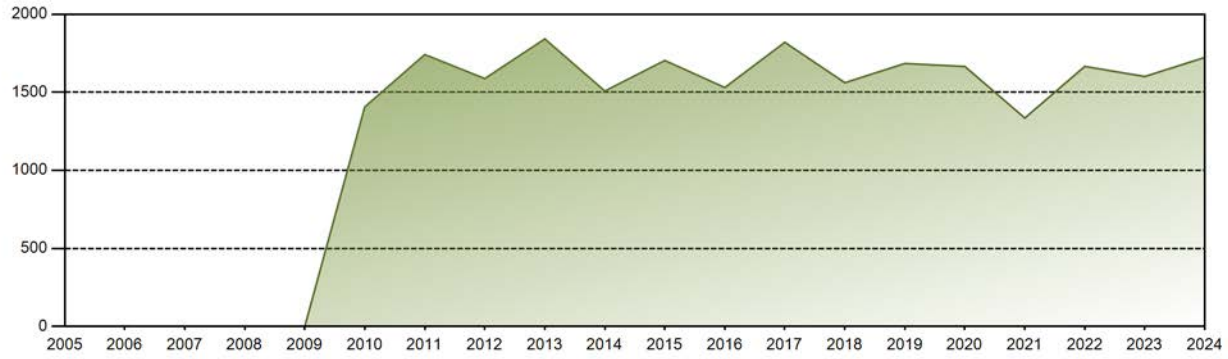
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	146.21	148.79	145.30	67.79	152.46	147.03	152.11	153.07	147.57	153.52	151.26	158.72	1723.82
EAF [%]	100.00	100.00	100.00	47.98	100.00	100.00	100.00	100.00	100.00	100.00	99.89	99.53	95.69
UCF [%]	100.00	100.00	100.00	47.98	100.00	100.00	100.00	100.00	100.00	100.00	99.89	99.53	95.69
LF [%]	97.29	105.83	96.68	46.61	101.45	101.10	101.21	101.85	101.46	102.15	104.00	105.61	97.15
OF [%]	92.34	100.00	93.15	47.92	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.50
FLR [%]	0.00	0.00	0.00	52.02	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.47	4.31
UCL [%]	0.00	0.00	0.00	52.02	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.47	4.31
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

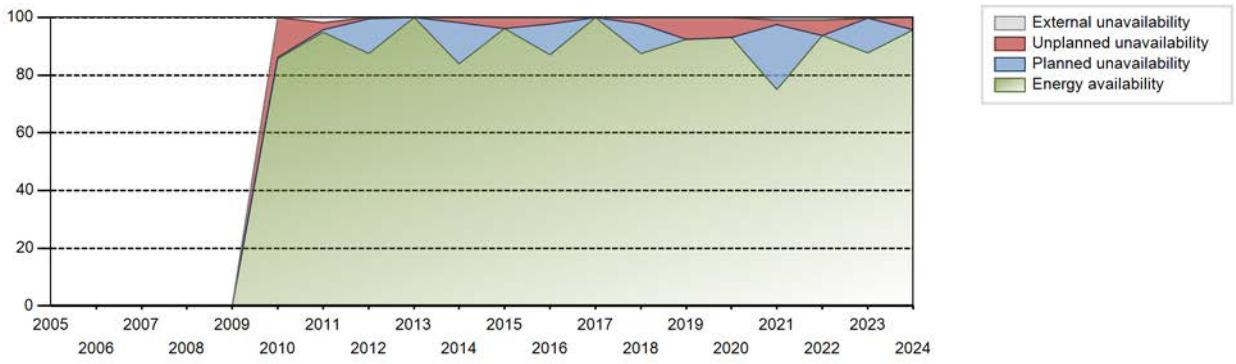
Lifetime energy generation	:	24379.75 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.67 %
Cumulative Energy Availability Factor (EAF)	:	90.72 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.47 %
Cumulative Unit Capability Factor (UCF)	:	90.99 %	Cumulative Planned Unavailability Factor (PUF)	:	5.54 %
Cumulative Load Factor (LF)	:	92.31 %	Cumulative Externally cause unavailability (XUF)	:	0.27 %
Cumulative Operating Factor (OF)	:	90.85 %			

Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2010	1406.17	7158	202	85.72	85.72	86.84	89.30	14.00	13.95	0.32	0.00
2011	1741.80	8325	202	94.91	96.66	98.43	95.03	2.56	2.54	0.80	1.75
2012	1587.81	7590	202	87.49	87.49	89.49	86.41	0.63	0.55	11.95	0.00
2013	1842.26	8760	202	100.00	100.00	104.11	100.00	0.00	0.00	0.00	0.00
2014	1508.24	7329	202	83.83	83.83	85.23	83.66	2.06	1.76	14.40	0.00
2015	1703.88	8429	202	96.28	96.28	96.29	96.22	3.72	3.72	0.00	0.00
2016	1530.66	7643	202	87.14	87.14	86.27	87.01	2.61	2.34	10.52	0.00
2017	1820.58	8760	202	100.00	100.00	102.89	100.00	0.00	0.00	0.00	0.00
2018	1561.42	7654	202	87.51	87.51	88.24	87.37	2.51	2.25	10.24	0.00
2019	1684.90	8087	202	92.41	92.41	95.22	92.32	7.59	7.59	0.00	0.00
2020	1665.65	8159	202	92.98	92.98	93.87	92.88	7.02	7.02	0.00	0.00
2021	1335.29	6610	202	75.09	76.08	75.46	75.46	2.00	1.55	22.36	0.99
2022	1665.99	8293	202	93.70	94.72	94.15	94.67	5.28	5.28	0.00	1.02
2023	1601.27	7691	202	87.64	87.91	90.49	87.80	0.00	0.00	12.09	0.27
2024	1723.82	8301	202	95.69	95.69	97.15	94.50	4.31	4.31	0.00	0.00

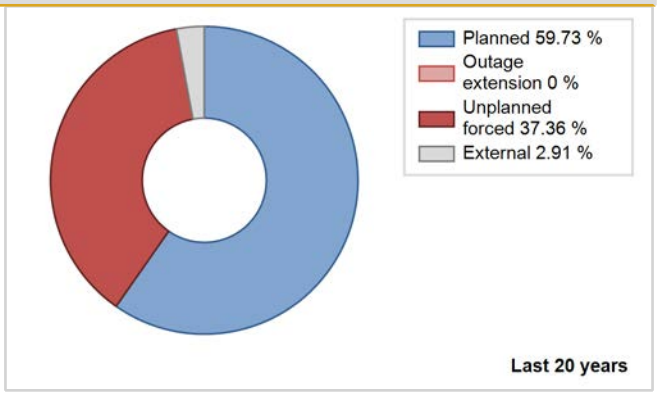
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2010 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					246	
D. Inspection, maintenance or repair without refuelling				481		
E. Testing of plant systems or components				2	0	
J. Grid limitation, failure or grid unavailability			108			23
L. Human factor related					4	
Z. Other		375		7	36	4
Subtotal		375	108	490	286	27
Total		**483**			**803**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2010 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		72
12. Reactor I&C Systems		34
15. Reactor Cooling Systems	375	66
16. Steam generation systems		3
21. Fuel Handling and Storage Facilities		0
31. Turbine and auxiliaries		16
33. Circulating Water System		10
34. Miscellaneous Systems		3
35. All other I&C Systems		0
41. Main Generator Systems		87
42. Electrical Power Supply Systems	108	14
Total	**483**	**305**

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2024 Operating Experience

IN-20 RAJASTHAN-6 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	TURBOATO (TURBOATOM Kharkiv Turbine Manufacture Plant)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube type
Thermal power	:	801 MWth
Gross electrical power	:	220 MWe
Reference unit power (net)	:	202 MWe

Key Dates

Construction Date	:	2003-01-20
Grid Date	:	2010-03-28
Commercial Date	:	2010-03-31
Age at end of year	:	14 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	7000
Active core diameter [m]	:	6.38
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	5096
Fuel linear heat generation rate [kW/m]	:	20.18
Number of control rod assemblies	:	4
Number of external reactor coolant loops	:	1
Coolant type	:	D2O

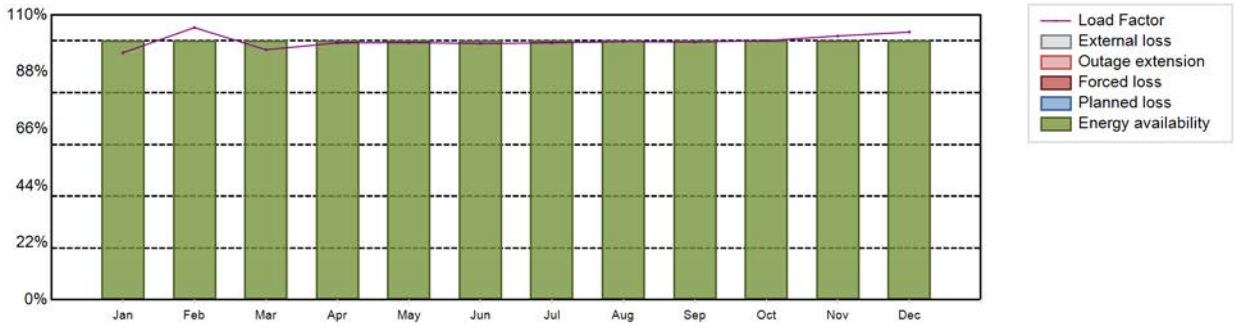
Operating coolant pressure [MPa]	:	0.991
Reactor outlet temperature [°C]	:	293
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	1.73
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	3.972
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	1771.92 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	99.86 %
Operating Factor (OF)	:	98.59 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	124 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	143.42	147.81	145.15	144.32	149.32	143.95	149.19	149.89	144.80	150.46	148.20	155.40	1771.92
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00
LF [%]	95.43	105.14	96.58	99.23	99.36	98.97	99.27	99.73	99.56	100.12	101.90	103.40	99.86
OF [%]	91.13	100.00	93.55	98.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.59
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

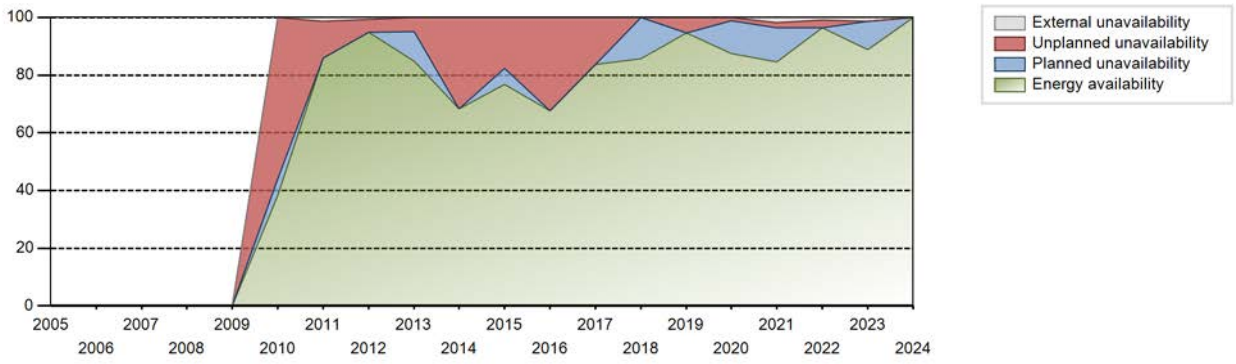
Lifetime energy generation	:	21911.17 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	12.24 %
Cumulative Energy Availability Factor (EAF)	:	83.28 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	11.76 %
Cumulative Unit Capability Factor (UCF)	:	83.69 %	Cumulative Planned Unavailability Factor (PUF)	:	4.55 %
Cumulative Load Factor (LF)	:	83.87 %	Cumulative Externally cause unavailability (XUF)	:	0.41 %
Cumulative Operating Factor (OF)	:	84.3 %			

Electricity Production (net) [GWh]



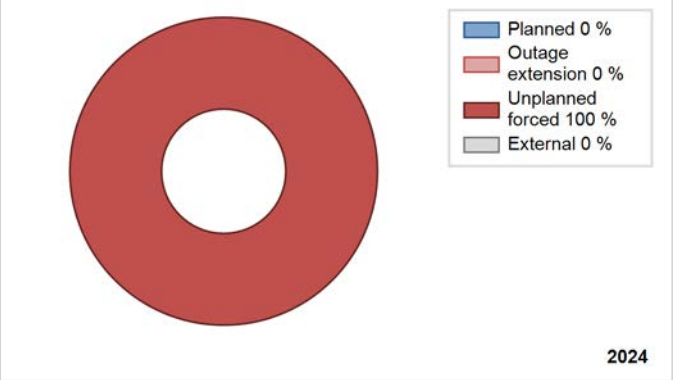
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2010	494.85	3041	202	38.11	38.11	37.12	46.08	59.53	56.06	5.83	0.00
2011	1570.55	7506	202	85.84	87.27	88.76	85.68	12.73	12.73	0.00	1.43
2012	1711.31	8317	202	94.75	95.52	96.45	94.68	4.48	4.48	0.00	0.76
2013	1533.21	7420	202	84.87	84.87	86.65	84.70	5.38	4.83	10.30	0.00
2014	1231.86	6514	202	68.36	68.36	69.62	74.36	31.64	31.64	0.00	0.00
2015	1333.69	7042	202	76.86	76.86	75.37	80.39	18.72	17.70	5.44	0.00
2016	1153.85	5921	202	67.75	67.75	65.03	67.41	32.25	32.25	0.00	0.00
2017	1436.62	7321	202	83.74	83.74	81.19	83.57	16.26	16.26	0.00	0.00
2018	1543.92	7489	202	85.64	85.64	87.25	85.49	0.01	0.01	14.35	0.00
2019	1711.86	8281	202	94.59	94.59	96.74	94.53	5.41	5.41	0.00	0.00
2020	1580.21	7680	202	87.56	87.56	89.06	87.43	0.00	1.26	11.19	0.00
2021	1519.08	7429	202	84.67	86.42	85.85	84.81	2.18	1.93	11.65	1.75
2022	1728.96	8513	202	96.38	97.20	97.71	97.18	2.80	2.80	0.00	0.82
2023	1589.28	7890	202	88.85	90.16	89.81	90.07	0.00	0.00	9.84	1.31
2024	1771.92	8660	202	100.00	100.00	99.86	98.59	0.00	0.00	0.00	0.00

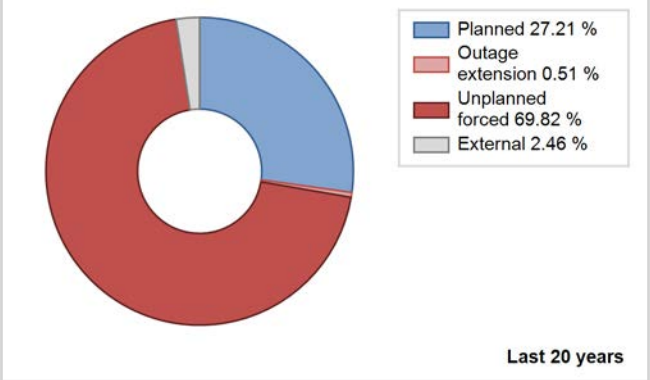
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2010 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					920	
D. Inspection, maintenance or repair without refuelling				401		
J. Grid limitation, failure or grid unavailability			128			22
L. Human factor related					16	
P. Fire					5	
Z. Other						9
Subtotal			128	401	941	31
Total		**128**			**1373**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2010 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		40
12. Reactor I&C Systems		24
13. Reactor Auxiliary Systems		5
14. Safety Systems		8
15. Reactor Cooling Systems		4
16. Steam generation systems		27
31. Turbine and auxiliaries		143
32. Feedwater and Main Steam System		6
33. Circulating Water System		13
35. All other I&C Systems		4
41. Main Generator Systems		426
42. Electrical Power Supply Systems	128	258
Total	**128**	**958**

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2024 Operating Experience

IN-23 TARAPUR-3 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube Type
Thermal power	:	1730 MWth
Gross electrical power	:	540 MWe
Reference unit power (net)	:	490 MWe

Key Dates

Construction Date	:	2000-05-12
Grid Date	:	2006-06-15
Commercial Date	:	2006-08-18
Age at end of year	:	18 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	7000
Active core diameter [m]	:	6.38
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	5096
Fuel linear heat generation rate [kW/m]	:	20.18
Number of control rod assemblies	:	4
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

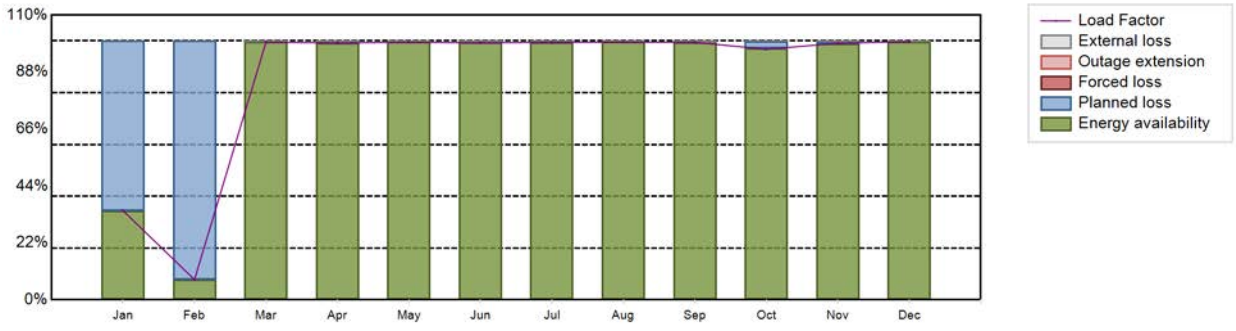
Operating coolant pressure [MPa]	:	0.7
Reactor outlet temperature [°C]	:	304
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	1.44
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	4.1
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3720.12 GW(e).h
Energy Availability Factor (EAF)	:	86.43 %
Unit Capability Factor (UCF)	:	86.82 %
Load Factor (LF)	:	86.43 %
Operating Factor (OF)	:	87.43 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	13.18 %
Externally cause unavailability (XUF)	:	0.39 %
Total off-line time	:	1104 hours

Annual Summary



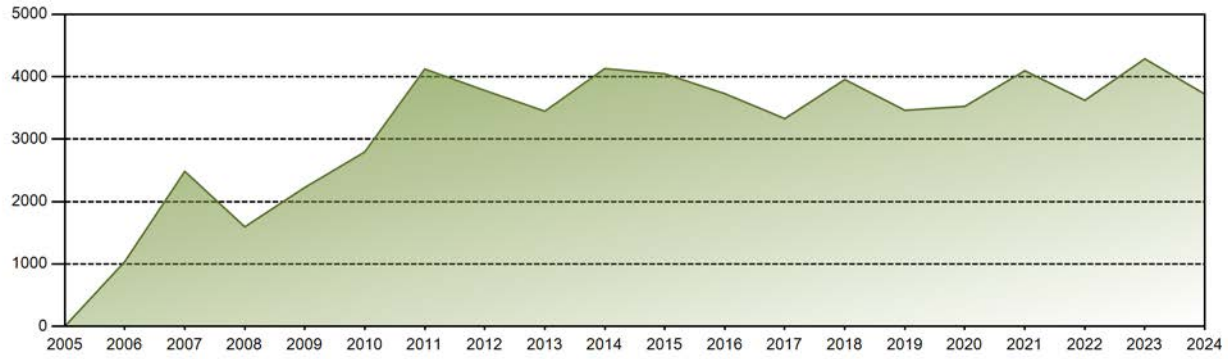
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	125.63	26.67	362.75	350.02	362.74	350.14	362.64	362.78	350.82	352.83	349.58	363.51	3720.12
EAF [%]	34.46	7.82	99.50	99.21	99.50	99.25	99.47	99.51	99.44	97.01	98.85	99.71	86.43
UCF [%]	34.46	7.82	100.00	100.00	100.00	100.00	99.64	100.00	100.00	97.15	99.35	100.00	86.82
LF [%]	34.46	7.82	99.50	99.21	99.50	99.25	99.47	99.51	99.44	96.78	99.09	99.71	86.43
OF [%]	35.22	10.63	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	87.43
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	65.54	92.18	0.00	0.00	0.00	0.00	0.36	0.00	0.00	2.85	0.65	0.00	13.18
XUF [%]	0.00	0.00	0.50	0.79	0.50	0.75	0.17	0.49	0.56	0.13	0.50	0.29	0.39

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Historical Summary

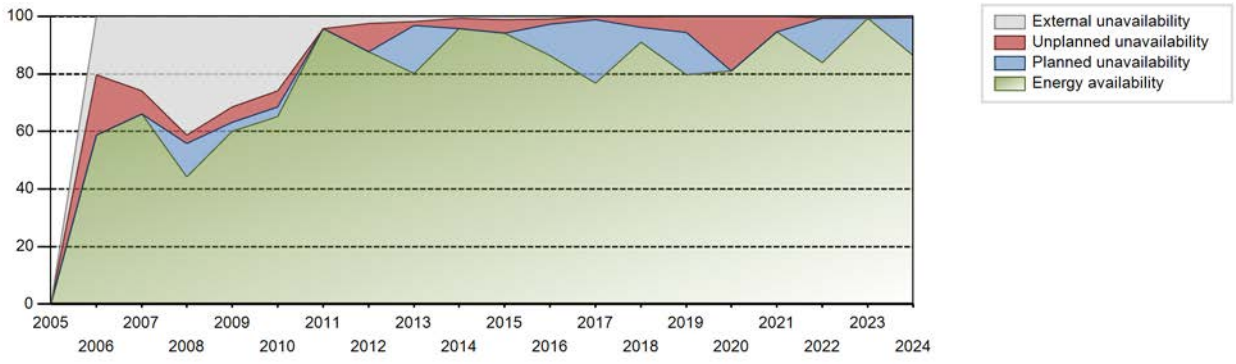
Lifetime energy generation	:	63366.24 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.78 %
Cumulative Energy Availability Factor (EAF)	:	81.15 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.66 %
Cumulative Unit Capability Factor (UCF)	:	89 %	Cumulative Planned Unavailability Factor (PUF)	:	6.34 %
Cumulative Load Factor (LF)	:	80.27 %	Cumulative Externally cause unavailability (XUF)	:	7.85 %
Cumulative Operating Factor (OF)	:	89.1 %			

Electricity Production (net) [GWh]



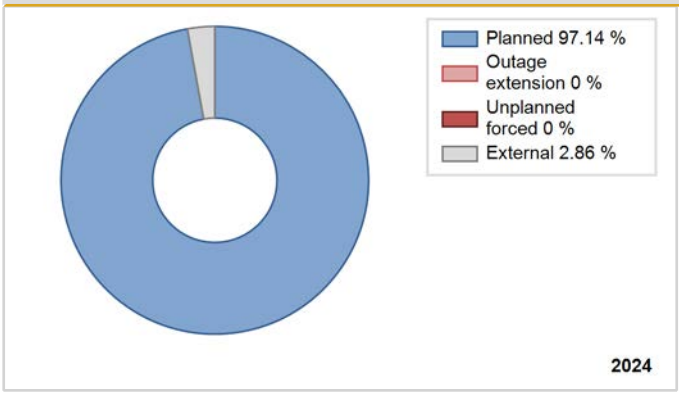
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2006	1037.77	3599	490	58.83	79.15	61.08	80.50	20.85	20.85	0.00	20.32
2007	2482.81	7967	490	66.18	92.12	57.84	90.95	7.88	7.88	0.00	25.93
2008	1594.38	7465	490	44.33	85.57	37.04	84.98	3.24	2.86	11.56	41.25
2009	2225.01	8022	490	60.11	91.58	51.84	91.58	5.45	5.27	3.15	31.47
2010	2794.03	7972	490	65.09	91.01	65.09	91.00	4.64	5.50	3.49	25.92
2011	4122.20	8760	490	95.78	100.00	96.03	100.00	0.00	0.00	0.00	4.22
2012	3779.47	7923	490	87.67	90.20	87.81	90.20	9.80	9.80	0.00	2.53
2013	3447.26	7200	490	80.22	82.08	80.31	82.19	1.53	1.28	16.65	1.86
2014	4129.97	8463	490	95.79	96.51	96.22	96.61	3.49	3.49	0.00	0.72
2015	4046.11	8352	490	94.07	95.17	94.26	95.34	4.83	4.83	0.00	1.10
2016	3728.32	7688	490	86.42	87.34	86.62	87.52	2.12	1.89	10.77	0.93
2017	3328.06	6785	490	76.89	76.89	77.53	77.45	1.34	1.05	22.07	0.00
2018	3954.15	7992	490	90.95	91.24	92.12	91.23	3.15	3.56	5.21	0.29
2019	3461.87	7054	490	79.57	79.57	80.65	80.53	4.46	5.62	14.81	0.00
2020	3525.17	7140	490	81.06	81.06	81.90	81.28	18.94	18.94	0.00	0.00
2021	4095.66	8302	490	94.51	94.51	95.42	94.77	5.49	5.49	0.00	0.00
2022	3621.42	7381	490	83.87	84.35	84.37	84.26	0.30	0.26	15.39	0.49
2023	4286.26	8703	490	99.28	99.28	99.86	99.35	0.71	0.71	0.00	0.00
2024	3720.12	7680	490	86.43	86.82	86.43	87.43	0.00	0.00	13.18	0.39

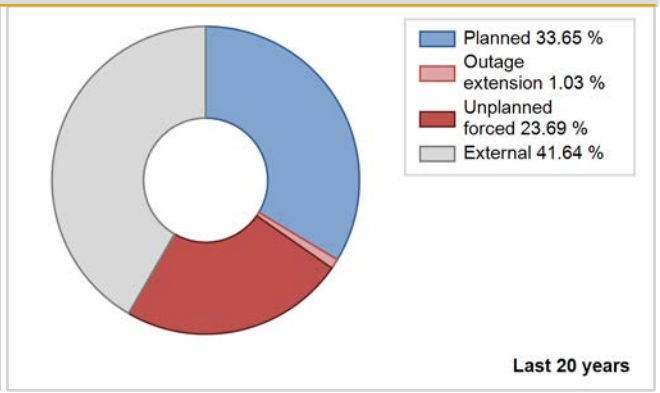
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2006 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					384	
D. Inspection, maintenance or repair without refuelling	1104			540	12	
E. Testing of plant systems or components				9	9	
J. Grid limitation, failure or grid unavailability						8
L. Human factor related					23	
P. Fire					1	
Z. Other						2
Subtotal	1104			549	429	10
Total	**1104**			**988**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2006 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		100
12. Reactor I&C Systems		105
14. Safety Systems		10
15. Reactor Cooling Systems		86
31. Turbine and auxiliaries		65
32. Feedwater and Main Steam System		15
33. Circulating Water System		5
34. Miscellaneous Systems		4
41. Main Generator Systems		12
42. Electrical Power Supply Systems		22
Total		**424**

Highlights (2024)

During the year Unit achieved Availability factor of 87.43% and Capacity factor of 86.46%.
After BSD- 2024, due to wet quarantining of four coolant channels reactor power reduced by 1.5% FP.

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2024 Operating Experience

IN-24 TARAPUR-4 INDIA

Status at end of year	:	**Operational**
Operator	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Owner	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD.)
Reactor Supplier	:	NPCIL (NUCLEAR POWER CORPORATION OF INDIA, LTD. Vikram Sarabhai Bhavan, Anushakti Nagar, Mumbai - 400 094.)
Turbine Supplier	:	BHEL (Bharat Heavy Electricals Ltd (BHEL) www.bhel.com)

Reactor Unit Details

Reactor type and model	:	PHWR / Horizontal Pressure Tube Type
Thermal power	:	1730 MWth
Gross electrical power	:	540 MWe
Reference unit power (net)	:	490 MWe

Key Dates

Construction Date	:	2000-03-08
Grid Date	:	2005-06-04
Commercial Date	:	2005-09-12
Age at end of year	:	19 years

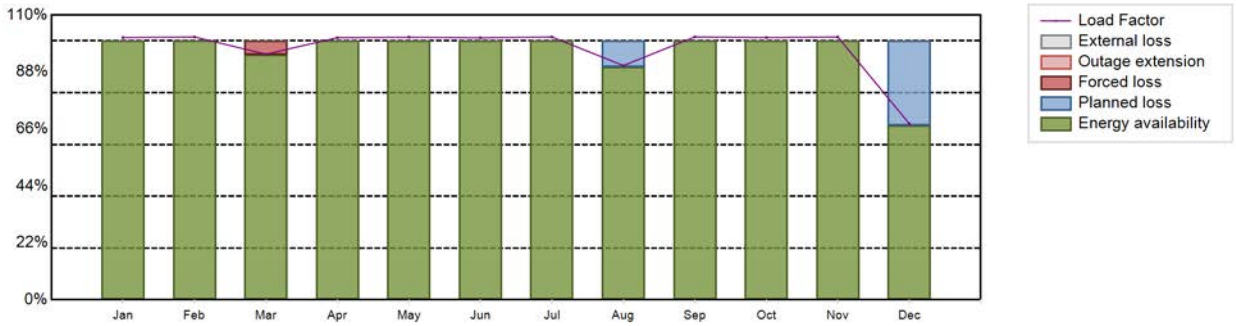
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	11.6
Reactor vessel centreline orientation	:	Horizontal	Reactor outlet temperature [°C]	:	304
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	-
Moderator material	:	D2O	Containment design pressure [MPa]	:	1.44
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	7000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	6.38	HP cylinder inlet steam pressure [MPa]	:	4.1
Active core height/length [m]	:	5.94	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	5096	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	20.18	Number of main condensate pumps	:	-
Number of control rod assemblies	:	4	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4178.87 GW(e).h	Forced Loss Rate (FLR)	:	0.47 %
Energy Availability Factor (EAF)	:	95.94 %	Unplanned Capability Loss Factor (UCL)	:	0.45 %
Unit Capability Factor (UCF)	:	95.94 %	Planned Unavailability Factor (PUF)	:	3.6 %
Load Factor (LF)	:	97.09 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	95.95 %	Total off-line time	:	356 hours

Annual Summary



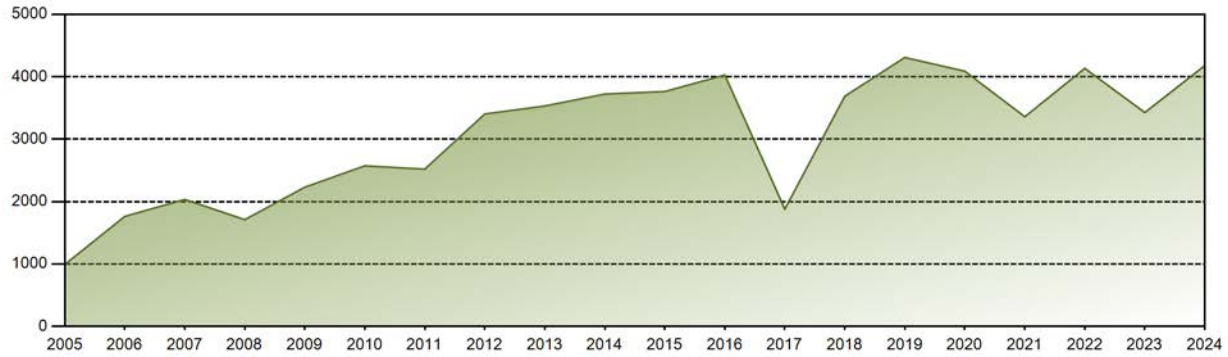
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	369.33	346.26	345.89	357.16	369.76	356.99	370.12	329.82	358.26	369.28	358.16	247.83	4178.87
EAF [%]	100.00	100.00	94.66	100.00	100.00	100.00	100.00	90.01	100.00	100.00	100.00	67.45	95.94
UCF [%]	100.00	100.00	94.66	100.00	100.00	100.00	100.00	90.01	100.00	100.00	100.00	67.45	95.94
LF [%]	101.31	101.53	94.88	101.24	101.43	101.19	101.52	90.47	101.55	101.29	101.52	67.98	97.09
OF [%]	100.00	100.00	94.62	100.00	100.00	100.00	100.00	90.05	100.00	100.00	100.00	67.47	95.95
FLR [%]	0.00	0.00	5.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47
UCL [%]	0.00	0.00	5.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.99	0.00	0.00	0.00	32.55	3.60
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

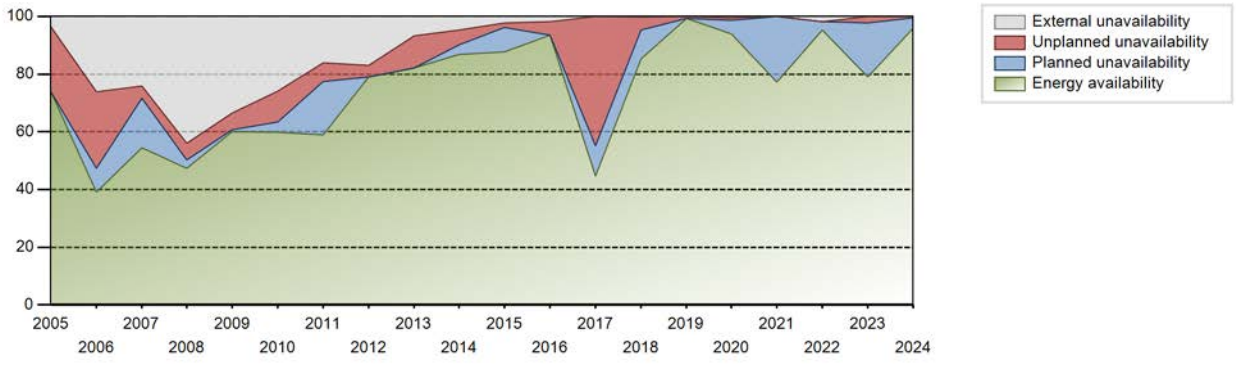
Lifetime energy generation	:	61330.09 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.23 %
Cumulative Energy Availability Factor (EAF)	:	74.72 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.6 %
Cumulative Unit Capability Factor (UCF)	:	85.37 %	Cumulative Planned Unavailability Factor (PUF)	:	7.03 %
Cumulative Load Factor (LF)	:	73.78 %	Cumulative Externally cause unavailability (XUF)	:	10.65 %
Cumulative Operating Factor (OF)	:	85.36 %			

Electricity Production (net) [GWh]



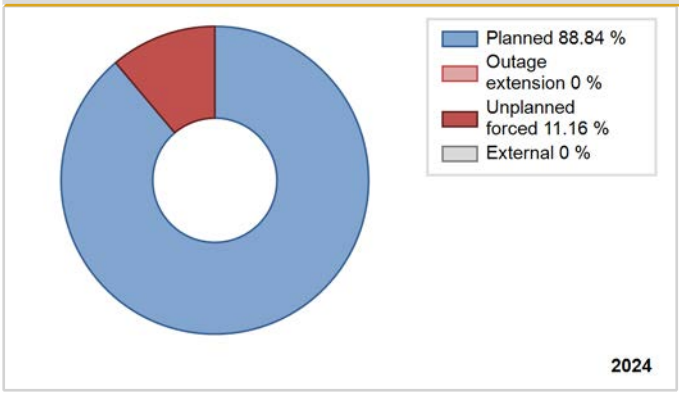
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2005	990.44	2770	490	73.84	77.37	65.69	76.03	22.63	22.63	0.00	3.54
2006	1762.12	5454	490	39.01	65.22	41.05	62.26	28.87	26.47	8.30	26.21
2007	2032.97	6797	490	54.43	78.54	47.36	77.59	5.22	4.32	17.13	24.11
2008	1709.82	8022	490	47.37	91.33	39.72	91.33	5.98	5.81	2.86	43.97
2009	2229.28	8187	490	59.98	93.47	51.94	93.46	5.76	5.71	0.82	33.49
2010	2571.83	7526	490	59.92	85.91	59.92	85.91	10.94	10.55	3.54	25.99
2011	2518.86	6568	490	58.84	74.99	58.68	74.98	0.13	6.41	18.61	16.15
2012	3402.67	8440	490	79.06	96.08	79.06	96.08	3.92	3.92	0.00	17.02
2013	3530.42	7779	490	82.16	88.80	82.25	88.80	11.20	11.20	0.00	6.64
2014	3722.25	8409	490	86.72	91.35	86.72	95.99	5.49	5.30	3.34	4.64
2015	3762.17	7881	490	87.75	89.97	87.65	89.97	1.69	1.54	8.48	2.22
2016	4027.88	8381	490	93.58	95.41	93.58	95.41	4.59	4.59	0.00	1.83
2017	1876.84	3951	490	44.67	44.67	43.72	45.10	0.21	44.81	10.52	0.00
2018	3687.88	7494	490	85.33	85.55	85.92	85.55	0.56	4.41	10.04	0.22
2019	4308.00	8717	490	99.40	99.40	100.36	99.51	0.11	0.60	0.00	0.00
2020	4088.13	8280	490	94.03	94.49	94.98	94.26	0.63	0.89	4.62	0.47
2021	3358.57	6806	490	77.23	77.23	78.24	77.69	0.00	0.00	22.77	0.00
2022	4133.62	8364	490	95.35	97.08	96.30	95.48	0.03	0.03	2.89	1.74
2023	3425.53	6964	490	79.12	79.12	79.80	79.50	2.86	2.33	18.55	0.00
2024	4178.87	8428	490	95.94	95.94	97.09	95.95	0.47	0.45	3.60	0.00

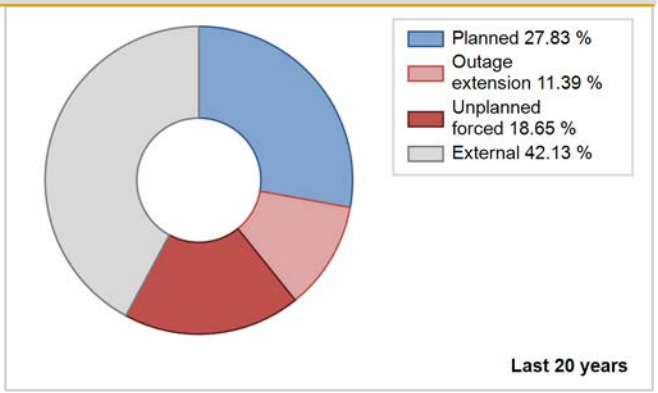
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2005 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		40			457	
D. Inspection, maintenance or repair without refuelling	316			557	218	
E. Testing of plant systems or components				16	1	
G. Major backfitting, refurbishment or upgrading activities without refuelling				37		
J. Grid limitation, failure or grid unavailability						24
L. Human factor related					18	
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						22
Z. Other					4	10
Subtotal	316	40		610	698	56
Total	**356**			**1364**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2005 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		57
12. Reactor I&C Systems		127
13. Reactor Auxiliary Systems		31
14. Safety Systems		13
15. Reactor Cooling Systems		15
16. Steam generation systems		4
21. Fuel Handling and Storage Facilities		50
31. Turbine and auxiliaries		18
32. Feedwater and Main Steam System		5
33. Circulating Water System		13
34. Miscellaneous Systems		6
35. All other I&C Systems		0
41. Main Generator Systems		76
42. Electrical Power Supply Systems	40	81
Total	**40**	**496**

Highlights (2024)

During the year Unit achieved Availabilty factor of 95.94% and Capacity factor of 96.82%.

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2024 Operating Experience

IR-1 BUSHEHR-1 IRAN, ISLAMIC REPUBLIC OF

Status at end of year	:	**Operational**
Operator	:	NPPDCO (Nuclear Power Production and Development Co. of Iran)
Owner	:	NPPDCO (Nuclear Power Production and Development Co. of Iran)
Reactor Supplier	:	JSC ASE (JSC "Atomstroyexport")
Turbine Supplier	:	JSC ASE (JSC "Atomstroyexport")



Reactor Unit Details

Reactor type and model	:	PWR / VVER V-446
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	915 MWe

Key Dates

Construction Date	:	1975-05-01
Grid Date	:	2011-09-03
Commercial Date	:	2013-09-23
Age at end of year	:	13 years

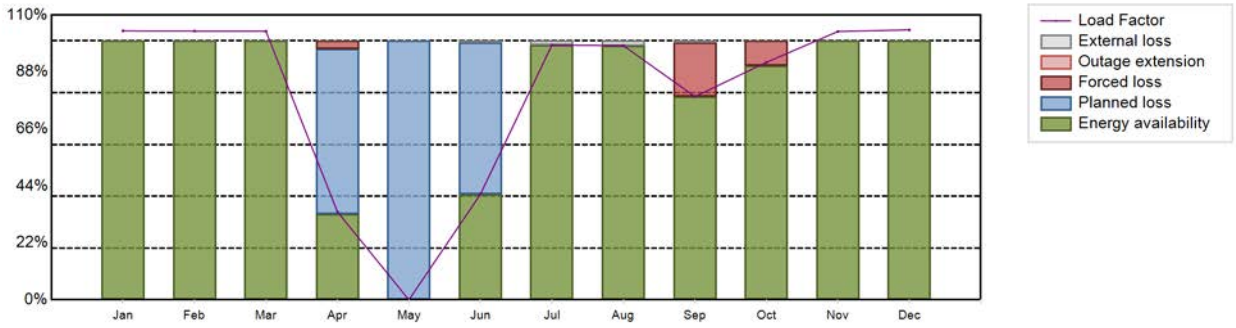
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.7
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.46
Average fuel enrichment [% of U235]	:	2.45	**Secondary systems**		
Refuelling frequency [month]	:	10	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	43000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	5.88
Active core height/length [m]	:	3.53	Output voltage [kV]	:	27
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.67	Number of main condensate pumps	:	3
Number of control rod assemblies	:	103	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	8
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6438.94 GW(e).h	Forced Loss Rate (FLR)	:	3.4 %
Energy Availability Factor (EAF)	:	78.34 %	Unplanned Capability Loss Factor (UCL)	:	2.77 %
Unit Capability Factor (UCF)	:	78.73 %	Planned Unavailability Factor (PUF)	:	18.49 %
Load Factor (LF)	:	80.11 %	Externally cause unavailability (XUF)	:	0.4 %
Operating Factor (OF)	:	81.59 %	Total off-line time	:	1617 hours

Annual Summary



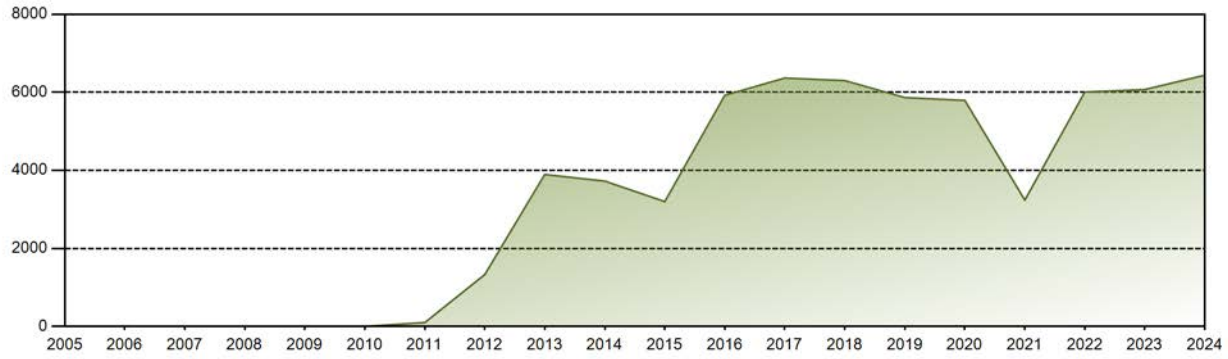
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	707.04	660.86	706.09	224.08	0.00	268.76	669.80	668.37	517.01	624.36	682.76	709.80	6438.94
EAF [%]	100.00	100.00	100.00	33.15	0.00	40.80	98.39	98.18	78.48	90.47	100.00	100.00	78.34
UCF [%]	100.00	100.00	100.00	33.15	0.00	41.50	100.00	100.00	79.06	90.47	100.00	100.00	78.73
LF [%]	103.86	103.77	103.72	34.01	0.00	40.80	98.39	98.18	78.48	91.72	103.64	104.27	80.11
OF [%]	100.00	100.00	100.00	36.39	0.00	42.36	100.00	100.00	100.00	100.00	100.00	100.00	81.59
FLR [%]	0.00	0.00	0.00	8.45	0.00	0.00	0.00	0.00	20.94	9.53	0.00	0.00	3.40
UCL [%]	0.00	0.00	0.00	3.06	0.00	0.00	0.00	0.00	20.94	9.53	0.00	0.00	2.77
PUF [%]	0.00	0.00	0.00	63.79	100.00	58.50	0.00	0.00	0.00	0.00	0.00	0.00	18.49
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.71	1.61	1.82	0.58	0.00	0.00	0.00	0.40

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Historical Summary

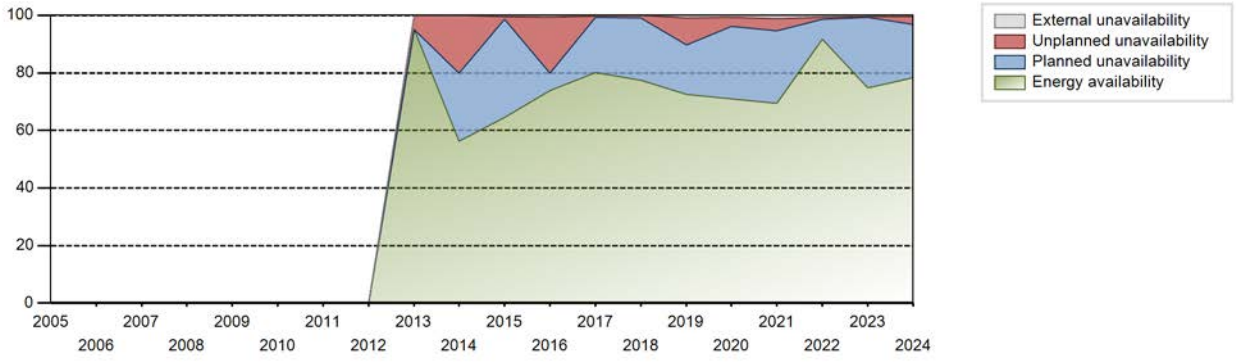
Lifetime energy generation	:	64466.2 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.25 %
Cumulative Energy Availability Factor (EAF)	:	74.12 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.62 %
Cumulative Unit Capability Factor (UCF)	:	74.66 %	Cumulative Planned Unavailability Factor (PUF)	:	19.72 %
Cumulative Load Factor (LF)	:	67.42 %	Cumulative Externally cause unavailability (XUF)	:	0.54 %
Cumulative Operating Factor (OF)	:	69.61 %			

Electricity Production (net) [GWh]



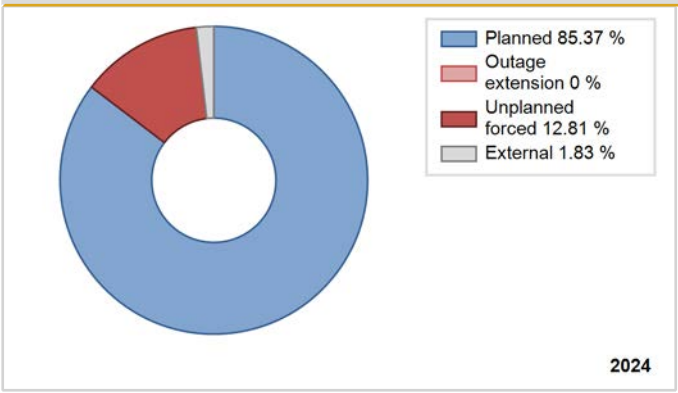
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2013	3893.67	4523	915	95.11	95.11	95.43	95.47	4.89	4.89	0.00	0.00
2014	3723.60	5181	915	56.36	56.40	46.46	59.14	8.50	20.09	23.50	0.04
2015	3198.24	3992	915	64.42	64.85	39.90	45.57	1.31	0.86	34.29	0.44
2016	5923.97	6615	915	73.91	74.64	73.71	75.31	11.39	19.46	5.90	0.72
2017	6366.21	6971	915	80.03	80.37	79.42	79.58	0.35	0.28	19.35	0.34
2018	6300.12	6851	915	77.50	77.63	78.60	78.21	0.91	0.71	21.65	0.14
2019	5865.73	6611	915	72.53	73.41	73.18	75.47	11.36	9.41	17.18	0.88
2020	5792.22	6349	915	71.05	71.66	72.07	72.28	3.77	3.32	25.02	0.61
2021	3235.97	3665	915	69.32	70.58	40.37	41.84	5.59	4.18	25.24	1.26
2022	6008.02	6544	915	91.79	92.52	74.96	74.70	0.20	0.59	6.89	0.73
2023	6071.16	6605	915	74.77	75.29	75.74	75.40	0.00	0.26	24.44	0.52
2024	6438.94	7167	915	78.34	78.73	80.11	81.59	3.40	2.77	18.49	0.40

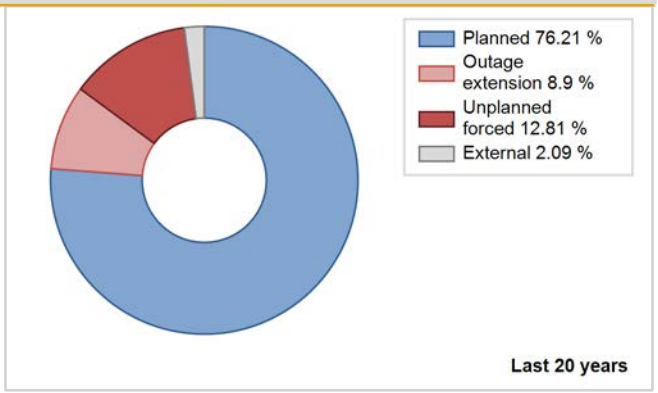
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2013 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					394	
C. Inspection, maintenance or repair combined with refuelling	1617			1564		
D. Inspection, maintenance or repair without refuelling				144		
E. Testing of plant systems or components				2		
J. Grid limitation, failure or grid unavailability						8
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						534
L. Human factor related					19	
Z. Other					4	
Subtotal	1617			1710	417	542
Total	**1617**			**2669**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2013 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		12
15. Reactor Cooling Systems		74
16. Steam generation systems		8
31. Turbine and auxiliaries		78
32. Feedwater and Main Steam System		8
33. Circulating Water System		117
34. Miscellaneous Systems		3
41. Main Generator Systems		84
42. Electrical Power Supply Systems		5
Total		**389**

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2024 Operating Experience

JP-45 GENKAI-3 JAPAN



Status at end of year	:	**Operational**
Operator	:	KYUSHU (Kyushu Electric Power Co., Inc.)
Owner	:	KYUSHU (Kyushu Electric Power Co., Inc.)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / M (4-loop)
Thermal power	:	3423 MWth
Gross electrical power	:	1180 MWe
Reference unit power (net)	:	1127 MWe

Key Dates

Construction Date	:	1988-06-01
Grid Date	:	1993-06-15
Commercial Date	:	1994-03-18
Age at end of year	:	31 years

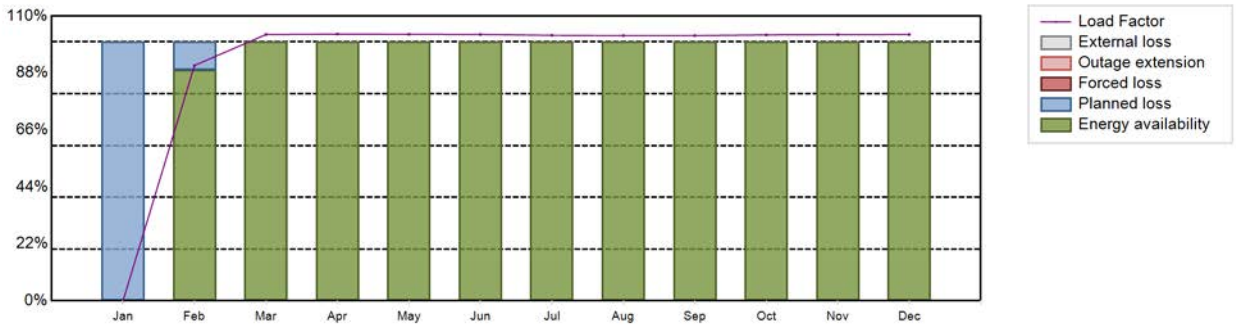
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2/MOX
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.1
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	46
Average discharge burnup [MWd/t]	:	43000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.9
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	325
Number of SG	:	4
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.76
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	DS

Annual Production Results (2024)

Net Energy Production	:	9217.44 GW(e).h
Energy Availability Factor (EAF)	:	90.67 %
Unit Capability Factor (UCF)	:	90.67 %
Load Factor (LF)	:	93.11 %
Operating Factor (OF)	:	91.09 %
Equivalent non-electrical energy generated (NEG)	:	5.2 GW(e).h
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	9.33 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	783 hours

Annual Summary



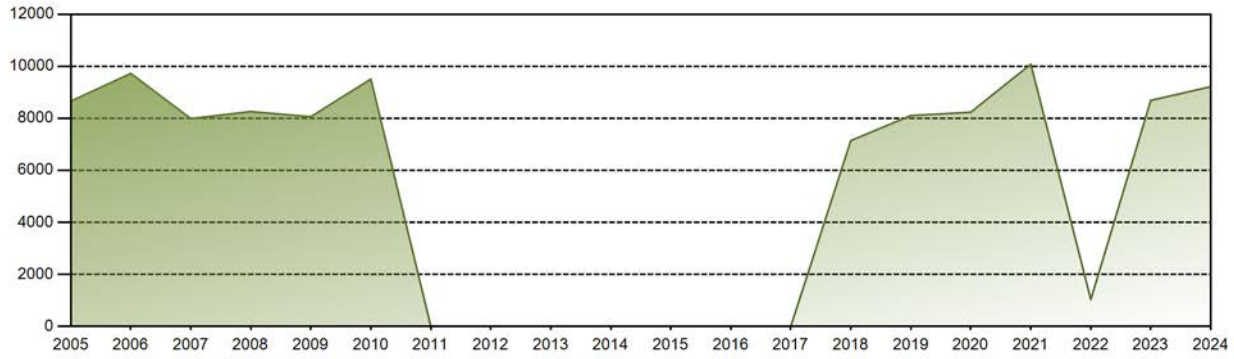
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	713.01	862.37	836.10	863.20	834.80	859.82	858.80	831.31	861.24	834.30	862.48	9217.44
EAF [%]	0.00	89.08	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.67
UCF [%]	0.00	89.08	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.67
LF [%]	0.00	90.90	102.85	103.04	102.95	102.88	102.54	102.42	102.45	102.71	102.82	102.86	93.11
OF [%]	0.00	94.40	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.09
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	100.00	10.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.33
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	201889.34 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.28 %
Cumulative Energy Availability Factor (EAF)	:	63.22 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.18 %
Cumulative Unit Capability Factor (UCF)	:	63.22 %	Cumulative Planned Unavailability Factor (PUF)	:	36.61 %
Cumulative Load Factor (LF)	:	64.29 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	63.49 %			

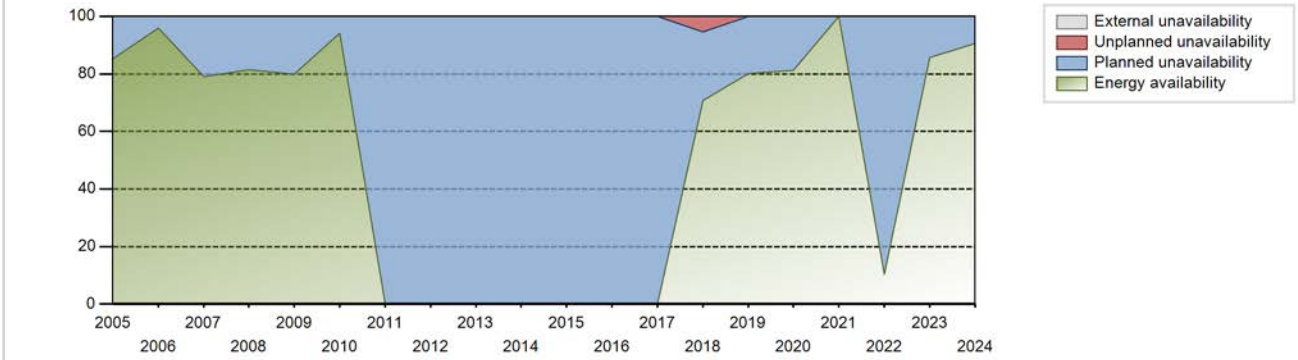
Electricity Production (net) [GWh]



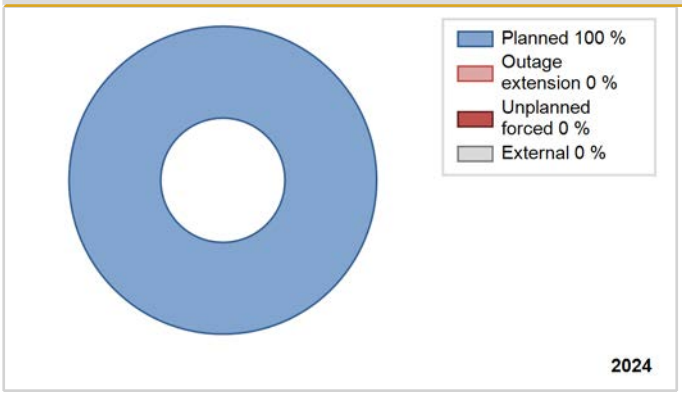
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1994	8795.82	7828	1127	96.91	96.91	97.39	97.00	0.00	0.00	3.09	0.00
1995	7356.33	6588	1127	74.14	74.14	74.51	75.21	0.00	0.00	25.86	0.00
1996	7444.90	6663	1127	74.86	74.86	75.20	75.85	0.00	0.00	25.14	0.00
1997	8259.94	7358	1127	83.29	83.29	83.67	84.00	0.00	0.00	16.71	0.00
1998	9633.13	8514	1127	97.14	97.14	97.58	97.19	0.00	0.00	2.86	0.00
1999	7999.83	7068	1127	80.67	80.67	81.03	80.68	0.00	0.00	19.33	0.00
2000	8109.74	7164	1127	81.55	81.55	81.92	81.56	0.00	0.00	18.45	0.00
2001	8205.05	7249	1127	82.74	82.74	83.11	82.75	0.00	0.00	17.26	0.00
2002	9561.54	8446	1127	96.40	96.40	96.85	96.42	0.00	0.00	3.60	0.00
2003	8667.78	7497	1127	85.59	85.59	87.80	85.58	0.00	0.00	14.41	0.00
2004	8121.12	7015	1127	79.87	79.87	82.04	79.86	0.00	0.00	20.13	0.00
2005	8658.87	7523	1127	85.32	85.32	87.71	85.88	0.00	0.00	14.68	0.00
2006	9725.17	8401	1127	95.86	95.86	98.51	95.90	0.00	0.00	4.14	0.00
2007	7988.29	6987	1127	79.11	79.11	80.91	79.76	0.00	0.00	20.89	0.00
2008	8259.64	7211	1127	81.57	81.57	83.43	82.09	0.00	0.00	18.43	0.00
2009	8061.86	7043	1127	79.87	79.87	81.66	80.40	0.00	0.00	20.13	0.00
2010	9506.52	8257	1127	94.22	94.22	96.29	94.26	0.00	0.00	5.78	0.00
2011	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2012	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2013	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2014	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2015	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2016	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2017	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2018	7143.28	6313	1127	70.82	70.82	72.36	72.07	7.13	5.44	23.74	0.00
2019	8106.36	7067	1127	80.14	80.14	82.11	80.67	0.00	0.00	19.86	0.00
2020	8236.08	7187	1127	81.29	81.29	83.20	81.82	0.00	0.00	18.71	0.00
2021	10083.48	8760	1127	100.00	100.00	102.14	100.00	0.00	0.00	0.00	0.00
2022	1036.79	946	1127	10.34	10.34	10.50	10.80	0.00	0.00	89.66	0.00
2023	8691.55	7513	1127	85.73	85.73	88.04	85.76	0.00	0.00	14.27	0.00
2024	9217.44	8001	1127	90.67	90.67	93.11	91.09	0.00	0.00	9.33	0.00

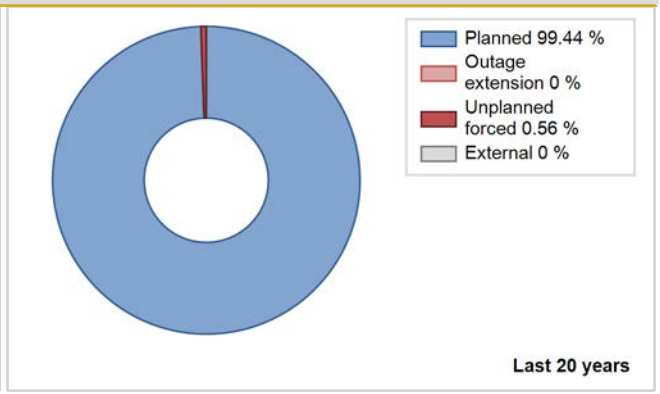
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1994 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					14	
C. Inspection, maintenance or repair combined with refuelling	783			1205		
G. Major backfitting, refurbishment or upgrading activities without refuelling				1985		
Subtotal	783			3190	14	
Total	**783**			**3204**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1994 to 2024
	Hours Lost	Average hours lost per reactor-year
32. Feedwater and Main Steam System		14
Total		**14**

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2024 Operating Experience

JP-46 GENKAI-4 JAPAN



Status at end of year	:	**Operational**
Operator	:	KYUSHU (Kyushu Electric Power Co., Inc.)
Owner	:	KYUSHU (Kyushu Electric Power Co., Inc.)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / M (4-loop)
Thermal power	:	3423 MWth
Gross electrical power	:	1180 MWe
Reference unit power (net)	:	1127 MWe

Key Dates

Construction Date	:	1992-07-15
Grid Date	:	1996-11-12
Commercial Date	:	1997-07-25
Age at end of year	:	28 years

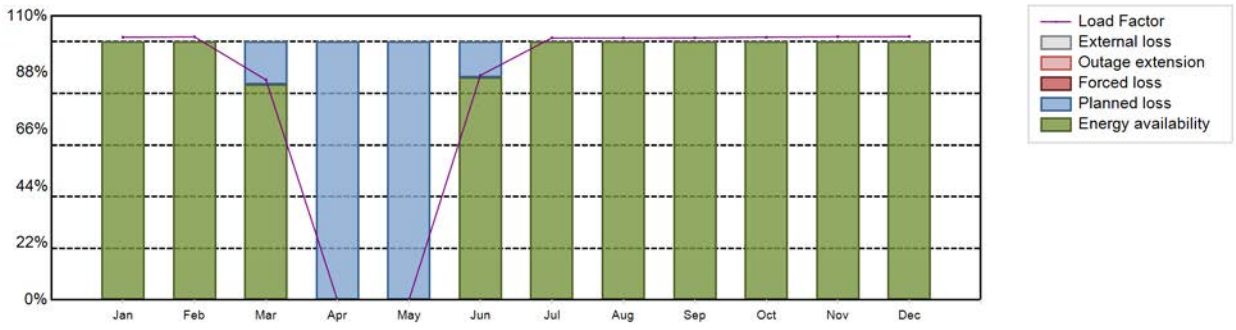
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.1
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	46
Average discharge burnup [MWd/t]	:	44000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.9
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	325
Number of SG	:	4
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.76
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	DS

Annual Production Results (2024)

Net Energy Production	:	8134.2 GW(e).h
Energy Availability Factor (EAF)	:	80.8 %
Unit Capability Factor (UCF)	:	80.8 %
Load Factor (LF)	:	82.17 %
Operating Factor (OF)	:	81.26 %
Equivalent non-electrical energy generated (NEG)	:	1.43 GW(e).h
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	19.2 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1646 hours

Annual Summary



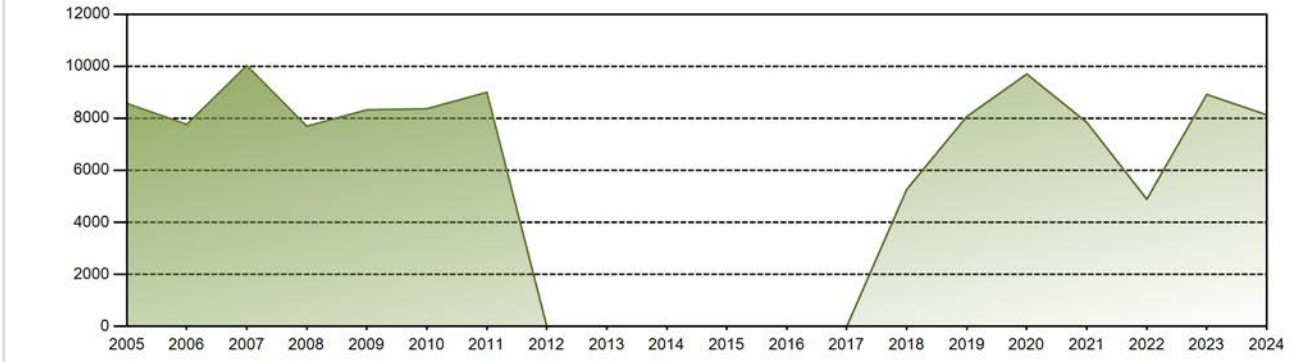
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	853.15	799.36	714.77	0.00	0.00	706.00	850.94	850.74	823.59	853.36	827.13	855.16	8134.21
EAF [%]	100.00	100.00	83.57	0.00	0.00	86.09	100.00	100.00	100.00	100.00	100.00	100.00	80.80
UCF [%]	100.00	100.00	83.57	0.00	0.00	86.09	100.00	100.00	100.00	100.00	100.00	100.00	80.80
LF [%]	101.75	101.91	85.24	0.00	0.00	87.01	101.49	101.46	101.50	101.77	101.93	101.99	82.17
OF [%]	100.00	100.00	84.01	0.00	0.00	91.25	100.00	100.00	100.00	100.00	100.00	100.00	81.26
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	16.43	100.00	100.00	13.91	0.00	0.00	0.00	0.00	0.00	0.00	19.20
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	178689.38 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.92 %
Cumulative Energy Availability Factor (EAF)	:	64.26 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.59 %
Cumulative Unit Capability Factor (UCF)	:	64.26 %	Cumulative Planned Unavailability Factor (PUF)	:	35.15 %
Cumulative Load Factor (LF)	:	65.19 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	64.55 %			

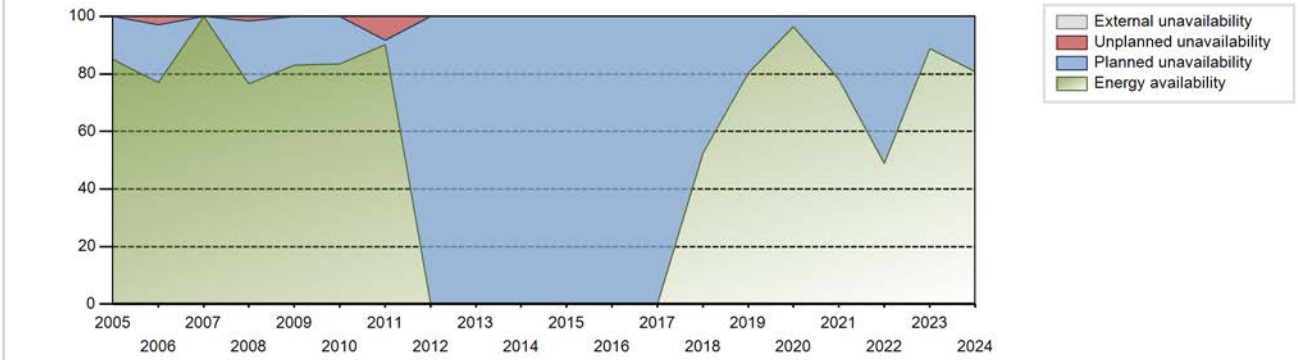
Electricity Production (net) [GWh]



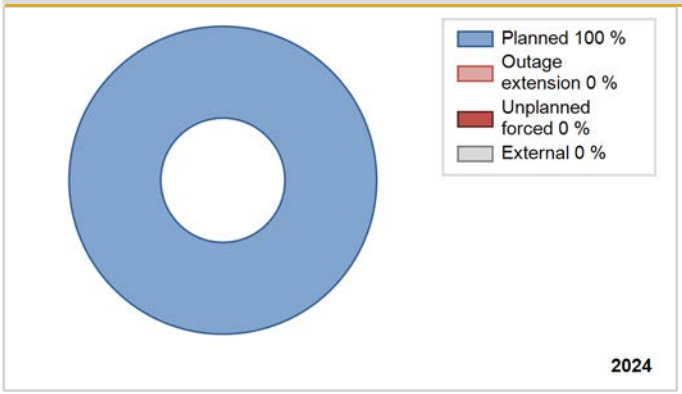
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1997	5841.01	5901	1127	99.99	99.99	100.73	100.00	0.00	0.00	0.01	0.00
1998	7634.53	6783	1127	76.75	76.75	77.33	77.43	0.00	0.00	23.25	0.00
1999	9716.30	8559	1127	97.69	97.69	98.42	97.71	0.00	0.00	2.31	0.00
2000	8181.18	7205	1127	82.02	82.02	82.64	82.02	0.00	0.00	17.98	0.00
2001	8107.23	7142	1127	81.51	81.51	82.12	81.53	0.00	0.00	18.49	0.00
2002	8208.29	7217	1127	82.37	82.37	83.14	82.39	0.00	0.00	17.63	0.00
2003	9678.75	8422	1127	96.12	96.12	98.04	96.14	0.00	0.00	3.88	0.00
2004	8330.56	7243	1127	82.44	82.44	84.15	82.46	4.05	3.48	14.09	0.00
2005	8572.52	7499	1127	85.04	85.04	86.83	85.61	0.00	0.00	14.96	0.00
2006	7765.58	6813	1127	76.97	76.97	78.66	77.77	3.64	2.91	20.12	0.00
2007	10025.27	8760	1127	100.00	100.00	101.55	100.00	0.00	0.00	0.00	0.00
2008	7695.98	6797	1127	76.61	76.61	77.74	77.38	2.15	1.69	21.71	0.00
2009	8325.59	7331	1127	83.07	83.07	84.33	83.69	0.00	0.00	16.93	0.00
2010	8365.65	7355	1127	83.43	83.43	84.74	83.96	0.00	0.00	16.57	0.00
2011	8999.40	7918	1127	90.09	90.09	91.16	90.39	8.35	8.21	1.70	0.00
2012	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2013	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2014	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2015	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2016	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2017	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2018	5269.18	4706	1127	52.56	52.56	53.37	53.72	0.00	0.00	47.44	0.00
2019	8067.74	7091	1127	80.41	80.41	81.72	80.95	0.00	0.00	19.59	0.00
2020	9703.45	8473	1127	96.42	96.42	98.02	96.46	0.00	0.00	3.58	0.00
2021	7840.45	6897	1127	78.22	78.22	79.42	78.73	0.00	0.00	21.78	0.00
2022	4888.76	4319	1127	48.81	48.81	49.52	49.30	0.00	0.00	51.19	0.00
2023	8916.51	7809	1127	88.72	88.72	90.32	89.14	0.00	0.00	11.28	0.00
2024	8134.20	7138	1127	80.80	80.80	82.17	81.26	0.00	0.00	19.20	0.00

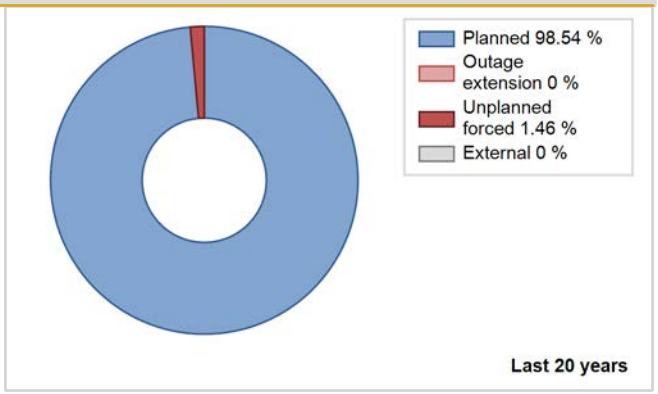
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1997 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					50	
C. Inspection, maintenance or repair combined with refuelling	1646			1108		
G. Major backfitting, refurbishment or upgrading activities without refuelling				2002		
Subtotal	1646			3110	50	
Total	**1646**			**3160**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1997 to 2024
	Hours Lost	Average hours lost per reactor-year
15. Reactor Cooling Systems		8
31. Turbine and auxiliaries		26
41. Main Generator Systems		16
Total		**50**

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2024 Operating Experience

JP-47 IKATA-3 JAPAN



Status at end of year	:	**Operational**
Operator	:	SHIKOKU (SHIKOKU ELECTRIC POWER CO., INC)
Owner	:	SHIKOKU (SHIKOKU ELECTRIC POWER CO., INC)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / M (3-loop)
Thermal power	:	2660 MWth
Gross electrical power	:	890 MWe
Reference unit power (net)	:	846 MWe

Key Dates

Construction Date	:	1990-10-01
Grid Date	:	1994-03-29
Commercial Date	:	1994-12-15
Age at end of year	:	30 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2/MOX
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.8
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	48000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.1
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

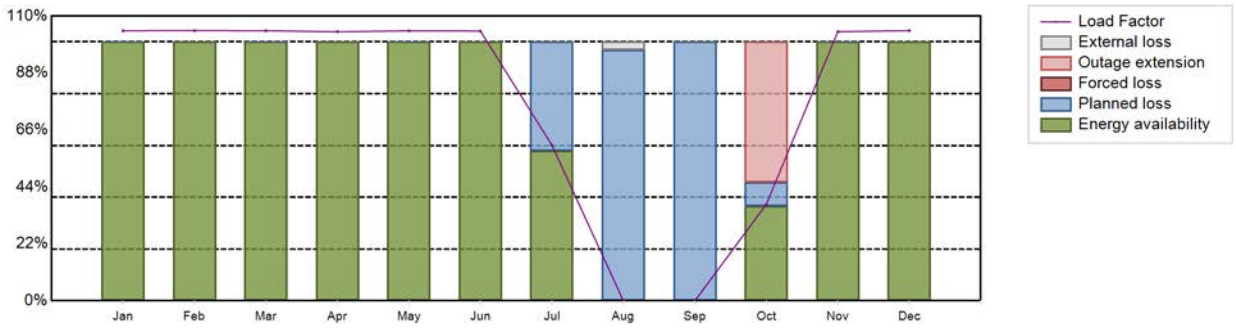
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Double
Containment design pressure [MPa]	:	0.283
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	5.1
Output voltage [kV]	:	23
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	DS / DS

Annual Production Results (2024)

Net Energy Production	:	5755.18 GW(e).h
Energy Availability Factor (EAF)	:	74.4 %
Unit Capability Factor (UCF)	:	74.67 %
Load Factor (LF)	:	77.45 %
Operating Factor (OF)	:	74.97 %
Equivalent non-electrical energy generated (NEG)	:	2.2 GW(e).h

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	4.6 %
Planned Unavailability Factor (PUF)	:	20.73 %
Externally cause unavailability (XUF)	:	0.27 %
Total off-line time	:	2199 hours

Annual Summary



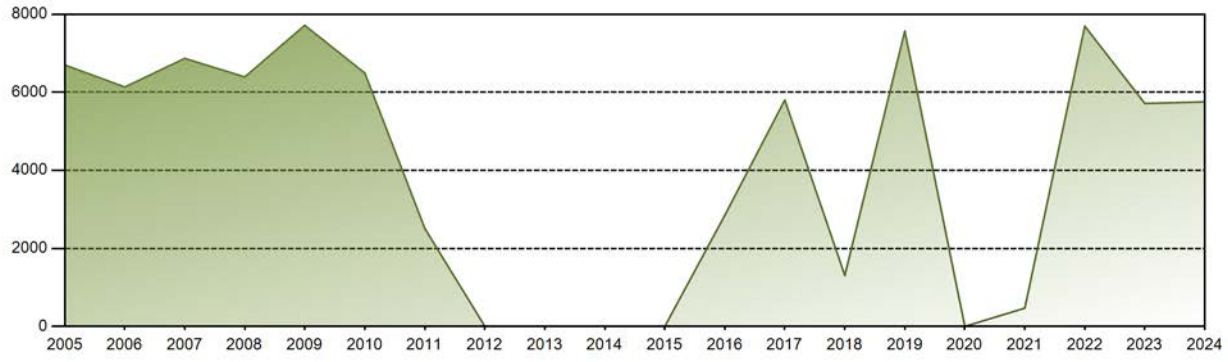
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	656.62	614.51	656.54	632.95	656.37	634.71	378.57	0.00	0.00	234.88	633.21	656.82	5755.18
EAF [%]	100.00	100.00	99.99	100.00	100.00	100.00	57.84	0.00	0.00	36.69	100.00	100.00	74.40
UCF [%]	100.00	100.00	99.99	100.00	100.00	100.00	57.84	3.23	0.00	36.69	100.00	100.00	74.67
LF [%]	104.32	104.36	104.31	103.91	104.28	104.20	60.15	0.00	0.00	37.32	103.95	104.35	77.45
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	58.06	0.00	0.00	43.15	100.00	100.00	74.97
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.30	0.00	0.00	4.60
PUF [%]	0.00	0.00	0.01	0.00	0.00	0.00	42.16	96.77	100.00	9.01	0.00	0.00	20.73
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.23	0.00	0.00	0.00	0.00	0.27

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Historical Summary

Lifetime energy generation	:	145239.76 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.69 %
Cumulative Energy Availability Factor (EAF)	:	65.96 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.83 %
Cumulative Unit Capability Factor (UCF)	:	65.96 %	Cumulative Planned Unavailability Factor (PUF)	:	33.2 %
Cumulative Load Factor (LF)	:	65.22 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	63.44 %			

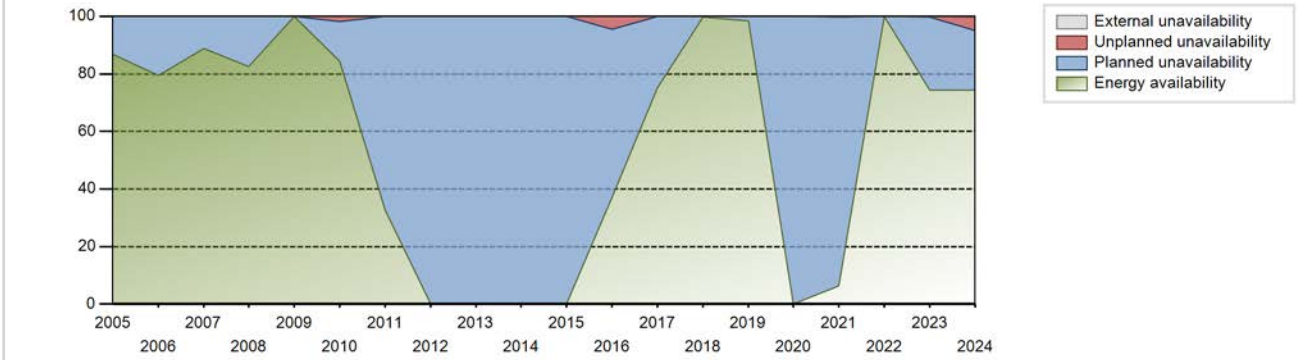
Electricity Production (net) [GWh]



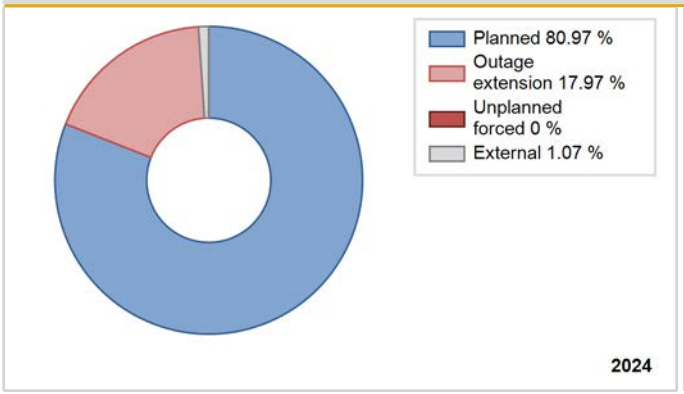
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1994	2195.52	3669	846	100.00	100.00	101.17	100.00	0.00	0.00	0.00	0.00
1995	7491.81	8760	846	99.99	99.99	101.09	100.00	0.00	0.00	0.01	0.00
1996	5578.21	6621	846	74.23	74.23	75.06	75.38	0.00	0.00	25.76	0.00
1997	6134.74	7242	846	81.87	81.87	82.78	82.67	0.00	0.00	18.13	0.00
1998	6250.38	7374	846	83.43	83.43	84.34	84.18	0.00	0.00	16.57	0.00
1999	6298.35	7368	846	84.09	84.09	84.99	84.11	3.16	2.74	13.17	0.00
2000	6660.35	7790	846	88.68	88.68	89.63	88.68	10.78	10.71	0.61	0.00
2001	6210.74	7267	846	82.94	82.94	83.80	82.96	0.00	0.00	17.06	0.00
2002	6599.51	7518	846	85.82	85.82	89.05	85.82	0.00	0.00	14.18	0.00
2003	5862.10	6560	846	74.86	74.86	79.10	74.89	0.00	0.00	25.14	0.00
2004	7828.92	8784	846	100.00	100.00	105.35	100.00	0.00	0.00	0.00	0.00
2005	6699.37	7637	846	86.84	86.84	90.40	87.18	0.00	0.00	13.16	0.00
2006	6134.56	6990	846	79.53	79.53	82.78	79.79	0.00	0.00	20.47	0.00
2007	6869.33	7813	846	88.88	88.88	92.69	89.19	0.00	0.00	11.12	0.00
2008	6392.97	7282	846	82.57	82.57	86.03	82.90	0.00	0.00	17.43	0.00
2009	7716.65	8760	846	99.96	99.96	104.12	100.00	0.04	0.04	0.00	0.00
2010	6490.71	7410	846	84.34	84.34	87.58	84.59	0.00	1.71	13.95	0.00
2011	2511.01	2852	846	32.58	32.58	33.88	32.56	0.00	0.00	67.42	0.00
2012	0.00	0	846	0.06	0.06	0.00	0.00	0.00	0.00	99.94	0.00
2013	0.00	0	846	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2014	0.00	0	846	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2015	0.00	0	846	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2016	2848.03	3322	846	37.02	37.02	38.32	37.82	0.00	4.53	58.45	0.00
2017	5802.18	6600	846	75.32	75.32	78.29	75.34	0.00	0.00	24.68	0.00
2018	1306.34	1511	846	99.72	99.72	17.63	17.25	0.00	0.00	0.28	0.00
2019	7570.95	8616	846	98.34	98.34	102.16	98.36	0.00	0.00	1.66	0.00
2020	0.00	0	846	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2021	468.08	606	846	6.29	6.29	6.32	6.92	5.33	0.35	93.36	0.00
2022	7695.11	8760	846	99.99	99.99	103.83	100.00	0.00	0.00	0.01	0.00
2023	5715.39	6529	846	74.24	74.24	77.12	74.53	0.00	0.33	25.43	0.00
2024	5755.18	6585	846	74.40	74.67	77.45	74.97	0.00	4.60	20.73	0.27

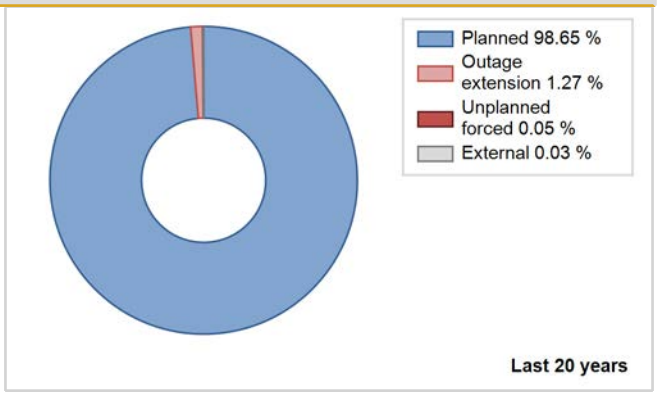
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1994 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		395			55	
C. Inspection, maintenance or repair combined with refuelling	1771			1463		
E. Testing of plant systems or components		9			0	
G. Major backfitting, refurbishment or upgrading activities without refuelling				1539		
L. Human factor related					1	
M. Governmental requirements or court decisions						250
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			24			1
Z. Other					19	
Subtotal	1771	404	24	3002	75	251
Total	**2199**			**3328**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1994 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems	395	14
13. Reactor Auxiliary Systems		1
15. Reactor Cooling Systems		14
35. All other I&C Systems	9	0
41. Main Generator Systems		8
42. Electrical Power Supply Systems		32
Total	**404**	**69**

Highlights (2024)

Operation at full power in base load mode
Conduct the 17th periodical inspection of Ikata Unit 3

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2024 Operating Experience

JP-14 MIHAMA-3 JAPAN



Status at end of year	:	**Operational**
Operator	:	KEPCO (Kansai Electric Power Co.)
Owner	:	KEPCO (Kansai Electric Power Co.)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / M (3-loop)
Thermal power	:	2440 MWth
Gross electrical power	:	826 MWe
Reference unit power (net)	:	780 MWe

Key Dates

Construction Date	:	1972-08-07
Grid Date	:	1976-02-19
Commercial Date	:	1976-12-01
Age at end of year	:	48 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.0
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	43000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.64
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	20.3
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

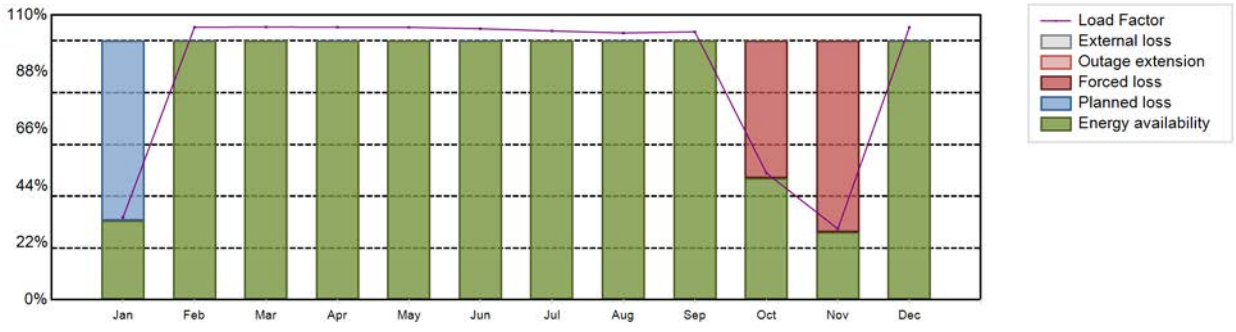
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	323
Number of SG	:	3
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.24
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.8
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5988.62 GW(e).h
Energy Availability Factor (EAF)	:	83.57 %
Unit Capability Factor (UCF)	:	83.57 %
Load Factor (LF)	:	87.41 %
Operating Factor (OF)	:	84.47 %

Forced Loss Rate (FLR)	:	11.2 %
Unplanned Capability Loss Factor (UCL)	:	10.54 %
Planned Unavailability Factor (PUF)	:	5.89 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1364 hours

Annual Summary



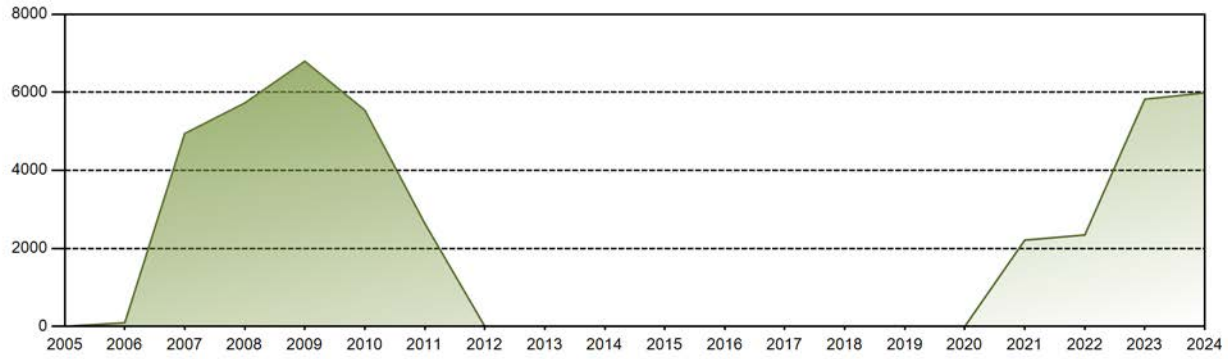
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	184.62	571.55	611.47	591.18	610.82	588.04	602.60	598.10	581.25	284.47	153.92	610.60	5988.62
EAF [%]	30.54	99.99	100.00	99.99	100.00	99.99	100.00	99.99	100.00	46.95	26.28	99.99	83.57
UCF [%]	30.54	99.99	100.00	99.99	100.00	99.99	100.00	99.99	100.00	46.95	26.28	99.99	83.57
LF [%]	31.81	105.28	105.37	105.27	105.26	104.71	103.84	103.06	103.50	49.02	27.41	105.22	87.41
OF [%]	36.29	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	47.58	30.56	100.00	84.47
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.05	73.72	0.00	11.20
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.05	73.72	0.00	10.54
PUF [%]	69.46	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	5.89
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	185217.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.11 %
Cumulative Energy Availability Factor (EAF)	:	55.57 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.56 %
Cumulative Unit Capability Factor (UCF)	:	55.59 %	Cumulative Planned Unavailability Factor (PUF)	:	42.86 %
Cumulative Load Factor (LF)	:	56.33 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	56.3 %			

Electricity Production (net) [GWh]

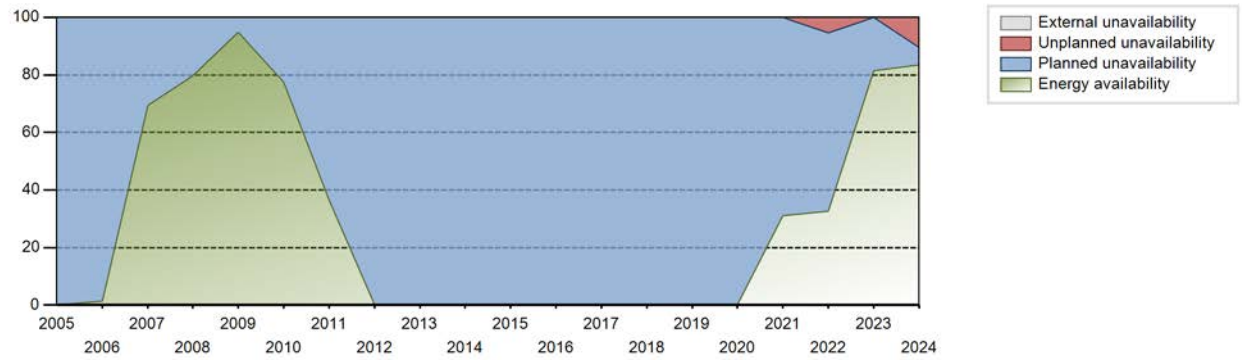


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1976	2615.00	5285	780	85.10	85.10	85.06	100.00	0.00	0.00	14.90	0.00
1977	4498.50	6159	780	65.85	65.85	65.84	70.31	1.27	0.85	33.31	0.00
1978	4166.60	5537	780	59.52	59.52	60.98	63.21	0.00	0.00	40.48	0.00
1979	1697.40	2307	780	24.85	24.85	24.84	26.34	0.00	0.00	75.15	0.00
1980	4597.70	5964	780	67.00	67.00	67.10	67.90	1.17	0.79	32.21	0.00
1981	5832.90	7607	780	85.16	85.16	85.37	86.84	0.33	0.28	14.55	0.00
1982	5239.10	6952	780	76.38	76.38	76.68	79.36	0.00	0.00	23.62	0.00
1983	4818.00	6330	780	70.63	70.63	70.51	72.26	0.00	0.00	29.37	0.00
1984	5353.73	6906	780	77.82	77.82	78.14	78.62	0.00	0.00	22.18	0.00
1985	4971.94	6426	780	72.65	72.65	72.77	73.36	0.00	0.00	27.35	0.00
1986	6848.35	8760	780	99.78	99.78	100.23	100.00	0.00	0.00	0.22	0.00
1987	4822.71	6268	780	71.55	71.55	70.58	71.55	3.89	2.90	25.55	0.00
1988	4261.32	5625	780	64.04	64.04	62.20	64.04	5.10	3.44	32.53	0.00
1989	5299.69	6834	780	78.01	78.01	77.56	78.01	0.00	0.00	21.99	0.00
1990	6867.04	8760	780	99.98	99.98	100.50	100.00	0.00	0.00	0.02	0.00
1991	4246.18	5495	780	59.68	59.68	62.14	62.73	0.00	0.00	40.32	0.00
1992	4709.88	6095	780	68.54	68.54	68.74	69.39	0.00	0.00	31.46	0.00
1993	4526.62	5951	780	66.11	66.42	66.25	67.93	0.74	0.50	33.08	0.31
1994	6623.04	8486	780	96.81	96.83	96.93	96.87	1.78	1.76	1.42	0.01
1995	3389.17	4534	780	49.61	49.74	49.60	51.76	21.69	13.77	36.49	0.13
1996	4491.42	5760	780	65.30	65.50	65.55	65.57	0.00	0.00	34.50	0.19
1997	6262.81	7963	780	91.24	91.24	91.66	90.90	0.00	0.00	8.76	0.00
1998	5979.86	7788	780	87.10	87.10	87.52	88.90	1.39	1.23	11.66	0.00
1999	5795.30	7398	780	84.44	84.44	84.82	84.45	3.45	3.01	12.54	0.00
2000	4784.98	6117	780	69.60	69.61	69.84	69.64	15.88	13.15	17.25	0.00
2001	6853.68	8760	780	99.96	99.99	100.31	100.00	0.00	0.00	0.01	0.03
2002	5248.01	6732	780	76.84	76.84	76.81	76.85	5.19	4.21	18.95	0.00
2003	6111.49	7701	780	87.91	87.91	89.44	87.91	0.00	0.00	12.09	0.00
2004	4301.26	5319	780	60.48	60.48	62.78	60.55	2.06	13.02	26.50	0.00
2005	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2006	92.08	181	780	1.35	1.35	1.35	2.07	0.00	0.00	98.65	0.00
2007	4943.91	6190	780	69.45	69.45	72.36	70.66	0.00	0.00	30.55	0.00
2008	5725.55	7049	780	79.72	79.72	83.57	80.25	0.00	0.00	20.28	0.00
2009	6795.53	8315	780	94.86	94.86	99.45	94.92	0.00	0.00	5.14	0.00
2010	5541.00	6823	780	77.39	77.39	81.09	77.89	0.00	0.00	22.61	0.00
2011	2637.14	3203	780	36.51	36.51	38.60	36.56	0.00	0.00	63.49	0.00
2012	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00

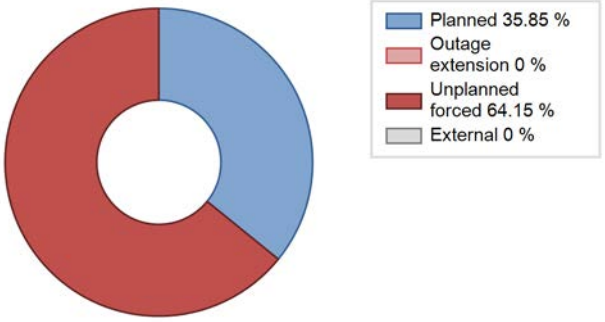
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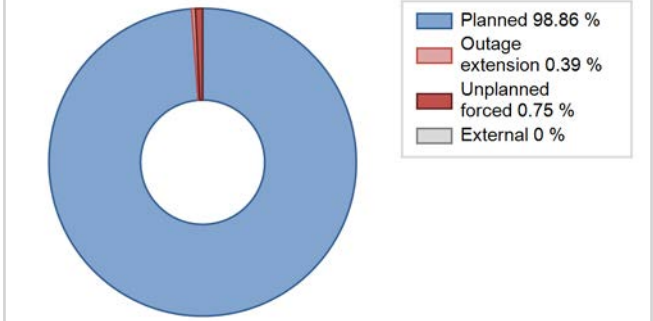
2013	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2014	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2015	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2016	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2017	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2018	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2019	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2020	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2021	2211.25	2804	780	31.12	31.12	32.36	32.01	0.00	0.00	68.88	0.00
2022	2343.68	2908	780	32.70	32.70	34.30	33.20	0.00	5.48	61.82	0.00
2023	5823.48	7139	780	81.44	81.44	85.23	81.50	0.00	0.00	18.56	0.00
2024	5988.62	7420	780	83.57	83.57	87.41	84.47	11.20	10.54	5.89	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1976 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		898			120	
C. Inspection, maintenance or repair combined with refuelling	474			1980		
E. Testing of plant systems or components				0	3	
G. Major backfitting, refurbishment or upgrading activities without refuelling				1728		
L. Human factor related					5	
Subtotal	474	898		3708	128	
Total	**1372**			**3836**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1976 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		23
13. Reactor Auxiliary Systems	898	28
15. Reactor Cooling Systems		8
16. Steam generation systems		23
32. Feedwater and Main Steam System		42
34. Miscellaneous Systems		3
Total	**898**	**127**

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2024 Operating Experience

JP-50 OHI-3 JAPAN



Status at end of year	:	**Operational**
Operator	:	KEPCO (Kansai Electric Power Co.)
Owner	:	KEPCO (Kansai Electric Power Co.)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / M (4-loop)
Thermal power	:	3423 MWth
Gross electrical power	:	1180 MWe
Reference unit power (net)	:	1127 MWe

Key Dates

Construction Date	:	1987-10-03
Grid Date	:	1991-06-07
Commercial Date	:	1991-12-18
Age at end of year	:	33 years

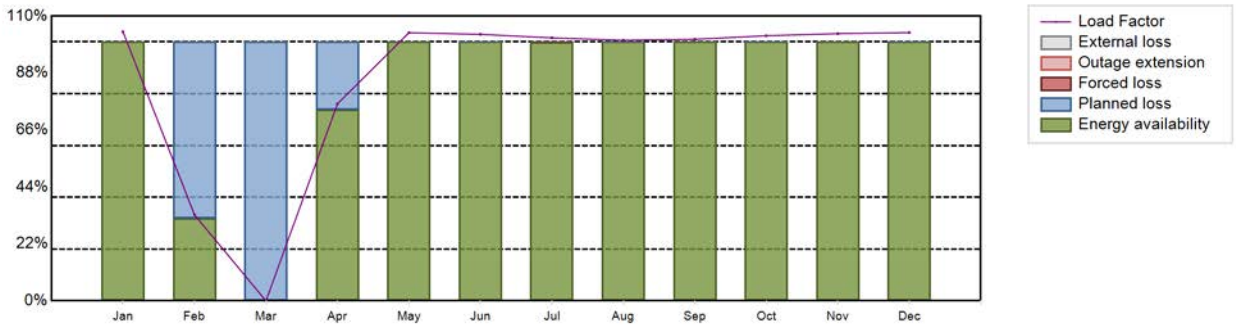
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.1
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	44000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.9
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	325
Number of SG	:	4
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.4
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	DS

Annual Production Results (2024)

Net Energy Production	:	8532.36 GW(e).h
Energy Availability Factor (EAF)	:	83.99 %
Unit Capability Factor (UCF)	:	83.99 %
Load Factor (LF)	:	86.19 %
Operating Factor (OF)	:	84.35 %
Equivalent non-electrical energy generated (NEG)	:	20.03 GW(e).h
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	16.01 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1375 hours

Annual Summary



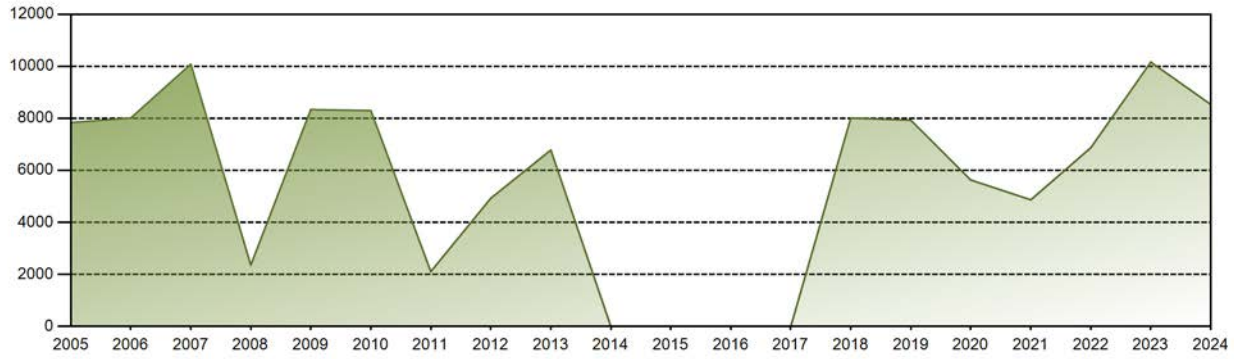
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	871.55	260.69	0.00	617.39	868.16	835.15	851.51	843.77	819.67	858.45	837.41	868.61	8532.36
EAF [%]	100.00	31.96	0.00	73.77	100.00	100.00	99.99	100.00	100.00	100.00	100.00	100.00	83.99
UCF [%]	100.00	31.96	0.00	73.77	100.00	100.00	99.99	100.00	100.00	100.00	100.00	100.00	83.99
LF [%]	103.94	33.23	0.00	76.09	103.54	102.92	101.55	100.63	101.01	102.38	103.20	103.59	86.19
OF [%]	100.00	32.47	0.00	77.64	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	84.35
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	68.04	100.00	26.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.01
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	219867.73 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.79 %
Cumulative Energy Availability Factor (EAF)	:	66.28 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.09 %
Cumulative Unit Capability Factor (UCF)	:	66.3 %	Cumulative Planned Unavailability Factor (PUF)	:	29.61 %
Cumulative Load Factor (LF)	:	67.3 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	66.58 %			

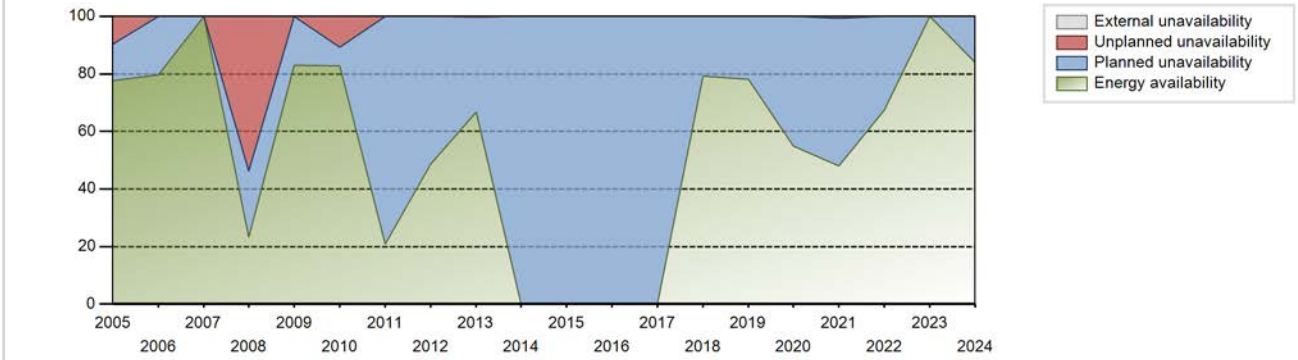
Electricity Production (net) [GWh]



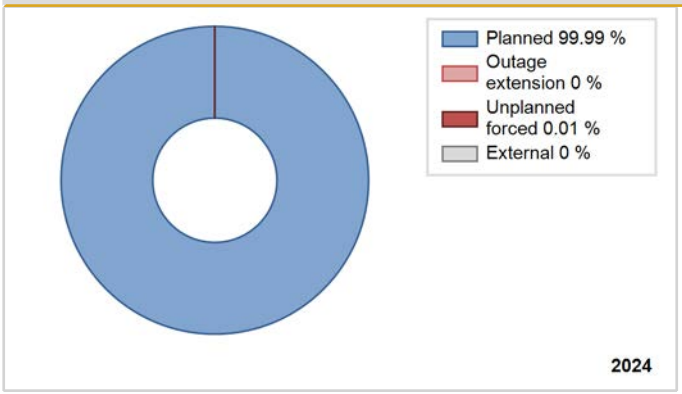
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1991	2524.41	3228	1127	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1992	9954.69	8784	1127	99.98	99.98	100.56	100.00	0.00	0.00	0.02	0.00
1993	7863.69	7025	1127	79.43	79.43	79.65	80.19	0.00	0.00	20.57	0.00
1994	8139.08	7265	1127	82.53	82.53	82.44	82.93	0.00	0.00	17.47	0.00
1995	7701.72	6887	1127	77.82	77.82	78.01	78.62	0.00	0.00	22.18	0.00
1996	9957.45	8784	1127	99.99	99.99	100.58	100.00	0.00	0.00	0.01	0.00
1997	8333.01	7385	1127	83.88	83.88	84.41	84.30	0.00	0.00	16.12	0.00
1998	8872.74	7867	1127	89.30	89.30	89.87	89.81	0.00	0.00	10.70	0.00
1999	8892.35	7875	1127	89.52	89.89	90.07	89.90	0.00	0.00	10.11	0.37
2000	8868.86	7824	1127	89.06	89.06	89.59	89.07	0.00	0.00	10.94	0.00
2001	8474.65	7481	1127	85.38	85.38	85.84	85.40	0.00	0.00	14.62	0.01
2002	9918.68	8760	1127	99.99	99.99	100.47	100.00	0.00	0.00	0.01	0.00
2003	8683.19	7525	1127	85.89	85.89	87.95	85.90	0.00	0.00	14.11	0.00
2004	3040.18	2634	1127	30.01	30.01	30.71	29.99	0.00	59.84	10.15	0.00
2005	7834.00	6968	1127	77.64	77.64	79.35	79.54	7.12	9.73	12.63	0.00
2006	8012.30	7001	1127	79.62	79.62	81.16	79.92	0.00	0.00	20.38	0.00
2007	10080.14	8760	1127	99.99	99.99	102.10	100.00	0.00	0.00	0.01	0.00
2008	2355.61	2081	1127	23.36	23.36	23.80	23.69	0.00	53.75	22.90	0.00
2009	8335.16	7282	1127	83.08	83.08	84.43	83.13	0.00	0.00	16.92	0.00
2010	8297.03	7299	1127	82.76	82.76	84.04	83.32	11.51	10.76	6.48	0.00
2011	2104.70	1834	1127	20.89	20.89	21.32	20.94	0.00	0.00	79.11	0.00
2012	4925.65	4325	1127	48.78	48.78	49.76	49.24	0.00	0.00	51.22	0.00
2013	6779.28	5879	1127	66.75	67.10	68.67	67.11	0.00	0.00	32.90	0.36
2014	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2015	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2016	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2017	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2018	8009.80	6967	1127	79.13	79.13	81.13	79.53	0.00	0.00	20.87	0.00
2019	7928.91	6881	1127	78.12	78.12	80.31	78.55	0.00	0.00	21.88	0.00
2020	5627.87	4834	1127	54.99	54.99	56.85	55.03	0.00	0.00	45.01	0.00
2021	4866.36	4303	1127	48.13	48.13	49.29	49.12	1.32	0.64	51.22	0.00
2022	6869.56	5943	1127	67.48	67.48	69.58	67.84	0.00	0.00	32.52	0.00
2023	10162.58	8760	1127	100.00	100.00	102.94	100.00	0.00	0.00	0.00	0.00
2024	8532.36	7409	1127	83.99	83.99	86.19	84.35	0.00	0.00	16.01	0.00

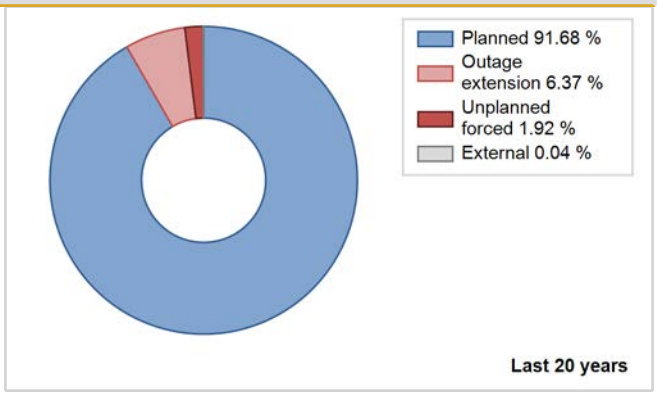
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1991 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					338	
C. Inspection, maintenance or repair combined with refuelling	1375			1136		
F. Major backfitting, refurbishment or upgrading activities with refuelling				638		
G. Major backfitting, refurbishment or upgrading activities without refuelling				890		
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					29	
Subtotal	1375			2664	367	
Total	**1375**			**3031**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1991 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		203
13. Reactor Auxiliary Systems		16
15. Reactor Cooling Systems		148
Total		**367**

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2024 Operating Experience

JP-51 OHI-4 JAPAN



Status at end of year	:	**Operational**
Operator	:	KEPCO (Kansai Electric Power Co.)
Owner	:	KEPCO (Kansai Electric Power Co.)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / M (4-loop)
Thermal power	:	3423 MWth
Gross electrical power	:	1180 MWe
Reference unit power (net)	:	1127 MWe

Key Dates

Construction Date	:	1988-06-13
Grid Date	:	1992-06-19
Commercial Date	:	1993-02-02
Age at end of year	:	32 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.1
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	44000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.9
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

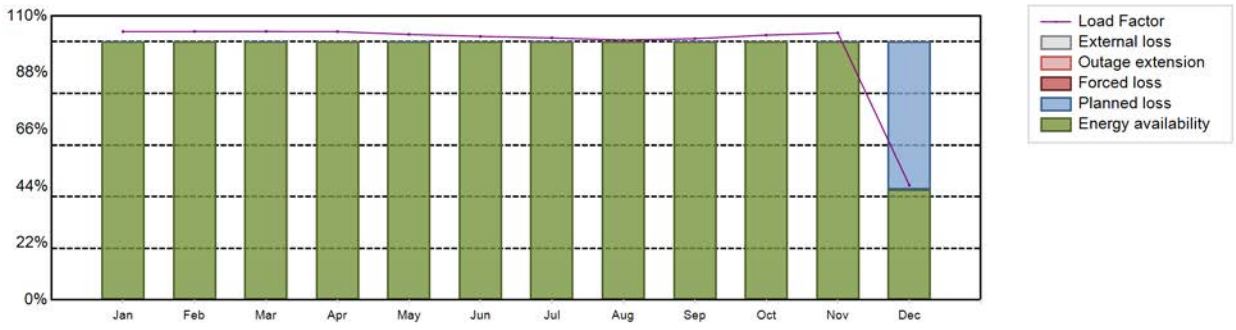
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	325
Number of SG	:	4
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.4
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	DS

Annual Production Results (2024)

Net Energy Production	:	9680.38 GW(e).h
Energy Availability Factor (EAF)	:	95.15 %
Unit Capability Factor (UCF)	:	95.15 %
Load Factor (LF)	:	97.79 %
Operating Factor (OF)	:	95.2 %
Equivalent non-electrical energy generated (NEG)	:	0 GW(e).h

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	4.85 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	422 hours

Annual Summary



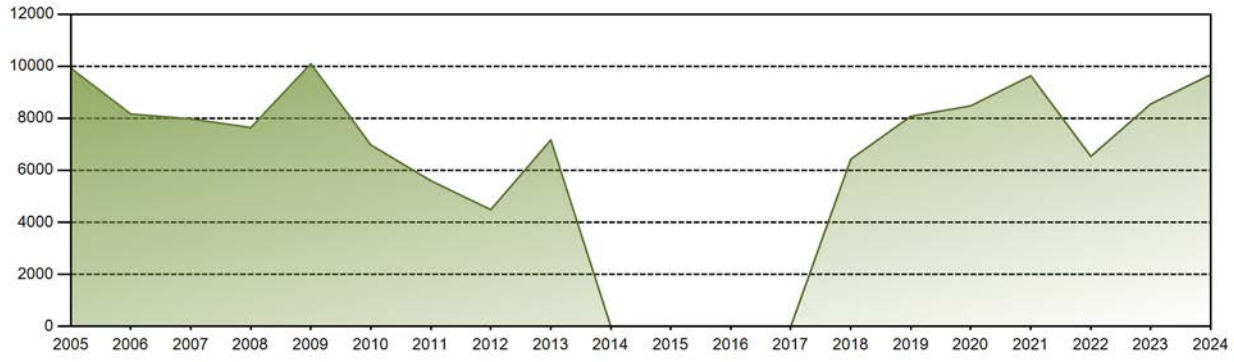
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	871.42	815.45	871.92	843.19	862.32	828.33	850.92	843.93	821.08	860.21	839.13	372.47	9680.38
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	42.80	95.15
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	42.80	95.15
LF [%]	103.93	103.96	103.99	103.91	102.84	102.08	101.48	100.65	101.19	102.59	103.41	44.42	97.79
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	43.28	95.20
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.20	4.85
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	226568.58 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.9 %
Cumulative Energy Availability Factor (EAF)	:	70.59 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.46 %
Cumulative Unit Capability Factor (UCF)	:	70.6 %	Cumulative Planned Unavailability Factor (PUF)	:	27.94 %
Cumulative Load Factor (LF)	:	71.85 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	70.79 %			

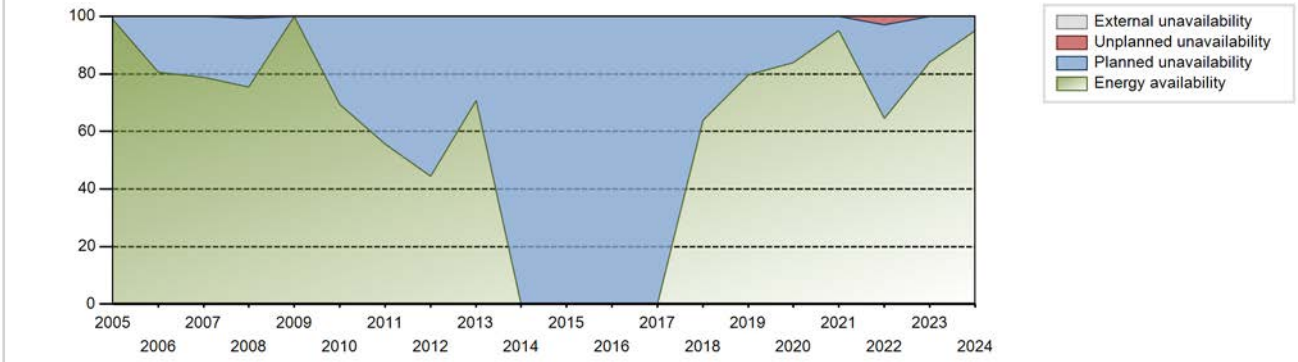
Electricity Production (net) [GWh]



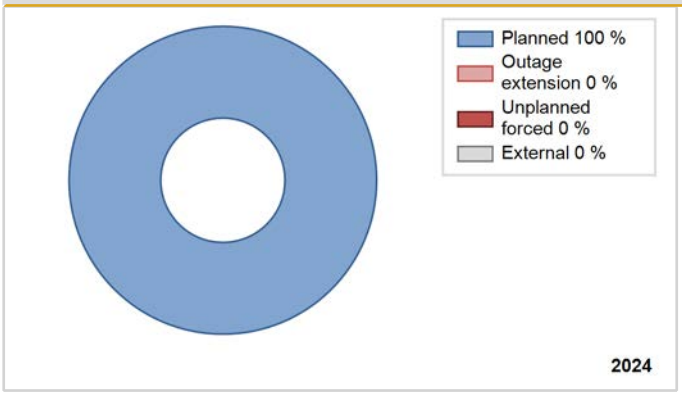
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1993	9923.46	8760	1127	99.98	99.98	100.51	100.00	0.00	0.00	0.02	0.00
1994	7851.52	7063	1127	79.68	79.68	79.53	80.63	0.00	0.00	20.32	0.00
1995	7495.11	6695	1127	75.63	75.63	75.92	76.43	0.00	0.00	24.37	0.00
1996	7051.09	6221	1127	70.81	70.81	71.23	70.82	16.12	13.61	15.58	0.00
1997	7660.20	6756	1127	77.10	77.10	77.59	77.12	22.89	22.89	0.01	0.00
1998	8839.42	7835	1127	88.96	88.96	89.54	89.44	0.00	0.00	11.04	0.00
1999	8903.44	7872	1127	89.54	89.85	90.18	89.86	0.00	0.00	10.15	0.31
2000	8649.77	7629	1127	86.83	86.83	87.38	86.85	0.00	0.00	13.17	0.00
2001	9283.56	8179	1127	93.36	93.36	94.03	93.37	0.00	0.00	6.64	0.00
2002	9217.09	8017	1127	91.50	91.50	93.36	91.52	0.00	0.00	8.50	0.00
2003	8762.57	7557	1127	86.26	86.26	88.76	86.27	0.00	0.00	13.74	0.00
2004	8318.19	7186	1127	81.78	81.78	84.03	81.81	7.44	6.57	11.65	0.00
2005	9929.00	8657	1127	98.77	98.77	100.57	98.82	0.00	0.00	1.23	0.00
2006	8163.92	7087	1127	80.66	80.66	82.69	80.90	0.00	0.00	19.34	0.00
2007	7978.56	6934	1127	78.87	78.87	80.82	79.16	0.00	0.00	21.13	0.00
2008	7642.69	6654	1127	75.41	75.41	77.20	75.75	0.79	0.60	23.98	0.00
2009	10097.36	8760	1127	99.99	99.99	102.28	100.00	0.00	0.00	0.01	0.00
2010	6977.31	6109	1127	69.41	69.41	70.67	69.74	0.00	0.00	30.59	0.00
2011	5599.90	4872	1127	55.56	55.56	56.72	55.62	0.00	0.00	44.44	0.00
2012	4486.58	3941	1127	44.41	44.41	45.32	44.87	0.00	0.00	55.59	0.00
2013	7167.72	6191	1127	70.67	70.67	72.60	70.67	0.00	0.00	29.33	0.00
2014	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2015	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2016	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2017	0.00	0	1127	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2018	6428.38	5623	1127	63.79	63.79	65.11	64.19	0.00	0.00	36.21	0.00
2019	8077.29	7011	1127	79.65	79.65	81.82	80.03	0.00	0.00	20.35	0.00
2020	8481.35	7378	1127	83.95	83.95	85.67	83.99	0.00	0.00	16.05	0.00
2021	9636.22	8357	1127	95.07	95.07	97.61	95.40	0.00	0.00	4.93	0.00
2022	6536.56	5681	1127	64.47	64.47	66.21	64.85	0.00	3.01	32.51	0.00
2023	8554.07	7395	1127	84.06	84.06	86.65	84.42	0.00	0.00	15.94	0.00
2024	9680.38	8362	1127	95.15	95.15	97.79	95.20	0.00	0.00	4.85	0.00

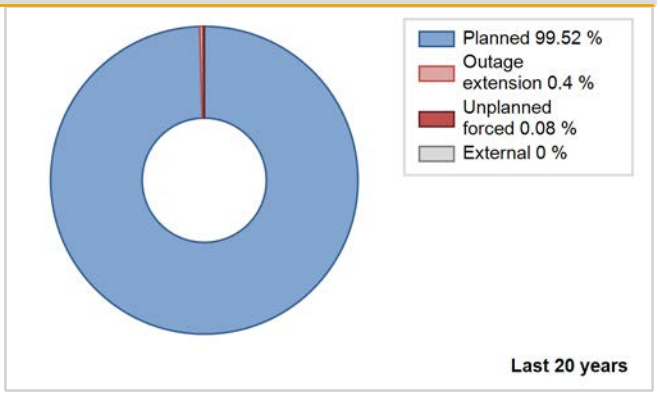
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1993 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					114	
C. Inspection, maintenance or repair combined with refuelling	422			980		
F. Major backfitting, refurbishment or upgrading activities with refuelling				648		
G. Major backfitting, refurbishment or upgrading activities without refuelling				877		
Z. Other					19	
Subtotal	422			2505	133	
Total	**422**			**2638**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1993 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
31. Turbine and auxiliaries		19
32. Feedwater and Main Steam System		9
41. Main Generator Systems		103
Total		**133**

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2024 Operating Experience

JP-54 ONAGAWA-2 JAPAN



Status at end of year	:	**Operational**
Operator	:	TOHOKU (Tohoku Electric Power Co., Inc)
Owner	:	TOHOKU (Tohoku Electric Power Co., Inc)
Reactor Supplier	:	TOSHIBA (TOSHIBA CORPORATION)
Turbine Supplier	:	TOSHIBA (TOSHIBA CORPORATION)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-5
Thermal power	:	2436 MWth
Gross electrical power	:	825 MWe
Reference unit power (net)	:	796 MWe

Key Dates

Construction Date	:	1991-04-12
Grid Date	:	1994-12-23
Commercial Date	:	1995-07-28
Age at end of year	:	30 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.7
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	25
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	4.07
Active core height/length [m]	:	3.71
Number of fissile fuel assemblies/bundles	:	560
Fuel linear heat generation rate [kW/m]	:	15.9
Number of control rod assemblies	:	137
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

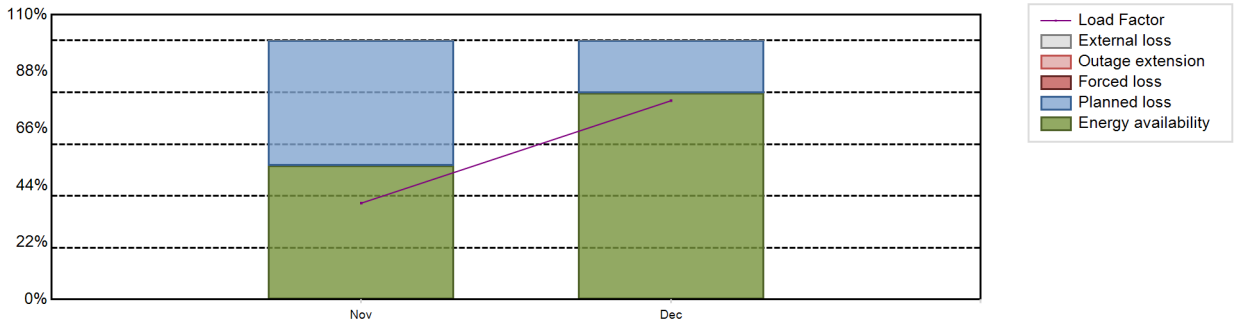
Operating coolant pressure [MPa]	:	6.93
Reactor outlet temperature [°C]	:	286
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.43
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.55
Output voltage [kV]	:	17
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	6
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	568.48 GW(e).h
Energy Availability Factor (EAF)	:	70.26 %
Unit Capability Factor (UCF)	:	70.26 %
Load Factor (LF)	:	63.31 %
Operating Factor (OF)	:	70.21 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	29.74 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	336 hours

Annual Summary



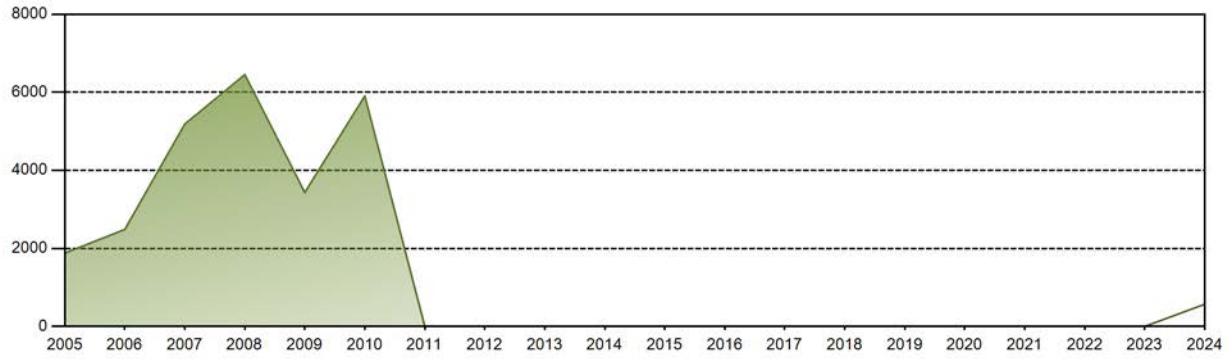
	Jan	Oct	Feb	Mar	Apr	May	Jun	Jul	Sep	Aug	Nov	Dec	Annual
GW(e)-h											113.75	454.73	568.48
EAF [%]											51.82	79.77	70.26
UCF [%]											51.82	79.77	70.26
LF [%]											37.21	76.78	63.31
OF [%]											51.82	79.70	70.21
FLR [%]											0.00	0.00	0.00
UCL [%]											0.00	0.00	0.00
PUF [%]											48.18	20.23	29.74
XUF [%]											0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	81733.48 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.64 %
Cumulative Energy Availability Factor (EAF)	:	73.08 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.01 %
Cumulative Unit Capability Factor (UCF)	:	75.71 %	Cumulative Planned Unavailability Factor (PUF)	:	17.28 %
Cumulative Load Factor (LF)	:	73.17 %	Cumulative Externally cause unavailability (XUF)	:	2.63 %
Cumulative Operating Factor (OF)	:	73.33 %			

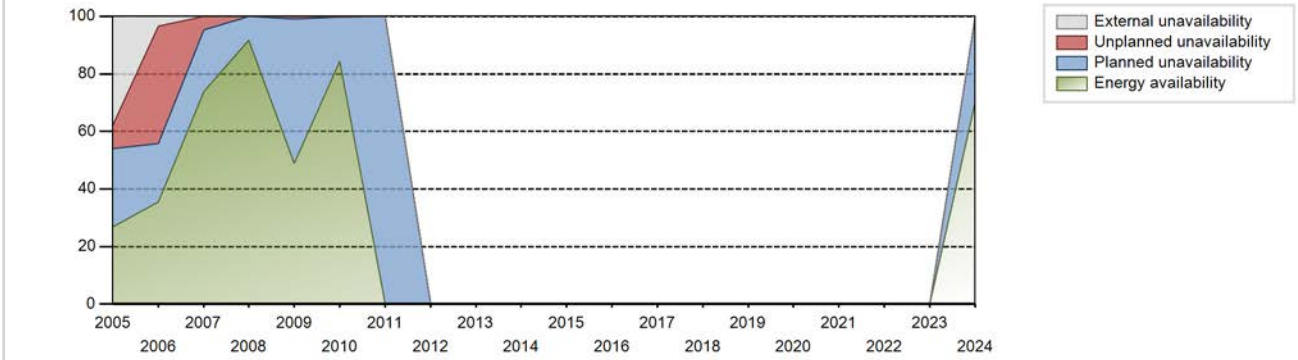
Electricity Production (net) [GWh]



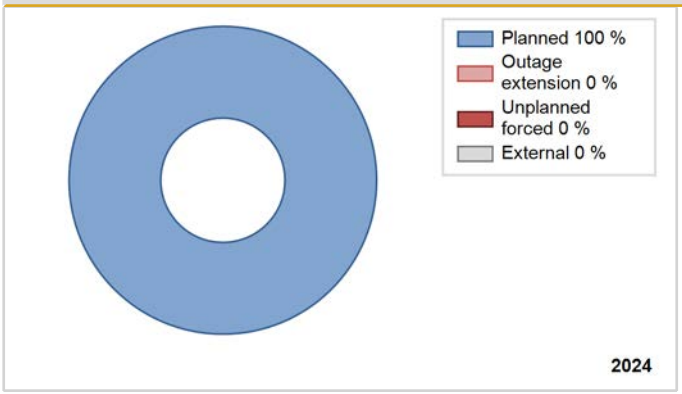
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1995	4496.61	6510	796	95.35	95.35	94.74	95.59	4.55	4.55	0.10	0.00
1996	5175.27	6545	796	74.44	74.44	74.02	74.51	2.69	2.06	23.50	0.00
1997	6931.60	8760	796	99.91	99.92	99.41	100.00	0.00	0.00	0.08	0.01
1998	5647.72	7185	796	81.11	81.12	80.99	82.02	2.63	2.19	16.69	0.00
1999	5841.18	7383	796	84.23	84.23	83.77	84.28	0.00	0.00	15.77	0.00
2000	5858.59	7402	796	84.25	84.25	83.79	84.27	0.00	0.00	15.75	0.00
2001	6521.16	8238	796	93.96	93.96	93.52	94.04	2.96	2.87	3.17	0.00
2002	5242.91	6368	796	72.44	72.44	75.19	72.69	3.21	8.96	18.60	0.00
2003	3272.36	4139	796	47.17	47.28	46.93	47.25	0.00	37.62	15.11	0.11
2004	7040.38	8784	796	100.00	100.00	100.69	100.00	0.00	0.00	0.00	0.00
2005	1877.27	2367	796	26.78	64.46	26.92	27.02	0.00	8.20	27.34	37.68
2006	2484.73	3188	796	35.56	38.88	35.63	36.39	33.66	40.74	20.37	3.33
2007	5184.62	6491	796	73.83	73.83	74.35	74.10	1.47	4.65	21.51	0.00
2008	6453.43	8086	796	91.76	91.76	92.30	92.05	0.00	0.11	8.13	0.00
2009	3430.26	4330	796	48.98	49.01	49.19	49.43	0.00	0.87	50.11	0.04
2010	5905.54	7417	796	84.40	84.62	84.69	84.67	0.00	0.00	15.38	0.22
2011	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2012	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0	796	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	Data not available - Suspended Operation										
2023	"										
2024	568.48	792	796	70.26	70.26	63.31	70.21	0.00	0.00	29.74	0.00

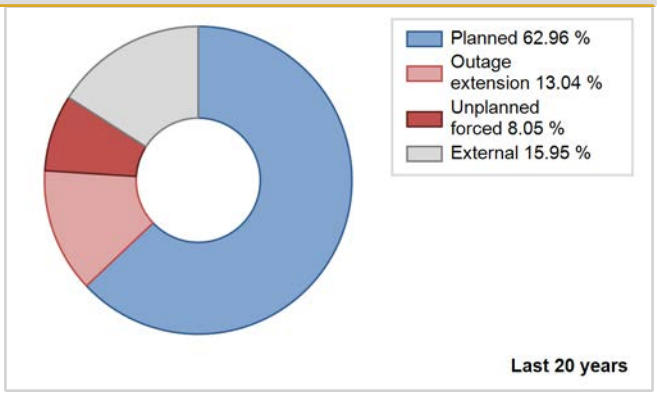
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1995 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					597	
C. Inspection, maintenance or repair combined with refuelling				1452	7	
D. Inspection, maintenance or repair without refuelling				39		
E. Testing of plant systems or components					12	
F. Major backfitting, refurbishment or upgrading activities with refuelling	336			21		
G. Major backfitting, refurbishment or upgrading activities without refuelling				5755		
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						489
Subtotal	336			7267	616	489
Total	**336**			**8372**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1995 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		54
12. Reactor I&C Systems		112
13. Reactor Auxiliary Systems		97
15. Reactor Cooling Systems		247
31. Turbine and auxiliaries		21
32. Feedwater and Main Steam System		47
34. Miscellaneous Systems		6
Total		**584**

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2024 Operating Experience

JP-28 SENDAI-1 JAPAN



Status at end of year	:	**Operational**
Operator	:	KYUSHU (Kyushu Electric Power Co., Inc.)
Owner	:	KYUSHU (Kyushu Electric Power Co., Inc.)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	SIEMENS (Siemens AG, Power Generation)

Reactor Unit Details

Reactor type and model	:	PWR / M (3-loop)
Thermal power	:	2660 MWth
Gross electrical power	:	890 MWe
Reference unit power (net)	:	846 MWe

Key Dates

Construction Date	:	1979-12-15
Grid Date	:	1983-09-16
Commercial Date	:	1984-07-04
Age at end of year	:	41 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.8
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	49000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.1
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

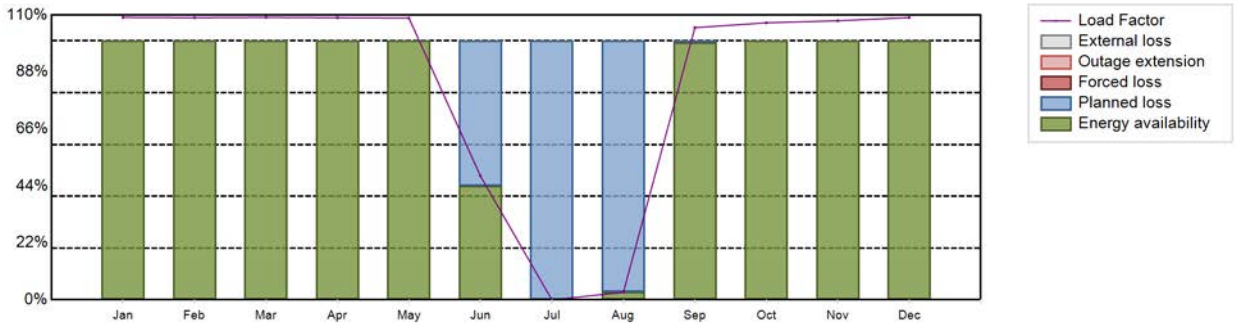
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.22
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.07
Output voltage [kV]	:	23
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6329.22 GW(e).h
Energy Availability Factor (EAF)	:	78.69 %
Unit Capability Factor (UCF)	:	78.69 %
Load Factor (LF)	:	85.17 %
Operating Factor (OF)	:	79.13 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	21.31 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1833 hours

Annual Summary



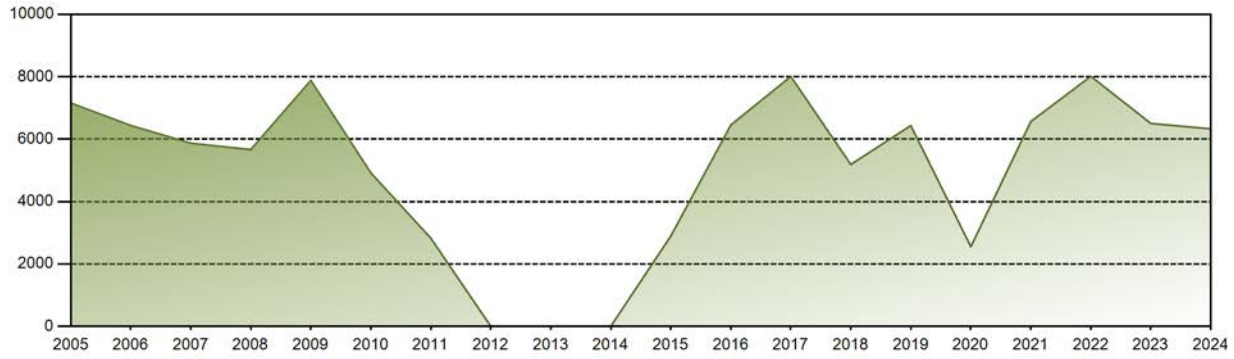
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	686.47	641.54	686.61	663.60	684.96	291.36	0.00	18.39	640.25	673.44	656.51	686.12	6329.23
EAF [%]	100.00	100.00	100.00	100.00	100.00	44.13	0.00	3.07	99.33	100.00	100.00	100.00	78.69
UCF [%]	100.00	100.00	100.00	100.00	100.00	44.13	0.00	3.07	99.33	100.00	100.00	100.00	78.69
LF [%]	109.06	108.95	109.09	108.94	108.82	47.83	0.00	2.92	105.11	106.99	107.78	109.01	85.17
OF [%]	100.00	100.00	100.00	100.00	100.00	44.58	0.00	7.26	100.00	100.00	100.00	100.00	79.13
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	55.87	100.00	96.93	0.67	0.00	0.00	0.00	21.31
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	231695.74 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.49 %
Cumulative Energy Availability Factor (EAF)	:	72.57 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.69 %
Cumulative Unit Capability Factor (UCF)	:	72.57 %	Cumulative Planned Unavailability Factor (PUF)	:	26.75 %
Cumulative Load Factor (LF)	:	75.14 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	73.07 %			

Electricity Production (net) [GWh]

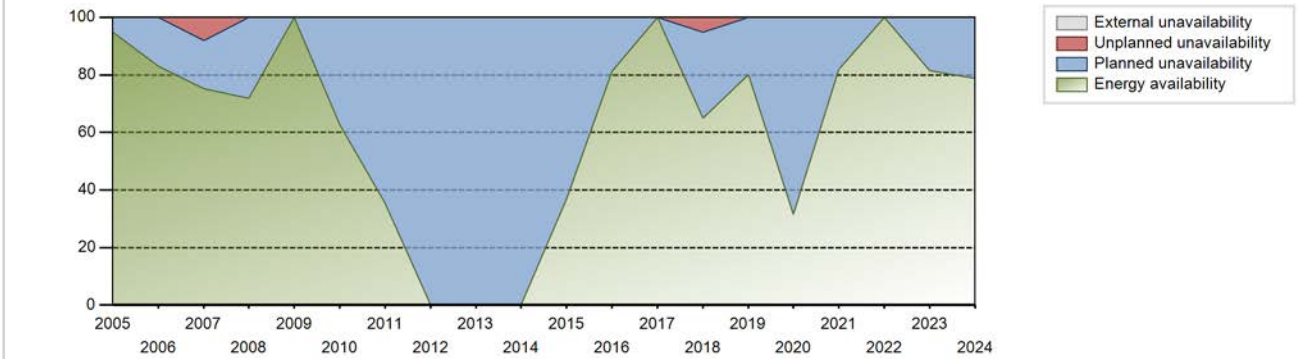


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	6069.77	7487	846	100.00	100.00	101.06	100.00	0.00	0.00	0.00	0.00
1985	5890.27	6964	846	78.68	78.68	79.48	79.50	0.00	0.00	21.32	0.00
1986	6084.02	7224	846	81.36	81.36	82.09	82.47	0.00	0.00	18.64	0.00
1987	6113.36	7261	846	81.74	81.74	82.49	82.89	0.00	0.00	18.26	0.00
1988	5683.09	6756	846	75.81	75.81	76.48	76.91	0.00	0.00	24.19	0.00
1989	7381.33	8641	846	98.69	98.69	99.60	98.64	0.00	0.00	1.31	0.00
1990	6154.95	7307	846	82.31	82.31	83.05	83.41	0.00	0.00	17.69	0.00
1991	5590.69	6684	846	74.76	74.76	75.44	76.30	1.23	0.93	24.31	0.00
1992	5713.89	6780	846	76.08	76.08	76.89	77.19	0.00	0.00	23.92	0.00
1993	6619.24	7753	846	88.43	88.43	89.32	88.50	0.00	0.00	11.57	0.00
1994	5778.34	6762	846	77.17	77.17	77.97	77.19	0.00	0.00	22.83	0.00
1995	5780.32	6863	846	77.28	77.28	78.00	78.34	0.00	0.00	22.72	0.00
1996	5185.37	6157	846	69.09	69.09	69.78	70.09	0.00	0.00	30.91	0.00
1997	7216.68	8449	846	96.40	96.40	97.38	96.45	0.00	0.00	3.60	0.00
1998	5291.22	6311	846	70.64	70.64	71.40	72.04	4.67	3.46	25.90	0.00
1999	6057.57	7082	846	80.83	80.83	81.74	80.84	3.06	2.55	16.62	0.00
2000	5654.00	6609	846	75.23	75.23	76.08	75.24	9.23	7.65	17.12	0.00
2001	7367.04	8614	846	98.31	98.31	99.41	98.33	0.00	0.00	1.69	0.00
2002	6323.03	7333	846	83.68	83.68	85.32	83.71	0.00	0.00	16.32	0.00
2003	6282.06	7278	846	83.08	83.08	84.77	83.08	0.00	0.00	16.92	0.00
2004	6080.79	7043	846	80.15	80.15	81.83	80.18	0.00	0.00	19.85	0.00
2005	7155.81	8305	846	94.74	94.74	96.56	94.81	0.00	0.00	5.26	0.00
2006	6436.58	7330	846	82.92	82.92	86.85	83.68	0.00	0.00	17.08	0.00
2007	5868.86	6660	846	75.21	75.21	79.19	76.03	0.00	8.05	16.74	0.00
2008	5665.09	6396	846	71.92	71.92	76.23	72.81	0.00	0.00	28.08	0.00
2009	7880.10	8760	846	100.00	100.00	106.33	100.00	0.00	0.00	0.00	0.00
2010	4919.57	5571	846	62.67	62.67	66.38	63.60	0.00	0.00	37.33	0.00
2011	2823.75	3097	846	35.32	35.32	38.10	35.35	0.00	0.00	64.68	0.00
2012	0.00	0	846	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2013	0.00	0	846	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2014	0.00	0	846	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2015	2893.82	3351	846	36.84	36.84	39.05	38.25	0.00	0.00	63.16	0.00
2016	6452.27	7188	846	81.16	81.16	86.83	81.83	0.00	0.00	18.84	0.00
2017	8007.73	8760	846	100.00	100.00	108.05	100.00	0.00	0.00	0.00	0.00
2018	5186.62	5756	846	65.03	65.03	69.99	65.71	0.00	5.10	29.87	0.00
2019	6434.71	7058	846	80.07	80.07	86.83	80.57	0.00	0.00	19.93	0.00
2020	2552.25	2818	846	31.58	31.58	34.34	32.08	0.00	0.00	68.42	0.00

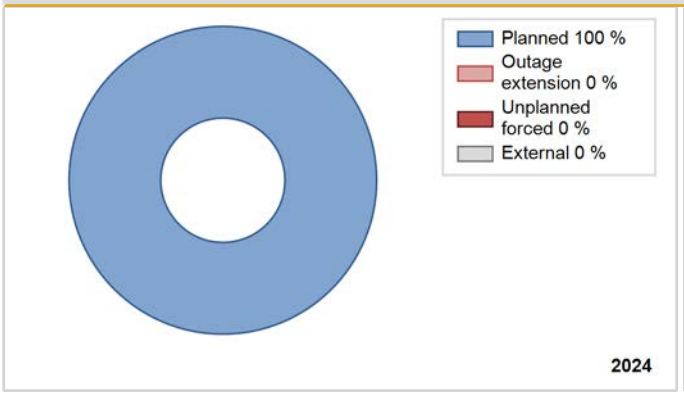
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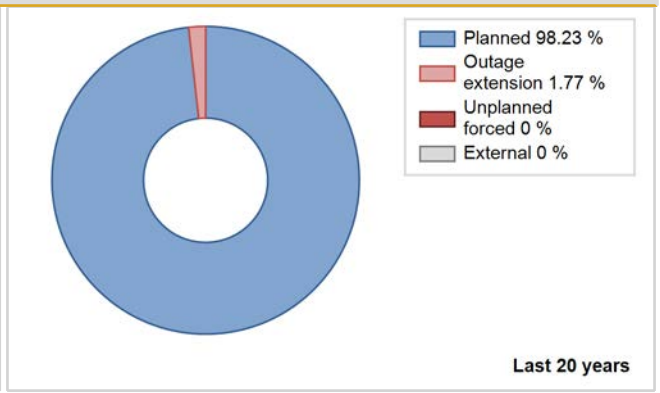
2021	6563.52	7215	846	81.90	81.90	88.57	82.36	0.00	0.00	18.10	0.00
2022	8012.33	8760	846	100.00	100.00	108.11	100.00	0.00	0.00	0.00	0.00
2023	6502.42	7167	846	81.37	81.37	87.74	81.82	0.00	0.00	18.63	0.00
2024	6329.23	6951	846	78.69	78.69	85.17	79.13	0.00	0.00	21.31	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					57	
C. Inspection, maintenance or repair combined with refuelling	1833			1458		
G. Major backfitting, refurbishment or upgrading activities without refuelling				891		
Subtotal	1833			2349	57	
Total	**1833**			**2406**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1984 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		11
12. Reactor I&C Systems		1
13. Reactor Auxiliary Systems		7
16. Steam generation systems		17
31. Turbine and auxiliaries		6
32. Feedwater and Main Steam System		16
Total		**58**

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2024 Operating Experience

JP-37 SENDAI-2 JAPAN



Status at end of year	:	**Operational**
Operator	:	KYUSHU (Kyushu Electric Power Co., Inc.)
Owner	:	KYUSHU (Kyushu Electric Power Co., Inc.)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	SIEMENS (Siemens AG, Power Generation)

Reactor Unit Details

Reactor type and model	:	PWR / M (3-loop)
Thermal power	:	2660 MWth
Gross electrical power	:	890 MWe
Reference unit power (net)	:	846 MWe

Key Dates

Construction Date	:	1981-10-12
Grid Date	:	1985-04-05
Commercial Date	:	1985-11-28
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.8
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	49000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.1
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

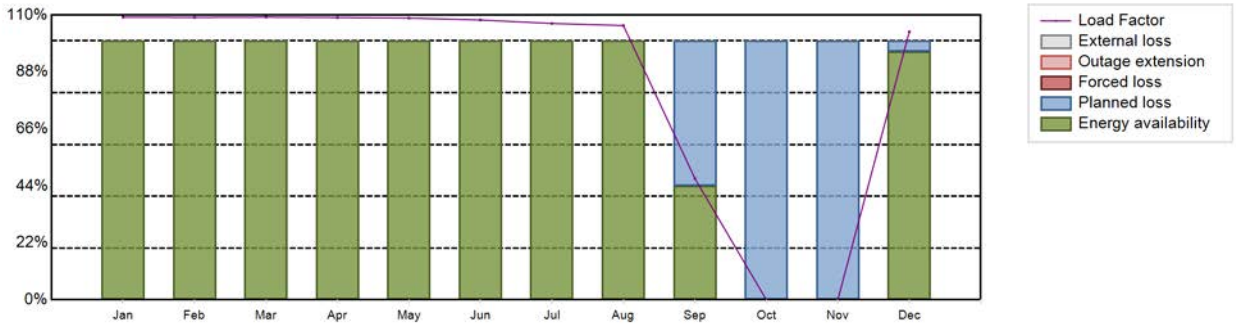
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.22
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.07
Output voltage [kV]	:	23
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6300.64 GW(e).h
Energy Availability Factor (EAF)	:	78.41 %
Unit Capability Factor (UCF)	:	78.41 %
Load Factor (LF)	:	84.79 %
Operating Factor (OF)	:	78.86 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	21.59 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1857 hours

Annual Summary



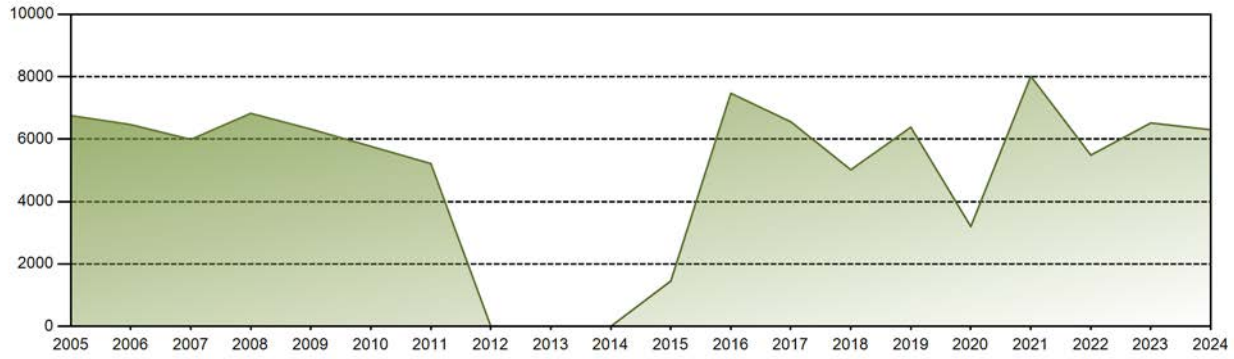
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	687.19	642.26	687.23	664.13	684.94	658.30	671.83	666.82	285.48	0.00	0.52	651.96	6300.65
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	44.13	0.00	0.12	95.86	78.41
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	44.13	0.00	0.12	95.86	78.41
LF [%]	109.18	109.08	109.18	109.03	108.82	108.07	106.74	105.94	46.87	0.00	0.09	103.58	84.79
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	44.58	0.00	0.83	100.00	78.86
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55.87	100.00	99.88	4.14	21.59
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	217561.49 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.04 %
Cumulative Energy Availability Factor (EAF)	:	73.29 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.03 %
Cumulative Unit Capability Factor (UCF)	:	73.29 %	Cumulative Planned Unavailability Factor (PUF)	:	26.68 %
Cumulative Load Factor (LF)	:	75.53 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	73.71 %			

Electricity Production (net) [GWh]

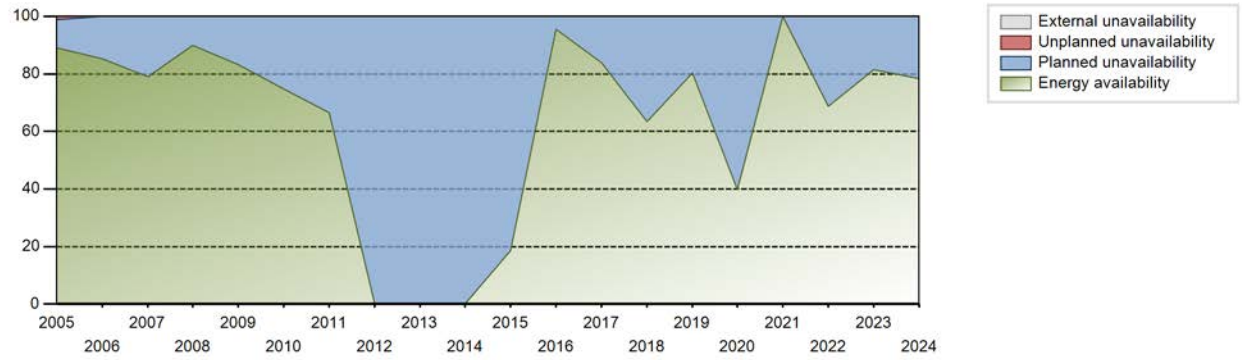


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	2816.07	4327	846	100.00	100.00	101.22	100.00	0.00	0.00	0.00	0.00
1986	5996.37	7112	846	80.14	80.14	80.91	81.19	0.00	0.00	19.86	0.00
1987	6080.60	7211	846	81.18	81.18	82.05	82.32	0.00	0.00	18.82	0.00
1988	7409.79	8665	846	98.70	98.70	99.71	98.65	0.00	0.00	1.30	0.00
1989	4999.37	5950	846	66.84	66.84	67.46	67.92	0.00	0.00	33.16	0.00
1990	6160.14	7309	846	82.37	82.37	83.12	83.44	0.00	0.00	17.63	0.00
1991	5665.26	6732	846	75.72	75.72	76.44	76.85	0.00	0.00	24.28	0.00
1992	7385.32	8639	846	98.30	98.30	99.38	98.35	0.00	0.00	1.70	0.00
1993	5821.98	6632	846	77.69	77.69	78.56	75.71	0.00	0.00	22.31	0.00
1994	5568.78	6557	846	74.30	74.30	75.14	74.85	0.00	0.00	25.70	0.00
1995	5658.40	6709	846	75.50	75.50	76.35	76.59	0.00	0.00	24.50	0.00
1996	7359.31	8617	846	98.05	98.05	99.03	98.10	0.00	0.00	1.95	0.00
1997	5950.29	7034	846	79.44	79.44	80.29	80.30	0.00	0.00	20.56	0.00
1998	5899.10	6973	846	78.72	78.72	79.60	79.60	0.00	0.00	21.28	0.00
1999	5658.29	6612	846	75.47	75.47	76.35	75.48	0.00	0.00	24.53	0.00
2000	7370.17	8614	846	98.04	98.04	99.18	98.06	0.00	0.00	1.96	0.00
2001	6210.15	7260	846	82.86	82.86	83.80	82.88	0.00	0.00	17.14	0.00
2002	6255.46	7257	846	82.83	82.83	84.41	82.84	0.00	0.00	17.17	0.00
2003	6348.77	7315	846	83.38	83.38	85.67	83.50	0.00	0.00	16.62	0.00
2004	6762.55	7774	846	88.48	88.48	91.00	88.50	0.00	0.00	11.52	0.00
2005	6752.80	7895	846	88.94	88.94	91.12	90.13	1.17	1.05	10.01	0.00
2006	6464.16	7548	846	85.35	85.35	87.22	86.16	0.00	0.00	14.65	0.00
2007	5989.31	6996	846	79.05	79.05	80.82	79.86	0.00	0.00	20.95	0.00
2008	6824.28	7897	846	89.86	89.86	91.83	89.90	0.00	0.00	10.14	0.00
2009	6320.24	7355	846	83.19	83.19	85.28	83.96	0.00	0.00	16.81	0.00
2010	5767.52	6630	846	74.78	74.78	77.82	75.68	0.00	0.00	25.22	0.00
2011	5216.82	5833	846	66.55	66.55	70.39	66.59	0.00	0.00	33.45	0.00
2012	0.00	0	846	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2013	0.00	0	846	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2014	0.00	0	846	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2015	1452.66	1729	846	18.63	18.63	19.60	19.74	0.00	0.00	81.37	0.00
2016	7468.59	8401	846	95.60	95.60	100.50	95.64	0.00	0.00	4.40	0.00
2017	6554.16	7401	846	83.87	83.87	88.44	84.49	0.00	0.00	16.13	0.00
2018	5016.93	5618	846	63.46	63.46	67.70	64.13	0.00	0.00	36.54	0.00
2019	6381.17	7082	846	80.38	80.38	86.10	80.84	0.00	0.00	19.62	0.00
2020	3197.98	3538	846	39.82	39.82	43.03	40.28	0.00	0.00	60.18	0.00
2021	8012.55	8760	846	100.00	100.00	108.12	100.00	0.00	0.00	0.00	0.00

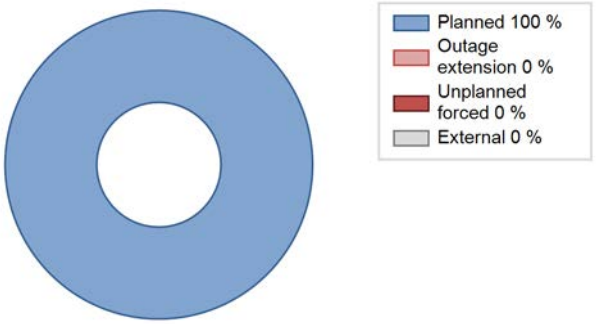
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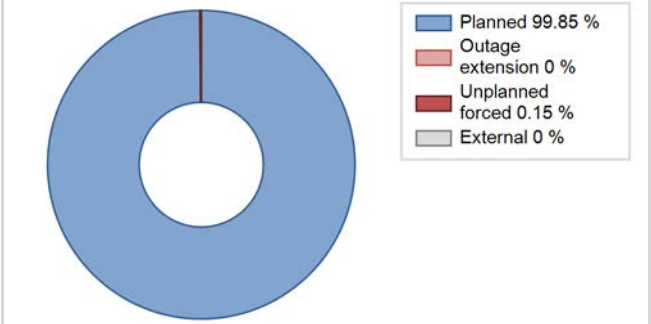
2022	5488.22	6063	846	68.71	68.71	74.06	69.21	0.00	0.00	31.29	0.00
2023	6518.10	7167	846	81.37	81.37	87.95	81.82	0.00	0.00	18.63	0.00
2024	6300.65	6927	846	78.41	78.41	84.79	78.86	0.00	0.00	21.59	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					3	
C. Inspection, maintenance or repair combined with refuelling	1857			1450		
G. Major backfitting, refurbishment or upgrading activities without refuelling				877		
Subtotal	1857			2327	3	
Total	**1857**			**2330**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1985 to 2024 Average hours lost per reactor-year
32. Feedwater and Main Steam System		3
Total		**3**

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2024 Operating Experience

JP-41 SHIMANE-2 JAPAN

Status at end of year	:	**Operational**
Operator	:	CHUGOKU (THE CHUGOKU ELECTRIC POWER CO., INC.)
Owner	:	CHUGOKU (THE CHUGOKU ELECTRIC POWER CO., INC.)
Reactor Supplier	:	HITACHI (HITACHI, LTD.)
Turbine Supplier	:	HITACHI (HITACHI, LTD.)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-5
Thermal power	:	2436 MWth
Gross electrical power	:	820 MWe
Reference unit power (net)	:	789 MWe

Key Dates

Construction Date	:	1985-02-02
Grid Date	:	1988-07-11
Commercial Date	:	1989-02-10
Age at end of year	:	36 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.7
Refuelling frequency [month]	:	14
Part of the core refuelled [%]	:	25
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	4.07
Active core height/length [m]	:	3.71
Number of fissile fuel assemblies/bundles	:	560
Fuel linear heat generation rate [kW/m]	:	44.0
Number of control rod assemblies	:	137
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

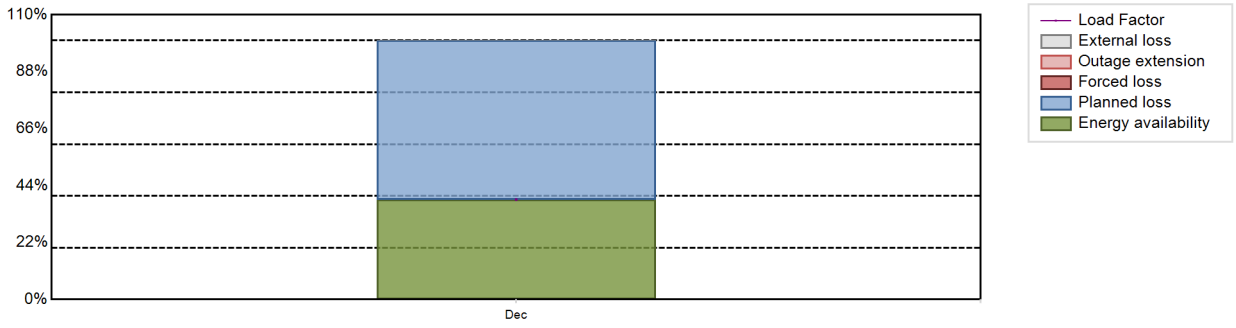
Operating coolant pressure [MPa]	:	6.93
Reactor outlet temperature [°C]	:	286
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.427
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.55
Output voltage [kV]	:	15.5
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	145.82 GW(e).h
Energy Availability Factor (EAF)	:	38.58 %
Unit Capability Factor (UCF)	:	38.58 %
Load Factor (LF)	:	38.58 %
Operating Factor (OF)	:	51.57 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	61.42 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	232 hours

Annual Summary



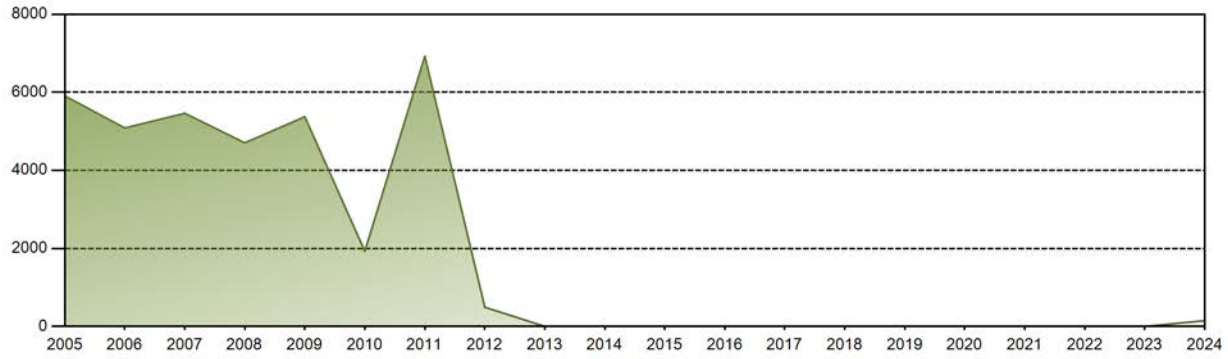
	Jan	Oct	Nov	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Dec	Annual
GW(e)-h												145.82	145.82
EAF [%]												38.58	38.58
UCF [%]												38.58	38.58
LF [%]												38.58	38.58
OF [%]												51.57	51.57
FLR [%]												0.00	0.00
UCL [%]												0.00	0.00
PUF [%]												61.42	61.42
XUF [%]												0.00	0.00

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Historical Summary

Lifetime energy generation	:	129322.82 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.73 %
Cumulative Energy Availability Factor (EAF)	:	80.16 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.62 %
Cumulative Unit Capability Factor (UCF)	:	80.18 %	Cumulative Planned Unavailability Factor (PUF)	:	16.2 %
Cumulative Load Factor (LF)	:	80.04 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	80.53 %			

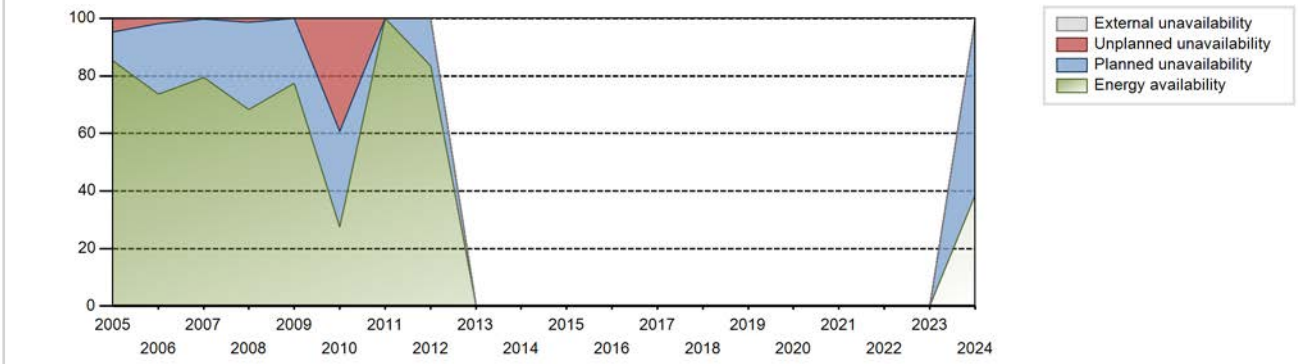
Electricity Production (net) [GWh]



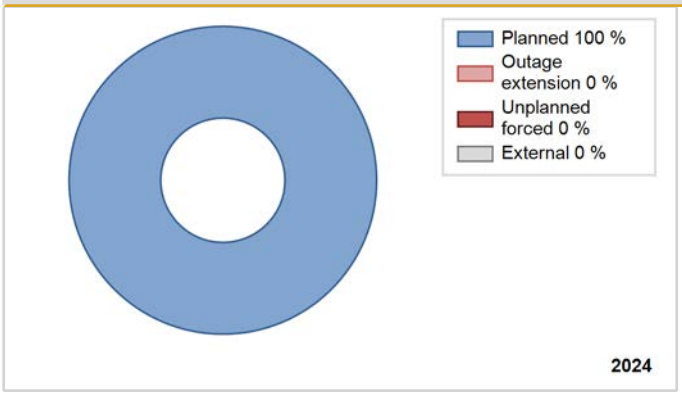
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	5852.06	7485	790	89.20	89.20	88.79	89.56	10.80	10.80	0.00	0.00
1990	5123.51	6592	790	74.03	74.03	74.03	75.25	7.01	5.58	20.38	0.00
1991	5544.50	7121	790	80.12	80.12	80.12	81.29	0.00	0.00	19.88	0.00
1992	5516.14	7072	790	79.69	79.69	79.49	80.51	0.00	0.00	20.31	0.00
1993	6756.90	8592	790	97.78	97.78	97.64	98.08	1.86	1.85	0.37	0.00
1994	5547.27	7071	790	80.55	80.62	80.16	80.72	0.00	0.00	19.38	0.07
1995	5363.61	6888	790	77.85	77.86	77.50	78.63	1.86	1.48	20.66	0.01
1996	5583.69	7166	790	80.83	80.83	80.46	81.58	0.00	0.00	19.17	0.00
1997	6903.19	8760	789	99.97	99.98	99.88	100.00	0.01	0.01	0.01	0.00
1998	5962.47	7600	789	86.46	86.50	86.27	86.76	0.00	0.00	13.50	0.03
1999	5758.72	7319	789	83.50	83.50	83.32	83.55	0.00	0.00	16.50	0.00
2000	6083.96	7747	789	88.12	88.17	87.78	88.19	0.00	0.00	11.83	0.05
2001	6901.04	8760	789	99.95	99.98	99.85	100.00	0.00	0.00	0.02	0.03
2002	6055.09	7678	789	87.61	87.64	87.61	87.65	0.00	0.00	12.36	0.03
2003	4836.24	6133	789	70.00	70.06	69.97	70.01	0.00	6.82	23.13	0.05
2004	4097.56	5202	789	58.97	58.97	59.12	59.22	13.59	10.64	30.40	0.00
2005	5907.46	7544	789	85.36	85.56	85.47	86.12	4.96	4.46	9.97	0.21
2006	5085.40	6469	789	73.61	73.61	73.58	73.85	0.00	1.77	24.62	0.00
2007	5462.01	6970	789	79.52	79.52	79.03	79.57	0.00	0.29	20.20	0.00
2008	4703.60	6001	789	68.25	68.25	67.87	68.32	0.00	1.37	30.38	0.00
2009	5373.85	6799	789	77.46	77.46	77.75	77.61	0.00	0.00	22.54	0.00
2010	1924.42	2438	789	27.61	27.61	27.84	27.83	0.00	39.32	33.07	0.00
2011	6921.96	8760	789	99.98	99.98	100.15	100.00	0.00	0.01	0.01	0.00
2012	491.69	625	789	83.37	83.37	83.76	84.01	0.00	0.00	16.63	0.00
2013	0.00	0	789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	0	789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0.00	0	789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	0.00	0	789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	0.00	0	789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018	0.00	0	789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0	789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0	789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0	789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	Data not available - Suspended Operation										
2023	"										
2024	145.82	247	789	38.58	38.58	38.58	51.57	0.00	0.00	61.42	0.00

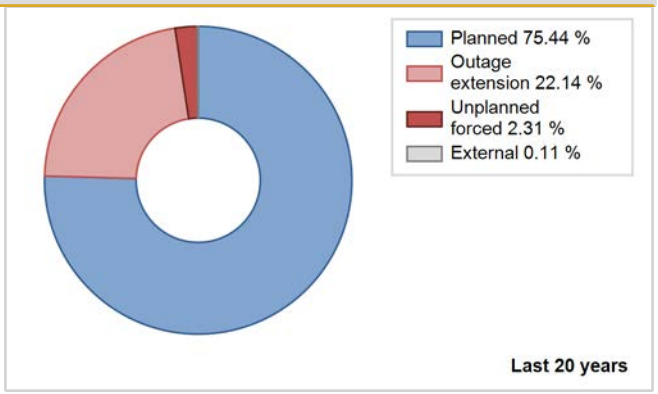
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					131	
C. Inspection, maintenance or repair combined with refuelling				1375	6	
D. Inspection, maintenance or repair without refuelling	232			15		
G. Major backfitting, refurbishment or upgrading activities without refuelling				3771		
H. Nuclear regulatory requirements					150	
L. Human factor related					5	
Z. Other					26	
Subtotal	232			5161	318	
Total	**232**			**5479**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1989 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		41
12. Reactor I&C Systems		4
13. Reactor Auxiliary Systems		16
15. Reactor Cooling Systems		69
Total		**130**

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2024 Operating Experience

JP-8 TAKAHAMA-1 JAPAN



Status at end of year	:	**Operational**
Operator	:	KEPCO (Kansai Electric Power Co.)
Owner	:	KEPCO (Kansai Electric Power Co.)
Reactor Supplier	:	WH/MHI (WESTINGHOUSE ELECTRIC CORPORATION / MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / M (3-loop)
Thermal power	:	2440 MWth
Gross electrical power	:	826 MWe
Reference unit power (net)	:	780 MWe

Key Dates

Construction Date	:	1970-04-25
Grid Date	:	1974-03-27
Commercial Date	:	1974-11-14
Age at end of year	:	50 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.0
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	43000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.64
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	20.3
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

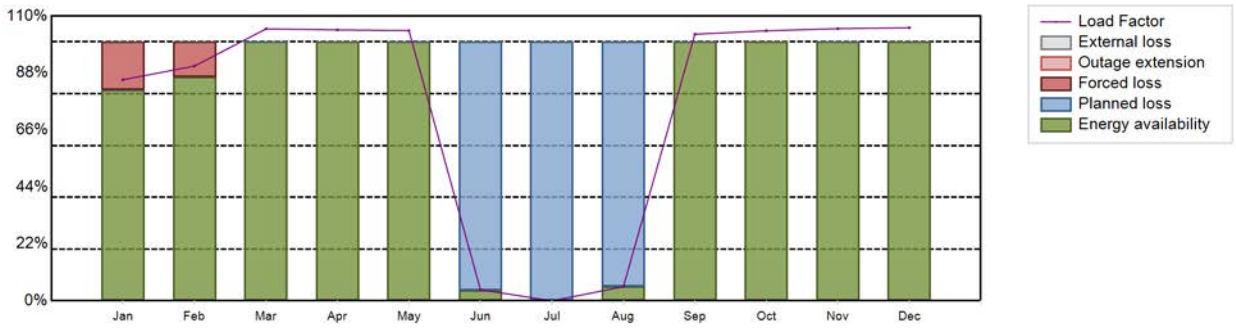
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	323
Number of SG	:	3
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.24
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.8
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5232.51 GW(e).h
Energy Availability Factor (EAF)	:	73.03 %
Unit Capability Factor (UCF)	:	73.03 %
Load Factor (LF)	:	76.37 %
Operating Factor (OF)	:	76.07 %

Forced Loss Rate (FLR)	:	3.48 %
Unplanned Capability Loss Factor (UCL)	:	2.63 %
Planned Unavailability Factor (PUF)	:	24.34 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	2102 hours

Annual Summary



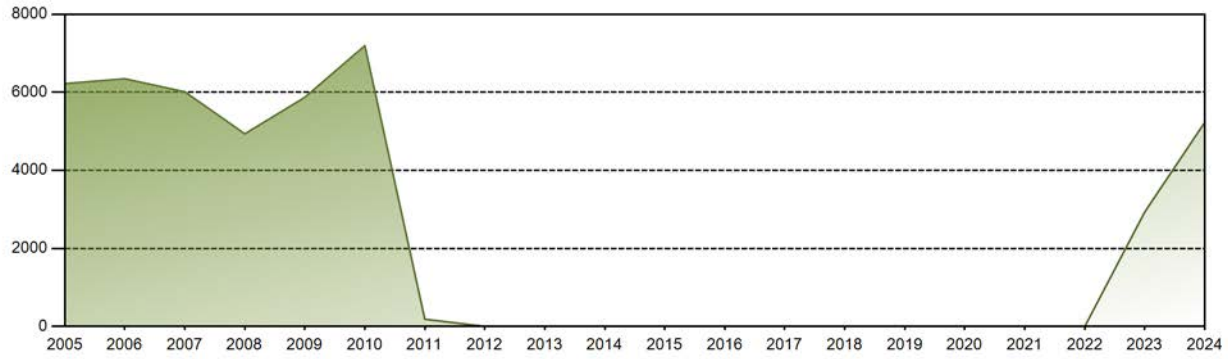
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	495.43	492.28	609.49	587.68	605.76	24.21	0.00	31.71	578.28	605.25	590.40	612.01	5232.51
EAF [%]	81.54	86.50	99.99	100.00	99.99	4.15	0.00	5.45	99.99	100.00	99.99	100.00	73.03
UCF [%]	81.54	86.50	99.99	100.00	99.99	4.15	0.00	5.45	99.99	100.00	99.99	100.00	73.03
LF [%]	85.37	90.68	105.03	104.64	104.38	4.31	0.00	5.46	102.97	104.30	105.13	105.46	76.37
OF [%]	100.00	100.00	100.00	100.00	100.00	4.72	0.00	9.68	100.00	100.00	100.00	100.00	76.07
FLR [%]	18.45	13.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.48
UCL [%]	18.45	13.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.63
PUF [%]	0.01	0.00	0.01	0.00	0.01	95.85	100.00	94.55	0.01	0.00	0.01	0.00	24.34
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	182482.61 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.23 %
Cumulative Energy Availability Factor (EAF)	:	69.9 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.72 %
Cumulative Unit Capability Factor (UCF)	:	69.93 %	Cumulative Planned Unavailability Factor (PUF)	:	25.36 %
Cumulative Load Factor (LF)	:	70.99 %	Cumulative Externally cause unavailability (XUF)	:	0.03 %
Cumulative Operating Factor (OF)	:	71.13 %			

Electricity Production (net) [GWh]

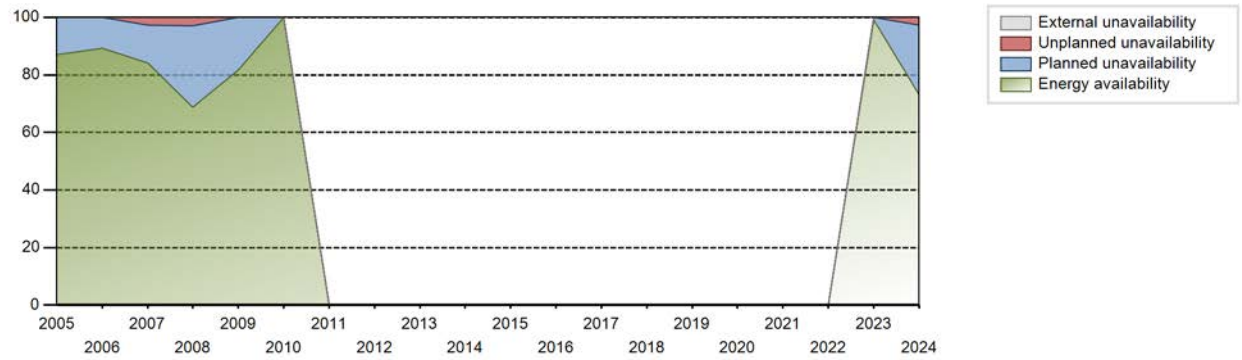


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1974	2660.40	4392	780	94.03	94.03	92.81	93.99	5.08	5.03	0.93	0.00
1975	4980.40	6938	780	72.81	72.81	72.89	79.20	12.81	10.70	16.49	0.00
1976	3170.10	4900	780	46.19	46.19	46.27	55.78	19.20	10.98	42.83	0.00
1977	383.80	569	780	5.61	5.61	5.62	6.50	94.39	94.39	0.00	0.00
1978	2762.50	4088	780	40.42	40.42	40.43	46.67	5.59	2.39	57.18	0.00
1979	1648.90	2269	780	24.14	24.14	24.13	25.90	0.00	0.00	75.86	0.00
1980	2705.10	3604	780	39.42	39.42	39.48	41.03	0.00	0.00	60.58	0.00
1981	3990.20	5180	780	58.33	58.33	58.40	59.13	0.00	0.00	41.67	0.00
1982	3872.10	5085	780	56.50	56.50	56.67	58.05	0.00	0.00	43.50	0.00
1983	5716.20	7403	780	83.72	83.72	83.66	84.51	0.65	0.54	15.74	0.00
1984	3537.44	4586	780	51.41	51.41	51.63	52.21	0.54	0.28	48.31	0.00
1985	5000.77	6473	780	72.84	72.84	73.19	73.89	0.00	0.00	27.16	0.00
1986	5070.31	6507	780	73.86	73.86	74.21	74.28	1.25	0.94	25.21	0.00
1987	4701.39	6148	780	70.18	70.18	68.81	70.18	18.82	16.27	13.55	0.00
1988	4147.14	5351	780	60.92	60.92	60.53	60.92	0.00	0.00	39.08	0.00
1989	4877.26	6311	780	72.04	72.04	71.38	72.04	0.00	0.00	27.96	0.00
1990	6265.50	8002	780	90.76	90.76	91.70	91.35	0.00	0.00	9.24	0.00
1991	4795.05	6202	780	68.25	68.25	70.18	70.80	0.00	0.00	31.75	0.00
1992	4644.96	6051	780	67.62	67.62	67.79	68.89	1.28	0.88	31.50	0.00
1993	3299.67	4458	780	48.36	48.36	48.29	50.89	30.51	21.23	30.41	0.00
1994	4024.04	5146	780	58.84	58.84	58.89	58.74	0.00	0.00	41.16	0.00
1995	6585.13	8485	780	96.05	96.05	96.38	96.86	0.00	0.00	3.95	0.00
1996	3358.80	4331	780	48.81	48.82	49.02	49.31	8.78	4.70	46.48	0.01
1997	4674.40	6000	780	68.10	68.10	68.41	68.49	0.00	0.00	31.90	0.00
1998	6856.82	8760	780	99.99	99.99	100.35	100.00	0.00	0.00	0.01	0.00
1999	5704.24	7291	780	83.22	84.30	83.48	83.23	0.00	0.00	15.70	1.08
2000	6008.07	7716	780	87.42	87.42	87.69	87.84	0.47	0.41	12.17	0.00
2001	6005.80	7731	780	87.62	87.62	87.90	88.25	0.70	0.62	11.76	0.00
2002	6056.31	7749	780	88.44	88.44	88.64	88.46	0.00	0.00	11.56	0.00
2003	6247.16	7637	780	87.17	87.17	91.43	87.18	0.00	0.00	12.83	0.00
2004	5539.92	6785	780	77.21	77.21	80.86	77.24	4.89	3.97	18.81	0.00
2005	6222.49	7659	780	87.07	87.07	91.07	87.43	0.00	0.00	12.93	0.00
2006	6347.13	7811	780	89.16	89.16	92.89	89.17	0.00	0.00	10.84	0.00
2007	6012.94	7399	780	84.15	84.15	88.00	84.46	0.00	2.66	13.19	0.00
2008	4935.75	6077	780	68.84	68.84	72.04	69.18	4.11	2.95	28.21	0.00
2009	5870.09	7193	780	81.73	81.73	85.91	82.11	0.00	0.00	18.27	0.00
2010	7193.46	8760	780	99.99	99.99	105.28	100.00	0.00	0.00	0.01	0.00

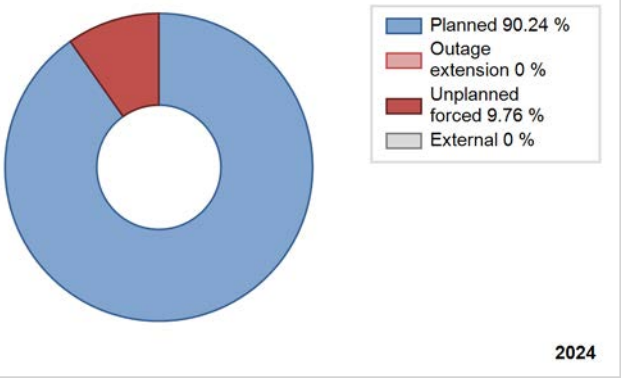
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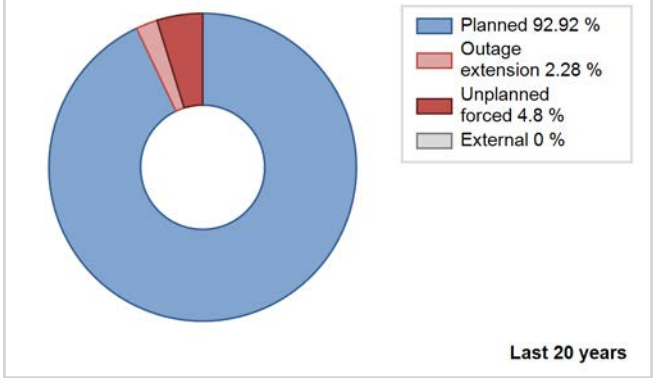
2011	183.43	226	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	Data not available - Suspended Operation										
2023	2936.11	3633	780	99.13	99.13	103.19	99.59	0.00	0.00	0.87	0.00
2024	5232.51	6682	780	73.03	73.03	76.37	76.07	3.48	2.63	24.34	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1974 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					365	
C.	Inspection, maintenance or repair combined with refuelling	2102			2110		
D.	Inspection, maintenance or repair without refuelling				189		
E.	Testing of plant systems or components				0		
F.	Major backfitting, refurbishment or upgrading activities with refuelling				48		
G.	Major backfitting, refurbishment or upgrading activities without refuelling				2512		
J.	Grid limitation, failure or grid unavailability						3
L.	Human factor related					1	
Z.	Other					9	
Subtotal		2102			4859	375	3
Total		**2102**			**5237**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1974 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		7
15. Reactor Cooling Systems		92
16. Steam generation systems		214
31. Turbine and auxiliaries		24
32. Feedwater and Main Steam System		23
42. Electrical Power Supply Systems		1
Total		**368**

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2024 Operating Experience

JP-13 TAKAHAMA-2 JAPAN



Status at end of year	:	**Operational**
Operator	:	KEPCO (Kansai Electric Power Co.)
Owner	:	KEPCO (Kansai Electric Power Co.)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / M (3-loop)
Thermal power	:	2440 MWth
Gross electrical power	:	826 MWe
Reference unit power (net)	:	780 MWe

Key Dates

Construction Date	:	1971-03-09
Grid Date	:	1975-01-17
Commercial Date	:	1975-11-14
Age at end of year	:	49 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.0
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	43000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.64
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	20.3
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

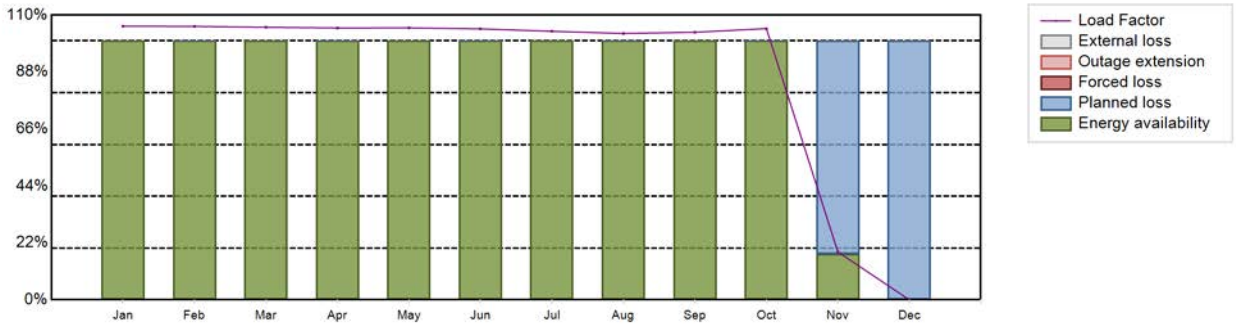
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	323
Number of SG	:	3
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.24
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.8
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6075.97 GW(e).h
Energy Availability Factor (EAF)	:	84.77 %
Unit Capability Factor (UCF)	:	84.77 %
Load Factor (LF)	:	88.68 %
Operating Factor (OF)	:	84.82 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	15.23 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1333 hours

Annual Summary



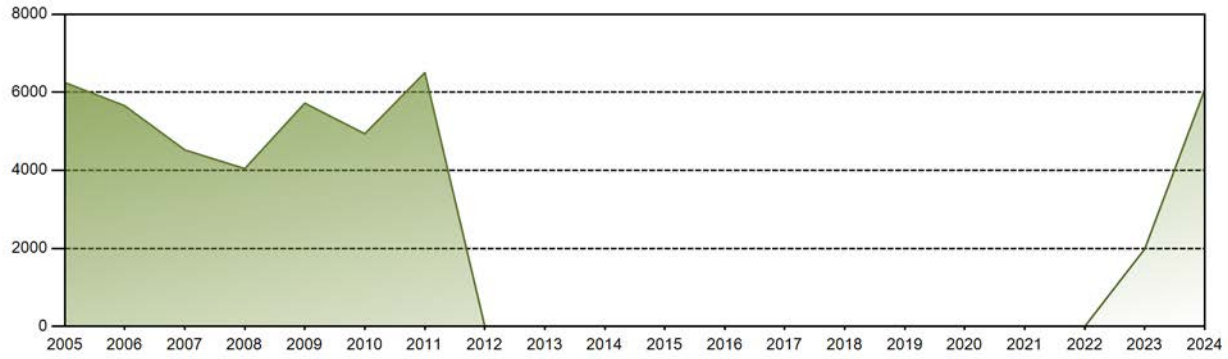
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	613.33	573.31	610.92	589.73	609.58	587.73	601.90	597.03	580.39	607.95	104.10	0.00	6075.97
EAF [%]	100.00	99.99	100.00	99.99	100.00	99.99	100.00	99.99	100.00	99.99	17.63	0.00	84.77
UCF [%]	100.00	99.99	100.00	99.99	100.00	99.99	100.00	99.99	100.00	99.99	17.63	0.00	84.77
LF [%]	105.69	105.61	105.27	105.01	105.04	104.65	103.72	102.88	103.35	104.76	18.54	0.00	88.68
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	18.19	0.00	84.82
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	82.37	100.00	15.23
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	180721.75 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.56 %
Cumulative Energy Availability Factor (EAF)	:	69.35 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.62 %
Cumulative Unit Capability Factor (UCF)	:	69.45 %	Cumulative Planned Unavailability Factor (PUF)	:	26.92 %
Cumulative Load Factor (LF)	:	70.78 %	Cumulative Externally cause unavailability (XUF)	:	0.1 %
Cumulative Operating Factor (OF)	:	70.77 %			

Electricity Production (net) [GWh]

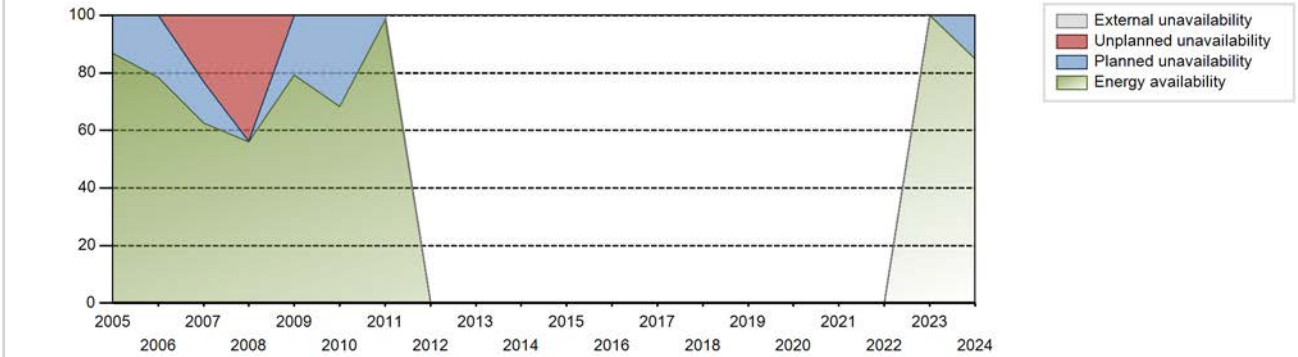


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	3168.50	5532	780	99.55	99.55	100.44	100.00	0.00	0.00	0.45	0.00
1976	3728.80	6214	780	54.17	54.17	54.42	70.74	23.83	16.94	28.89	0.00
1977	4742.00	6429	780	69.40	69.40	69.40	73.39	0.11	0.08	30.52	0.00
1978	4170.30	5751	780	61.04	61.04	61.03	65.65	0.59	0.37	38.59	0.00
1979	1281.00	1826	780	18.75	18.75	18.75	20.84	0.00	0.00	81.25	0.00
1980	5751.10	7450	780	83.72	83.72	83.94	84.81	0.92	0.78	15.51	0.00
1981	4763.20	6198	780	69.55	69.55	69.71	70.75	0.30	0.21	30.23	0.00
1982	4133.90	5407	780	60.26	60.26	60.50	61.72	0.62	0.37	39.36	0.00
1983	3549.40	4645	780	51.74	51.74	51.95	53.03	0.80	0.42	47.84	0.00
1984	4503.14	5746	780	65.38	65.38	65.72	65.41	0.00	0.00	34.62	0.00
1985	4967.39	6466	780	72.38	72.38	72.70	73.81	18.83	16.79	10.83	0.00
1986	3997.83	5183	780	58.37	58.37	58.51	59.17	0.81	0.48	41.16	0.00
1987	4621.76	6154	780	67.31	70.25	67.64	70.25	0.00	0.00	29.75	2.94
1988	3071.35	4001	780	45.55	45.55	44.83	45.55	10.15	5.15	49.31	0.00
1989	3991.50	5213	780	59.51	59.51	58.42	59.51	0.00	0.00	40.49	0.00
1990	1727.89	2218	780	20.85	20.85	25.29	25.32	0.00	0.00	79.15	0.00
1991	2265.80	3054	780	32.25	32.25	33.16	34.86	23.38	9.84	57.91	0.00
1992	4873.75	6226	780	70.80	70.80	71.13	70.88	0.00	0.00	29.20	0.00
1993	5757.04	7426	780	83.96	83.96	84.26	84.77	0.00	0.00	16.04	0.00
1994	3357.26	4299	780	49.29	49.29	49.13	49.08	0.00	0.00	50.71	0.00
1995	4458.67	5906	780	65.12	65.12	65.25	67.42	5.98	4.14	30.74	0.00
1996	6709.05	8629	780	97.34	97.66	97.92	98.24	2.33	2.33	0.01	0.32
1997	4981.24	6306	780	72.51	72.51	72.90	71.99	0.54	0.39	27.10	0.00
1998	5972.92	7657	780	86.96	86.96	87.42	87.41	0.00	0.00	13.04	0.00
1999	5989.80	7717	780	87.17	87.20	87.66	88.09	0.99	0.87	11.93	0.03
2000	6849.93	8784	780	99.50	99.50	99.98	100.00	0.49	0.49	0.01	0.00
2001	5900.98	7572	780	85.99	85.99	86.36	86.44	0.50	0.43	13.57	0.00
2002	6097.67	7626	780	87.04	87.04	89.24	87.05	0.00	0.00	12.96	0.00
2003	5470.78	6717	780	76.40	76.40	80.07	76.68	1.39	1.33	22.27	0.00
2004	6346.62	7839	780	88.87	89.33	92.63	89.24	7.07	6.80	3.87	0.46
2005	6249.51	7625	780	86.74	86.74	91.46	87.04	0.00	0.00	13.26	0.00
2006	5653.43	6890	780	78.31	78.31	82.74	78.65	0.00	0.00	21.69	0.00
2007	4521.77	5483	780	62.53	62.53	66.18	62.59	0.00	23.29	14.18	0.00
2008	4042.51	4949	780	56.05	56.05	59.00	56.34	0.00	43.66	0.29	0.00
2009	5720.06	6978	780	79.28	79.28	83.71	79.66	0.00	0.00	20.72	0.00
2010	4935.20	6017	780	68.28	68.28	72.23	68.69	0.08	0.05	31.66	0.00
2011	6502.50	7895	780	98.42	98.42	104.00	98.49	0.00	0.00	1.58	0.00

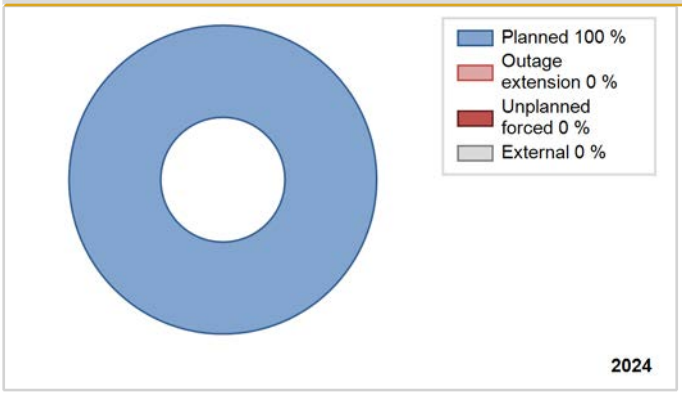
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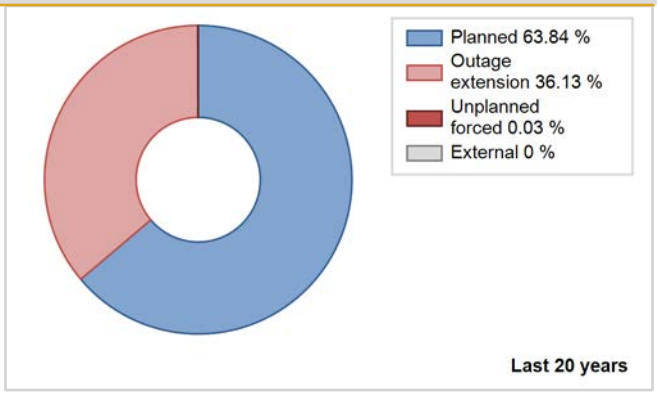
2012	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	Data not available - Suspended Operation										
2023	1987.78	2457	780	99.99	99.99	105.21	100.00	0.00	0.00	0.01	0.00
2024	6075.97	7451	780	84.77	84.77	88.68	84.82	0.00	0.00	15.23	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1975 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					275	
C. Inspection, maintenance or repair combined with refuelling	1333			2427		
D. Inspection, maintenance or repair without refuelling				9		
F. Major backfitting, refurbishment or upgrading activities with refuelling				54		
G. Major backfitting, refurbishment or upgrading activities without refuelling				2329		
L. Human factor related					5	
Z. Other					15	
Subtotal	1333			4819	295	
Total	**1333**			**5114**		

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		192
16. Steam generation systems		72
31. Turbine and auxiliaries		18
32. Feedwater and Main Steam System		7
42. Electrical Power Supply Systems		6
Total		**295**

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2024 Operating Experience

JP-29 TAKAHAMA-3 JAPAN



Status at end of year	:	**Operational**
Operator	:	KEPCO (Kansai Electric Power Co.)
Owner	:	KEPCO (Kansai Electric Power Co.)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / M (3-loop)
Thermal power	:	2660 MWth
Gross electrical power	:	870 MWe
Reference unit power (net)	:	830 MWe

Key Dates

Construction Date	:	1980-12-12
Grid Date	:	1984-05-09
Commercial Date	:	1985-01-17
Age at end of year	:	40 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2/MOX
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.1
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.1
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

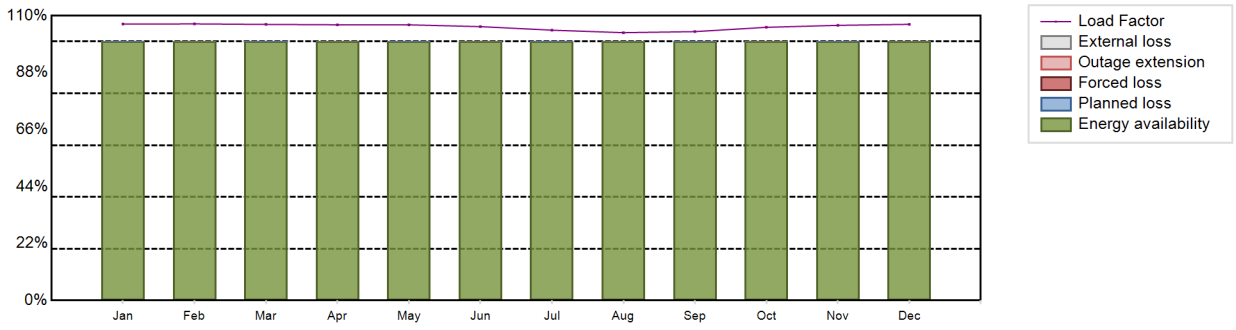
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.28
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.1
Output voltage [kV]	:	23
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	DS

Annual Production Results (2024)

Net Energy Production	:	7710.59 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	105.76 %
Operating Factor (OF)	:	100 %
Equivalent non-electrical energy generated (NEG)	:	7.53 GW(e).h

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	0 hours

Annual Summary



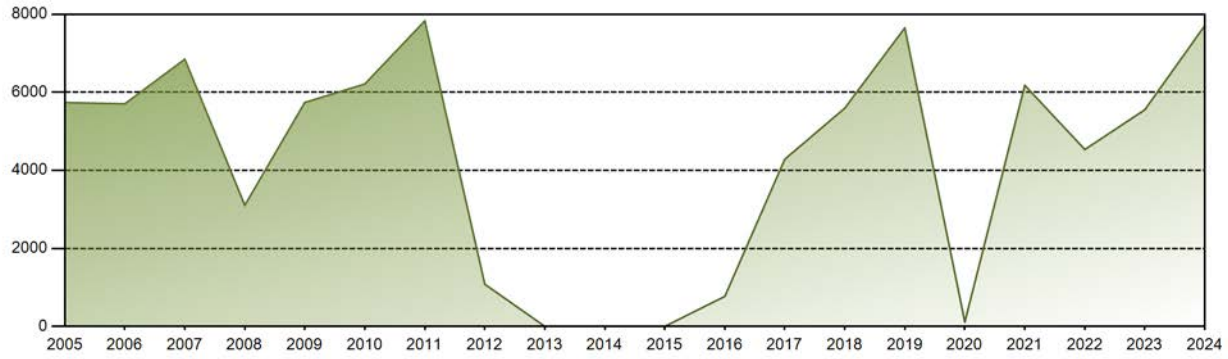
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	659.22	617.15	658.49	636.36	657.52	632.13	644.81	638.87	620.63	651.61	635.13	658.67	7710.59
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	99.99	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	99.99	100.00	100.00	100.00	100.00
LF [%]	106.75	106.83	106.63	106.49	106.48	105.78	104.42	103.46	103.85	105.52	106.28	106.66	105.76
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	209106.15 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.26 %
Cumulative Energy Availability Factor (EAF)	:	71.52 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.44 %
Cumulative Unit Capability Factor (UCF)	:	71.55 %	Cumulative Planned Unavailability Factor (PUF)	:	28.02 %
Cumulative Load Factor (LF)	:	71.87 %	Cumulative Externally cause unavailability (XUF)	:	0.03 %
Cumulative Operating Factor (OF)	:	69.96 %			

Electricity Production (net) [GWh]

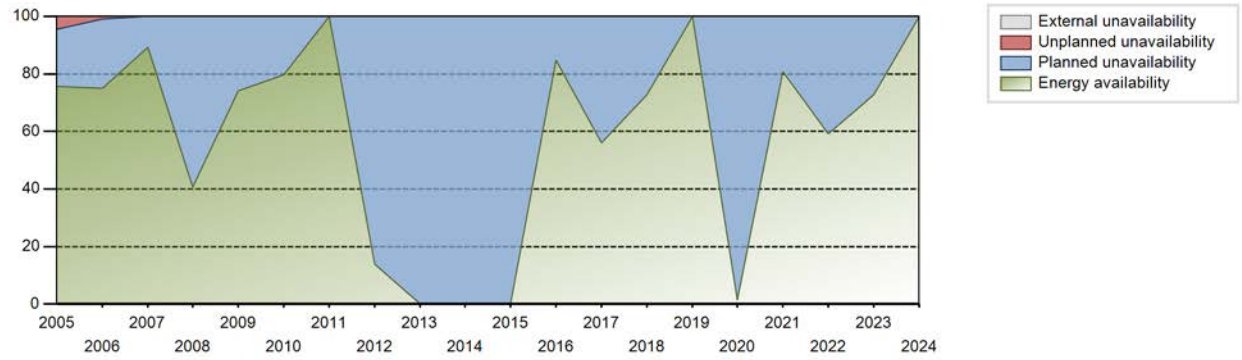


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	6199.46	7426	830	83.31	83.31	84.14	83.36	0.00	0.00	16.69	0.00
1986	6833.58	8215	830	93.08	93.08	93.99	93.78	0.00	0.00	6.92	0.00
1987	6030.38	7265	830	82.93	82.93	82.94	82.93	0.00	0.00	17.07	0.00
1988	5743.18	6948	830	79.10	79.10	78.77	79.10	0.42	0.33	20.57	0.00
1989	5987.22	7138	830	81.48	81.48	82.35	81.48	0.00	0.00	18.52	0.00
1990	6775.04	8143	830	91.88	91.88	93.18	92.96	0.00	0.00	8.12	0.00
1991	5513.55	6641	830	73.86	73.86	75.83	75.81	0.00	0.00	26.14	0.00
1992	6059.91	7292	830	82.22	82.22	83.12	83.01	0.00	0.00	17.78	0.00
1993	5804.78	6983	830	77.57	77.57	79.84	79.71	0.00	0.00	22.43	0.00
1994	7361.14	8760	830	100.00	100.00	101.24	100.00	0.00	0.00	0.00	0.00
1995	5662.92	6809	830	77.00	77.00	77.89	77.73	0.00	0.00	23.00	0.00
1996	5479.31	6576	830	74.24	74.24	75.15	74.86	0.00	0.00	25.76	0.00
1997	6028.89	7206	830	81.88	81.88	82.92	82.26	0.00	0.00	18.12	0.00
1998	6853.72	8161	830	93.11	93.11	94.26	93.16	0.00	0.00	6.89	0.00
1999	6833.42	8131	830	92.80	93.85	93.98	92.82	0.00	0.00	6.15	1.05
2000	5898.88	7023	830	79.94	79.94	80.91	79.95	0.00	0.00	20.06	0.00
2001	6167.20	7340	830	83.77	83.77	84.82	83.79	0.00	0.00	16.23	0.00
2002	6463.31	7654	830	87.35	87.35	88.89	87.37	0.00	0.00	12.65	0.00
2003	7355.67	8421	830	96.11	96.11	101.17	96.13	0.00	0.00	3.89	0.00
2004	5625.10	6512	830	74.11	74.11	77.15	74.13	8.83	11.68	14.21	0.00
2005	5738.44	6656	830	75.61	75.61	78.92	75.98	0.00	4.58	19.81	0.00
2006	5702.85	6604	830	75.04	75.04	78.43	75.39	0.02	0.82	24.14	0.00
2007	6847.38	7834	830	89.37	89.37	94.18	89.43	0.00	0.00	10.63	0.00
2008	3102.63	3608	830	40.65	40.65	42.56	41.07	0.00	0.00	59.35	0.00
2009	5738.94	6525	830	74.19	74.19	78.93	74.49	0.00	0.00	25.81	0.00
2010	6212.08	7006	830	79.70	79.70	85.44	79.98	0.00	0.00	20.30	0.00
2011	7828.83	8760	830	99.99	99.99	107.67	100.00	0.00	0.00	0.01	0.00
2012	1079.91	1223	830	13.92	13.92	14.81	13.92	0.00	0.00	86.08	0.00
2013	0.00	0	830	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2014	0.00	0	830	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2015	0.00	0	830	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2016	768.25	915	830	84.77	84.77	10.54	10.42	0.00	0.00	15.23	0.00
2017	4284.64	4944	830	56.03	56.03	58.93	56.44	0.00	0.00	43.97	0.00
2018	5595.11	6402	830	72.75	72.75	76.95	73.08	0.00	0.00	27.25	0.00
2019	7651.68	8760	830	99.99	99.99	105.24	100.00	0.00	0.00	0.01	0.00
2020	111.74	131	830	1.45	1.45	1.53	1.49	0.00	0.00	98.55	0.00
2021	6178.54	7111	830	80.80	80.80	84.98	81.18	0.00	0.00	19.20	0.00

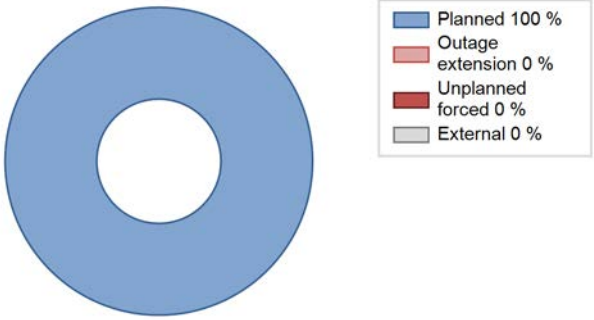
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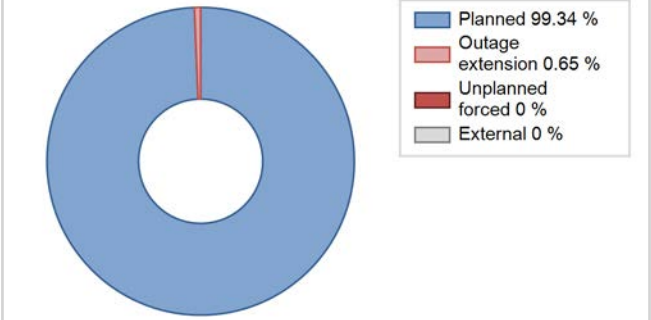
2022	4534.48	5226	830	59.24	59.24	62.37	59.66	0.00	0.00	40.76	0.00
2023	5552.80	6402	830	72.75	72.75	76.37	73.08	0.00	0.00	27.25	0.00
2024	7710.59	8784	830	100.00	100.00	105.76	100.00	0.00	0.00	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					3	
C. Inspection, maintenance or repair combined with refuelling				1573		
F. Major backfitting, refurbishment or upgrading activities with refuelling				16		
G. Major backfitting, refurbishment or upgrading activities without refuelling				850		
H. Nuclear regulatory requirements					10	
J. Grid limitation, failure or grid unavailability						2
M. Governmental requirements or court decisions						165
Z. Other					26	
Subtotal				2439	39	167
Total	**0**			**2645**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1985 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		11
13. Reactor Auxiliary Systems		2
16. Steam generation systems		10
31. Turbine and auxiliaries		16
32. Feedwater and Main Steam System		0
Total		**39**

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2024 Operating Experience

JP-30 TAKAHAMA-4 JAPAN



Status at end of year	:	**Operational**
Operator	:	KEPCO (Kansai Electric Power Co.)
Owner	:	KEPCO (Kansai Electric Power Co.)
Reactor Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	PWR / M (3-loop)
Thermal power	:	2660 MWth
Gross electrical power	:	870 MWe
Reference unit power (net)	:	830 MWe

Key Dates

Construction Date	:	1981-03-19
Grid Date	:	1984-11-01
Commercial Date	:	1985-06-05
Age at end of year	:	40 years

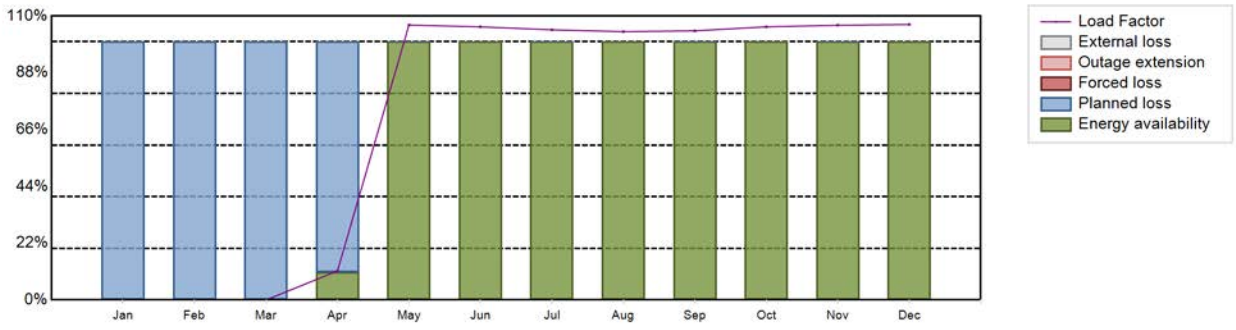
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.1
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.1
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	321
Number of SG	:	3
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.28
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.21
Output voltage [kV]	:	23
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	DS

Annual Production Results (2024)

Net Energy Production	:	5215.43 GW(e).h
Energy Availability Factor (EAF)	:	67.83 %
Unit Capability Factor (UCF)	:	67.83 %
Load Factor (LF)	:	71.54 %
Operating Factor (OF)	:	68.11 %
Equivalent non-electrical energy generated (NEG)	:	0 GW(e).h
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	32.17 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	2801 hours

Annual Summary



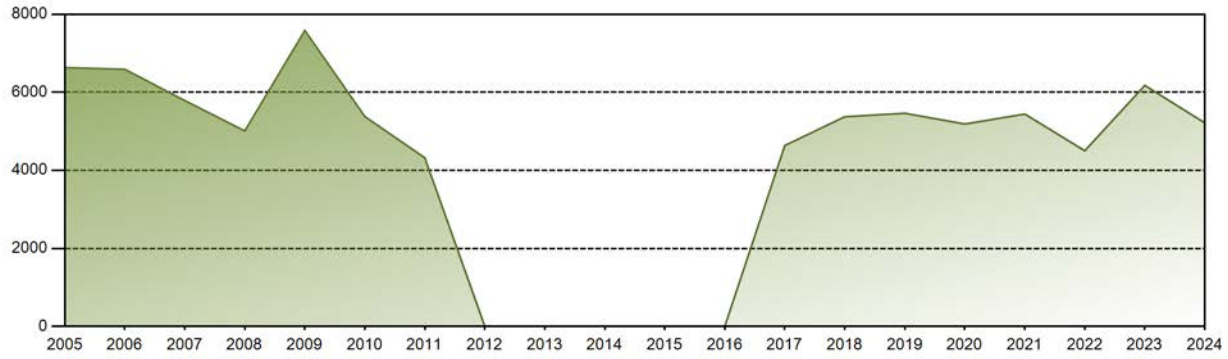
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	0.00	66.99	657.48	632.11	646.14	641.75	622.98	653.32	635.75	658.89	5215.43
EAF [%]	0.00	0.00	0.00	10.83	100.00	100.00	99.99	100.00	99.99	100.00	100.00	100.00	67.83
UCF [%]	0.00	0.00	0.00	10.83	100.00	100.00	99.99	100.00	99.99	100.00	100.00	100.00	67.83
LF [%]	0.00	0.00	0.00	11.21	106.47	105.77	104.64	103.92	104.25	105.80	106.38	106.70	71.54
OF [%]	0.00	0.00	0.00	14.31	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	68.11
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	100.00	100.00	100.00	89.17	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	32.17
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	205436.86 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.85 %
Cumulative Energy Availability Factor (EAF)	:	71.85 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.8 %
Cumulative Unit Capability Factor (UCF)	:	71.88 %	Cumulative Planned Unavailability Factor (PUF)	:	27.32 %
Cumulative Load Factor (LF)	:	71.32 %	Cumulative Externally cause unavailability (XUF)	:	0.03 %
Cumulative Operating Factor (OF)	:	69.5 %			

Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	5479.31	6887	830	100.00	100.00	101.21	100.00	0.00	0.00	0.00	0.00
1986	5864.02	7073	830	79.59	79.59	80.65	80.74	0.00	0.00	20.41	0.00
1987	5588.52	6743	830	76.97	76.97	76.86	76.97	0.00	0.00	23.03	0.00
1988	6437.90	7666	830	87.27	87.27	88.30	87.27	0.00	0.00	12.73	0.00
1989	6802.70	8167	830	93.23	93.23	93.56	93.23	0.00	0.00	6.77	0.00
1990	5174.56	6233	830	68.98	68.98	71.17	71.15	0.00	0.00	31.02	0.00
1991	6170.12	7409	830	83.05	83.05	84.86	84.58	0.00	0.00	16.95	0.00
1992	6048.41	7265	830	81.93	81.93	82.96	82.71	0.00	0.00	18.07	0.00
1993	7210.91	8578	830	97.86	97.86	99.18	97.92	0.00	0.00	2.14	0.00
1994	5767.17	6861	830	78.51	78.51	79.32	78.32	0.00	0.00	21.49	0.00
1995	5651.76	6785	830	76.72	76.72	77.73	77.45	0.00	0.00	23.28	0.00
1996	5666.52	6785	830	76.68	76.68	77.72	77.24	0.00	0.00	23.32	0.00
1997	7367.27	8760	830	99.99	99.99	101.33	100.00	0.00	0.00	0.01	0.00
1998	6470.18	7727	830	87.79	87.79	88.99	88.21	0.00	0.00	12.21	0.00
1999	5500.34	6542	830	74.64	75.83	75.65	74.68	3.70	2.92	21.25	1.20
2000	6099.01	7254	830	82.57	82.57	83.65	82.58	0.00	0.00	17.43	0.00
2001	7364.55	8760	830	99.99	99.99	101.29	100.00	0.00	0.00	0.01	0.00
2002	6145.46	7316	830	83.50	83.50	84.52	83.52	0.00	0.00	16.50	0.00
2003	6490.21	7531	830	85.98	85.98	89.26	85.97	0.00	0.00	14.02	0.00
2004	5987.82	6868	830	78.17	78.17	82.13	78.19	0.00	3.71	18.12	0.00
2005	6633.20	7657	830	87.35	87.35	91.23	87.41	0.00	0.00	12.65	0.00
2006	6589.83	7612	830	86.56	86.56	90.63	86.89	0.00	0.00	13.44	0.00
2007	5787.60	6688	830	76.04	76.04	79.60	76.35	0.00	0.00	23.96	0.00
2008	5009.76	5825	830	65.56	65.56	68.71	66.31	0.00	0.00	34.44	0.00
2009	7584.98	8760	830	99.67	99.67	104.32	100.00	0.00	0.00	0.33	0.00
2010	5379.61	6130	830	69.45	69.45	73.99	69.98	5.60	4.12	26.43	0.00
2011	4320.16	4847	830	55.29	55.29	59.42	55.33	0.00	0.00	44.71	0.00
2012	0.00	0	830	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2013	0.00	0	830	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2014	0.00	0	830	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2015	0.00	0	830	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2016	0.00	0	830	81.24	81.24	0.00	0.00	2.96	2.48	16.28	0.00
2017	4636.34	5362	830	84.51	84.51	63.77	61.21	0.00	0.00	15.49	0.00
2018	5374.49	6167	830	70.04	70.04	73.92	70.40	0.00	0.00	29.96	0.00
2019	5463.11	6251	830	71.31	71.31	75.14	71.36	0.00	0.00	28.69	0.00
2020	5187.90	5969	830	67.55	67.55	71.16	67.95	0.00	0.00	32.45	0.00
2021	5443.67	6247	830	70.94	70.94	74.87	71.31	0.00	0.00	29.06	0.00

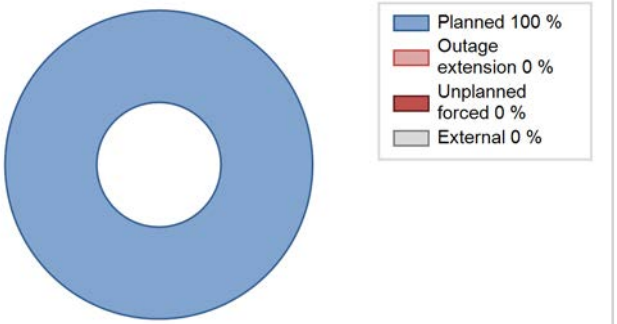
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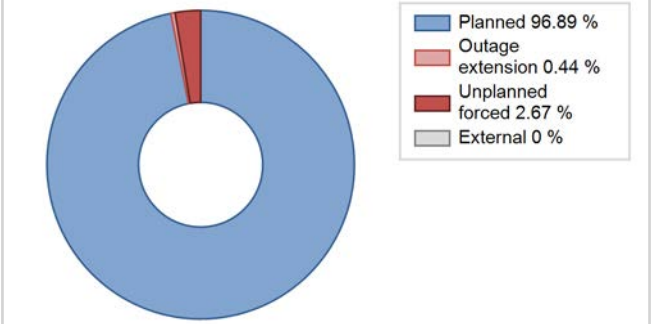
2022	4502.02	5132	830	58.17	58.17	61.92	58.58	0.00	3.54	38.29	0.00
2023	6177.84	7089	830	80.68	80.68	84.97	80.92	15.69	15.02	4.30	0.00
2024	5215.43	5983	830	67.83	67.83	71.54	68.11	0.00	0.00	32.17	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					63	
C. Inspection, maintenance or repair combined with refuelling	2801			1444		
G. Major backfitting, refurbishment or upgrading activities without refuelling				975		
J. Grid limitation, failure or grid unavailability						3
M. Governmental requirements or court decisions						236
Z. Other					8	
Subtotal	2801			2419	71	239
Total	**2801**			**2729**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1985 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		41
15. Reactor Cooling Systems		8
16. Steam generation systems		8
41. Main Generator Systems		14
Total		**71**

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2024 Operating Experience

KR-7 HANBIT-1 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH F
Thermal power	:	2787 MWth
Gross electrical power	:	1025 MWe
Reference unit power (net)	:	965 MWe

Key Dates

Construction Date	:	1981-06-04
Grid Date	:	1986-03-05
Commercial Date	:	1986-08-25
Age at end of year	:	38 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.65
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	41
Average discharge burnup [MWd/t]	:	18190
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.658
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.83
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

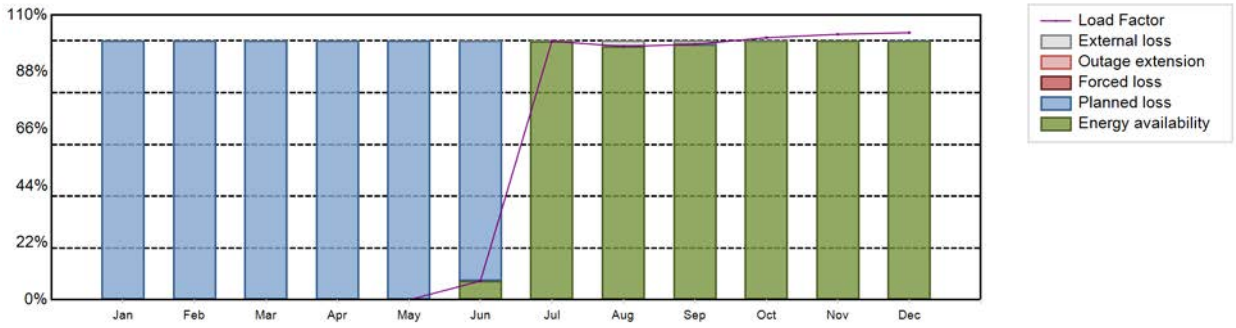
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	326
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.54
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4335.96 GW(e).h
Energy Availability Factor (EAF)	:	50.56 %
Unit Capability Factor (UCF)	:	50.87 %
Load Factor (LF)	:	51.15 %
Operating Factor (OF)	:	51.23 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	49.13 %
Externally cause unavailability (XUF)	:	0.31 %
Total off-line time	:	4284 hours

Annual Summary



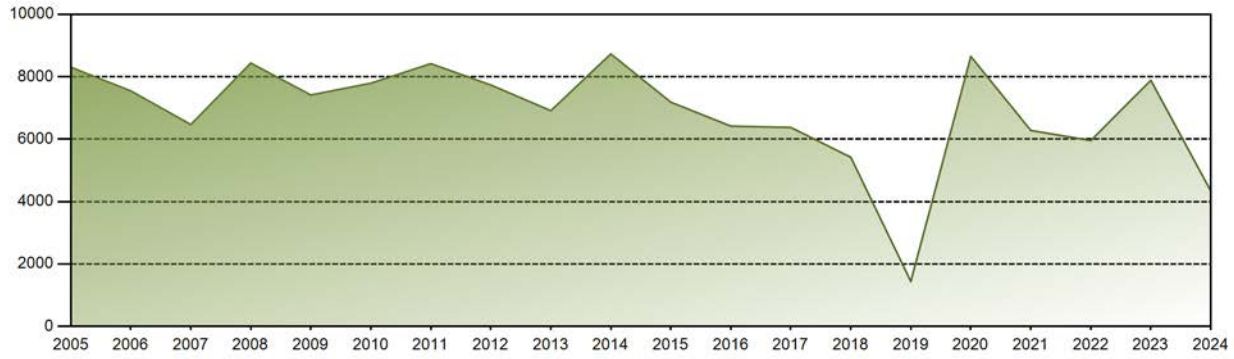
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	0.00	0.00	0.00	50.46	717.39	702.46	685.64	726.80	712.50	740.71	4335.96
EAF [%]	0.00	0.00	0.00	0.00	0.00	7.26	99.77	97.84	98.68	99.99	100.00	99.99	50.56
UCF [%]	0.00	0.00	0.00	0.00	0.00	7.27	100.00	100.00	99.96	100.00	100.00	99.99	50.87
LF [%]	0.00	0.00	0.00	0.00	0.00	7.26	99.92	97.84	98.68	101.23	102.55	103.17	51.15
OF [%]	0.00	0.00	0.00	0.00	0.00	11.67	100.00	100.00	100.00	100.00	100.00	100.00	51.23
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	100.00	100.00	100.00	100.00	100.00	92.73	0.00	0.00	0.04	0.00	0.00	0.01	49.13
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.23	2.16	1.28	0.01	0.00	0.00	0.31

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Historical Summary

Lifetime energy generation	:	266618.73 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.01 %
Cumulative Energy Availability Factor (EAF)	:	83.03 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.6 %
Cumulative Unit Capability Factor (UCF)	:	83.36 %	Cumulative Planned Unavailability Factor (PUF)	:	14.04 %
Cumulative Load Factor (LF)	:	84.54 %	Cumulative Externally cause unavailability (XUF)	:	0.32 %
Cumulative Operating Factor (OF)	:	84.02 %			

Electricity Production (net) [GWh]

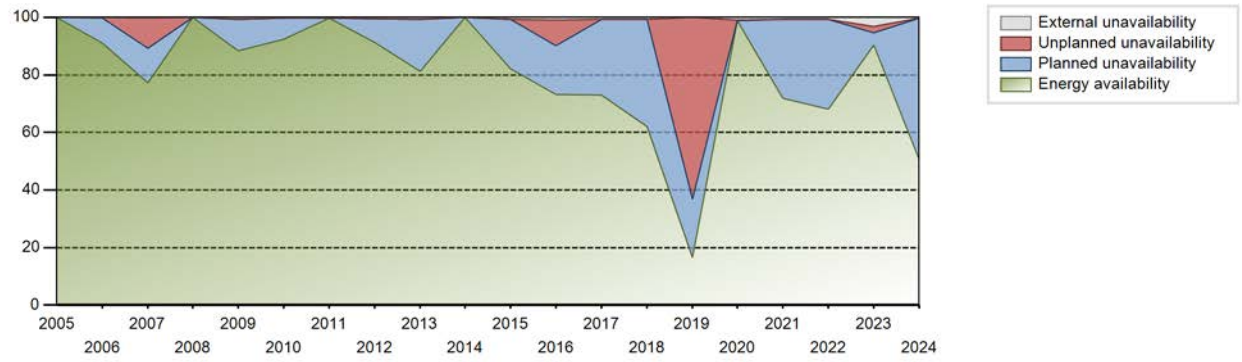


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	2467.92	2928	900	94.44	94.67	89.14	94.47	3.50	3.43	1.89	0.23
1987	5973.92	6870	900	78.77	78.77	75.77	78.42	2.26	1.82	19.41	0.00
1988	6199.62	6844	900	77.91	77.91	78.42	77.91	0.98	0.77	21.31	0.00
1989	6451.79	7136	900	81.46	81.46	81.83	81.46	0.34	0.27	18.26	0.00
1990	6897.48	7507	900	85.70	85.70	87.49	85.70	0.21	0.18	14.12	0.00
1991	6695.62	7383	900	84.27	84.27	84.93	84.28	0.27	0.23	15.50	0.00
1992	6947.35	7600	900	86.52	86.52	87.88	86.52	0.14	0.13	13.35	0.00
1993	6723.95	7603	900	86.79	86.79	85.29	86.79	0.00	0.00	13.21	0.00
1994	8230.12	8751	890	99.45	99.45	105.56	99.90	0.47	0.47	0.08	0.00
1995	6094.64	6781	900	74.94	74.94	77.30	77.41	1.58	1.20	23.85	0.00
1996	6755.47	7255	900	81.35	81.37	85.45	82.59	0.47	0.39	18.24	0.02
1997	8236.06	8741	900	99.39	99.39	104.47	99.78	0.52	0.52	0.09	0.01
1998	7104.49	7599	900	85.49	85.49	90.11	86.75	0.32	0.28	14.23	0.00
1999	6729.98	7242	900	81.07	81.07	85.36	82.67	0.41	0.33	18.60	0.00
2000	7215.09	7696	900	87.51	87.51	91.27	87.61	0.01	0.01	12.48	0.00
2001	8346.44	8760	900	99.94	99.94	105.87	100.00	0.00	0.00	0.06	0.00
2002	7419.03	7867	900	88.81	88.81	94.10	89.81	0.43	0.38	10.81	0.00
2003	7074.39	7593	900	86.32	86.34	89.73	86.68	2.68	2.38	11.28	0.02
2004	7207.19	7688	900	86.69	86.69	91.17	87.52	0.04	0.03	13.28	0.00
2005	8302.85	8760	900	99.95	99.97	105.31	100.00	0.00	0.00	0.03	0.02
2006	7545.07	8030	945	91.06	91.06	91.14	91.67	0.17	0.15	8.78	0.00
2007	6466.51	6855	942	77.26	77.62	78.36	78.25	11.85	10.44	11.95	0.36
2008	8434.70	8784	953	99.86	99.99	100.76	100.00	0.00	0.00	0.01	0.13
2009	7414.03	7785	953	88.45	89.05	88.81	88.87	0.00	0.00	10.95	0.60
2010	7791.08	8158	953	92.41	92.68	93.33	93.13	0.00	0.00	7.32	0.27
2011	8417.70	8760	953	99.80	99.95	100.83	100.00	0.00	0.00	0.05	0.16
2012	7733.46	8103	959	91.31	91.76	91.80	92.25	0.00	0.00	8.24	0.45
2013	6911.44	7204	997	81.23	81.94	81.66	82.24	0.00	0.00	18.06	0.71
2014	8729.35	8760	997	100.00	100.00	99.95	100.00	0.00	0.00	0.00	0.00
2015	7184.07	7289	997	82.02	82.65	82.26	83.21	0.20	0.17	17.18	0.63
2016	6417.05	6539	996	73.15	74.13	73.35	74.44	10.68	8.86	17.01	0.97
2017	6374.24	6484	996	72.97	73.78	73.06	74.02	0.00	0.00	26.22	0.81
2018	5419.36	5506	995	62.03	62.67	62.18	62.85	0.00	0.00	37.33	0.64
2019	1440.24	1472	995	16.52	16.55	16.52	16.80	0.00	63.06	20.39	0.03
2020	8648.72	8784	995	98.92	99.89	98.95	100.00	0.07	0.07	0.04	0.96
2021	6278.25	6411	995	71.96	72.76	72.03	73.18	0.01	0.01	27.24	0.79
2022	5955.26	6067	995	68.16	68.83	68.32	69.26	0.01	0.00	31.17	0.67

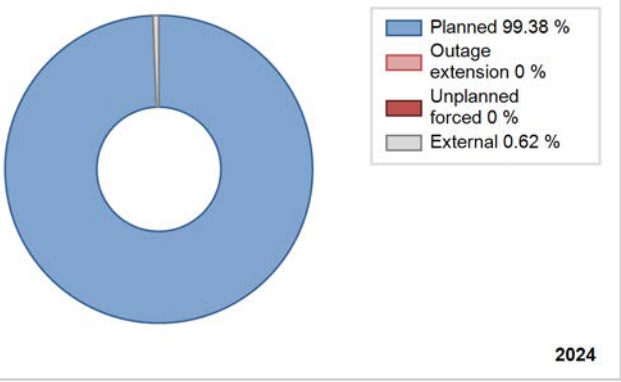
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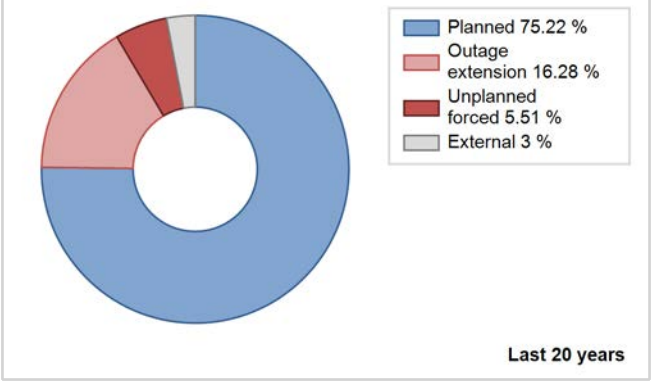
2023	7885.10	8410	995	90.45	93.64	90.46	96.00	2.28	2.19	4.18	3.19
2024	4335.96	4500	965	50.56	50.87	51.15	51.23	0.00	0.00	49.13	0.31

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					63	
C. Inspection, maintenance or repair combined with refuelling	4287			1186		
D. Inspection, maintenance or repair without refuelling				4		
J. Grid limitation, failure or grid unavailability						0
L. Human factor related					109	
P. Fire					35	
Z. Other						1
Subtotal	4287			1190	207	1
Total	**4287**			**1398**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1986 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		112
15. Reactor Cooling Systems		36
16. Steam generation systems		0
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		22
32. Feedwater and Main Steam System		2
34. Miscellaneous Systems		0
41. Main Generator Systems		28
42. Electrical Power Supply Systems		1
Total		**203**

Highlights (2024)

27th Refueling and maintenance(23.12.17~24.6.27)

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2024 Operating Experience

KR-8 HANBIT-2 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH F
Thermal power	:	2787 MWth
Gross electrical power	:	1024 MWe
Reference unit power (net)	:	952 MWe

Key Dates

Construction Date	:	1981-12-01
Grid Date	:	1986-11-11
Commercial Date	:	1987-06-10
Age at end of year	:	38 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.65
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	41
Average discharge burnup [MWd/t]	:	17960
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.658
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.83
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

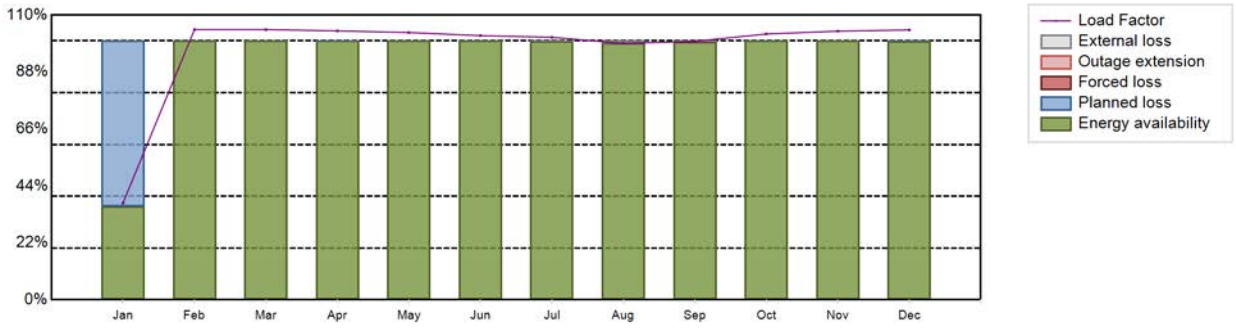
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	326
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.54
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8119.06 GW(e).h
Energy Availability Factor (EAF)	:	94.46 %
Unit Capability Factor (UCF)	:	94.57 %
Load Factor (LF)	:	97.09 %
Operating Factor (OF)	:	94.84 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	5.43 %
Externally cause unavailability (XUF)	:	0.11 %
Total off-line time	:	453 hours

Annual Summary



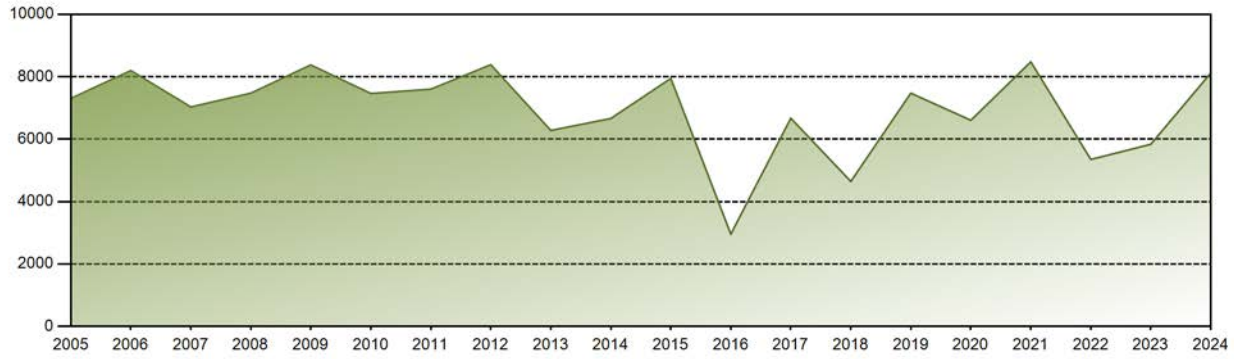
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	264.75	691.64	739.31	712.02	731.20	699.44	718.25	701.23	684.45	727.23	711.26	738.29	8119.06
EAF [%]	36.00	100.00	100.00	99.99	100.00	100.00	99.98	99.00	99.63	100.00	100.00	99.97	94.46
UCF [%]	36.00	100.00	100.00	99.99	100.00	100.00	99.98	100.00	99.92	100.00	100.00	99.97	94.57
LF [%]	37.38	104.38	104.38	103.88	103.23	102.04	101.41	99.00	99.86	102.67	103.77	104.24	97.09
OF [%]	39.11	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.84
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
PUF [%]	64.00	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.03	0.00	0.00	0.03	5.43
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.29	0.00	0.00	0.00	0.11

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Historical Summary

Lifetime energy generation	:	260179.9 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.89 %
Cumulative Energy Availability Factor (EAF)	:	82.68 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.92 %
Cumulative Unit Capability Factor (UCF)	:	82.87 %	Cumulative Planned Unavailability Factor (PUF)	:	16.21 %
Cumulative Load Factor (LF)	:	84.04 %	Cumulative Externally cause unavailability (XUF)	:	0.2 %
Cumulative Operating Factor (OF)	:	83.58 %			

Electricity Production (net) [GWh]

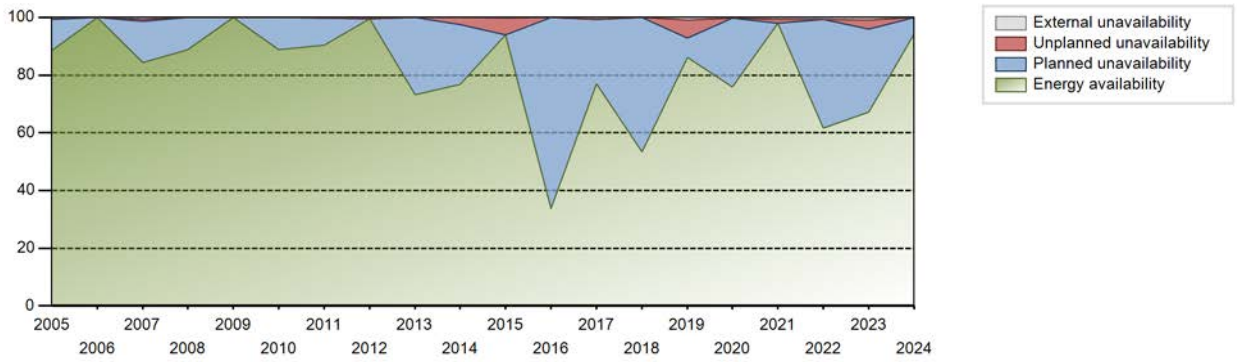


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	4297.03	4826	900	98.15	98.15	97.02	98.07	1.85	1.85	0.00	0.00
1988	6280.88	7085	900	80.65	80.65	79.45	80.66	0.31	0.25	19.10	0.00
1989	5703.24	6446	900	73.60	73.60	72.34	73.58	6.35	4.99	21.42	0.00
1990	5964.51	6757	900	77.13	77.13	75.65	77.13	1.27	0.99	21.87	0.00
1991	6714.99	7433	900	84.85	84.85	85.17	84.85	0.35	0.30	14.85	0.00
1992	6434.62	7259	900	82.64	82.64	81.39	82.64	0.41	0.34	17.02	0.00
1993	6930.49	7506	900	85.69	85.83	87.91	85.68	1.23	1.07	13.10	0.15
1994	7132.86	7687	890	85.55	85.55	91.49	87.75	0.00	0.00	14.45	0.00
1995	6036.45	6696	900	74.20	74.20	76.57	76.44	1.06	0.80	25.00	0.00
1996	7656.10	8189	900	91.59	91.65	96.84	93.23	0.00	0.00	8.35	0.06
1997	6657.34	7453	900	81.21	81.21	84.44	85.08	0.84	0.68	18.11	0.00
1998	6010.35	6583	900	74.39	74.50	76.23	75.15	0.00	0.00	25.49	0.11
1999	6718.91	7301	900	82.08	82.08	85.22	83.34	1.66	1.38	16.54	0.00
2000	7144.06	7753	900	87.07	87.07	90.37	88.26	0.31	0.27	12.66	0.00
2001	7169.67	7726	900	87.08	87.08	90.94	88.20	0.01	0.01	12.91	0.00
2002	8194.23	8744	900	99.61	99.90	103.93	99.82	0.06	0.06	0.04	0.29
2003	7413.30	7931	900	89.63	89.66	94.03	90.54	0.00	0.00	10.34	0.03
2004	7242.94	7764	900	87.51	87.51	91.62	88.39	2.05	1.83	10.66	0.00
2005	7302.40	7881	900	88.62	88.64	92.62	89.97	0.70	0.62	10.74	0.02
2006	8195.68	8719	939	99.92	99.99	99.64	99.53	0.00	0.00	0.01	0.07
2007	7030.06	7523	936	84.37	85.11	85.74	85.88	0.62	0.53	14.36	0.74
2008	7472.86	7850	947	88.91	89.05	89.83	89.37	0.00	0.00	10.95	0.13
2009	8376.93	8760	947	99.94	99.99	100.98	100.00	0.00	0.00	0.01	0.05
2010	7461.45	7830	947	88.86	88.95	89.94	89.38	0.00	0.00	11.05	0.09
2011	7600.63	7988	947	90.38	90.67	91.62	91.19	0.00	0.00	9.33	0.29
2012	8383.44	8784	958	99.47	99.97	99.62	100.00	0.01	0.01	0.01	0.50
2013	6277.11	6509	958	73.22	73.25	74.80	74.30	0.00	0.00	26.75	0.03
2014	6661.49	6789	977	76.84	76.92	77.83	77.50	2.91	2.30	20.78	0.08
2015	7944.95	8060	984	93.91	94.18	92.17	92.01	5.82	5.82	0.01	0.26
2016	2953.95	2986	988	33.80	33.80	34.04	33.99	0.02	0.01	66.19	0.00
2017	6669.35	6820	988	76.91	77.54	77.06	77.85	0.08	0.06	22.40	0.63
2018	4643.92	4714	988	53.42	53.54	53.66	53.81	0.00	0.00	46.46	0.11
2019	7473.09	7657	988	86.23	87.13	86.35	87.41	0.01	6.20	6.67	0.90
2020	6603.94	6722	988	75.93	76.11	76.09	76.53	0.00	0.00	23.89	0.19
2021	8475.06	8700	988	97.85	98.66	97.92	99.32	1.19	1.19	0.15	0.81
2022	5348.60	5495	988	61.68	62.30	61.80	62.73	0.03	0.02	37.68	0.62
2023	5835.89	5967	988	67.28	68.10	67.43	68.12	4.66	3.33	28.57	0.82

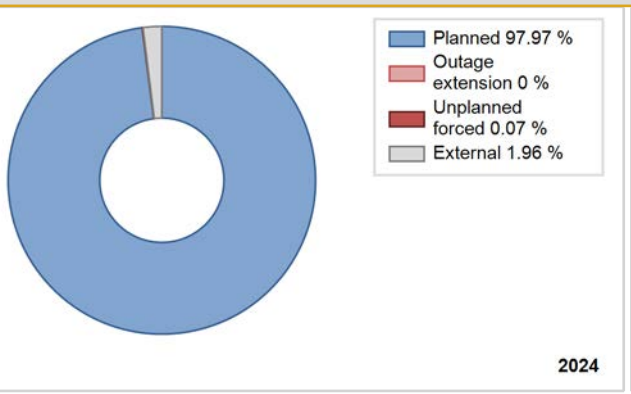
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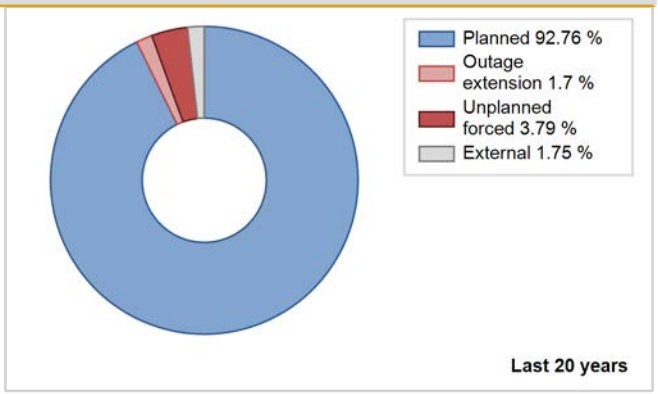
2024	8119.06	8331	952	94.46	94.57	97.09	94.84	0.00	0.00	5.43	0.11

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					55	
C. Inspection, maintenance or repair combined with refuelling	456			1293		
D. Inspection, maintenance or repair without refuelling				68		
J. Grid limitation, failure or grid unavailability						6
L. Human factor related					17	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
Subtotal	456			1361	72	6
Total	**456**			**1439**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1987 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		1
15. Reactor Cooling Systems		15
16. Steam generation systems		24
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		3
32. Feedwater and Main Steam System		5
35. All other I&C Systems		0
41. Main Generator Systems		10
42. Electrical Power Supply Systems		13
Total		**71**

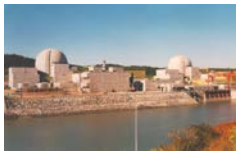
Highlights (2024)

26th Refueling and maintenance(23.09.19~24.01.19)

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2024 Operating Experience

KR-11 HANBIT-3 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKAEC (DOOSAN HEAVY INDUSTRIES AND CONSTRUCTION CO. LTD./KOREA ATOMIC ENERGY RESEARCH INSTITUTE/COMBUSTION ENGINEERING)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1041 MWe
Reference unit power (net)	:	983 MWe

Key Dates

Construction Date	:	1989-12-23
Grid Date	:	1994-10-30
Commercial Date	:	1995-03-31
Age at end of year	:	30 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.2
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36
Average discharge burnup [MWd/t]	:	42700
Active core diameter [m]	:	3.124
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.26
Number of control rod assemblies	:	73
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

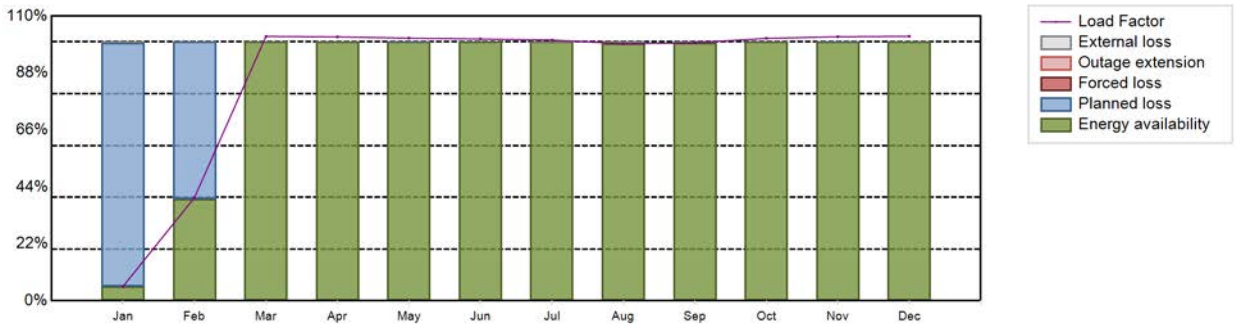
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	0.37
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	7.14
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7618.14 GW(e).h
Energy Availability Factor (EAF)	:	87.12 %
Unit Capability Factor (UCF)	:	87.23 %
Load Factor (LF)	:	88.23 %
Operating Factor (OF)	:	87.63 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	12.77 %
Externally cause unavailability (XUF)	:	0.1 %
Total off-line time	:	1087 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	40.72	272.86	746.98	721.51	741.87	715.60	736.66	726.10	705.55	741.24	721.85	747.19	7618.14
EAF [%]	5.67	39.28	100.00	100.00	100.00	100.00	100.00	99.38	99.73	100.00	100.00	100.00	87.12
UCF [%]	6.01	39.28	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00	100.00	87.23
LF [%]	5.57	39.88	102.14	101.94	101.44	101.11	100.73	99.28	99.69	101.35	101.99	102.17	88.23
OF [%]	5.78	44.54	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	87.63
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	93.99	60.72	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	12.77
XUF [%]	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.26	0.00	0.00	0.00	0.10

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Historical Summary

Lifetime energy generation	:	205389.28 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.99 %
Cumulative Energy Availability Factor (EAF)	:	78.8 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.79 %
Cumulative Unit Capability Factor (UCF)	:	78.94 %	Cumulative Planned Unavailability Factor (PUF)	:	20.27 %
Cumulative Load Factor (LF)	:	79.98 %	Cumulative Externally cause unavailability (XUF)	:	0.14 %
Cumulative Operating Factor (OF)	:	79.47 %			

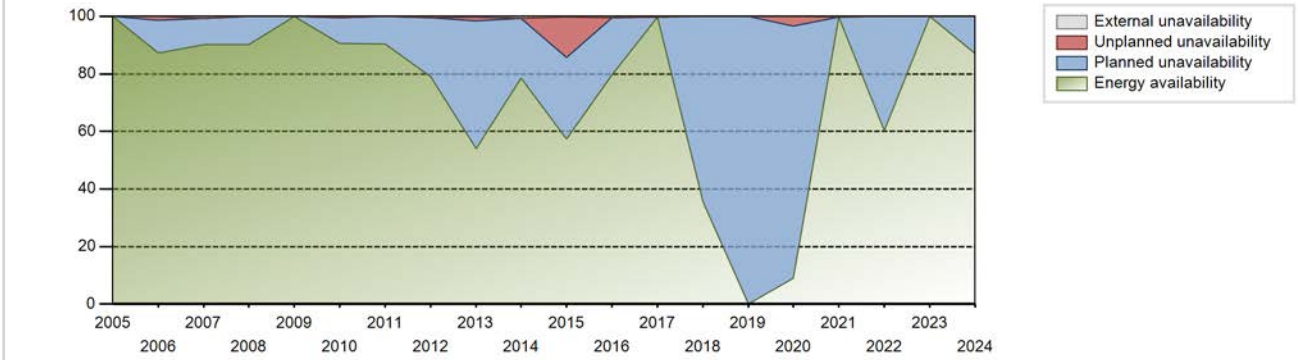
Electricity Production (net) [GWh]



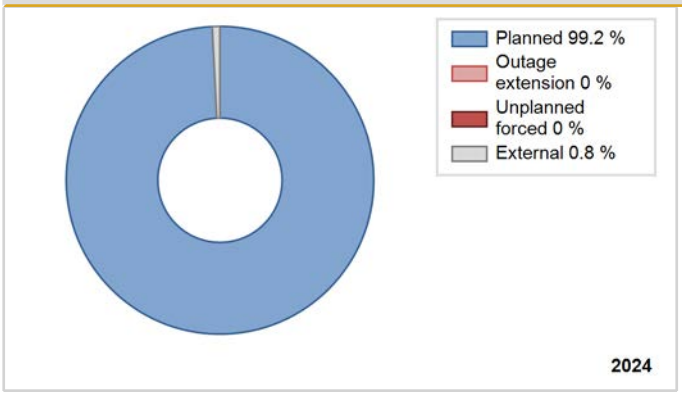
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1995	6430.28	6573	950	99.19	99.19	102.56	99.59	0.77	0.77	0.04	0.00
1996	6366.17	6589	950	73.97	73.98	76.29	75.01	0.22	0.17	25.85	0.01
1997	7229.61	7443	950	84.03	84.03	86.87	84.97	0.53	0.45	15.52	0.00
1998	7400.78	7566	950	85.47	85.47	88.93	86.37	0.00	0.00	14.53	0.00
1999	7395.31	7678	950	86.70	86.70	88.86	87.65	0.83	0.73	12.57	0.00
2000	7262.02	7568	950	85.62	85.62	87.02	86.16	0.17	0.15	14.23	0.00
2001	8629.13	8760	950	99.96	99.96	103.69	100.00	0.04	0.04	0.00	0.00
2002	7658.18	7831	950	89.09	89.09	92.02	89.39	0.08	0.07	10.84	0.00
2003	7818.09	7971	950	90.08	90.08	93.94	90.99	0.51	0.46	9.46	0.00
2004	7654.72	7801	950	90.35	90.35	91.73	88.81	0.48	0.43	9.22	0.00
2005	8675.55	8760	950	99.98	99.98	104.25	100.00	0.02	0.02	0.00	0.01
2006	7556.77	7800	985	87.34	87.40	87.58	89.04	1.44	1.27	11.32	0.06
2007	7778.30	7916	987	90.18	90.81	89.96	90.37	0.00	0.00	9.19	0.63
2008	7861.88	7967	997	90.11	90.21	89.77	90.70	0.00	0.00	9.79	0.10
2009	8737.18	8760	997	100.00	100.00	100.04	100.00	0.00	0.00	0.00	0.00
2010	7953.95	8014	997	90.68	91.13	91.07	91.48	0.00	0.00	8.87	0.46
2011	7944.10	7973	997	90.45	90.52	90.96	91.02	0.06	0.05	9.43	0.07
2012	6961.94	6994	1000	79.02	79.49	79.26	79.62	0.00	0.00	20.51	0.47
2013	4719.06	4809	997	53.98	54.28	54.03	54.90	2.28	1.27	44.45	0.30
2014	6882.52	6938	1000	78.55	79.16	78.57	79.20	0.00	0.00	20.84	0.61
2015	5012.19	5125	994	57.44	57.63	57.56	58.50	19.65	14.10	28.27	0.19
2016	6965.40	7091	994	79.59	80.08	79.78	80.73	0.00	0.00	19.92	0.49
2017	8628.46	8760	986	99.69	99.99	99.90	100.00	0.00	0.00	0.01	0.30
2018	3078.30	3130	986	35.54	35.54	35.64	35.73	0.00	0.00	64.46	0.00
2019	0.00	0	986	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2020	783.33	903	986	9.00	9.00	9.04	10.28	27.50	3.41	87.59	0.00
2021	8655.69	8760	986	99.75	99.94	100.21	100.00	0.06	0.06	0.01	0.19
2022	5249.90	5343	986	60.27	60.28	60.78	60.99	0.00	0.00	39.72	0.00
2023	8733.45	8760	986	99.97	100.00	101.11	100.00	0.00	0.00	0.00	0.03
2024	7618.14	7697	983	87.12	87.23	88.23	87.63	0.00	0.00	12.77	0.10

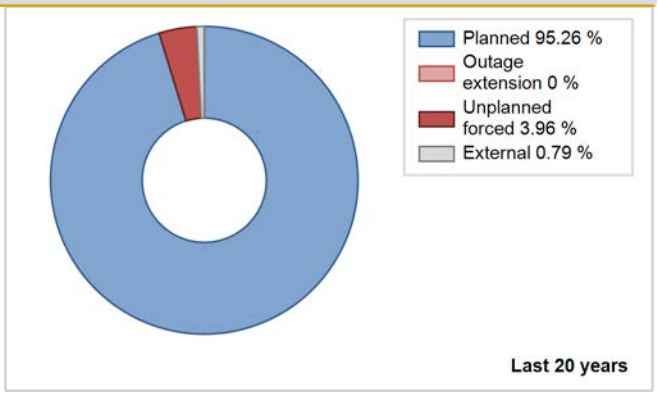
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1995 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					58	
C. Inspection, maintenance or repair combined with refuelling	1090			1738		
D. Inspection, maintenance or repair without refuelling				4		
E. Testing of plant systems or components					0	
L. Human factor related					0	
Subtotal	1090			1742	58	
Total	**1090**			**1800**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1995 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		1
15. Reactor Cooling Systems		40
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		1
35. All other I&C Systems		1
41. Main Generator Systems		0
42. Electrical Power Supply Systems		12
Total		**57**

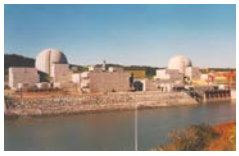
Highlights (2024)

Refueling and Maintenance(2024.01.03.~2024.02.17.)

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2024 Operating Experience

KR-12 HANBIT-4 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKAEC (DOOSAN HEAVY INDUSTRIES AND CONSTRUCTION CO. LTD./KOREA ATOMIC ENERGY RESEARCH INSTITUTE/COMBUSTION ENGINEERING)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1041 MWe
Reference unit power (net)	:	961 MWe

Key Dates

Construction Date	:	1990-05-26
Grid Date	:	1995-07-18
Commercial Date	:	1996-01-01
Age at end of year	:	29 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.2
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36
Average discharge burnup [MWd/t]	:	42700
Active core diameter [m]	:	3.124
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.26
Number of control rod assemblies	:	73
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

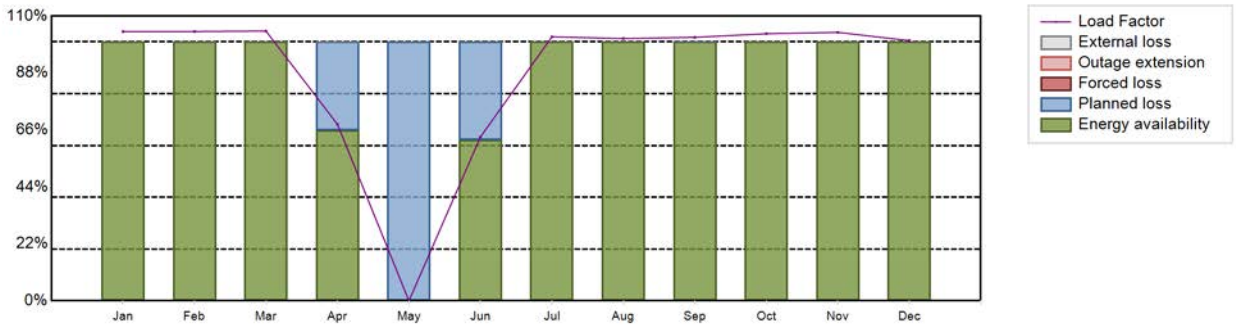
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	0.37
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	7.14
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7425.12 GW(e).h
Energy Availability Factor (EAF)	:	85.64 %
Unit Capability Factor (UCF)	:	85.64 %
Load Factor (LF)	:	87.96 %
Operating Factor (OF)	:	87.07 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	14.36 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1136 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	743.52	695.73	744.95	471.94	0.00	437.94	728.98	724.29	704.25	737.60	717.46	718.44	7425.12
EAF [%]	100.00	100.00	100.00	65.91	0.00	62.20	100.00	100.00	100.00	100.00	100.00	100.00	85.64
UCF [%]	100.00	100.00	100.00	65.92	0.00	62.20	100.00	100.00	100.00	100.00	100.00	100.00	85.64
LF [%]	103.99	104.02	104.19	68.21	0.00	63.29	101.96	101.30	101.78	103.16	103.69	100.48	87.96
OF [%]	100.00	100.00	100.00	67.64	0.00	77.92	100.00	100.00	100.00	100.00	100.00	100.00	87.07
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	34.08	100.00	37.80	0.00	0.00	0.00	0.00	0.00	0.00	14.36
XUF [%]	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	182482.98 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.35 %
Cumulative Energy Availability Factor (EAF)	:	71.85 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.3 %
Cumulative Unit Capability Factor (UCF)	:	72 %	Cumulative Planned Unavailability Factor (PUF)	:	27.7 %
Cumulative Load Factor (LF)	:	73.18 %	Cumulative Externally cause unavailability (XUF)	:	0.15 %
Cumulative Operating Factor (OF)	:	72.48 %			

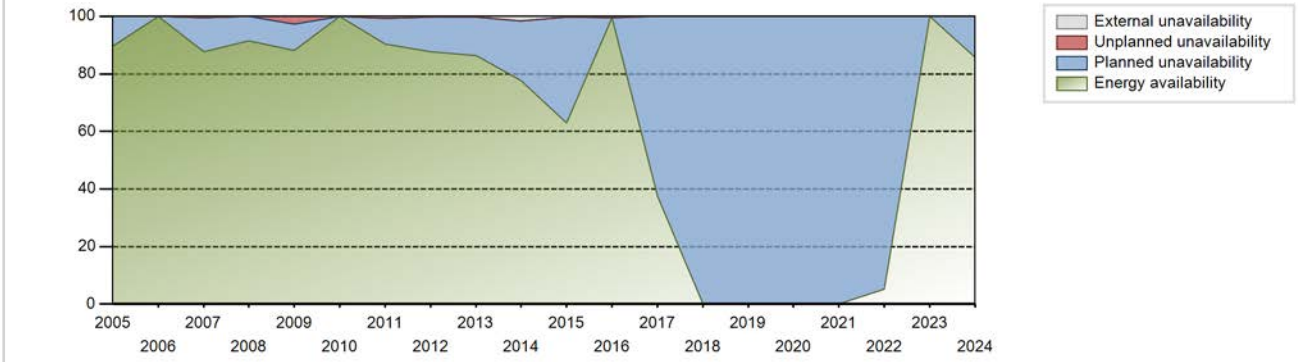
Electricity Production (net) [GWh]



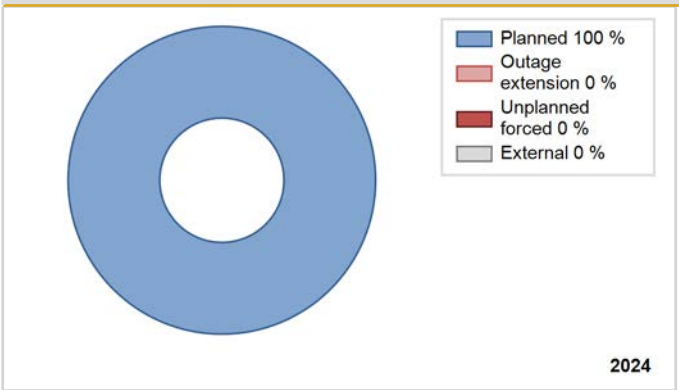
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1996	7197.47	7565	950	83.49	83.50	86.25	86.12	1.71	1.45	15.05	0.00
1997	6767.71	7125	950	78.80	78.80	81.32	81.34	3.24	2.64	18.56	0.00
1998	8427.31	8591	950	97.14	97.14	101.27	98.07	0.09	0.08	2.78	0.00
1999	7627.93	7883	950	89.03	89.03	91.66	89.99	0.37	0.33	10.64	0.00
2000	7252.26	7441	950	84.65	84.65	86.91	84.71	0.25	0.21	15.14	0.00
2001	7237.24	7424	950	84.76	84.76	86.97	84.75	0.00	0.00	15.24	0.00
2002	7653.46	7808	950	88.65	88.65	91.97	89.13	0.00	0.00	11.35	0.00
2003	8576.76	8652	950	98.68	98.68	103.06	98.77	1.22	1.22	0.10	0.00
2004	7624.86	7782	950	88.28	88.28	91.37	88.59	0.00	0.00	11.72	0.00
2005	7754.98	7879	950	89.80	89.80	93.19	89.94	0.00	0.00	10.20	0.01
2006	8646.19	8760	988	99.99	99.99	99.90	100.00	0.00	0.00	0.01	0.00
2007	7651.07	7790	987	87.78	88.37	88.49	88.93	0.00	0.00	11.63	0.59
2008	7992.63	8084	994	91.42	91.44	91.54	92.03	0.04	0.04	8.52	0.02
2009	7694.28	7768	994	88.07	88.07	88.36	88.68	1.51	2.68	9.25	0.00
2010	8760.58	8760	994	99.91	99.97	100.61	100.00	0.03	0.03	0.00	0.06
2011	7923.20	8005	994	90.37	91.00	90.99	91.38	0.00	0.00	9.00	0.64
2012	7705.11	7765	996	87.65	87.83	88.07	88.40	0.00	0.00	12.17	0.17
2013	7563.57	7618	997	86.44	86.80	86.60	86.96	0.00	0.00	13.20	0.36
2014	6796.58	6989	998	77.74	79.30	77.74	79.78	0.00	0.00	20.70	1.56
2015	5400.06	5584	980	62.89	63.18	62.90	63.74	0.00	0.00	36.82	0.29
2016	8487.73	8784	970	99.54	99.99	99.62	100.00	0.00	0.00	0.01	0.45
2017	3188.64	3298	970	37.48	37.49	37.53	37.65	0.00	0.00	62.51	0.01
2018	0.00	0	970	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2019	0.00	0	970	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2020	0.00	0	970	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2021	0.00	0	970	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2022	452.16	505	970	5.19	5.19	5.32	5.76	0.00	0.00	94.81	0.00
2023	8732.26	8760	970	99.98	99.98	102.77	100.00	0.02	0.02	0.00	0.00
2024	7425.12	7648	961	85.64	85.64	87.96	87.07	0.00	0.00	14.36	0.00

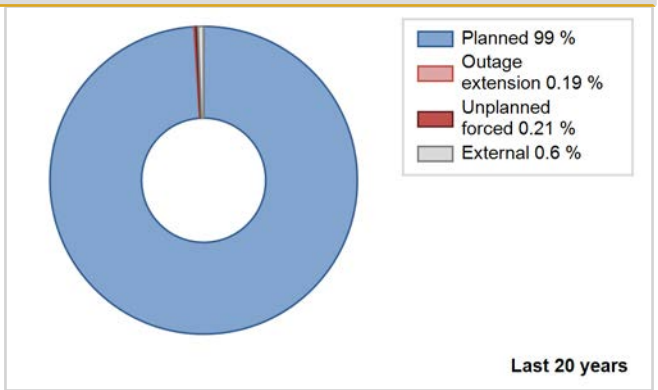
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1996 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					20	
C. Inspection, maintenance or repair combined with refuelling	1138			2391		
L. Human factor related					0	
Subtotal	1138			2391	20	
Total	**1138**			**2411**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1996 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		3
14. Safety Systems		4
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		2
41. Main Generator Systems		4
42. Electrical Power Supply Systems		7
Total		**22**

Highlights (2024)

Refueling and Maintenance(2024.04.21.~2024.06.07.)

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2024 Operating Experience

KR-17 HANBIT-5 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1051 MWe
Reference unit power (net)	:	974 MWe

Key Dates

Construction Date	:	1997-06-29
Grid Date	:	2001-12-19
Commercial Date	:	2002-05-21
Age at end of year	:	23 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36
Average discharge burnup [MWd/t]	:	13820
Active core diameter [m]	:	3.124
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	19.68
Number of control rod assemblies	:	73
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

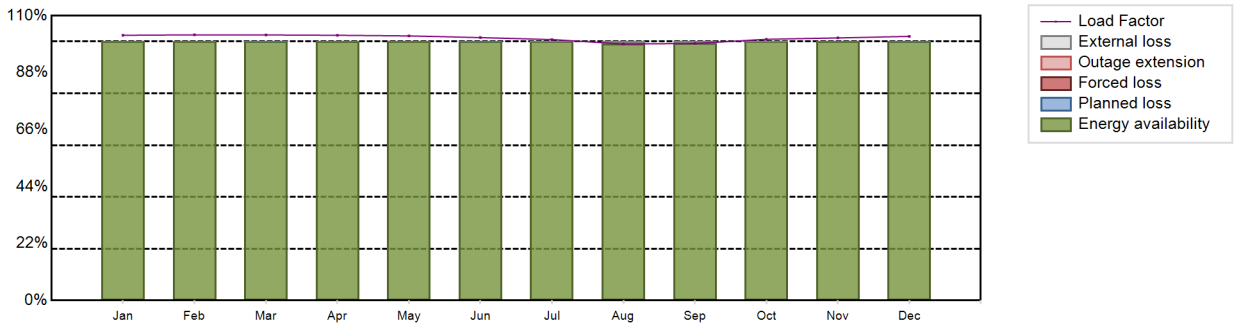
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	4
HP cylinder inlet steam pressure [MPa]	:	7.14
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8678.39 GW(e).h
Energy Availability Factor (EAF)	:	99.86 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	101.43 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0.14 %
Total off-line time	:	0 hours

Annual Summary



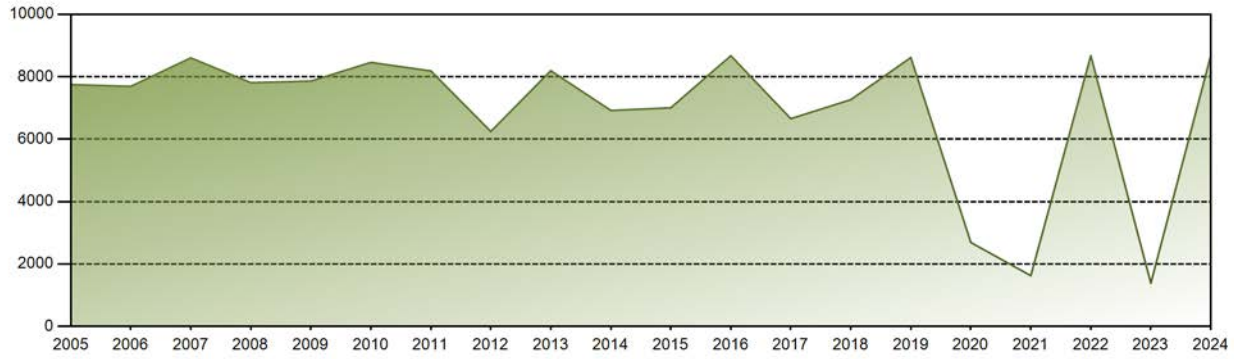
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	742.37	695.58	743.25	718.46	740.55	712.15	730.31	718.02	696.08	731.18	711.20	739.24	8678.39
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.08	99.26	100.00	100.00	100.00	99.86
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00
LF [%]	102.44	102.61	102.57	102.45	102.19	101.55	100.78	99.08	99.26	100.90	101.41	102.01	101.43
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.92	0.73	0.00	0.00	0.00	0.14

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Historical Summary

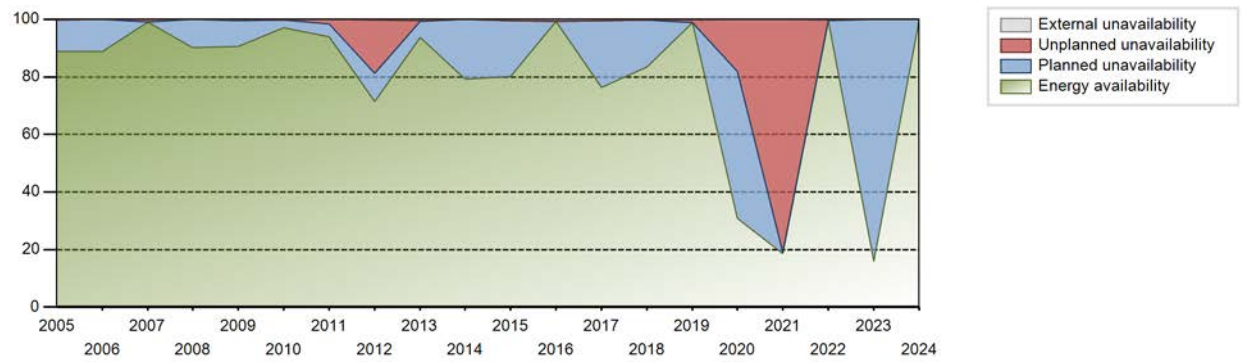
Lifetime energy generation	:	158055.16 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.45 %
Cumulative Energy Availability Factor (EAF)	:	79.41 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.6 %
Cumulative Unit Capability Factor (UCF)	:	79.59 %	Cumulative Planned Unavailability Factor (PUF)	:	14.82 %
Cumulative Load Factor (LF)	:	80.15 %	Cumulative Externally cause unavailability (XUF)	:	0.18 %
Cumulative Operating Factor (OF)	:	80.2 %			

Electricity Production (net) [GWh]



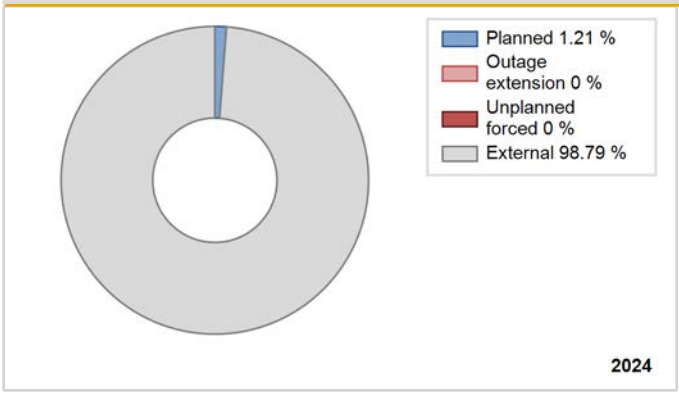
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2002	5006.77	5095	950	98.71	98.71	102.59	99.18	1.25	1.25	0.03	0.00
2003	6694.37	6856	950	77.12	77.12	80.44	78.26	1.14	0.89	22.00	0.00
2004	5524.51	5611	950	63.34	63.34	66.20	63.88	3.63	2.39	34.27	0.00
2005	7748.43	7873	950	88.80	89.00	93.11	89.87	0.00	0.00	11.00	0.20
2006	7688.25	7859	987	88.80	88.83	88.92	89.71	0.00	0.00	11.17	0.04
2007	8601.74	8725	990	99.11	99.12	99.19	99.60	0.88	0.88	0.00	0.01
2008	7807.37	7972	988	90.21	90.24	89.96	90.76	0.00	0.00	9.76	0.03
2009	7857.49	7987	988	90.56	90.58	90.79	91.18	0.46	0.42	9.00	0.02
2010	8457.74	8528	988	97.12	97.27	97.72	97.35	0.00	0.00	2.73	0.15
2011	8183.75	8283	988	93.90	93.94	94.56	94.55	1.65	1.58	4.48	0.04
2012	6244.61	6428	993	71.41	71.60	71.59	73.18	20.53	18.50	9.89	0.19
2013	8191.47	8290	997	93.81	94.29	93.79	94.63	0.19	0.18	5.53	0.47
2014	6918.10	6984	994	79.19	79.30	79.45	79.73	0.00	0.00	20.70	0.12
2015	7004.72	7122	994	80.16	80.74	80.45	81.30	0.00	0.00	19.26	0.57
2016	8671.06	8784	994	99.31	100.00	99.31	100.00	0.00	0.00	0.00	0.69
2017	6655.11	6783	994	76.41	76.79	76.43	77.43	0.00	0.00	23.21	0.38
2018	7265.08	7387	992	83.43	83.76	83.60	84.33	0.00	0.00	16.24	0.33
2019	8613.69	8709	992	98.95	99.30	99.12	99.42	0.69	0.69	0.00	0.35
2020	2688.51	2882	992	30.76	30.76	30.85	32.81	0.00	18.19	51.05	0.00
2021	1624.65	1660	992	18.59	18.59	18.70	18.95	0.00	81.04	0.37	0.00
2022	8671.23	8760	992	99.62	99.94	99.78	100.00	0.05	0.05	0.00	0.33
2023	1384.55	1443	992	15.89	15.90	15.93	16.47	0.03	0.00	84.09	0.01
2024	8678.39	8784	974	99.86	100.00	101.43	100.00	0.00	0.00	0.00	0.14

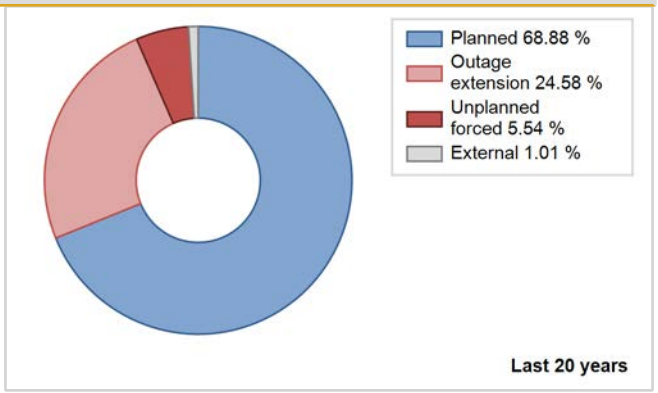
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2002 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					163	
C. Inspection, maintenance or repair combined with refuelling				1239		
D. Inspection, maintenance or repair without refuelling				18		
E. Testing of plant systems or components					316	
Subtotal				1257	479	
Total		**0**			**1736**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2002 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		382
13. Reactor Auxiliary Systems		2
14. Safety Systems		2
16. Steam generation systems		9
35. All other I&C Systems		11
42. Electrical Power Supply Systems		61
Total		**471**

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2024 Operating Experience

KR-18 HANBIT-6 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1053 MWe
Reference unit power (net)	:	978 MWe

Key Dates

Construction Date	:	1997-11-20
Grid Date	:	2002-09-16
Commercial Date	:	2002-12-24
Age at end of year	:	22 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36
Average discharge burnup [MWd/t]	:	13450
Active core diameter [m]	:	3.124
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	19.68
Number of control rod assemblies	:	73
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

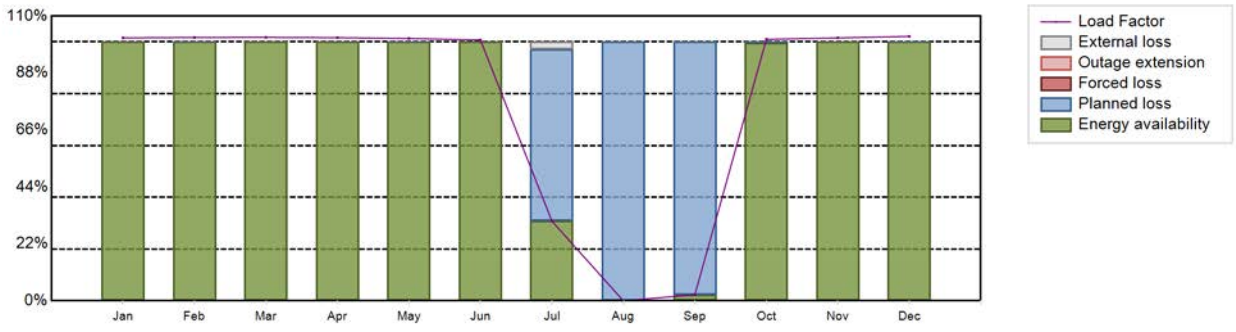
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	7.14
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6767.81 GW(e).h
Energy Availability Factor (EAF)	:	77.63 %
Unit Capability Factor (UCF)	:	77.88 %
Load Factor (LF)	:	78.78 %
Operating Factor (OF)	:	78.26 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	22.12 %
Externally cause unavailability (XUF)	:	0.25 %
Total off-line time	:	1910 hours

Annual Summary



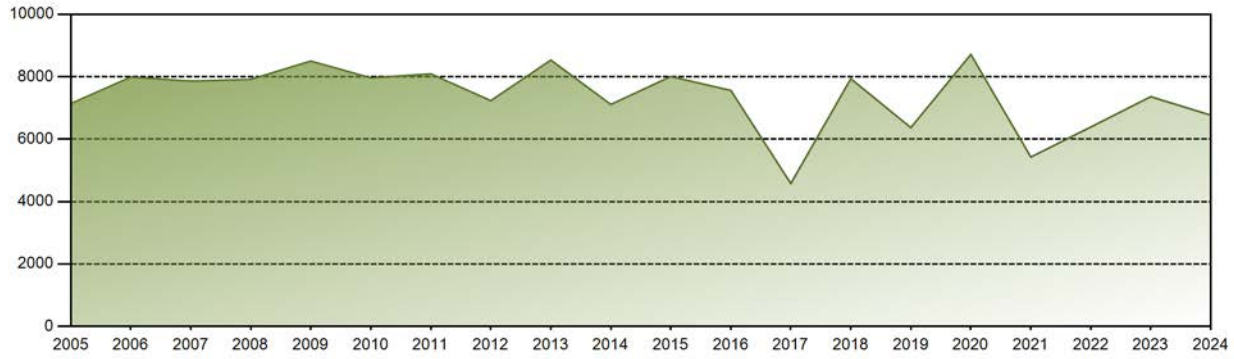
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	739.02	692.36	740.36	715.66	737.24	709.37	224.06	0.00	16.75	734.77	715.08	743.14	6767.81
EAF [%]	100.00	100.00	100.00	100.00	99.99	100.00	30.75	0.00	2.38	99.56	100.00	100.00	77.63
UCF [%]	100.00	100.00	100.00	100.00	99.99	100.00	33.74	0.00	2.38	99.56	100.00	100.00	77.88
LF [%]	101.57	101.71	101.75	101.63	101.32	100.74	30.79	0.00	2.38	100.98	101.55	102.13	78.78
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	33.60	0.00	6.67	100.00	100.00	100.00	78.26
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.01	0.00	66.26	100.00	97.62	0.44	0.00	0.00	22.12
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	2.98	0.00	0.00	0.00	0.00	0.00	0.25

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Historical Summary

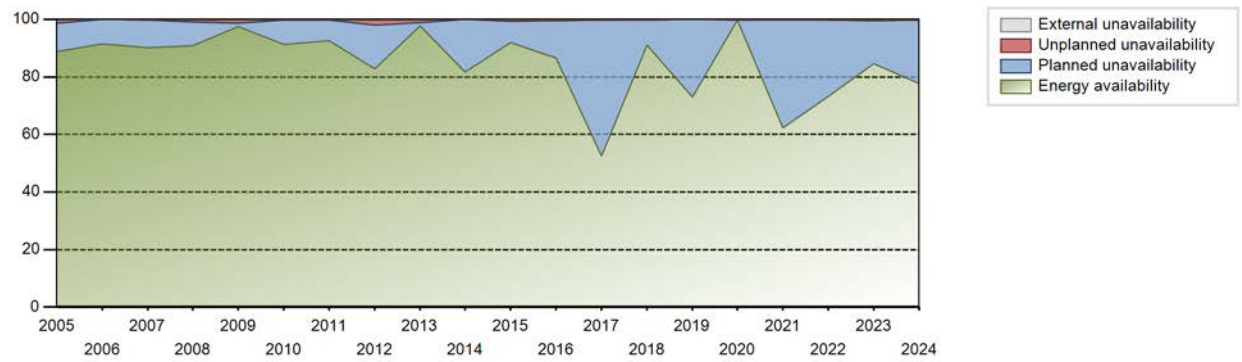
Lifetime energy generation	:	163155.4 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.32 %
Cumulative Energy Availability Factor (EAF)	:	84.48 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.27 %
Cumulative Unit Capability Factor (UCF)	:	84.73 %	Cumulative Planned Unavailability Factor (PUF)	:	15 %
Cumulative Load Factor (LF)	:	84.8 %	Cumulative Externally cause unavailability (XUF)	:	0.25 %
Cumulative Operating Factor (OF)	:	85.17 %			

Electricity Production (net) [GWh]



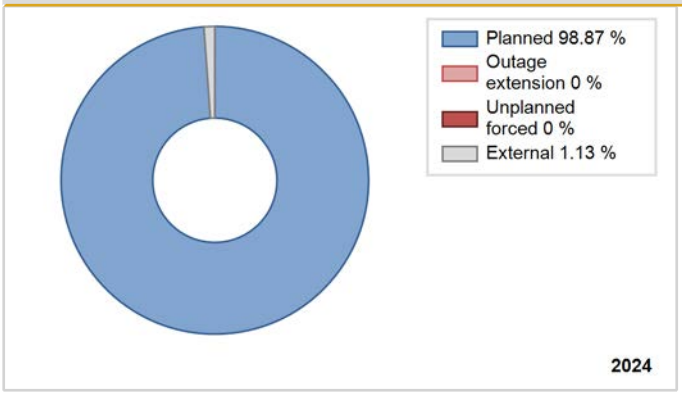
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2002	1058.41	1461	996	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	7652.19	7728	950	88.21	88.21	91.95	88.22	0.00	0.00	11.79	0.00
2004	6354.49	6449	950	72.78	72.78	76.15	73.42	0.82	0.60	26.61	0.00
2005	7137.13	7906	950	88.78	89.13	85.76	90.25	1.12	1.01	9.87	0.35
2006	7988.59	8064	993	91.48	91.52	91.84	92.05	0.00	0.00	8.48	0.03
2007	7859.23	7957	993	90.14	90.35	90.35	90.83	0.02	0.02	9.63	0.21
2008	7914.57	8073	996	90.90	91.13	90.46	91.91	0.66	0.61	8.27	0.23
2009	8501.44	8606	996	97.56	97.90	97.44	98.24	0.95	0.94	1.16	0.34
2010	7961.42	8060	996	91.19	91.48	91.25	92.01	0.00	0.00	8.52	0.29
2011	8090.64	8179	996	92.65	92.90	92.73	93.37	0.00	0.00	7.10	0.24
2012	7231.21	7325	993	82.72	82.96	82.90	83.39	2.12	1.80	15.24	0.24
2013	8531.74	8631	995	97.74	98.04	97.88	98.53	0.89	0.88	1.08	0.31
2014	7110.37	7235	993	81.59	81.73	81.74	82.59	0.00	0.00	18.27	0.14
2015	8006.79	8122	993	91.92	92.48	92.05	92.72	0.07	0.07	7.46	0.56
2016	7559.26	7667	993	86.50	86.88	86.66	87.28	0.00	0.00	13.12	0.38
2017	4576.12	4642	993	52.57	52.82	52.61	52.99	0.00	0.00	47.18	0.25
2018	7934.90	8042	993	91.06	91.41	91.22	91.80	0.00	0.00	8.59	0.36
2019	6367.31	6446	993	72.99	73.01	73.20	73.58	0.00	0.00	26.99	0.01
2020	8714.05	8784	993	99.71	100.00	99.90	100.00	0.00	0.00	0.00	0.29
2021	5425.44	5532	993	62.25	62.45	62.37	63.15	0.00	0.00	37.55	0.20
2022	6389.15	6444	993	73.27	73.53	73.45	73.56	0.00	0.00	26.47	0.26
2023	7360.22	7490	993	84.54	85.00	84.61	85.50	0.07	0.06	14.94	0.46
2024	6767.81	6874	978	77.63	77.88	78.78	78.26	0.00	0.00	22.12	0.25

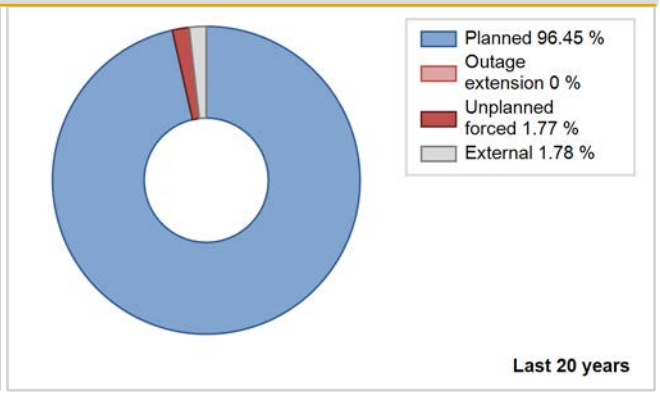
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2002 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					19	
C. Inspection, maintenance or repair combined with refuelling	1894			1277		
D. Inspection, maintenance or repair without refuelling				4		
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						0
Subtotal	1894			1281	19	0
Total	**1894**			**1300**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2002 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		2
17. Safety I&C Systems (excluding reactor I&C)		3
41. Main Generator Systems		2
42. Electrical Power Supply Systems		9
Total		**19**

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2024 Operating Experience

KR-9 HANUL-1 KOREA, REPUBLIC OF

Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)



Reactor Unit Details

Reactor type and model	:	PWR / France CPI
Thermal power	:	2775 MWth
Gross electrical power	:	1014 MWe
Reference unit power (net)	:	953 MWe

Key Dates

Construction Date	:	1983-01-26
Grid Date	:	1988-04-07
Commercial Date	:	1988-09-10
Age at end of year	:	36 years

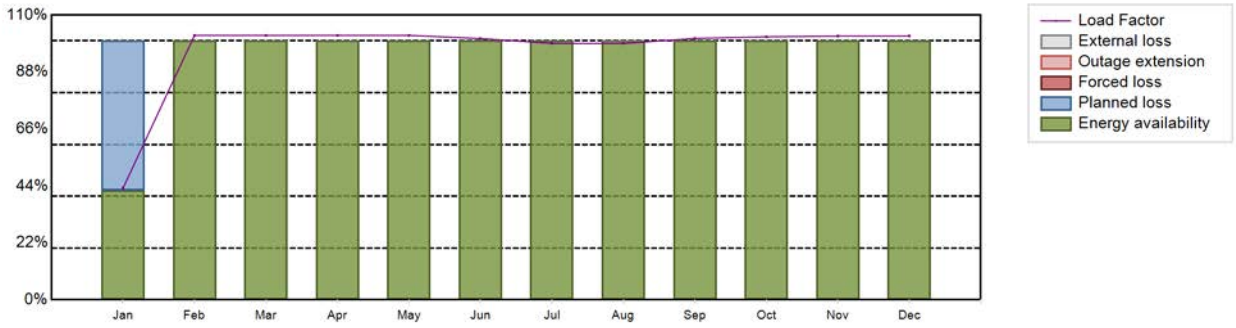
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.4
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	323.2
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.42
Average fuel enrichment [% of U235]	:	4	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	38	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	42500	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.53
Active core height/length [m]	:	3.66	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.83	Number of main condensate pumps	:	3
Number of control rod assemblies	:	48	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8063.66 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	95.11 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	95.11 %	Planned Unavailability Factor (PUF)	:	4.89 %
Load Factor (LF)	:	96.33 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	95.36 %	Total off-line time	:	408 hours

Annual Summary



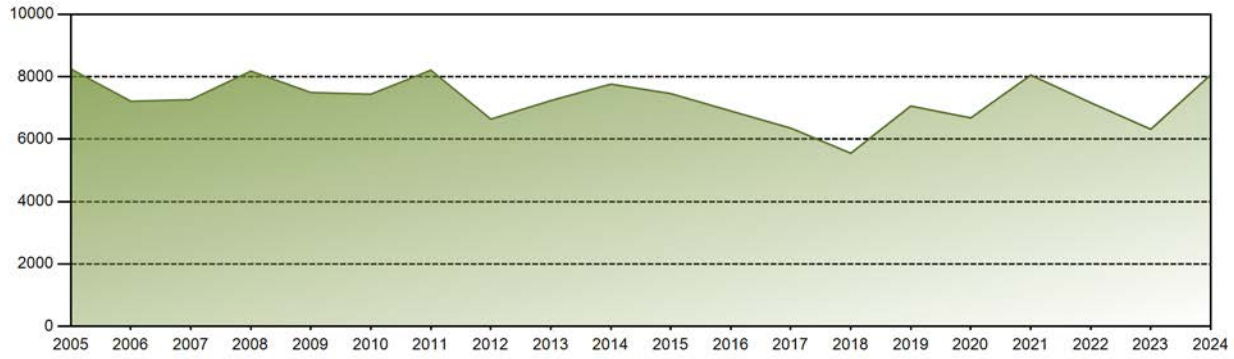
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	305.71	677.42	723.99	700.96	724.32	692.43	702.28	702.03	692.69	720.29	698.90	722.65	8063.66
EAF [%]	42.26	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00	95.11
UCF [%]	42.26	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	95.11
LF [%]	43.12	102.13	102.11	102.16	102.16	100.91	99.05	99.01	100.95	101.59	101.86	101.92	96.33
OF [%]	45.16	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	95.36
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	57.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.89
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	257322.34 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.2 %
Cumulative Energy Availability Factor (EAF)	:	85.49 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.93 %
Cumulative Unit Capability Factor (UCF)	:	85.87 %	Cumulative Planned Unavailability Factor (PUF)	:	12.2 %
Cumulative Load Factor (LF)	:	85.78 %	Cumulative Externally cause unavailability (XUF)	:	0.38 %
Cumulative Operating Factor (OF)	:	86.02 %			

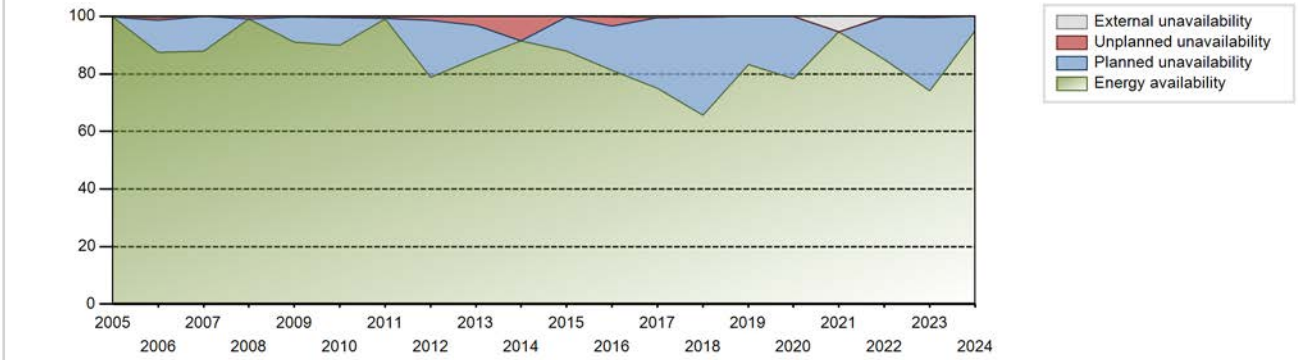
Electricity Production (net) [GWh]



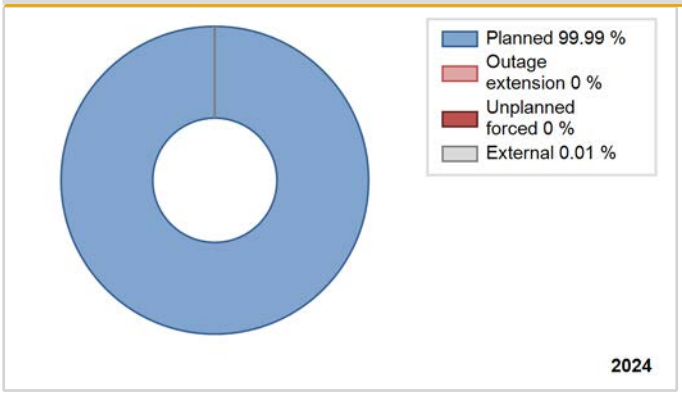
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	Data not provided										
1989	5205.36	5821	920	66.45	66.45	64.59	66.45	15.49	12.18	21.37	0.00
1990	6166.21	7156	920	81.69	81.69	76.51	81.69	1.16	0.96	17.35	0.00
1991	7244.32	7970	920	90.98	90.98	89.89	90.98	2.19	2.04	6.99	0.00
1992	7020.77	7675	920	87.37	87.37	86.88	87.37	0.04	0.03	12.59	0.00
1993	6977.60	7651	920	87.34	87.34	86.58	87.34	0.20	0.18	12.48	0.00
1994	6878.53	7293	890	82.02	82.02	88.23	83.25	0.01	0.00	17.97	0.00
1995	7153.82	7698	920	85.73	85.73	88.77	87.88	0.31	0.27	14.00	0.00
1996	7113.66	7631	920	85.42	85.63	88.03	86.87	0.93	0.81	13.56	0.21
1997	6801.00	7323	920	82.25	83.72	84.39	83.60	2.57	2.21	14.07	1.46
1998	7642.97	8256	920	91.45	94.06	94.84	94.25	0.00	0.00	5.94	2.61
1999	7161.55	7639	920	86.12	86.12	88.86	87.20	0.53	0.46	13.42	0.00
2000	7230.77	7736	920	86.34	86.75	89.48	88.07	0.23	0.20	13.05	0.41
2001	7022.30	7483	920	84.48	85.14	87.13	85.42	7.14	6.55	8.31	0.66
2002	5462.40	6052	920	75.98	75.98	67.78	69.09	24.01	24.01	0.01	0.00
2003	6371.56	7446	920	85.20	85.21	79.06	85.00	0.35	0.30	14.49	0.01
2004	7420.13	7970	920	89.27	89.48	91.82	90.73	0.55	0.50	10.02	0.21
2005	8245.04	8760	920	99.80	99.88	102.31	100.00	0.11	0.11	0.00	0.08
2006	7212.78	7769	939	87.50	88.06	87.69	88.69	0.82	0.73	11.21	0.56
2007	7262.21	7747	940	87.97	87.97	88.19	88.44	0.06	0.05	11.98	0.00
2008	8177.42	8747	945	99.14	99.19	98.51	99.58	0.80	0.80	0.00	0.06
2009	7493.10	8024	945	90.99	90.99	90.52	91.60	0.33	0.30	8.70	0.00
2010	7437.82	7988	945	89.84	90.16	89.85	91.19	0.06	0.06	9.78	0.32
2011	8206.10	8730	945	99.13	99.40	99.13	99.66	0.53	0.53	0.07	0.27
2012	6640.08	6988	960	78.86	78.90	79.15	79.55	1.71	1.37	19.73	0.04
2013	7233.32	7545	960	85.54	85.57	86.01	86.13	3.53	3.13	11.29	0.03
2014	7762.26	8033	963	91.49	91.49	92.01	91.70	8.51	8.51	0.00	0.00
2015	7458.09	7747	966	87.88	87.96	88.13	88.44	0.15	0.13	11.91	0.08
2016	6901.60	7171	968	81.13	81.34	81.17	81.64	3.69	3.12	15.54	0.21
2017	6351.26	6622	968	74.90	75.34	74.90	75.59	0.00	0.00	24.66	0.44
2018	5547.64	5770	966	65.55	65.79	65.56	65.87	0.00	0.00	34.21	0.24
2019	7060.57	7322	966	83.22	83.33	83.44	83.58	0.00	0.00	16.67	0.11
2020	6679.80	6921	966	78.38	78.44	78.72	78.79	0.05	0.04	21.52	0.06
2021	8051.79	8364	966	94.70	100.00	95.15	95.48	0.00	0.00	0.00	5.30
2022	7165.36	7488	966	85.00	85.03	84.68	85.48	0.32	0.28	14.69	0.03
2023	6316.71	6538	966	74.19	74.39	74.65	74.63	0.25	0.18	25.43	0.20
2024	8063.66	8376	953	95.11	95.11	96.33	95.36	0.00	0.00	4.89	0.00

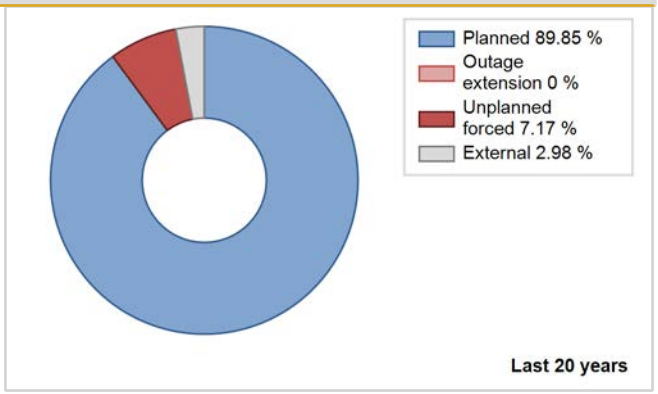
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					135	
C. Inspection, maintenance or repair combined with refuelling	408			1025		
D. Inspection, maintenance or repair without refuelling				75		
J. Grid limitation, failure or grid unavailability						0
L. Human factor related					6	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						13
Z. Other						2
Subtotal	408			1100	141	15
Total	**408**			**1256**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1988 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		27
15. Reactor Cooling Systems		2
17. Safety I&C Systems (excluding reactor I&C)		8
31. Turbine and auxiliaries		12
32. Feedwater and Main Steam System		4
33. Circulating Water System		4
41. Main Generator Systems		87
42. Electrical Power Supply Systems		5
Total		**149**

Highlights (2024)

Outage Due to abnormal situation in Yecheon Pumping-up Power Plant and Shin Jecheon Power Station(6/27 ~ 7/9)
Outage Due to Start-up after Maintenance in Shin Hanul Unit 1(8/8 ~ 8/10)

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2024 Operating Experience

KR-10 HANUL-2 KOREA, REPUBLIC OF

Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	ALSTOM (ALSTOM)



Reactor Unit Details

Reactor type and model	:	PWR / France CPI
Thermal power	:	2775 MWth
Gross electrical power	:	1011 MWe
Reference unit power (net)	:	957 MWe

Key Dates

Construction Date	:	1983-07-05
Grid Date	:	1989-04-14
Commercial Date	:	1989-09-30
Age at end of year	:	35 years

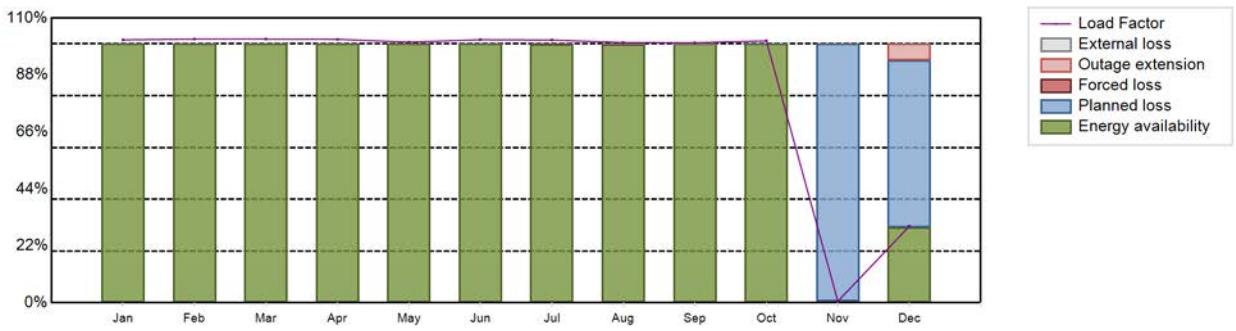
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.4
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	323.2
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.42
Average fuel enrichment [% of U235]	:	4	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	38	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	42500	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.53
Active core height/length [m]	:	3.66	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.83	Number of main condensate pumps	:	3
Number of control rod assemblies	:	48	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7311.17 GW(e).h	Forced Loss Rate (FLR)	:	0.02 %
Energy Availability Factor (EAF)	:	85.83 %	Unplanned Capability Loss Factor (UCL)	:	0.56 %
Unit Capability Factor (UCF)	:	85.84 %	Planned Unavailability Factor (PUF)	:	13.6 %
Load Factor (LF)	:	86.97 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	86.13 %	Total off-line time	:	1218 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	723.26	678.43	725.20	701.29	716.87	700.25	722.70	715.86	692.09	720.34	4.33	210.54	7311.17
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	99.94	99.83	100.00	100.00	0.63	29.14	85.83
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	99.94	99.88	100.00	100.00	0.63	29.14	85.84
LF [%]	101.58	101.86	101.85	101.78	100.68	101.63	101.50	100.54	100.44	101.17	0.63	29.57	86.97
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	1.39	31.72	86.13
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.12	0.00	0.00	0.00	0.00	0.02
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.12	0.00	0.00	0.00	6.41	0.56
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.37	64.45	13.60
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	253130.54 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1 %
Cumulative Energy Availability Factor (EAF)	:	86.19 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.06 %
Cumulative Unit Capability Factor (UCF)	:	86.51 %	Cumulative Planned Unavailability Factor (PUF)	:	12.43 %
Cumulative Load Factor (LF)	:	87.04 %	Cumulative Externally cause unavailability (XUF)	:	0.32 %
Cumulative Operating Factor (OF)	:	87.05 %			

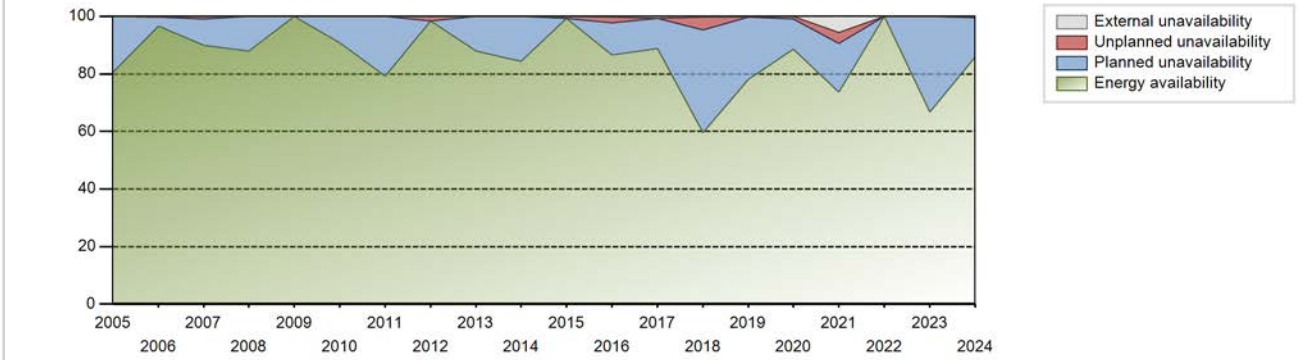
Electricity Production (net) [GWh]



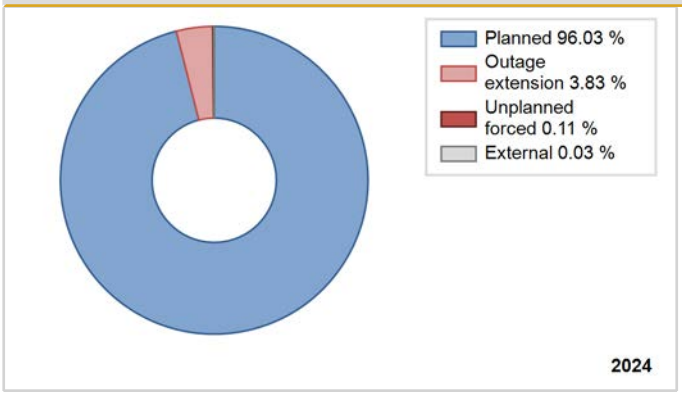
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	Data not provided										
1990	5547.29	6395	920	73.00	73.00	68.83	73.00	0.27	0.19	26.80	0.00
1991	6671.16	7603	920	86.79	86.79	82.78	86.79	0.05	0.05	13.16	0.00
1992	7076.88	7686	920	87.50	87.50	87.57	87.50	0.00	0.00	12.50	0.00
1993	7230.22	7693	920	87.82	87.82	89.71	87.82	0.16	0.14	12.04	0.00
1994	6889.67	7315	890	81.47	81.47	88.37	83.50	0.18	0.15	18.38	0.00
1995	7810.26	8223	920	93.39	93.42	96.91	93.87	0.34	0.32	6.26	0.03
1996	7696.38	8151	920	91.05	91.27	95.24	92.79	0.45	0.41	8.32	0.22
1997	7055.18	7534	920	84.27	85.99	87.54	86.00	0.52	0.45	13.56	1.72
1998	7388.87	7947	920	88.33	88.48	91.68	90.72	0.00	0.00	11.52	0.15
1999	7815.17	8748	920	94.53	94.58	96.97	99.86	5.17	5.16	0.27	0.05
2000	6836.81	7330	920	82.34	82.49	84.60	83.45	0.00	0.00	17.51	0.15
2001	7268.56	7848	920	89.18	90.16	90.19	89.59	0.94	0.85	8.99	0.97
2002	6485.83	6939	920	78.26	78.26	80.48	79.21	0.01	0.01	21.73	0.00
2003	7253.75	7686	920	87.12	87.12	90.01	87.74	12.87	12.87	0.00	0.00
2004	7253.74	7888	920	88.64	88.64	89.76	89.80	1.53	1.38	9.98	0.00
2005	6582.35	7218	920	80.66	80.75	81.68	82.40	0.00	0.00	19.25	0.09
2006	7882.51	8510	937	96.69	97.03	96.03	97.15	0.03	0.03	2.94	0.33
2007	7391.65	7946	937	90.02	90.02	90.05	90.71	1.06	0.96	9.01	0.00
2008	7264.19	7752	942	87.94	87.95	87.79	88.25	0.00	0.00	12.05	0.01
2009	8258.31	8760	942	100.00	100.00	100.08	100.00	0.00	0.00	0.00	0.00
2010	7506.86	7991	942	90.81	90.86	90.97	91.22	0.00	0.00	9.14	0.05
2011	6571.07	7003	942	79.26	79.30	79.63	79.94	0.00	0.00	20.70	0.04
2012	8325.47	8661	961	98.33	98.36	98.63	98.60	1.64	1.64	0.00	0.03
2013	7446.49	7740	962	87.98	87.98	88.36	88.36	0.01	0.01	12.01	0.00
2014	7161.63	7430	965	84.39	84.41	84.72	84.82	0.10	0.09	15.50	0.02
2015	8449.96	8760	967	99.35	99.38	99.75	100.00	0.62	0.62	0.00	0.03
2016	7373.63	7665	969	86.55	86.84	86.63	87.26	0.00	2.00	11.16	0.29
2017	7535.86	7858	969	88.78	89.39	88.78	89.70	0.00	0.00	10.61	0.60
2018	5046.21	5271	967	59.55	59.71	59.57	60.17	6.97	4.47	35.82	0.16
2019	6629.49	6874	967	78.13	78.38	78.26	78.47	0.00	0.00	21.62	0.25
2020	7544.08	7849	967	88.69	88.82	88.82	89.36	0.90	0.81	10.37	0.13
2021	6260.94	6606	967	73.77	79.39	73.91	75.41	0.00	3.82	16.78	5.62
2022	8427.91	8760	967	99.93	100.00	99.49	100.00	0.00	0.00	0.00	0.06
2023	5670.91	5879	967	66.69	66.75	66.95	67.11	0.11	0.08	33.18	0.05
2024	7311.17	7566	957	85.83	85.84	86.97	86.13	0.02	0.56	13.60	0.00

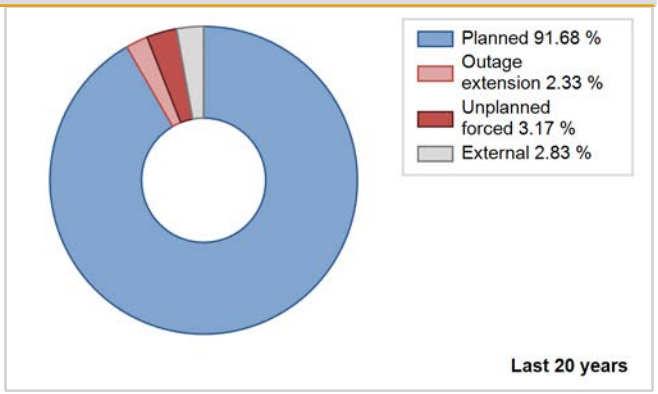
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		49			101	
C. Inspection, maintenance or repair combined with refuelling	1170			1049		
D. Inspection, maintenance or repair without refuelling				37		
E. Testing of plant systems or components					1	
J. Grid limitation, failure or grid unavailability						0
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						15
Z. Other						3
Subtotal	1170	49		1086	102	18
Total	**1219**			**1206**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1989 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		0
14. Safety Systems		9
15. Reactor Cooling Systems	49	1
16. Steam generation systems		1
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		54
32. Feedwater and Main Steam System		1
33. Circulating Water System		5
41. Main Generator Systems		31
42. Electrical Power Supply Systems		2
Total	**49**	**104**

Highlights (2024)

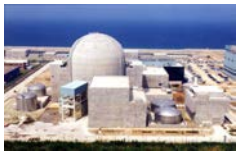
Outage Due to abnormal situation in Shin Chungju Power Station(4/30 ~ 5/1, 5/4 ~ 5/5)
Power Reduction Due to Maintenance of Pipe Pin hole after Normal Drain Valve(GSS 071VV) in Moisture Separator and Reheater System(7/31 ~ 8/2)

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2024 Operating Experience

KR-13 HANUL-3 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1051 MWe
Reference unit power (net)	:	991 MWe

Key Dates

Construction Date	:	1993-07-21
Grid Date	:	1998-01-06
Commercial Date	:	1998-08-11
Age at end of year	:	26 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36.7
Average discharge burnup [MWd/t]	:	45800
Active core diameter [m]	:	3.122
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.24
Number of control rod assemblies	:	73
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

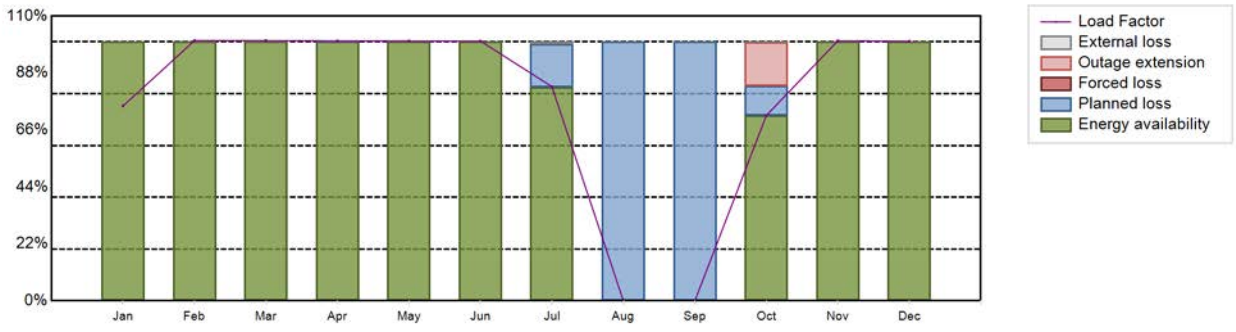
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	7.136
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6754.96 GW(e).h
Energy Availability Factor (EAF)	:	79.44 %
Unit Capability Factor (UCF)	:	79.5 %
Load Factor (LF)	:	77.6 %
Operating Factor (OF)	:	78.22 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	1.45 %
Planned Unavailability Factor (PUF)	:	19.05 %
Externally cause unavailability (XUF)	:	0.07 %
Total off-line time	:	1913 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	554.69	693.17	740.92	716.43	739.96	715.90	609.87	0.00	0.00	527.93	716.63	739.46	6754.96
EAF [%]	100.00	100.00	100.00	99.99	100.00	100.00	82.54	0.00	0.00	71.46	100.00	100.00	79.44
UCF [%]	100.00	100.00	100.00	99.99	100.00	100.00	83.31	0.00	0.00	71.48	100.00	100.00	79.50
LF [%]	75.23	100.50	100.49	100.41	100.36	100.33	82.72	0.00	0.00	71.60	100.44	100.29	77.60
OF [%]	77.02	100.00	100.00	100.00	100.00	100.00	85.22	0.00	0.00	77.42	100.00	100.00	78.22
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.11	0.00	0.00	1.45
PUF [%]	0.00	0.00	0.00	0.01	0.00	0.00	16.69	100.00	100.00	11.42	0.00	0.00	19.05
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.01	0.00	0.00	0.07

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Historical Summary

Lifetime energy generation	:	197106.09 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.37 %
Cumulative Energy Availability Factor (EAF)	:	85.01 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.46 %
Cumulative Unit Capability Factor (UCF)	:	85.2 %	Cumulative Planned Unavailability Factor (PUF)	:	14.33 %
Cumulative Load Factor (LF)	:	84.88 %	Cumulative Externally cause unavailability (XUF)	:	0.19 %
Cumulative Operating Factor (OF)	:	85.66 %			

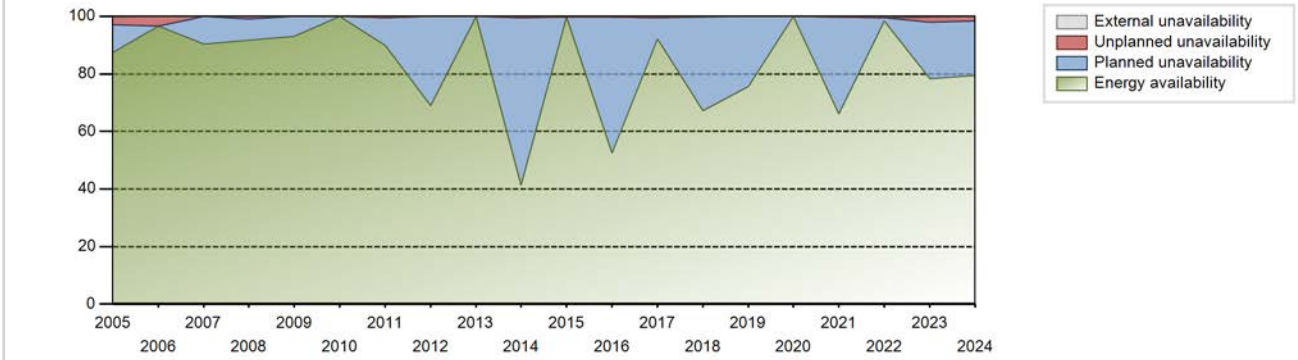
Electricity Production (net) [GWh]



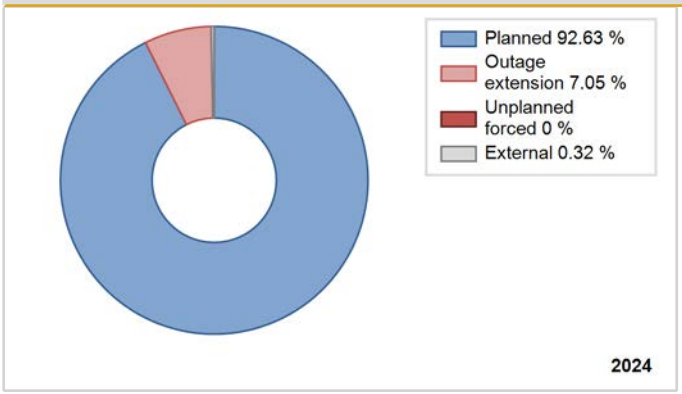
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1998	4822.23	5872	960	99.98	99.98	99.17	97.74	0.00	0.00	0.02	0.00
1999	6918.04	7149	960	79.67	81.45	82.26	81.61	0.68	0.56	17.99	1.78
2000	7489.09	7734	960	86.99	86.99	88.81	88.05	0.65	0.57	12.44	0.00
2001	7922.21	8025	960	91.25	91.25	94.20	91.61	0.00	0.00	8.75	0.00
2002	7031.29	7824	960	88.96	88.96	83.61	89.32	0.13	0.11	10.93	0.00
2003	7984.26	8758	960	99.56	99.56	94.94	99.98	0.00	0.43	0.01	0.00
2004	7187.59	7986	960	90.05	90.05	85.24	90.92	0.00	0.00	9.95	0.00
2005	7651.74	7834	960	87.58	87.73	90.99	89.43	2.99	2.70	9.57	0.15
2006	8425.90	8501	994	96.60	96.60	96.77	97.04	3.38	3.38	0.01	0.00
2007	7901.94	7970	995	90.35	90.35	90.66	90.98	0.12	0.11	9.54	0.00
2008	8034.73	8122	994	91.67	91.69	92.02	92.46	0.98	0.91	7.40	0.02
2009	8149.75	8225	994	93.15	93.26	93.60	93.89	0.00	0.00	6.74	0.10
2010	8740.74	8760	994	99.93	99.94	100.38	100.00	0.06	0.06	0.00	0.01
2011	7873.04	7960	994	90.04	90.45	90.42	90.87	0.00	0.00	9.55	0.41
2012	6056.35	6130	994	69.08	69.17	69.36	69.79	0.00	0.00	30.83	0.09
2013	8731.76	8760	994	99.94	99.99	100.28	100.00	0.00	0.00	0.01	0.06
2014	3609.51	3739	997	41.31	41.77	41.33	42.68	0.00	0.00	58.23	0.46
2015	8717.66	8760	997	99.80	100.00	99.82	100.00	0.00	0.00	0.00	0.20
2016	4601.49	4708	997	52.54	52.74	52.54	53.60	0.00	0.00	47.26	0.20
2017	8047.45	8122	997	92.14	92.52	92.14	92.72	0.03	0.02	7.46	0.38
2018	5868.02	5935	997	67.11	67.21	67.19	67.75	0.15	0.10	32.69	0.10
2019	6616.04	6687	997	75.70	75.76	75.75	76.34	0.00	0.00	24.24	0.06
2020	8772.41	8784	997	99.98	99.99	100.17	100.00	0.00	0.00	0.01	0.02
2021	5773.46	5868	997	66.03	66.36	66.11	66.99	0.00	0.00	33.64	0.33
2022	8531.57	8674	997	98.40	98.82	97.69	99.02	0.00	0.00	1.18	0.42
2023	6843.50	6921	997	78.31	78.53	78.36	79.01	0.00	1.88	19.59	0.21
2024	6754.96	6871	991	79.44	79.50	77.60	78.22	0.00	1.45	19.05	0.07

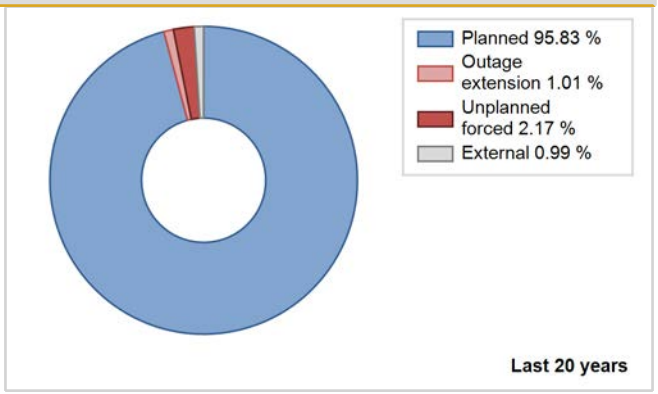
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1998 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		127			27	
C. Inspection, maintenance or repair combined with refuelling	1618			1236		
H. Nuclear regulatory requirements					6	
J. Grid limitation, failure or grid unavailability			171			7
Subtotal	1618	127	171	1236	33	7
Total	**1916**			**1276**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1998 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		8
15. Reactor Cooling Systems	127	5
31. Turbine and auxiliaries		1
32. Feedwater and Main Steam System		1
41. Main Generator Systems		11
42. Electrical Power Supply Systems	171	7
Total	**298**	**33**

Highlights (2024)

The 18th refueling(2024-07-27 ~ 2024-10-08)

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2024 Operating Experience

KR-14 HANUL-4 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1052 MWe
Reference unit power (net)	:	994 MWe

Key Dates

Construction Date	:	1993-11-01
Grid Date	:	1998-12-28
Commercial Date	:	1999-12-31
Age at end of year	:	26 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36
Average discharge burnup [MWd/t]	:	46603
Active core diameter [m]	:	3.122
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.24
Number of control rod assemblies	:	73
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

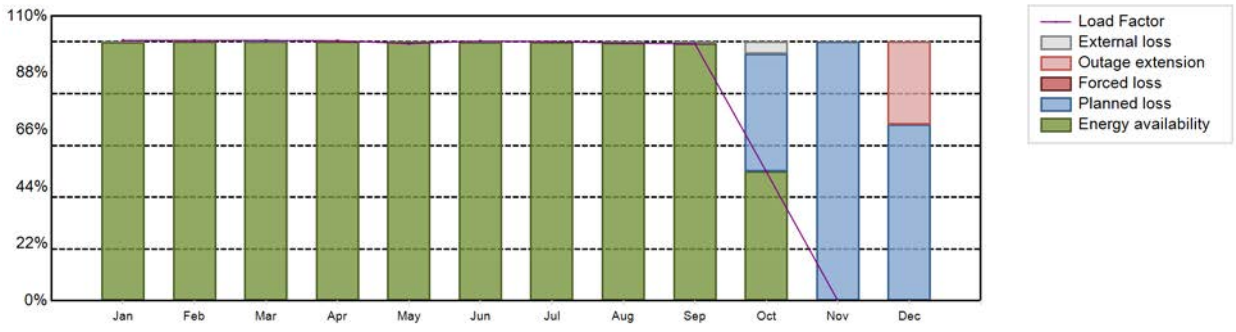
Operating coolant pressure [MPa]	:	15.52502
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	7.136
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6910.92 GW(e).h
Energy Availability Factor (EAF)	:	78.98 %
Unit Capability Factor (UCF)	:	79.46 %
Load Factor (LF)	:	79.15 %
Operating Factor (OF)	:	79.62 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	2.71 %
Planned Unavailability Factor (PUF)	:	17.83 %
Externally cause unavailability (XUF)	:	0.48 %
Total off-line time	:	1790 hours

Annual Summary



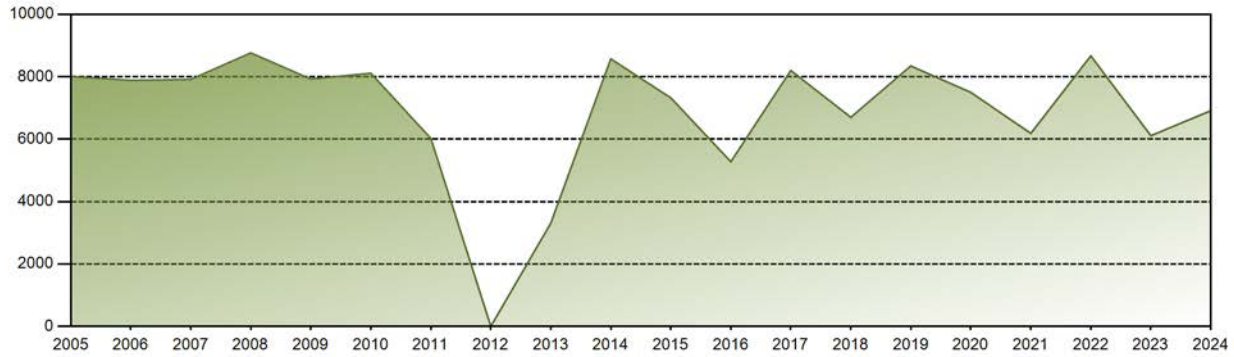
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	743.73	695.80	743.78	719.08	734.80	717.93	740.22	736.13	710.63	368.81	0.00	0.00	6910.92
EAF [%]	99.98	100.00	99.99	99.99	100.00	99.99	99.97	99.54	99.29	49.87	0.00	0.00	78.98
UCF [%]	99.99	100.00	99.99	99.99	100.00	99.99	100.00	100.00	99.97	54.35	0.00	0.00	79.46
LF [%]	100.57	100.57	100.57	100.48	99.36	100.32	100.09	99.54	99.29	49.87	0.00	0.00	79.15
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	56.18	0.00	0.00	79.62
FLR [%]	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
UCL [%]	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	31.99	2.71
PUF [%]	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02	45.65	100.00	68.01	17.83
XUF [%]	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.46	0.68	4.48	0.00	0.00	0.48

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Historical Summary

Lifetime energy generation	:	183423.39 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.23 %
Cumulative Energy Availability Factor (EAF)	:	80.64 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.23 %
Cumulative Unit Capability Factor (UCF)	:	80.78 %	Cumulative Planned Unavailability Factor (PUF)	:	17.98 %
Cumulative Load Factor (LF)	:	81.38 %	Cumulative Externally cause unavailability (XUF)	:	0.15 %
Cumulative Operating Factor (OF)	:	81.81 %			

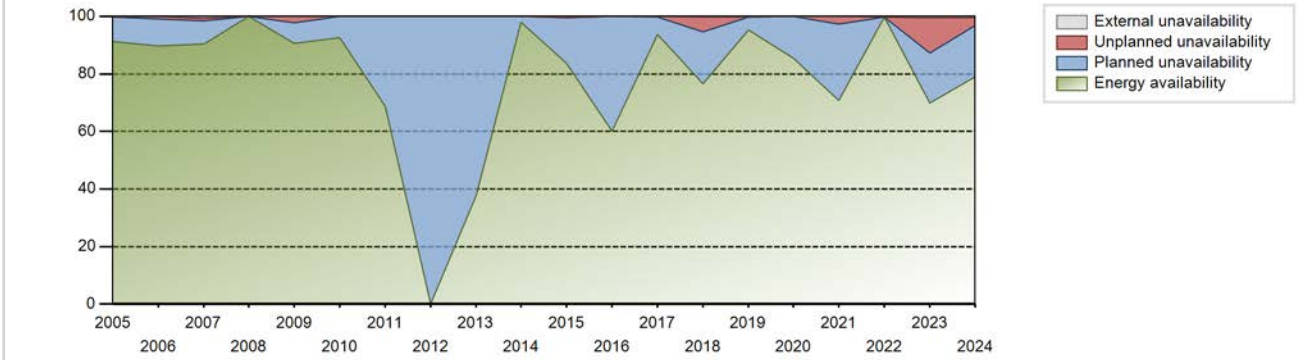
Electricity Production (net) [GWh]



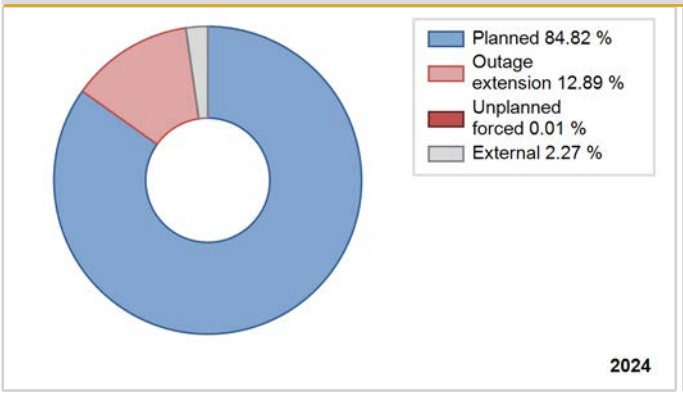
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1999	Data not provided										
2000	7042.47	7229	960	81.26	81.26	83.51	82.30	0.50	0.40	18.33	0.00
2001	7732.33	7880	960	89.94	89.99	91.95	89.95	0.30	0.27	9.74	0.04
2002	7311.29	7448	960	83.82	84.02	86.94	85.02	0.82	0.70	15.28	0.20
2003	7922.45	8081	960	91.62	91.63	94.21	92.25	0.96	0.89	7.48	0.01
2004	8623.08	8700	960	98.66	98.66	102.26	99.04	1.33	1.33	0.01	0.00
2005	8003.01	8085	960	91.33	91.54	95.17	92.29	0.00	0.00	8.46	0.21
2006	7886.16	7938	993	89.80	89.80	90.66	90.62	1.00	0.90	9.30	0.00
2007	7912.85	7998	992	90.34	90.97	91.06	91.30	0.99	0.91	8.12	0.63
2008	8762.75	8784	998	99.99	99.99	99.96	100.00	0.00	0.00	0.01	0.00
2009	7924.37	8047	998	90.61	90.61	90.64	91.86	2.36	2.19	7.20	0.00
2010	8110.60	8149	998	92.59	92.61	92.77	93.03	0.00	0.00	7.39	0.02
2011	6023.71	6034	998	68.73	68.75	68.90	68.88	0.00	0.00	31.25	0.02
2012	0.00	0	998	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2013	3307.10	3362	998	37.77	37.78	37.83	38.38	0.00	0.00	62.22	0.01
2014	8570.94	8606	999	97.87	98.00	97.94	98.24	0.00	0.00	2.00	0.13
2015	7322.33	7412	999	83.64	84.16	83.67	84.61	0.01	0.01	15.83	0.53
2016	5274.95	6298	999	60.11	60.12	60.11	71.70	0.22	0.13	39.75	0.01
2017	8198.68	8266	999	93.62	93.76	93.69	94.36	0.10	0.10	6.14	0.14
2018	6698.25	6802	999	76.53	76.72	76.54	77.65	6.27	5.14	18.14	0.19
2019	8344.45	8386	999	95.31	95.54	95.35	95.73	0.02	0.02	4.44	0.24
2020	7497.57	7548	999	85.41	85.50	85.44	85.93	0.04	0.03	14.47	0.09
2021	6182.87	6256	999	70.65	70.75	70.65	71.42	0.36	2.51	26.74	0.10
2022	8667.91	8760	999	99.79	99.99	99.05	100.00	0.01	0.01	0.01	0.20
2023	6109.90	6233	999	69.83	70.22	69.82	71.15	14.37	12.45	17.33	0.39
2024	6910.92	6994	994	78.98	79.46	79.15	79.62	0.00	2.71	17.83	0.48

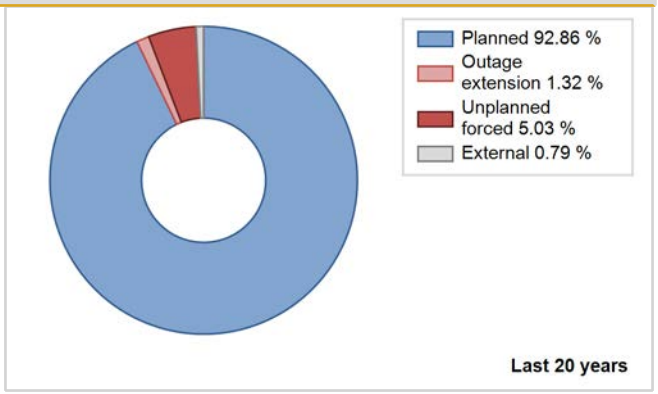
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1999 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		238			95	
C. Inspection, maintenance or repair combined with refuelling	1552			816		
D. Inspection, maintenance or repair without refuelling				6		
F. Major backfitting, refurbishment or upgrading activities with refuelling				676		
L. Human factor related					0	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
Subtotal	1552	238		1498	95	2
Total	**1790**			**1595**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1999 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		4
15. Reactor Cooling Systems		8
21. Fuel Handling and Storage Facilities	238	10
31. Turbine and auxiliaries		1
32. Feedwater and Main Steam System		19
34. Miscellaneous Systems		40
41. Main Generator Systems		6
42. Electrical Power Supply Systems		9
Total	**238**	**97**

Highlights (2024)

The 17th refueling(2024-10-18 ~ 2025-01-01)

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2024 Operating Experience

KR-19 HANUL-5 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1049 MWe
Reference unit power (net)	:	989 MWe

Key Dates

Construction Date	:	1999-10-01
Grid Date	:	2003-12-18
Commercial Date	:	2004-07-29
Age at end of year	:	21 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	5
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36.15
Average discharge burnup [MWd/t]	:	38723
Active core diameter [m]	:	3.12
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.69
Number of control rod assemblies	:	180
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

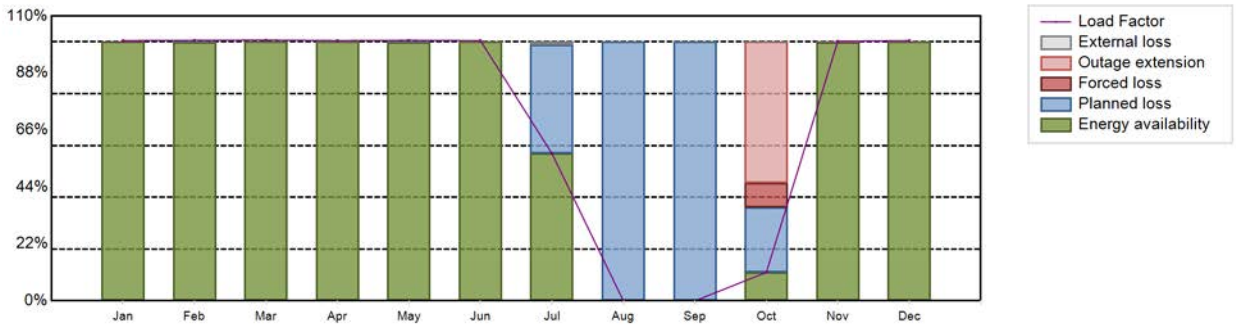
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	7.14
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6299.21 GW(e).h
Energy Availability Factor (EAF)	:	72.13 %
Unit Capability Factor (UCF)	:	72.24 %
Load Factor (LF)	:	72.51 %
Operating Factor (OF)	:	72.69 %

Forced Loss Rate (FLR)	:	1.09 %
Unplanned Capability Loss Factor (UCL)	:	5.41 %
Planned Unavailability Factor (PUF)	:	22.35 %
Externally cause unavailability (XUF)	:	0.11 %
Total off-line time	:	2399 hours

Annual Summary



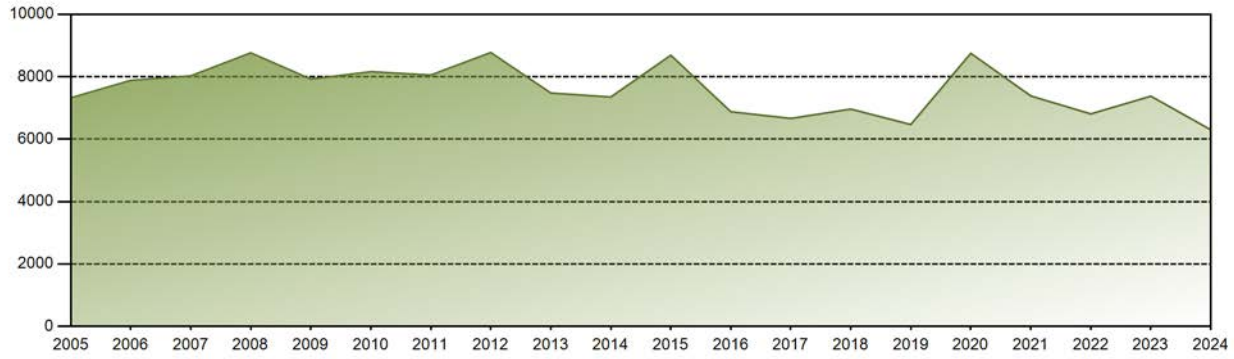
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	739.74	692.56	741.03	715.90	740.50	715.77	419.01	0.00	0.00	80.98	714.13	739.58	6299.21
EAF [%]	100.00	99.98	100.00	100.00	99.98	100.00	56.83	0.00	0.00	11.01	99.91	100.00	72.13
UCF [%]	100.00	99.98	100.00	100.00	99.98	100.00	58.06	0.00	0.00	11.01	99.94	100.00	72.24
LF [%]	100.53	100.61	100.71	100.54	100.64	100.52	56.94	0.00	0.00	11.01	100.29	100.51	72.51
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	59.41	0.00	0.00	14.92	100.00	100.00	72.69
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.84	0.06	0.00	1.09
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.84	0.06	0.00	5.41
PUF [%]	0.00	0.02	0.00	0.00	0.02	0.00	41.94	100.00	100.00	25.14	0.00	0.00	22.35
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	1.23	0.00	0.00	0.01	0.03	0.00	0.11

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Historical Summary

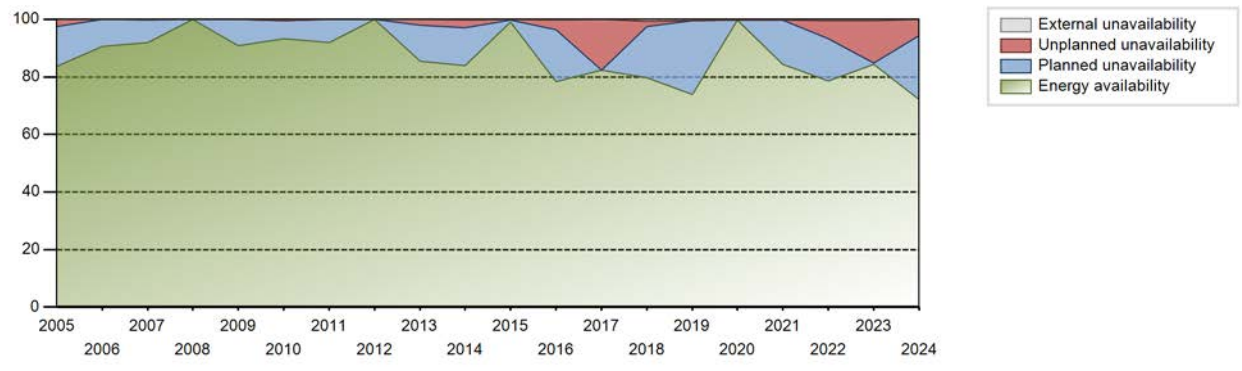
Lifetime energy generation	:	156714.94 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.9 %
Cumulative Energy Availability Factor (EAF)	:	87.43 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.81 %
Cumulative Unit Capability Factor (UCF)	:	87.64 %	Cumulative Planned Unavailability Factor (PUF)	:	9.55 %
Cumulative Load Factor (LF)	:	87.39 %	Cumulative Externally cause unavailability (XUF)	:	0.2 %
Cumulative Operating Factor (OF)	:	87.75 %			

Electricity Production (net) [GWh]



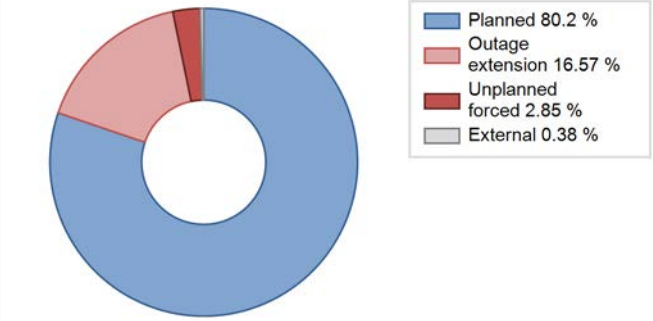
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2004	4415.65	4963	960	97.88	97.88	101.42	97.93	2.11	2.11	0.01	0.00
2005	7321.60	7409	960	83.79	83.79	87.06	84.58	2.77	2.39	13.82	0.00
2006	7882.81	7925	994	90.56	90.56	90.53	90.47	0.00	0.00	9.44	0.00
2007	8025.93	8115	995	91.87	91.87	92.08	92.64	0.27	0.25	7.88	0.00
2008	8763.82	8784	1001	99.93	99.96	99.67	100.00	0.04	0.04	0.01	0.03
2009	7924.16	7988	1001	90.75	90.75	90.37	91.19	0.00	0.00	9.25	0.00
2010	8160.25	8245	997	93.24	93.70	93.43	94.12	0.00	0.00	6.30	0.46
2011	8052.72	8106	997	92.00	92.07	92.20	92.53	0.00	0.00	7.92	0.08
2012	8773.91	8784	998	99.91	99.96	100.09	100.00	0.00	0.00	0.04	0.05
2013	7476.53	7544	996	85.42	85.45	85.69	86.12	2.20	1.92	12.63	0.02
2014	7349.72	7408	998	83.98	84.26	84.07	84.57	2.95	2.56	13.17	0.28
2015	8687.64	8742	998	99.10	99.19	99.37	99.79	0.18	0.18	0.64	0.08
2016	6877.61	6961	998	78.43	78.72	78.45	79.25	3.94	3.23	18.04	0.29
2017	6663.73	6707	998	82.31	82.42	76.22	76.56	17.58	17.58	0.00	0.11
2018	6962.42	7097	998	79.62	80.39	79.64	81.02	0.12	1.64	17.97	0.77
2019	6467.68	6575	998	73.98	74.50	73.98	75.06	0.00	0.00	25.50	0.52
2020	8750.36	8784	998	99.75	99.96	99.82	100.00	0.04	0.04	0.00	0.21
2021	7383.73	7478	998	84.46	84.76	84.46	85.37	0.09	0.07	15.17	0.30
2022	6809.01	6950	998	78.51	78.94	77.88	79.34	5.21	6.33	14.73	0.43
2023	7376.79	7488	998	84.38	84.78	84.38	85.48	0.33	14.84	0.38	0.40
2024	6299.21	6385	989	72.13	72.24	72.51	72.69	1.09	5.41	22.35	0.11

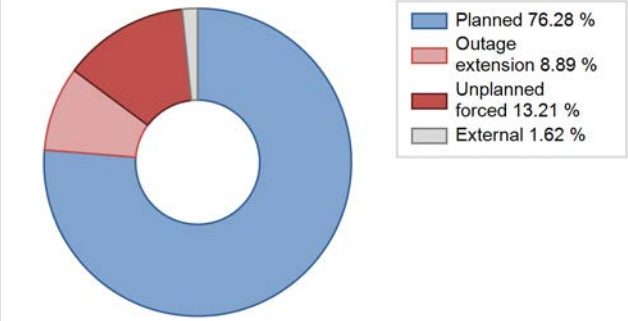
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2004 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		491			238	
C. Inspection, maintenance or repair combined with refuelling	1911			811		
M. Governmental requirements or court decisions						27
Subtotal	1911	491		811	238	27
Total	**2402**			**1076**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2004 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories	406	92
12. Reactor I&C Systems		71
15. Reactor Cooling Systems		23
16. Steam generation systems		7
31. Turbine and auxiliaries	85	4
35. All other I&C Systems		33
Total	**491**	**230**

Highlights (2024)

? Refueling and Maintenance (2024.07.19. - 10.23.)
? Turbine manual trip due to CV abnormal closing (2024.10.28. - 10.31.)

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2024 Operating Experience

KR-20 HANUL-6 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1049 MWe
Reference unit power (net)	:	987 MWe

Key Dates

Construction Date	:	2000-09-29
Grid Date	:	2005-01-07
Commercial Date	:	2005-04-22
Age at end of year	:	19 years

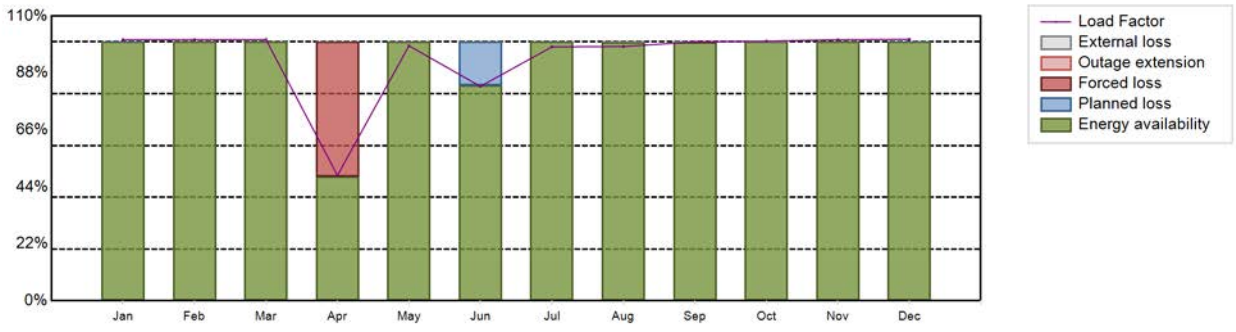
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327.3
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.39
Average fuel enrichment [% of U235]	:	5	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	4
Part of the core refuelled [%]	:	36.15	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	38829	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.124	HP cylinder inlet steam pressure [MPa]	:	7.14
Active core height/length [m]	:	3.81	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	177	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.69	Number of main condensate pumps	:	3
Number of control rod assemblies	:	180	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8178.29 GW(e).h	Forced Loss Rate (FLR)	:	4.33 %
Energy Availability Factor (EAF)	:	94.33 %	Unplanned Capability Loss Factor (UCL)	:	4.27 %
Unit Capability Factor (UCF)	:	94.35 %	Planned Unavailability Factor (PUF)	:	1.38 %
Load Factor (LF)	:	94.33 %	Externally cause unavailability (XUF)	:	0.02 %
Operating Factor (OF)	:	94.72 %	Total off-line time	:	464 hours

Annual Summary



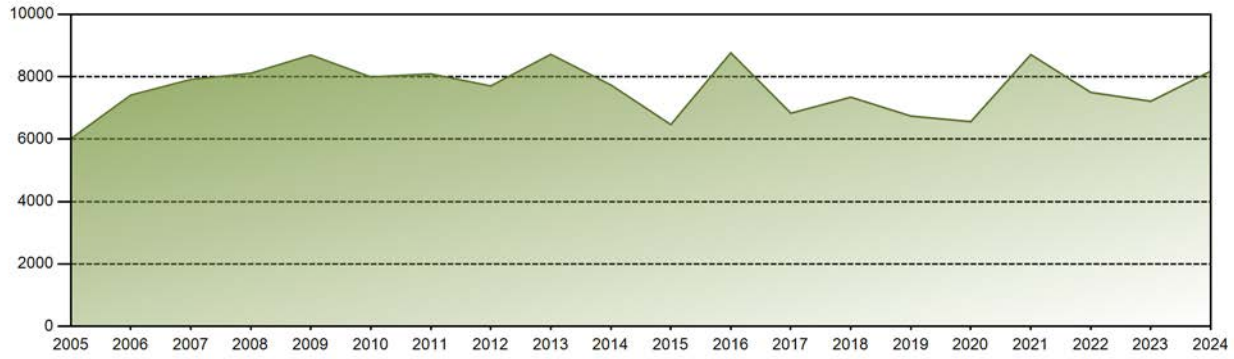
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	740.72	693.14	740.92	344.23	723.28	588.73	720.14	721.38	710.60	736.54	716.65	741.96	8178.29
EAF [%]	100.00	100.00	100.00	47.97	100.00	83.13	100.00	99.87	99.89	99.99	100.00	100.00	94.33
UCF [%]	100.00	100.00	100.00	47.97	100.00	83.13	100.00	100.00	99.99	100.00	100.00	100.00	94.35
LF [%]	100.87	100.90	100.90	48.44	98.50	82.84	98.07	98.24	99.99	100.30	100.85	101.04	94.33
OF [%]	100.00	100.00	100.00	49.86	100.00	85.69	100.00	100.00	100.00	100.00	100.00	100.00	94.72
FLR [%]	0.00	0.00	0.00	52.03	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	4.33
UCL [%]	0.00	0.00	0.00	52.03	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	4.27
PUF [%]	0.00	0.00	0.00	0.00	0.00	16.87	0.00	0.00	0.00	0.00	0.00	0.00	1.38
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.10	0.00	0.00	0.00	0.02

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Historical Summary

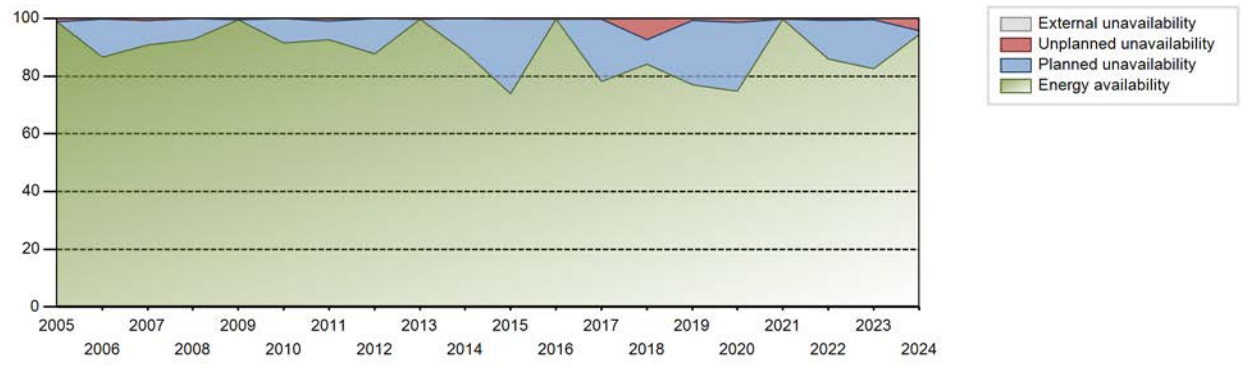
Lifetime energy generation	:	153750.9 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.93 %
Cumulative Energy Availability Factor (EAF)	:	88.77 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.84 %
Cumulative Unit Capability Factor (UCF)	:	88.92 %	Cumulative Planned Unavailability Factor (PUF)	:	10.24 %
Cumulative Load Factor (LF)	:	88.84 %	Cumulative Externally cause unavailability (XUF)	:	0.15 %
Cumulative Operating Factor (OF)	:	89.3 %			

Electricity Production (net) [GWh]



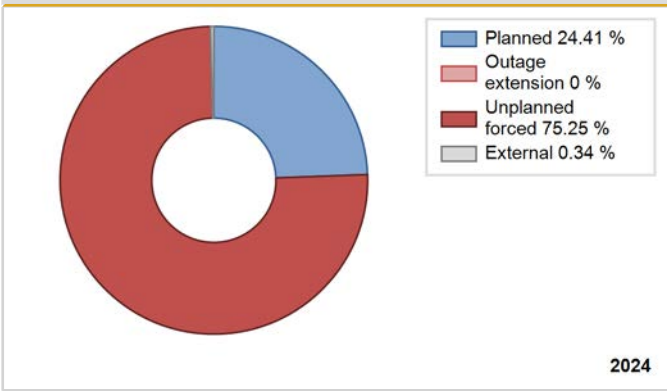
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2005	6010.96	6041	960	98.82	98.82	102.65	99.06	1.18	1.18	0.00	0.00
2006	7409.91	7543	991	86.65	86.65	85.36	86.11	0.38	0.33	13.02	0.00
2007	7911.30	8022	994	90.88	91.59	90.86	91.58	0.00	0.00	8.41	0.72
2008	8107.89	8168	1001	92.58	92.58	92.21	92.99	0.01	0.01	7.41	0.00
2009	8694.52	8724	1001	99.47	99.47	99.15	99.59	0.52	0.52	0.01	0.00
2010	7991.04	8055	997	91.44	91.54	91.50	91.95	0.02	0.02	8.45	0.10
2011	8090.56	8168	997	92.53	92.64	92.64	93.24	0.82	0.77	6.59	0.11
2012	7703.15	7763	997	87.81	87.92	87.96	88.38	0.00	0.00	12.08	0.11
2013	8716.35	8760	996	99.78	99.94	99.90	100.00	0.06	0.06	0.00	0.16
2014	7734.99	7810	997	88.47	88.57	88.56	89.16	0.00	0.00	11.43	0.10
2015	6465.70	6545	997	73.98	74.16	74.03	74.71	0.00	0.00	25.84	0.18
2016	8765.47	8784	997	99.85	100.00	100.09	100.00	0.00	0.00	0.00	0.14
2017	6830.58	6928	997	78.19	78.55	78.21	79.09	0.00	0.00	21.45	0.36
2018	7343.97	7419	997	84.08	84.40	84.09	84.69	7.76	7.10	8.51	0.31
2019	6739.28	6843	997	77.09	77.20	77.16	78.12	0.67	0.52	22.28	0.11
2020	6559.04	6607	997	74.81	74.83	74.89	75.22	1.76	1.34	23.83	0.02
2021	8708.44	8760	997	99.69	99.94	99.71	100.00	0.06	0.06	0.00	0.26
2022	7496.12	7620	997	85.84	85.99	85.83	86.99	0.55	0.48	13.53	0.16
2023	7214.72	7326	997	82.61	82.73	82.61	83.63	0.34	0.28	16.99	0.12
2024	8178.29	8320	987	94.33	94.35	94.33	94.72	4.33	4.27	1.38	0.02

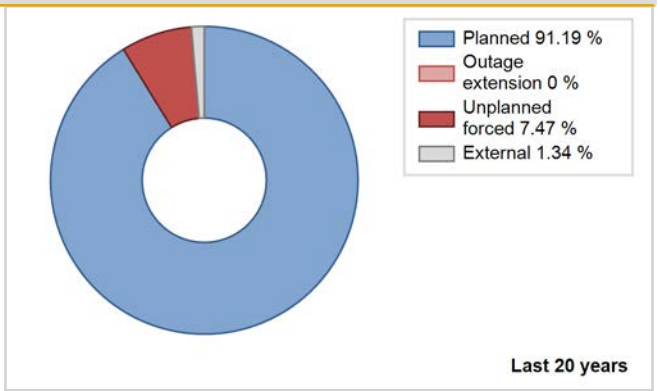
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2005 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		362			61	
C. Inspection, maintenance or repair combined with refuelling				865		
D. Inspection, maintenance or repair without refuelling	103			5		
L. Human factor related					6	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						3
Subtotal	103	362		870	67	3
Total	**465**			**940**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2005 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
15. Reactor Cooling Systems		3
32. Feedwater and Main Steam System	362	18
35. All other I&C Systems		36
41. Main Generator Systems		4
42. Electrical Power Supply Systems		4
Total	**362**	**68**

Highlights (2024)

? Automatic scram (2024.04.01. ~ 04.16.)
? Planned Shutdown for Interim maintenance (2024.06.11. ~ 06.17.)

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2024 Operating Experience

KR-2 KORI-2 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	PWR / WH F
Thermal power	:	1882 MWth
Gross electrical power	:	681 MWe
Reference unit power (net)	:	640 MWe

Key Dates

Construction Date	:	1977-12-23
Grid Date	:	1983-04-22
Commercial Date	:	1983-07-25
Age at end of year	:	41 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.8
Refuelling frequency [month]	:	13
Part of the core refuelled [%]	:	40
Average discharge burnup [MWd/t]	:	36946
Active core diameter [m]	:	2.46
Active core height/length [m]	:	3.658
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	18.04
Number of control rod assemblies	:	33
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

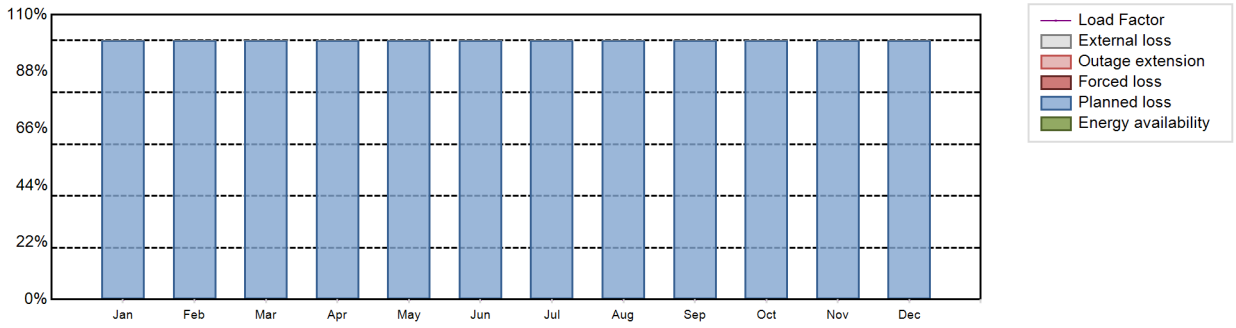
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	324.5
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	0.31
Secondary systems		
Number of turbine-generators per unit/reactor	:	3
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.35
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	100 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	8784 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EAF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	185221.57 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.96 %
Cumulative Energy Availability Factor (EAF)	:	80.41 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.61 %
Cumulative Unit Capability Factor (UCF)	:	80.73 %	Cumulative Planned Unavailability Factor (PUF)	:	17.66 %
Cumulative Load Factor (LF)	:	81.51 %	Cumulative Externally cause unavailability (XUF)	:	0.32 %
Cumulative Operating Factor (OF)	:	81.32 %			

Electricity Production (net) [GWh]

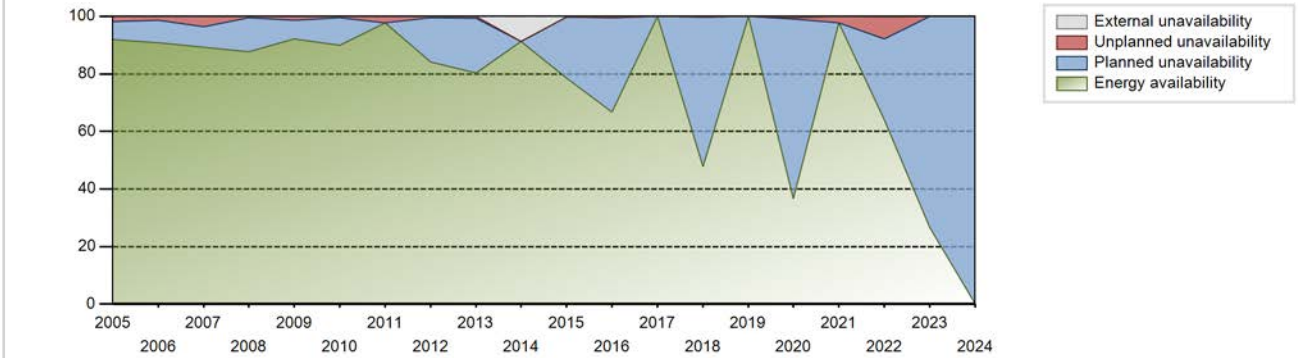


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	Data not provided										
1984	4086.38	6876	605	76.10	76.10	76.89	78.28	10.44	8.87	15.03	0.00
1985	3731.40	6641	605	69.83	69.83	70.41	75.81	16.53	13.82	16.35	0.00
1986	3945.20	6555	605	74.83	75.22	74.44	74.83	13.85	12.10	12.68	0.40
1987	4265.44	7251	605	81.64	82.07	80.48	82.77	0.60	0.49	17.43	0.43
1988	4504.67	7275	605	82.82	82.82	84.76	82.82	0.00	0.00	17.18	0.00
1989	5062.77	8387	605	95.74	95.74	95.53	95.74	3.94	3.93	0.33	0.00
1990	4349.88	7381	605	84.26	84.26	82.08	84.26	0.00	0.00	15.74	0.00
1991	4553.98	7512	605	85.75	85.75	85.93	85.75	0.09	0.08	14.17	0.00
1992	4517.20	7469	605	85.03	85.03	85.00	85.03	0.64	0.55	14.42	0.00
1993	4186.98	7048	605	80.46	80.46	79.00	80.46	0.85	0.69	18.85	0.00
1994	4693.89	7685	605	86.50	86.50	88.57	87.73	0.35	0.30	13.20	0.00
1995	5106.61	8370	605	94.71	94.78	96.35	95.55	0.78	0.75	4.48	0.07
1996	4673.92	7668	605	86.03	86.06	87.95	87.30	0.29	0.25	13.69	0.03
1997	4620.33	7639	605	86.62	86.75	87.18	87.20	0.01	0.01	13.24	0.14
1998	4697.63	7541	605	84.87	84.87	88.64	86.08	1.30	1.12	14.01	0.00
1999	4672.24	7472	605	83.62	83.62	88.16	85.30	0.00	0.00	16.38	0.00
2000	4914.70	7812	605	90.14	90.14	92.48	88.93	0.00	0.00	9.85	0.00
2001	4807.76	7650	605	87.29	87.29	90.72	87.33	0.02	0.02	12.69	0.00
2002	5051.22	7982	605	90.63	90.63	95.31	91.12	0.00	0.01	9.36	0.00
2003	4844.24	7709	605	85.43	86.52	91.40	88.00	1.24	1.09	12.40	1.09
2004	5501.54	8602	605	97.84	97.84	103.52	97.93	0.00	0.00	2.16	0.00
2005	5151.51	8080	605	92.05	92.05	97.20	92.24	2.02	1.89	6.06	0.00
2006	5099.16	7984	637	90.79	90.79	91.38	91.14	1.42	1.31	7.90	0.00
2007	5011.02	7886	637	89.21	89.23	89.80	90.02	3.82	3.54	7.23	0.01
2008	4933.94	7771	637	87.64	87.64	88.18	88.47	0.60	0.53	11.83	0.00
2009	5176.87	8110	637	92.18	92.18	92.77	92.58	1.55	1.45	6.37	0.00
2010	5025.59	7921	637	90.04	90.04	90.06	90.42	0.46	0.42	9.55	0.00
2011	5497.79	8578	637	97.78	97.78	98.52	97.92	2.21	2.21	0.01	0.00
2012	4703.69	7606	637	84.03	84.03	84.06	86.59	0.57	0.48	15.49	0.00
2013	4501.64	7118	639	80.28	80.31	80.42	81.26	0.79	0.64	19.05	0.03
2014	5127.37	8035	640	91.22	99.99	91.46	91.72	0.00	0.00	0.01	8.77
2015	4446.10	6923	640	78.67	78.84	79.30	79.03	0.00	0.00	21.16	0.16
2016	3769.97	5935	640	66.84	67.22	67.06	67.57	0.00	0.00	32.78	0.38
2017	5631.94	8760	640	99.95	99.99	100.46	100.00	0.00	0.00	0.01	0.04
2018	2694.13	4356	640	47.84	48.12	48.05	49.73	0.08	0.04	51.84	0.28
2019	5620.15	8760	640	99.92	99.98	100.25	100.00	0.01	0.01	0.01	0.06

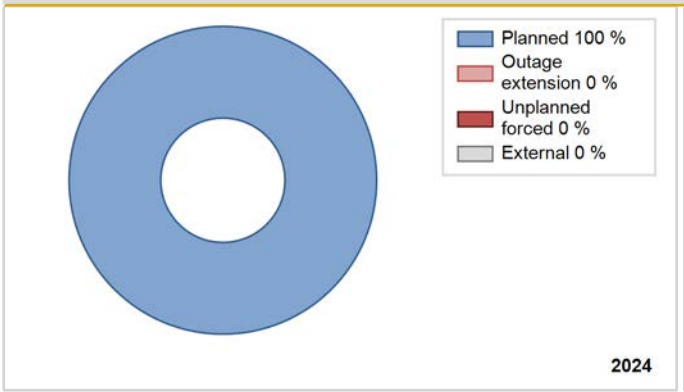
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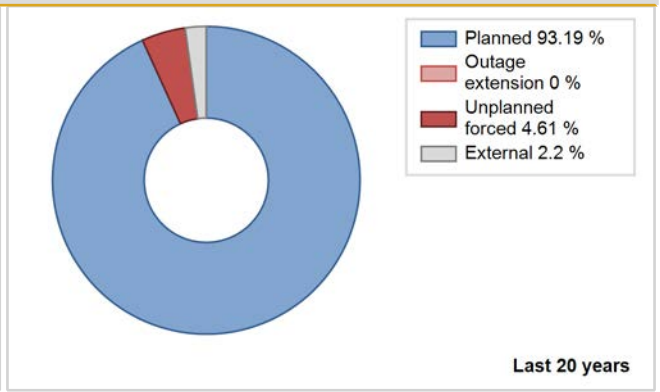
2020	2064.65	3327	640	36.59	37.14	36.73	37.88	1.14	0.43	62.44	0.55
2021	5502.38	8584	640	97.78	97.84	98.14	97.99	2.15	2.15	0.01	0.07
2022	3598.82	5677	640	63.98	64.31	64.19	64.81	10.42	7.48	28.21	0.33
2023	1504.50	2350	640	26.71	26.71	26.84	26.83	0.00	0.00	73.29	0.00
2024	0.00	0	640	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1983 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					106	
C. Inspection, maintenance or repair combined with refuelling	8784			1450		
D. Inspection, maintenance or repair without refuelling				23		
E. Testing of plant systems or components					0	
J. Grid limitation, failure or grid unavailability						4
L. Human factor related					7	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						18
Subtotal	8784			1473	113	22
Total	**8784**			**1608**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		14
14. Safety Systems		0
15. Reactor Cooling Systems		8
16. Steam generation systems		2
31. Turbine and auxiliaries		27
32. Feedwater and Main Steam System		9
33. Circulating Water System		18
35. All other I&C Systems		0
41. Main Generator Systems		27
42. Electrical Power Supply Systems		25
Total		**130**

Highlights (2024)

Maintenance(1.1-12.31)

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2024 Operating Experience

KR-5 KORI-3 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	PWR / WH F
Thermal power	:	2912 MWth
Gross electrical power	:	1046 MWe
Reference unit power (net)	:	996 MWe

Key Dates

Construction Date	:	1979-10-01
Grid Date	:	1985-01-22
Commercial Date	:	1985-09-30
Age at end of year	:	39 years

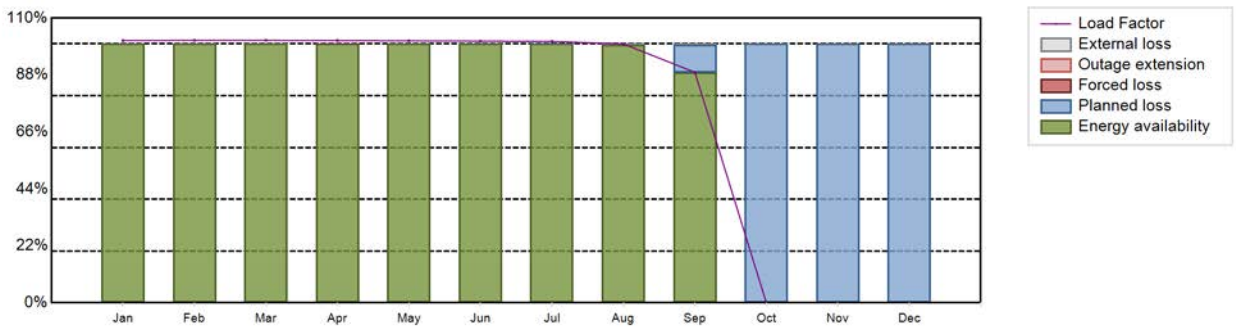
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.5
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	41
Average discharge burnup [MWd/t]	:	17910
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.658
Number of fissile fuel assemblies/bundles	:	151
Fuel linear heat generation rate [kW/m]	:	17.83
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.4
Reactor outlet temperature [°C]	:	326
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.31
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.53
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6533.54 GW(e).h
Energy Availability Factor (EAF)	:	73.93 %
Unit Capability Factor (UCF)	:	74 %
Load Factor (LF)	:	74.68 %
Operating Factor (OF)	:	74.2 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	26 %
Externally cause unavailability (XUF)	:	0.07 %
Total off-line time	:	2266 hours

Annual Summary



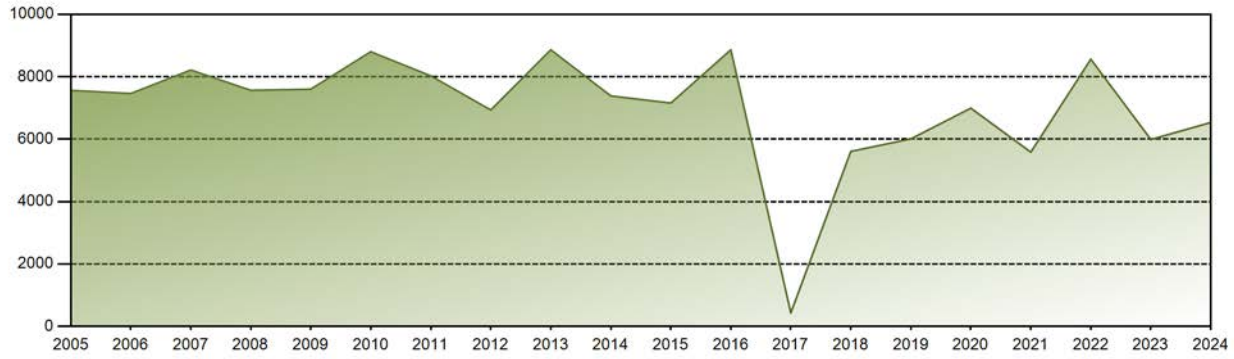
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	750.84	702.69	751.25	726.38	749.82	724.99	748.11	740.90	638.56	0.00	0.00	0.00	6533.54
EAF [%]	100.00	100.00	100.00	99.99	100.00	100.00	100.00	99.61	89.03	0.00	0.00	0.00	73.93
UCF [%]	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00	89.48	0.00	0.00	0.00	74.00
LF [%]	101.32	101.37	101.38	101.29	101.19	101.10	100.96	99.98	89.04	0.00	0.00	0.00	74.68
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.94	0.00	0.00	0.00	74.20
FLR [%]	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.52	100.00	100.00	100.00	26.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.44	0.00	0.00	0.00	0.07

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Historical Summary

Lifetime energy generation	:	274516.81 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.1 %
Cumulative Energy Availability Factor (EAF)	:	81.95 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.92 %
Cumulative Unit Capability Factor (UCF)	:	82.3 %	Cumulative Planned Unavailability Factor (PUF)	:	16.78 %
Cumulative Load Factor (LF)	:	83.59 %	Cumulative Externally cause unavailability (XUF)	:	0.34 %
Cumulative Operating Factor (OF)	:	82.65 %			

Electricity Production (net) [GWh]

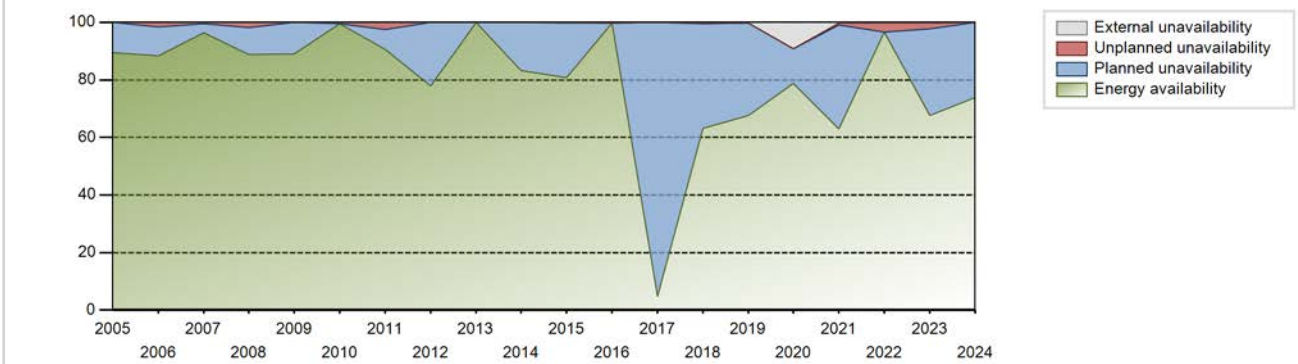


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	Data not provided										
1986	5611.72	6529	895	73.32	73.32	71.58	74.53	5.41	4.20	22.48	0.00
1987	5804.81	6665	895	78.78	79.12	74.04	76.08	2.13	1.72	19.16	0.34
1988	6119.71	7005	895	79.75	79.75	77.84	79.75	0.38	0.31	19.95	0.00
1989	6591.97	7206	895	82.26	82.26	84.08	82.26	1.89	1.59	16.15	0.00
1990	6838.13	7923	895	90.45	90.45	87.22	90.45	1.57	1.44	8.12	0.00
1991	5902.46	6578	895	75.09	75.09	75.28	75.09	10.59	8.89	16.02	0.00
1992	6746.17	7349	895	83.66	83.66	85.81	83.66	0.00	0.00	16.34	0.00
1993	7121.81	7721	895	88.14	88.14	90.84	88.14	1.37	1.22	10.63	0.00
1994	6545.31	7128	890	79.18	79.35	83.95	81.37	0.00	0.00	20.65	0.16
1995	6015.47	6863	895	73.75	73.75	76.73	78.34	0.66	0.49	25.76	0.00
1996	7939.72	8431	895	95.42	95.42	100.99	95.98	0.00	0.00	4.58	0.00
1997	6051.91	6503	895	73.82	73.82	77.19	74.24	0.00	0.00	26.18	0.00
1998	6902.53	7325	895	82.78	82.86	88.04	83.62	3.30	2.83	14.32	0.08
1999	7231.82	7615	895	86.30	86.30	92.24	86.93	0.21	0.18	13.52	0.00
2000	8094.33	8399	895	95.59	95.59	102.96	95.62	0.32	0.31	4.10	0.00
2001	7570.25	7881	895	89.41	89.41	96.56	89.97	0.00	0.00	10.59	0.00
2002	7684.80	8062	895	90.93	90.93	98.02	92.03	0.00	0.00	9.07	0.00
2003	8387.43	8689	895	99.05	100.00	106.98	99.19	0.00	0.00	0.00	0.95
2004	7312.46	7630	895	86.55	86.55	93.01	86.86	0.00	0.00	13.45	0.00
2005	7562.17	7885	895	89.44	89.44	96.45	90.01	0.00	0.00	10.56	0.00
2006	7461.77	7813	963	88.28	88.28	88.45	89.19	1.82	1.63	10.08	0.00
2007	8214.16	8503	964	96.40	96.40	97.27	97.07	0.49	0.47	3.12	0.00
2008	7564.39	7854	979	88.80	88.88	87.96	89.41	2.00	1.82	9.30	0.08
2009	7599.62	7820	1007	88.99	88.99	88.40	89.27	0.00	0.00	11.00	0.00
2010	8799.70	8732	1007	99.56	99.56	99.75	99.68	0.44	0.44	0.00	0.00
2011	8025.13	7971	1011	90.57	90.57	90.61	90.99	2.77	2.58	6.85	0.00
2012	6933.06	6875	1011	77.89	77.97	78.07	78.27	0.01	0.01	22.02	0.09
2013	8861.52	8760	1011	99.93	100.00	100.06	100.00	0.00	0.00	0.00	0.07
2014	7384.18	7332	1011	83.33	83.39	83.38	83.70	0.00	0.00	16.61	0.07
2015	7155.51	7119	1011	80.70	80.74	80.80	81.27	0.28	0.23	19.04	0.04
2016	8860.96	8784	1011	99.77	100.00	99.78	100.00	0.00	0.00	0.00	0.23
2017	432.36	442	1011	4.88	4.96	4.88	5.05	0.00	0.00	95.04	0.07
2018	5606.18	5610	1011	63.27	63.43	63.30	64.04	0.61	0.39	36.17	0.17
2019	6008.10	5962	1011	67.75	67.93	67.84	68.06	0.02	0.02	32.05	0.19
2020	6991.45	6953	1011	78.68	87.91	78.73	79.16	0.01	0.01	12.08	9.23
2021	5582.70	5576	1011	63.02	63.18	63.04	63.65	1.22	0.78	36.04	0.16

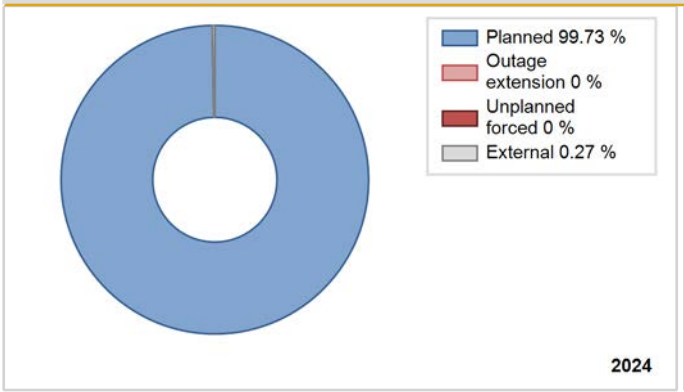
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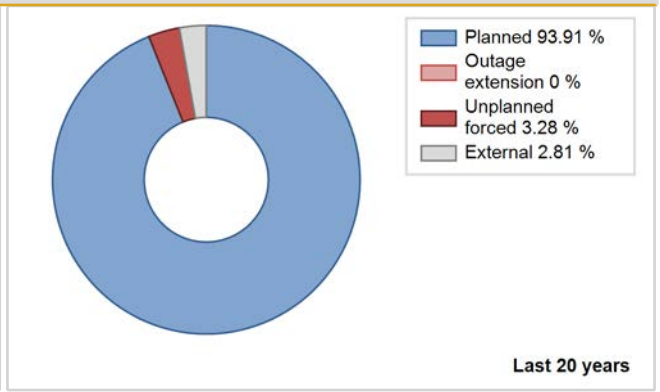
2022	8560.23	8528	1011	96.66	97.01	96.66	97.35	2.99	2.99	0.00	0.36
2023	5988.78	6033	1011	67.63	67.97	67.62	68.87	2.64	1.84	30.19	0.34
2024	6533.54	6518	996	73.93	74.00	74.68	74.20	0.00	0.00	26.00	0.07

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					70	
C. Inspection, maintenance or repair combined with refuelling	2266			1367		
D. Inspection, maintenance or repair without refuelling				16		
F. Major backfitting, refurbishment or upgrading activities with refuelling				24		
H. Nuclear regulatory requirements					4	
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					7	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						20
Subtotal	2266			1407	81	23
Total	**2266**			**1511**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1985 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		10
13. Reactor Auxiliary Systems		4
15. Reactor Cooling Systems		2
16. Steam generation systems		3
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		7
35. All other I&C Systems		4
41. Main Generator Systems		35
42. Electrical Power Supply Systems		3
Total		**78**

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Highlights (2024)

Refueling and Maintenance(Long-term shutdown, 2024. 9. 28. ~)

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2024 Operating Experience

KR-6 KORI-4 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	PWR / WH F
Thermal power	:	2912 MWth
Gross electrical power	:	1046 MWe
Reference unit power (net)	:	1001 MWe

Key Dates

Construction Date	:	1980-04-01
Grid Date	:	1985-12-31
Commercial Date	:	1986-04-29
Age at end of year	:	39 years

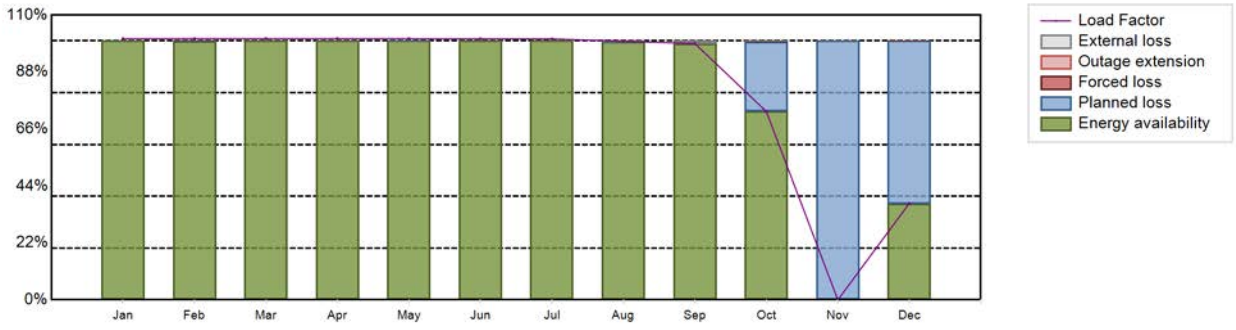
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.2
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	326
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.31
Average fuel enrichment [% of U235]	:	4.5	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	4
Part of the core refuelled [%]	:	41	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	18210	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.53
Active core height/length [m]	:	3.658	Output voltage [kV]	:	22
Number of fissile fuel assemblies/bundles	:	151	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.83	Number of main condensate pumps	:	4
Number of control rod assemblies	:	28	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7437.93 GW(e).h	Forced Loss Rate (FLR)	:	0.05 %
Energy Availability Factor (EAF)	:	84.04 %	Unplanned Capability Loss Factor (UCL)	:	0.04 %
Unit Capability Factor (UCF)	:	84.17 %	Planned Unavailability Factor (PUF)	:	15.79 %
Load Factor (LF)	:	84.59 %	Externally cause unavailability (XUF)	:	0.13 %
Operating Factor (OF)	:	84.64 %	Total off-line time	:	1349 hours

Annual Summary



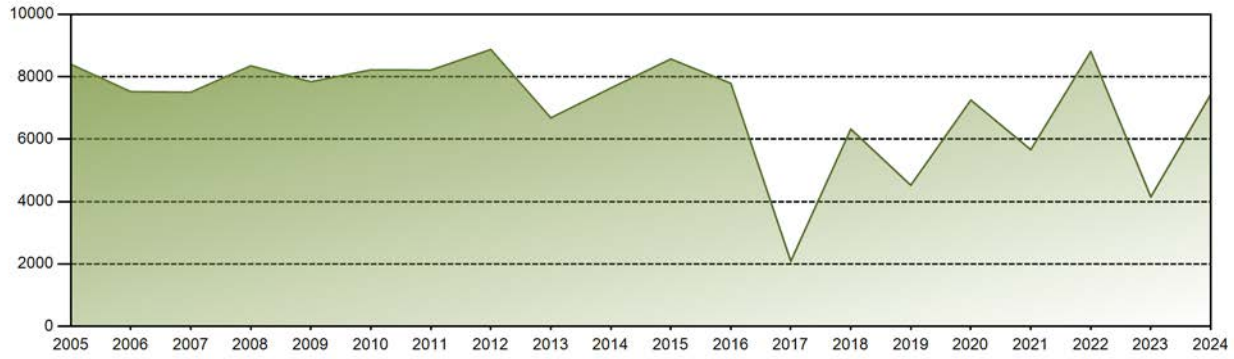
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	751.46	702.82	751.57	727.31	751.15	726.54	750.46	743.94	713.21	541.69	0.00	277.77	7437.93
EAF [%]	100.00	99.97	100.00	100.00	100.00	100.00	100.00	99.58	98.95	72.73	0.00	37.08	84.04
UCF [%]	100.00	99.97	100.00	100.00	100.00	100.00	100.00	99.99	100.00	72.79	0.00	37.08	84.17
LF [%]	100.90	100.88	100.92	100.91	100.86	100.81	100.77	99.89	98.96	72.74	0.00	37.30	84.59
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	75.54	0.00	39.92	84.64
FLR [%]	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.05
UCL [%]	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.04
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	26.77	100.00	62.92	15.79
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	1.05	0.06	0.00	0.00	0.13

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Historical Summary

Lifetime energy generation	:	274616.69 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.56 %
Cumulative Energy Availability Factor (EAF)	:	82.99 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.47 %
Cumulative Unit Capability Factor (UCF)	:	83.41 %	Cumulative Planned Unavailability Factor (PUF)	:	16.12 %
Cumulative Load Factor (LF)	:	84.75 %	Cumulative Externally cause unavailability (XUF)	:	0.42 %
Cumulative Operating Factor (OF)	:	83.7 %			

Electricity Production (net) [GWh]

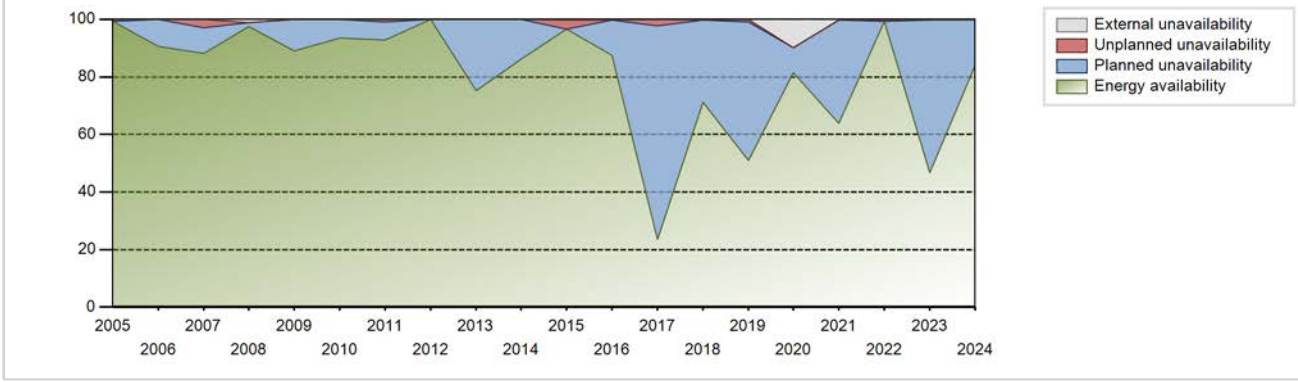


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	Data not provided										
1987	5860.82	6707	895	78.01	78.27	74.75	76.56	0.53	0.42	21.31	0.26
1988	5909.08	7006	895	79.76	80.70	75.16	79.76	0.34	0.27	19.02	0.94
1989	6177.37	6763	895	77.20	77.20	78.79	77.20	0.19	0.15	22.65	0.00
1990	6230.03	7140	895	81.51	81.51	79.46	81.51	1.08	0.89	17.60	0.00
1991	6353.02	7011	895	80.03	80.44	81.03	80.03	1.18	0.96	18.60	0.41
1992	6652.32	7266	895	82.72	82.72	84.62	82.72	0.68	0.57	16.71	0.00
1993	6835.92	7456	895	85.11	85.11	87.19	85.11	1.51	1.30	13.59	0.00
1994	7455.10	8160	890	90.02	90.05	95.62	93.15	0.50	0.46	9.50	0.03
1995	6950.57	7824	890	89.31	89.31	89.15	89.32	0.00	0.00	10.69	0.01
1996	6678.43	7147	895	80.04	80.04	84.95	81.36	0.00	0.00	19.96	0.00
1997	7014.21	7450	895	84.36	84.36	89.46	85.05	0.00	0.00	15.64	0.00
1998	8433.70	8760	895	100.00	100.00	107.57	100.00	0.00	0.00	0.00	0.00
1999	7128.95	7451	895	84.56	84.56	90.93	85.06	0.00	0.00	15.44	0.00
2000	7334.35	7578	895	86.17	86.17	93.29	86.27	0.45	0.39	13.44	0.00
2001	7615.10	7929	895	89.99	89.99	97.13	90.51	0.00	0.00	10.01	0.00
2002	8495.50	8760	895	100.00	100.00	108.36	100.00	0.00	0.00	0.00	0.00
2003	7596.96	7913	895	89.58	90.47	96.90	90.33	0.00	0.00	9.53	0.89
2004	7378.56	7669	895	86.83	86.83	93.85	87.31	0.95	0.83	12.34	0.00
2005	8397.18	8695	895	99.20	99.20	107.10	99.26	0.80	0.80	0.00	0.00
2006	7520.38	7824	967	90.67	90.67	88.78	89.32	0.15	0.14	9.19	0.00
2007	7500.92	7967	966	88.04	88.04	88.64	90.95	3.13	2.84	9.11	0.00
2008	8348.25	8674	977	97.62	98.76	97.28	98.75	0.00	0.00	1.24	1.14
2009	7836.76	7779	1007	89.02	89.02	89.06	88.80	0.00	0.00	10.98	0.00
2010	8218.18	8217	1007	93.55	93.56	93.16	93.80	0.00	0.00	6.44	0.01
2011	8210.90	8227	1009	92.77	92.83	92.90	93.92	0.88	0.82	6.35	0.06
2012	8871.96	8784	1007	99.95	100.00	100.30	100.00	0.00	0.00	0.00	0.05
2013	6681.28	6680	1010	75.32	75.41	75.52	76.26	0.00	0.00	24.59	0.09
2014	7635.09	7579	1010	86.04	86.04	86.30	86.52	0.00	0.00	13.96	0.00
2015	8566.93	8488	1012	96.59	96.74	96.64	96.89	3.26	3.26	0.00	0.15
2016	7786.10	7746	1012	87.57	87.87	87.59	88.18	0.02	0.02	12.11	0.30
2017	2088.18	2069	1012	23.55	23.59	23.55	23.62	8.76	2.27	74.14	0.03
2018	6320.55	6279	1012	71.26	71.41	71.30	71.68	0.03	0.02	28.57	0.15
2019	4521.89	4546	1012	50.96	50.97	51.01	51.89	1.59	0.82	48.21	0.00
2020	7250.24	7222	1012	81.52	91.37	81.56	82.22	0.08	0.07	8.56	9.84
2021	5660.06	5649	1012	63.80	63.99	63.85	64.49	0.08	0.05	35.96	0.20
2022	8807.27	8760	1012	99.35	99.65	99.35	100.00	0.35	0.35	0.00	0.31

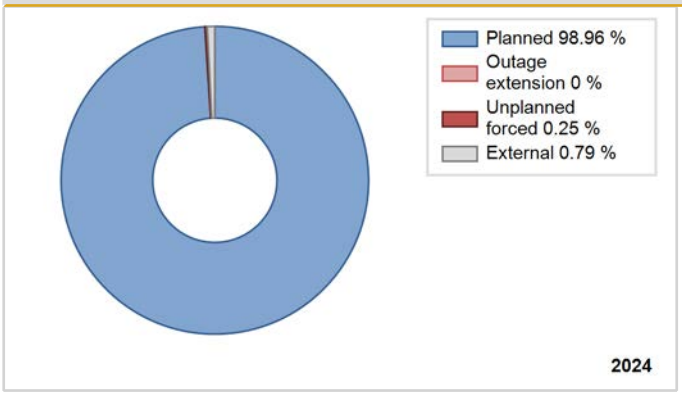
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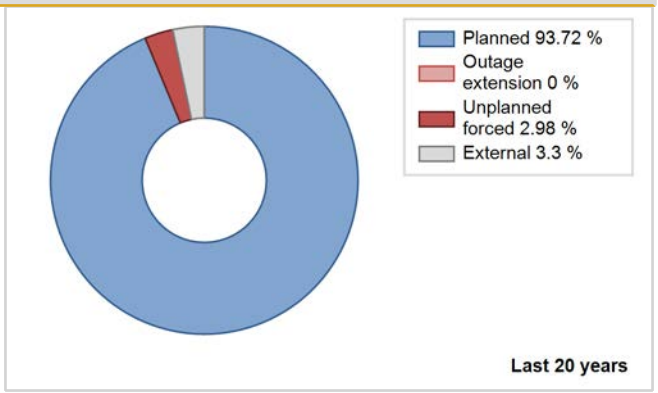
2023	4147.74	4206	1012	46.79	46.92	46.79	48.01	0.14	0.07	53.02	0.13
2024	7437.93	7435	1001	84.04	84.17	84.59	84.64	0.05	0.04	15.79	0.13

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					32	
C. Inspection, maintenance or repair combined with refuelling	1349			1306		
D. Inspection, maintenance or repair without refuelling				15		
E. Testing of plant systems or components					0	
F. Major backfitting, refurbishment or upgrading activities with refuelling				28		
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						24
Z. Other						0
Subtotal	1349			1349	33	26
Total	**1349**			**1408**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		0
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		0
15. Reactor Cooling Systems		2
16. Steam generation systems		5
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		7
32. Feedwater and Main Steam System		4
33. Circulating Water System		2
34. Miscellaneous Systems		1
41. Main Generator Systems		0
42. Electrical Power Supply Systems		9
Total		**37**

Highlights (2024)

28th Refueling and Maintenance(2024. 10. 24. ~ 2024. 12. 19.)

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2024 Operating Experience

KR-25 SAEUL-1 KOREA, REPUBLIC OF

Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / APR-1400
Thermal power	:	3983 MWth
Gross electrical power	:	1488 MWe
Reference unit power (net)	:	1392 MWe

Key Dates

Construction Date	:	2008-10-16
Grid Date	:	2016-01-15
Commercial Date	:	2016-12-20
Age at end of year	:	8 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.66
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	41
Average discharge burnup [MWd/t]	:	53073
Active core diameter [m]	:	3.647
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	241
Fuel linear heat generation rate [kW/m]	:	18.38
Number of control rod assemblies	:	93
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

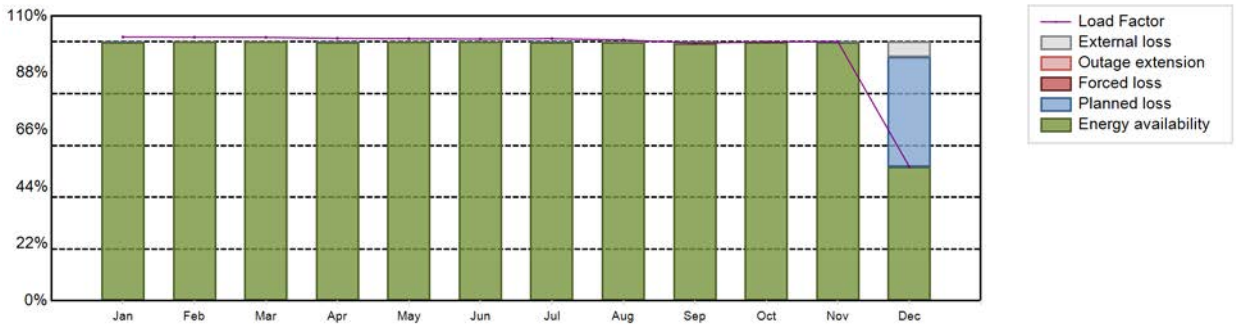
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	323.9
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.764
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	11838.57 GW(e).h
Energy Availability Factor (EAF)	:	95.82 %
Unit Capability Factor (UCF)	:	96.38 %
Load Factor (LF)	:	96.82 %
Operating Factor (OF)	:	96.57 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	3.62 %
Externally cause unavailability (XUF)	:	0.56 %
Total off-line time	:	301 hours

Annual Summary



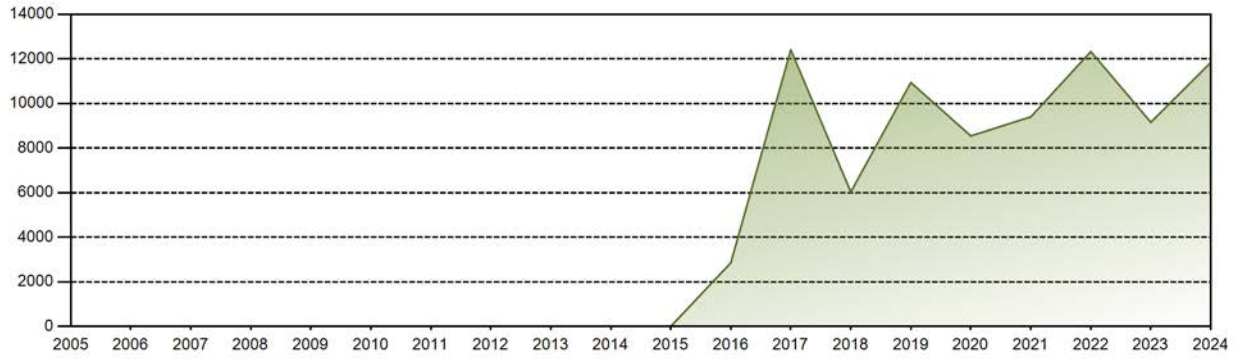
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1055.21	986.69	1053.65	1016.21	1048.37	1013.70	1048.64	1043.57	997.72	1035.06	1003.52	536.23	11838.57
EAF [%]	99.95	100.00	100.00	99.95	100.00	100.00	99.94	99.94	99.47	99.89	99.75	51.78	95.82
UCF [%]	99.95	100.00	100.00	99.95	100.00	100.00	99.94	100.00	100.00	100.00	99.89	57.57	96.38
LF [%]	101.89	101.84	101.74	101.39	101.23	101.14	101.25	100.76	99.55	99.94	100.13	51.78	96.82
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	59.54	96.57
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.05	0.00	0.00	0.05	0.00	0.00	0.06	0.00	0.00	0.00	0.11	42.43	3.62
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.53	0.11	0.14	5.79	0.56

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Historical Summary

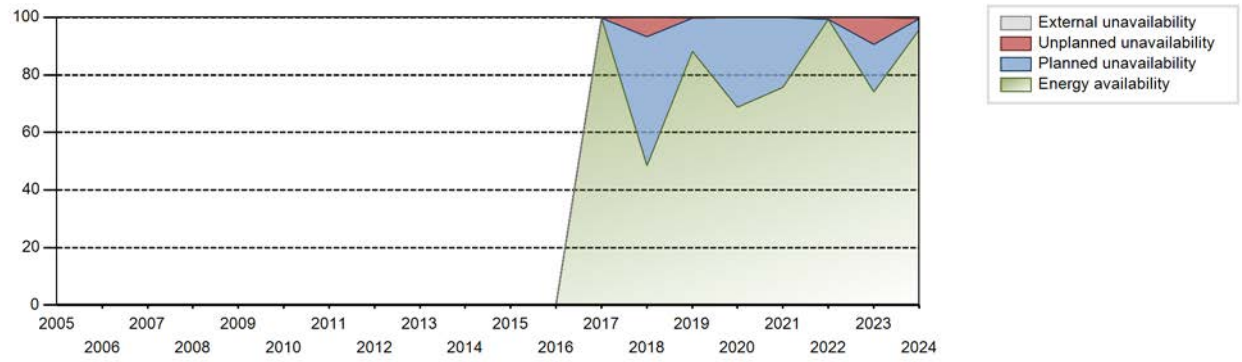
Lifetime energy generation	:	83490.66 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.15 %
Cumulative Energy Availability Factor (EAF)	:	81.26 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.11 %
Cumulative Unit Capability Factor (UCF)	:	81.44 %	Cumulative Planned Unavailability Factor (PUF)	:	16.46 %
Cumulative Load Factor (LF)	:	81.38 %	Cumulative Externally cause unavailability (XUF)	:	0.18 %
Cumulative Operating Factor (OF)	:	82.05 %			

Electricity Production (net) [GWh]

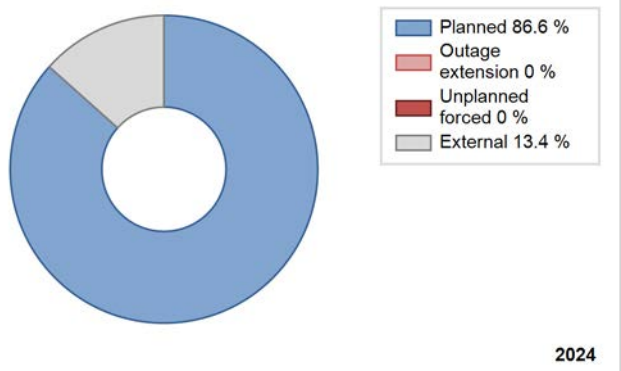


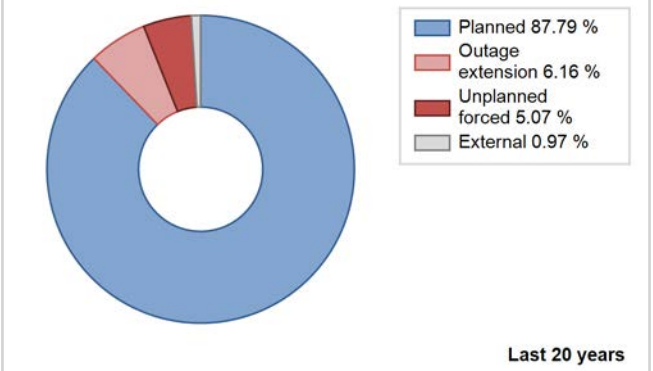
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	2851.25	2956	1383	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	12405.61	8760	1416	99.79	99.99	100.01	100.00	0.00	0.00	0.01	0.21
2018	6027.00	4360	1416	48.55	48.64	48.59	49.77	12.16	6.74	44.62	0.10
2019	10939.06	7762	1416	88.08	88.44	88.19	88.61	0.00	0.00	11.56	0.35
2020	8544.98	6120	1416	68.81	68.82	68.70	69.67	0.00	0.00	31.18	0.02
2021	9400.37	6706	1416	75.77	75.87	75.78	76.55	0.00	0.00	24.13	0.10
2022	12328.84	8760	1416	99.27	99.32	99.39	100.00	0.66	0.65	0.03	0.05
2023	9154.98	6587	1416	74.21	74.29	73.81	75.19	0.27	9.43	16.28	0.08
2024	11838.57	8483	1392	95.82	96.38	96.82	96.57	0.00	0.00	3.62	0.56

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					173	
C. Inspection, maintenance or repair combined with refuelling	301			1403		
E. Testing of plant systems or components				685		
Subtotal	301			2088	173	
Total	**301**			**2261**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		64
42. Electrical Power Supply Systems		90
Total		**154**

Highlights (2024)

Refueling and Maintenance : '24.12.19~

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2024 Operating Experience

KR-26 SAEUL-2 KOREA, REPUBLIC OF

Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / APR-1400
Thermal power	:	3983 MWth
Gross electrical power	:	1491 MWe
Reference unit power (net)	:	1392 MWe

Key Dates

Construction Date	:	2009-08-19
Grid Date	:	2019-04-22
Commercial Date	:	2019-08-29
Age at end of year	:	5 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.66
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	41
Average discharge burnup [MWd/t]	:	53073
Active core diameter [m]	:	3.647
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	241
Fuel linear heat generation rate [kW/m]	:	18.38
Number of control rod assemblies	:	93
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

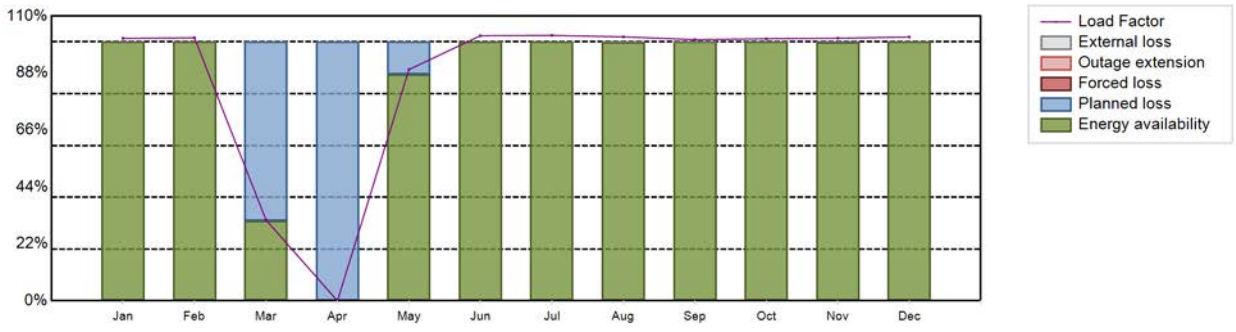
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	323.9
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.764
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	10557.79 GW(e).h
Energy Availability Factor (EAF)	:	84.87 %
Unit Capability Factor (UCF)	:	84.87 %
Load Factor (LF)	:	86.35 %
Operating Factor (OF)	:	85.56 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	15.13 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1268 hours

Annual Summary



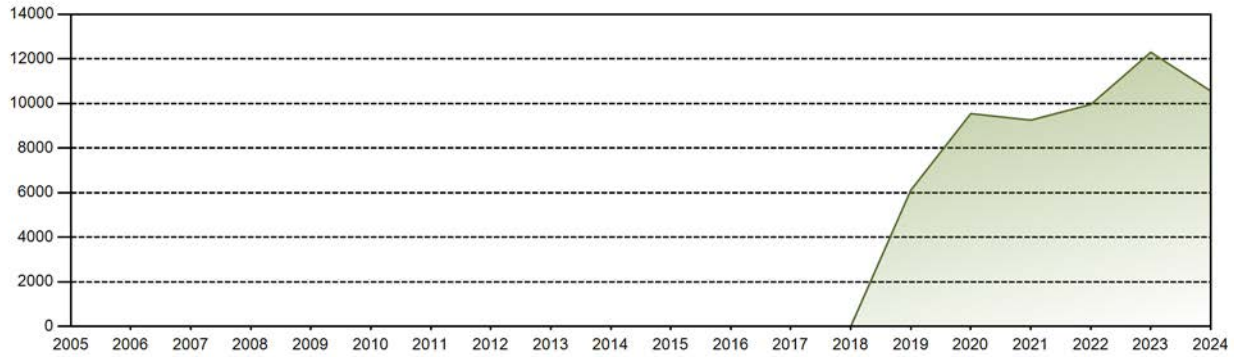
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1049.69	984.39	323.91	0.00	924.98	1026.24	1061.82	1055.87	1011.05	1048.20	1016.50	1055.14	10557.79
EAF [%]	100.00	100.00	30.81	0.00	87.41	100.00	100.00	99.95	100.00	100.00	99.96	100.00	84.87
UCF [%]	100.00	100.00	30.81	0.00	87.41	100.00	100.00	99.95	100.00	100.00	99.96	100.00	84.87
LF [%]	101.36	101.61	31.28	0.00	89.31	102.39	102.53	101.95	100.88	101.21	101.42	101.88	86.35
OF [%]	100.00	100.00	33.60	0.00	92.74	100.00	100.00	100.00	100.00	100.00	100.00	100.00	85.56
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	69.19	100.00	12.59	0.00	0.00	0.05	0.00	0.00	0.04	0.00	15.13
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

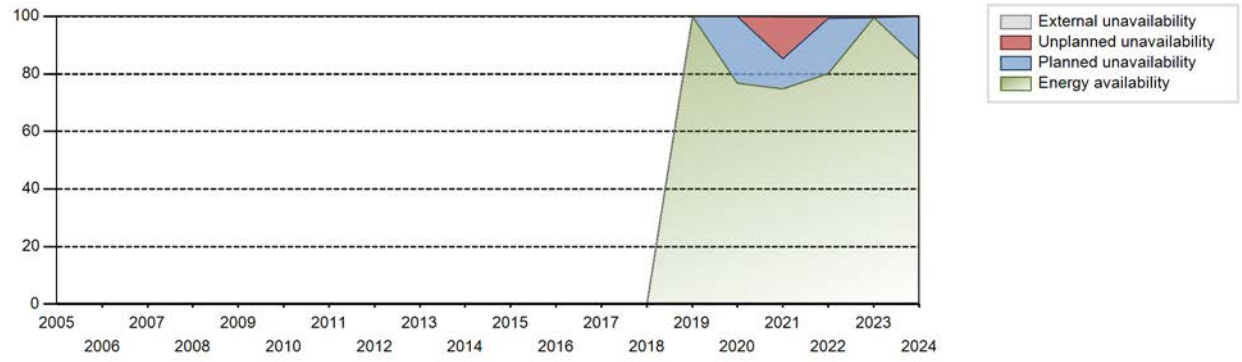
Lifetime energy generation	:	57711.9 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.34 %
Cumulative Energy Availability Factor (EAF)	:	84.25 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.92 %
Cumulative Unit Capability Factor (UCF)	:	84.38 %	Cumulative Planned Unavailability Factor (PUF)	:	12.71 %
Cumulative Load Factor (LF)	:	84.37 %	Cumulative Externally cause unavailability (XUF)	:	0.13 %
Cumulative Operating Factor (OF)	:	84.98 %			

Electricity Production (net) [GWh]

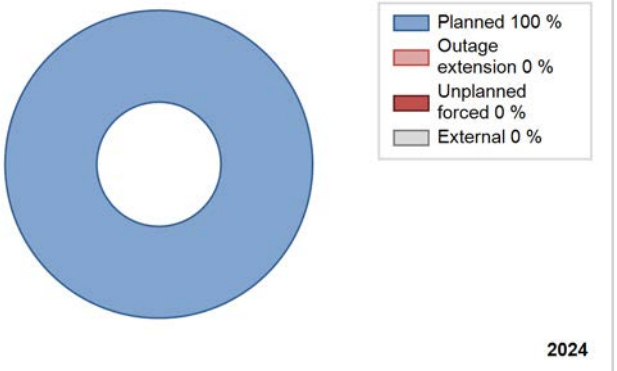


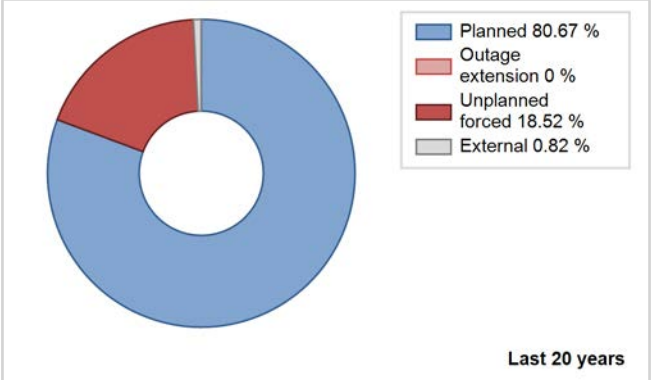
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2019	6107.40	4874	1418	99.95	100.00	100.34	100.00	0.00	0.00	0.00	0.05
2020	9543.62	6778	1418	76.73	76.77	76.62	77.16	0.00	0.00	23.23	0.03
2021	9252.75	6635	1418	74.85	75.03	74.49	75.74	16.34	14.66	10.31	0.18
2022	9954.85	7135	1418	80.17	80.42	80.14	81.45	0.62	0.51	19.07	0.25
2023	12295.49	8760	1418	99.41	99.62	98.98	100.00	0.35	0.35	0.03	0.21
2024	10557.79	7516	1392	84.87	84.87	86.35	85.56	0.00	0.00	15.13	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2019 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					3	
C. Inspection, maintenance or repair combined with refuelling	1268			1079		
E. Testing of plant systems or components				230		
P. Fire					238	
Subtotal	1268			1309	241	
Total	**1268**			**1550**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2019 to 2024
	Hours Lost	Average hours lost per reactor-year
31. Turbine and auxiliaries		2
41. Main Generator Systems		221
Total		**223**

Highlights (2024)

Refueling and Maintenance : '24.03.11~'24.05.03

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2024 Operating Experience

KR-27 SHIN-HANUL-1 KOREA, REPUBLIC OF

Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / APR-1400
Thermal power	:	3983 MWth
Gross electrical power	:	1455 MWe
Reference unit power (net)	:	1429 MWe

Key Dates

Construction Date	:	2012-07-10
Grid Date	:	2022-06-09
Commercial Date	:	2022-12-07
Age at end of year	:	2 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.66
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	41
Average discharge burnup [MWd/t]	:	53073
Active core diameter [m]	:	3.647
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	241
Fuel linear heat generation rate [kW/m]	:	18.38
Number of control rod assemblies	:	93
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

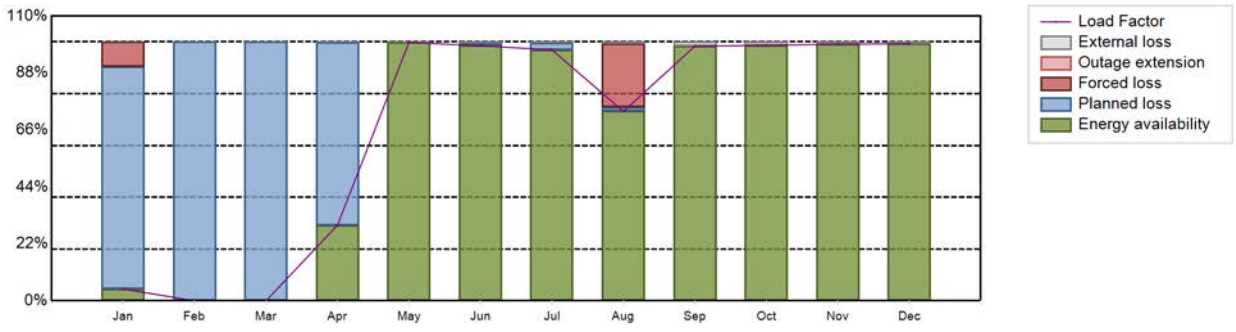
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	323.9
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.764
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8368.94 GW(e).h
Energy Availability Factor (EAF)	:	66.67 %
Unit Capability Factor (UCF)	:	67.21 %
Load Factor (LF)	:	66.67 %
Operating Factor (OF)	:	68.18 %

Forced Loss Rate (FLR)	:	4.13 %
Unplanned Capability Loss Factor (UCL)	:	2.9 %
Planned Unavailability Factor (PUF)	:	29.9 %
Externally cause unavailability (XUF)	:	0.54 %
Total off-line time	:	2795 hours

Annual Summary



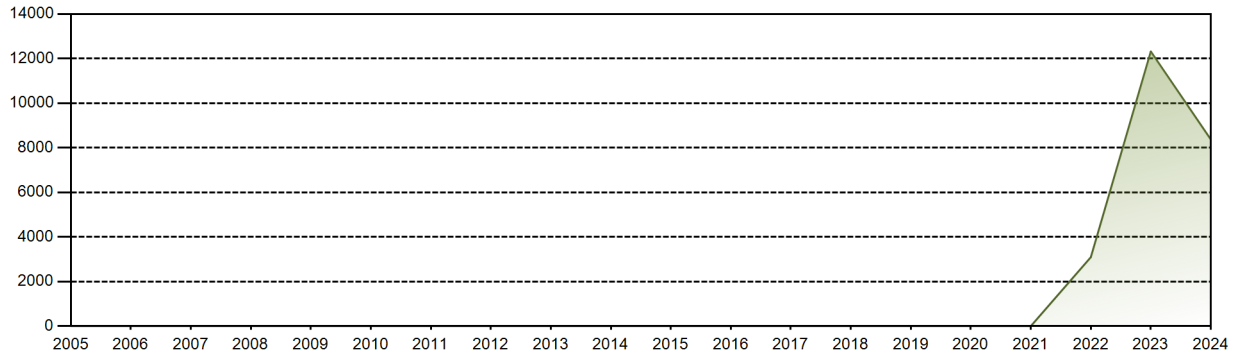
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	48.96	0.00	0.00	300.42	1061.04	1013.57	1030.43	778.21	1011.83	1049.11	1019.91	1055.44	8368.94
EAF [%]	4.57	0.00	0.00	29.20	99.80	98.51	96.92	73.20	98.34	98.68	99.13	99.27	66.67
UCF [%]	4.57	0.00	0.00	29.31	100.00	98.94	97.32	73.93	100.00	100.00	100.00	100.00	67.21
LF [%]	4.61	0.00	0.00	29.20	99.80	98.51	96.92	73.20	98.34	98.68	99.13	99.27	66.67
OF [%]	4.70	0.00	0.00	35.69	100.00	100.00	100.00	75.40	100.00	100.00	100.00	100.00	68.18
FLR [%]	67.82	0.00	0.00	0.00	0.00	0.00	0.00	24.95	0.00	0.00	0.00	0.00	4.13
UCL [%]	9.62	0.00	0.00	0.00	0.00	0.00	0.00	24.58	0.00	0.00	0.00	0.00	2.90
PUF [%]	85.81	100.00	100.00	70.69	0.00	1.06	2.68	1.49	0.00	0.00	0.00	0.00	29.90
XUF [%]	0.00	0.00	0.00	0.11	0.20	0.42	0.40	0.74	1.66	1.32	0.87	0.73	0.54

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Historical Summary

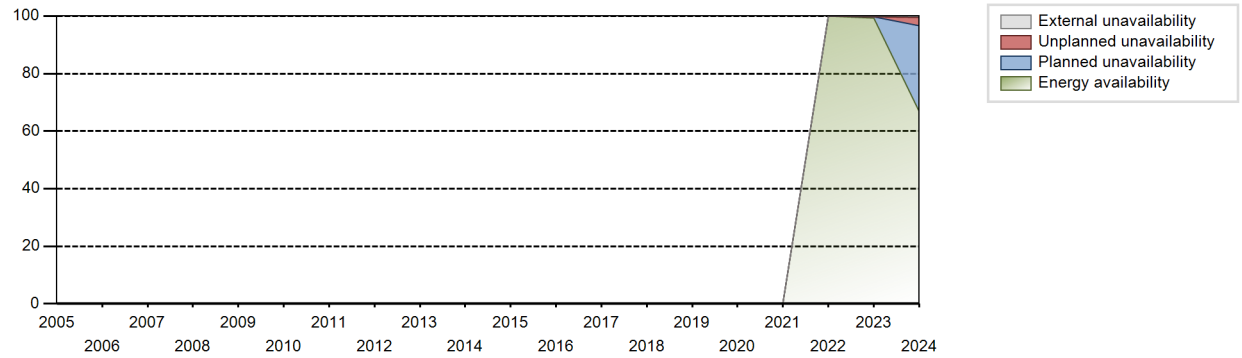
Lifetime energy generation	:	23779.13 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.64 %
Cumulative Energy Availability Factor (EAF)	:	83.56 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.4 %
Cumulative Unit Capability Factor (UCF)	:	84 %	Cumulative Planned Unavailability Factor (PUF)	:	14.6 %
Cumulative Load Factor (LF)	:	83.65 %	Cumulative Externally cause unavailability (XUF)	:	0.44 %
Cumulative Operating Factor (OF)	:	84.72 %			

Electricity Production (net) [GWh]

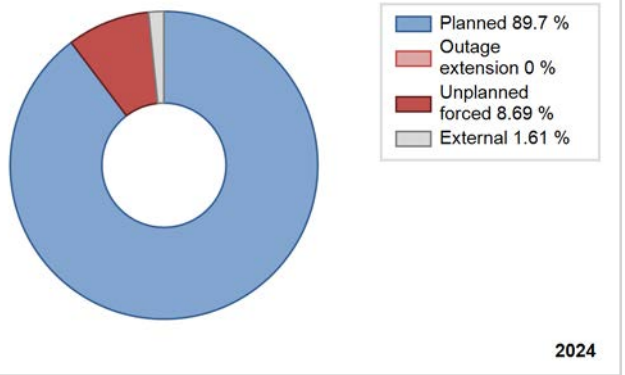


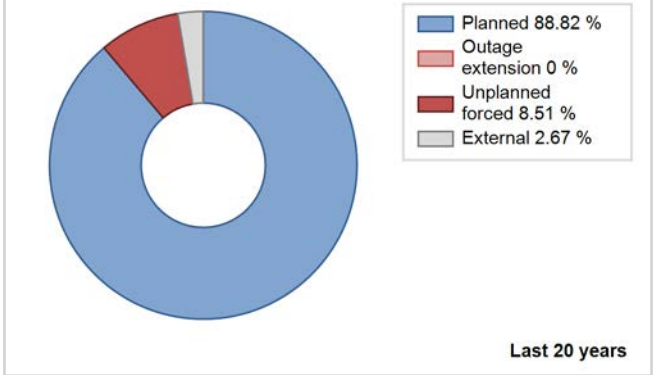
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2022	3090.99	3144	1414	99.97	99.97	100.08	100.00	0.00	0.00	0.03	0.00
2023	12319.20	8760	1414	99.29	99.66	99.46	100.00	0.00	0.00	0.34	0.37
2024	8368.94	5989	1429	66.67	67.21	66.67	68.18	4.13	2.90	29.90	0.54

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2022 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		254			122	
C. Inspection, maintenance or repair combined with refuelling	2541			1220		
E. Testing of plant systems or components				873		
Subtotal	2541	254		2093	122	
Total	**2795**			**2215**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2022 to 2024
	Hours Lost	Average hours lost per reactor-year
31. Turbine and auxiliaries	183	71
41. Main Generator Systems	71	28
Total	**254**	**99**

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2024 Operating Experience

KR-28 SHIN-HANUL-2 KOREA, REPUBLIC OF

Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / APR-1400
Thermal power	:	3983 MWth
Gross electrical power	:	1455 MWe
Reference unit power (net)	:	1416 MWe

Key Dates

Construction Date	:	2013-06-19
Grid Date	:	2023-12-21
Commercial Date	:	2024-04-05
Age at end of year	:	1 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	2.66
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	41
Average discharge burnup [MWd/t]	:	53073
Active core diameter [m]	:	3.647
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	241
Fuel linear heat generation rate [kW/m]	:	18.38
Number of control rod assemblies	:	93
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

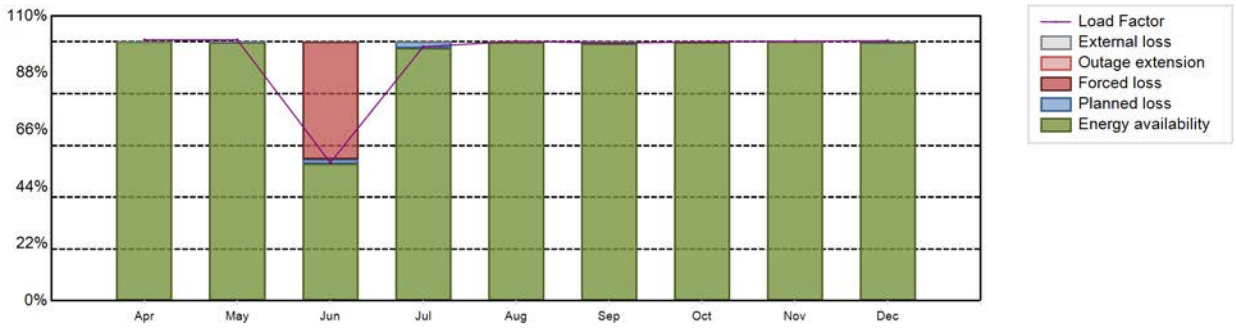
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	323.9
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.764
Output voltage [kV]	:	24
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	10097.64 GW(e).h
Energy Availability Factor (EAF)	:	94.5 %
Unit Capability Factor (UCF)	:	94.58 %
Load Factor (LF)	:	94.93 %
Operating Factor (OF)	:	94.38 %

Forced Loss Rate (FLR)	:	4.97 %
Unplanned Capability Loss Factor (UCL)	:	4.95 %
Planned Unavailability Factor (PUF)	:	0.46 %
Externally cause unavailability (XUF)	:	0.08 %
Total off-line time	:	1354 hours

Annual Summary



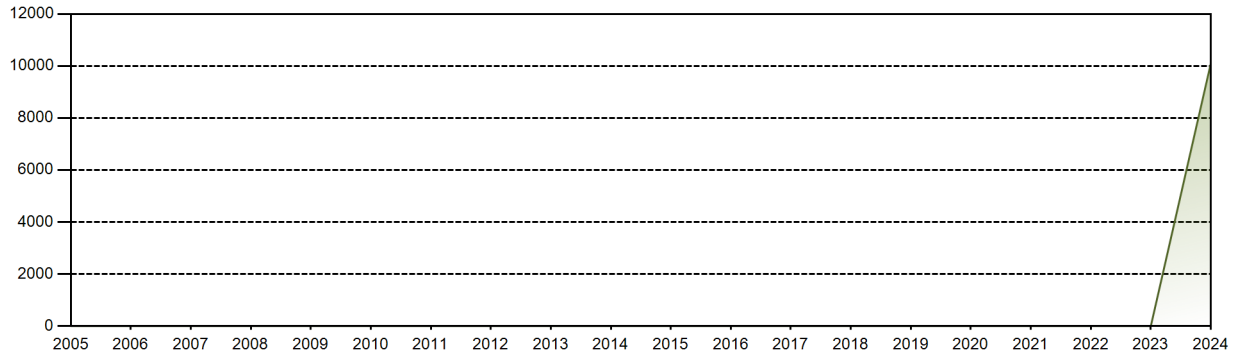
	Mar	Jan	Feb	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h				1027.26	1061.68	543.88	1034.21	1056.17	1014.71	1053.54	1022.45	1058.17	8872.08
EAF [%]				100.00	99.89	52.96	97.73	99.85	99.44	99.90	100.00	99.92	94.50
UCF [%]				100.00	99.92	52.96	97.74	100.00	99.89	100.00	100.00	99.92	94.58
LF [%]				100.76	100.78	53.35	98.17	100.25	99.53	100.00	100.29	100.44	94.93
OF [%]				100.00	100.00	48.47	100.00	100.00	100.00	100.00	100.00	100.00	94.38
FLR [%]				0.00	0.00	46.14	0.00	0.00	0.00	0.00	0.00	0.01	4.97
UCL [%]				0.00	0.00	45.38	0.00	0.00	0.00	0.00	0.00	0.01	4.95
PUF [%]				0.00	0.08	1.66	2.26	0.00	0.11	0.00	0.00	0.06	0.46
XUF [%]				0.00	0.03	0.00	0.01	0.15	0.45	0.10	0.00	0.00	0.08

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Historical Summary

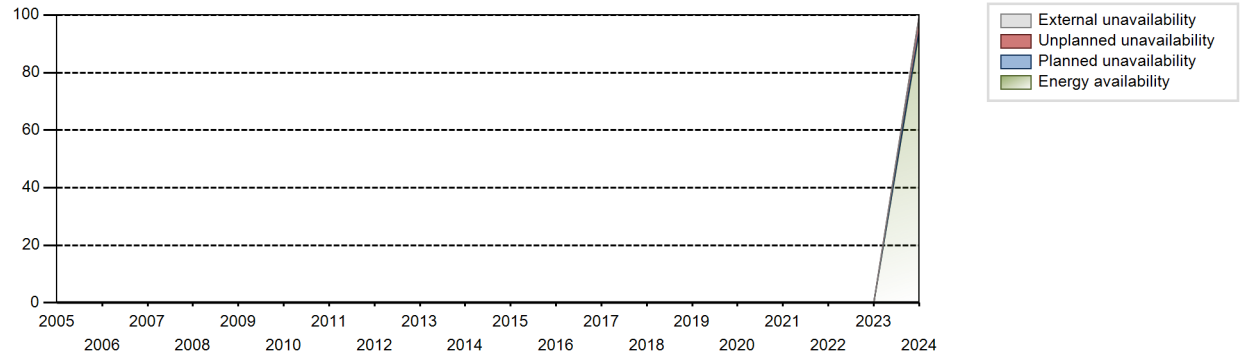
Lifetime energy generation	:	10097.64 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.97 %
Cumulative Energy Availability Factor (EAF)	:	94.5 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.95 %
Cumulative Unit Capability Factor (UCF)	:	94.58 %	Cumulative Planned Unavailability Factor (PUF)	:	0.46 %
Cumulative Load Factor (LF)	:	94.93 %	Cumulative Externally cause unavailability (XUF)	:	0.08 %
Cumulative Operating Factor (OF)	:	94.38 %			

Electricity Production (net) [GWh]

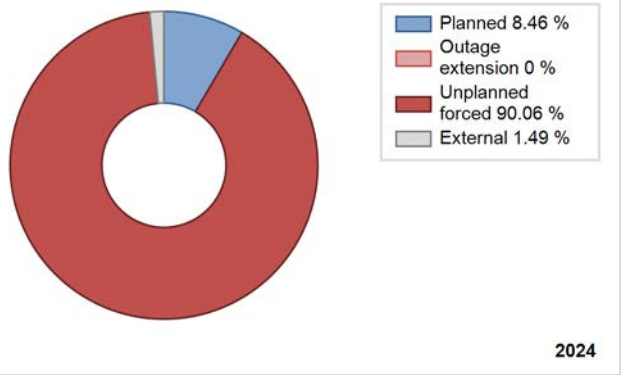


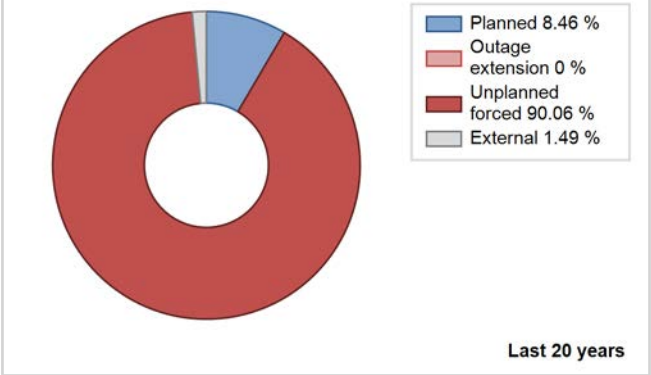
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2024	10097.64	7430	1416	94.50	94.58	94.93	94.38	4.97	4.95	0.46	0.08

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2024 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		350			466	
E. Testing of plant systems or components	982			1309		
Subtotal	982	350		1309	466	
Total	**1332**			**1775**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2024 to 2024
	Hours Lost	Average hours lost per reactor-year
31. Turbine and auxiliaries	350	350
Total	**350**	**350**

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2024 Operating Experience

KR-21 SHIN-KORI-1 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1048 MWe
Reference unit power (net)	:	986 MWe

Key Dates

Construction Date	:	2006-06-16
Grid Date	:	2010-08-04
Commercial Date	:	2011-02-28
Age at end of year	:	14 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.9
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36.15
Average discharge burnup [MWd/t]	:	38829
Active core diameter [m]	:	3.81
Active core height/length [m]	:	3.124
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.69
Number of control rod assemblies	:	180
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

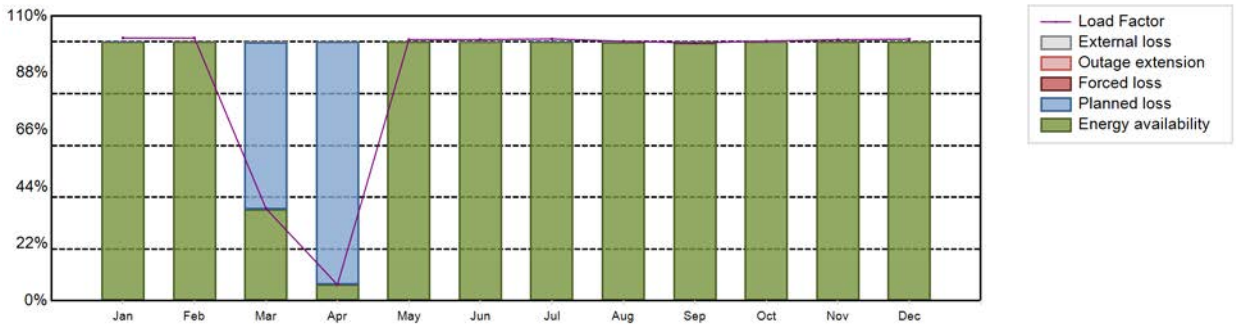
Operating coolant pressure [MPa]	:	17.237
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	7.14
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7581.35 GW(e).h
Energy Availability Factor (EAF)	:	86.78 %
Unit Capability Factor (UCF)	:	86.85 %
Load Factor (LF)	:	87.53 %
Operating Factor (OF)	:	87.5 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	13.15 %
Externally cause unavailability (XUF)	:	0.07 %
Total off-line time	:	1098 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	744.80	696.47	261.65	44.28	740.23	716.12	742.09	735.49	706.81	736.01	715.98	741.41	7581.35
EAF [%]	100.00	100.00	35.36	6.22	100.00	100.00	100.00	99.75	99.56	99.99	100.00	100.00	86.78
UCF [%]	100.00	100.00	35.47	6.22	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00	86.85
LF [%]	101.53	101.49	35.67	6.24	100.91	100.87	101.16	100.26	99.56	100.33	100.85	101.07	87.53
OF [%]	100.00	100.00	37.90	11.67	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	87.50
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	64.53	93.78	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	13.15
XUF [%]	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.25	0.44	0.01	0.00	0.00	0.07

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Historical Summary

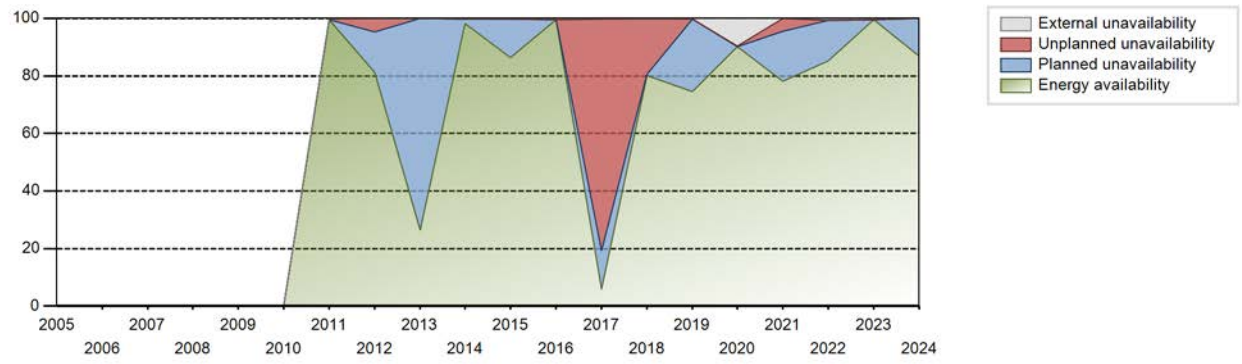
Lifetime energy generation	:	94522.73 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.86 %
Cumulative Energy Availability Factor (EAF)	:	77.74 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.87 %
Cumulative Unit Capability Factor (UCF)	:	78.68 %	Cumulative Planned Unavailability Factor (PUF)	:	13.45 %
Cumulative Load Factor (LF)	:	76.9 %	Cumulative Externally cause unavailability (XUF)	:	0.94 %
Cumulative Operating Factor (OF)	:	77.47 %			

Electricity Production (net) [GWh]



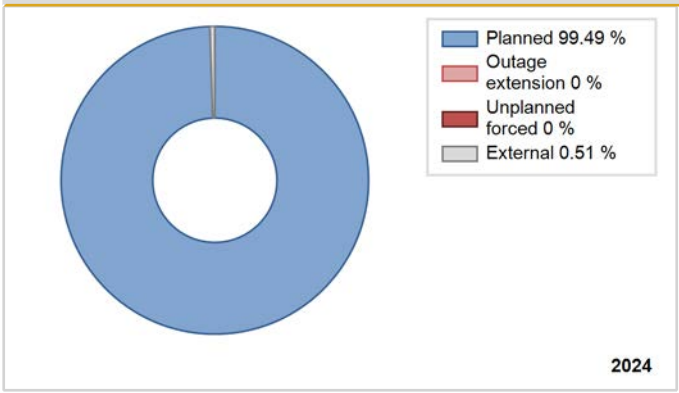
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2011	7867.03	8008	985	99.61	99.98	100.17	100.00	0.02	0.02	0.00	0.37
2012	7091.41	7220	997	81.24	81.31	80.97	82.19	5.45	4.69	14.00	0.07
2013	2328.10	2338	1000	26.49	26.49	26.58	26.69	0.00	0.00	73.51	0.00
2014	7419.09	7497	999	98.23	98.44	84.78	85.58	0.00	0.00	1.56	0.21
2015	7565.55	7656	999	86.45	86.75	86.45	87.40	0.00	0.00	13.25	0.30
2016	8729.83	8784	997	99.59	100.00	99.68	100.00	0.00	0.00	0.00	0.41
2017	508.50	538	997	5.82	5.99	5.82	6.14	0.00	80.59	13.42	0.17
2018	6997.79	7107	996	80.17	80.49	80.20	81.13	0.16	19.03	0.48	0.32
2019	6500.05	6602	996	74.47	74.70	74.50	75.37	0.02	0.01	25.29	0.23
2020	7895.37	7986	996	90.24	99.92	90.24	90.92	0.07	0.07	0.00	9.68
2021	6828.96	6949	996	78.22	78.33	78.27	79.33	5.41	4.48	17.19	0.12
2022	7467.99	7519	996	85.27	86.00	85.59	85.83	0.00	0.00	14.00	0.74
2023	8723.34	8760	996	99.62	100.00	99.98	100.00	0.00	0.00	0.00	0.38
2024	7581.35	7686	986	86.78	86.85	87.53	87.50	0.00	0.00	13.15	0.07

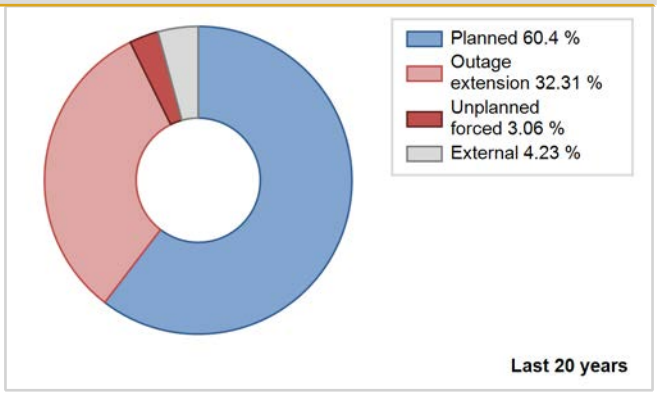
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2011 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					685	
C. Inspection, maintenance or repair combined with refuelling	1098			1145		
E. Testing of plant systems or components				165		
J. Grid limitation, failure or grid unavailability						85
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						62
Subtotal	1098			1310	685	147
Total	**1098**			**2142**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2011 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		27
15. Reactor Cooling Systems		605
42. Electrical Power Supply Systems		107
Total		**739**

Highlights (2024)

Refueling and Maintenance : '24.03.12 ~ 04.27

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2024 Operating Experience

KR-22 SHIN-KORI-2 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1047 MWe
Reference unit power (net)	:	982 MWe

Key Dates

Construction Date	:	2007-06-05
Grid Date	:	2012-01-28
Commercial Date	:	2012-07-20
Age at end of year	:	12 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.9
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36.15
Average discharge burnup [MWd/t]	:	38829
Active core diameter [m]	:	3.81
Active core height/length [m]	:	3.124
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.69
Number of control rod assemblies	:	180
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

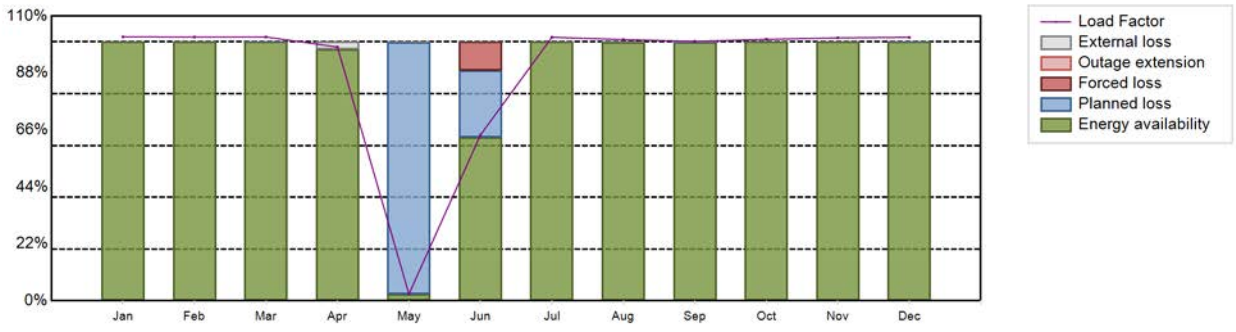
Operating coolant pressure [MPa]	:	17.237
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	7.14
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7739.53 GW(e).h
Energy Availability Factor (EAF)	:	88.48 %
Unit Capability Factor (UCF)	:	88.74 %
Load Factor (LF)	:	89.72 %
Operating Factor (OF)	:	89.46 %

Forced Loss Rate (FLR)	:	1.01 %
Unplanned Capability Loss Factor (UCL)	:	0.9 %
Planned Unavailability Factor (PUF)	:	10.35 %
Externally cause unavailability (XUF)	:	0.26 %
Total off-line time	:	926 hours

Annual Summary



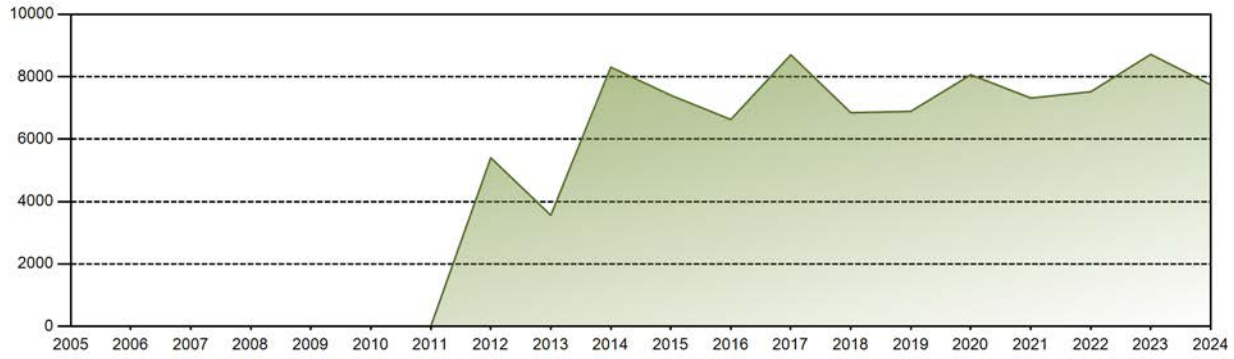
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	744.70	696.50	744.43	693.13	19.13	452.71	743.75	737.19	708.57	737.80	717.99	743.62	7739.53
EAF [%]	100.00	100.00	100.00	97.10	2.62	63.14	100.00	99.92	99.96	100.00	100.00	100.00	88.48
UCF [%]	100.00	100.00	100.00	100.00	2.78	63.14	100.00	100.00	99.99	100.00	100.00	100.00	88.74
LF [%]	101.93	101.91	101.89	98.03	2.62	64.03	101.80	100.90	100.22	100.98	101.55	101.78	89.72
OF [%]	100.00	100.00	100.00	100.00	4.57	70.00	100.00	100.00	100.00	100.00	100.00	100.00	89.46
FLR [%]	0.00	0.00	0.00	0.00	0.00	14.87	0.00	0.00	0.00	0.00	0.00	0.00	1.01
UCL [%]	0.00	0.00	0.00	0.00	0.00	11.03	0.00	0.00	0.00	0.00	0.00	0.00	0.90
PUF [%]	0.00	0.00	0.00	0.00	97.22	25.83	0.00	0.00	0.01	0.00	0.00	0.00	10.35
XUF [%]	0.00	0.00	0.00	2.90	0.16	0.00	0.00	0.08	0.04	0.00	0.00	0.00	0.26

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Historical Summary

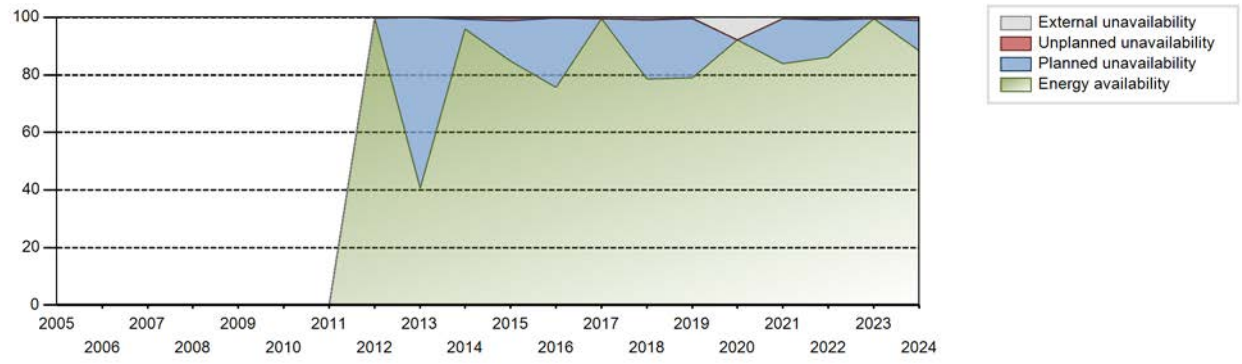
Lifetime energy generation	:	93087.85 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.31 %
Cumulative Energy Availability Factor (EAF)	:	84.23 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.27 %
Cumulative Unit Capability Factor (UCF)	:	85.16 %	Cumulative Planned Unavailability Factor (PUF)	:	14.57 %
Cumulative Load Factor (LF)	:	84.22 %	Cumulative Externally cause unavailability (XUF)	:	0.94 %
Cumulative Operating Factor (OF)	:	85.16 %			

Electricity Production (net) [GWh]



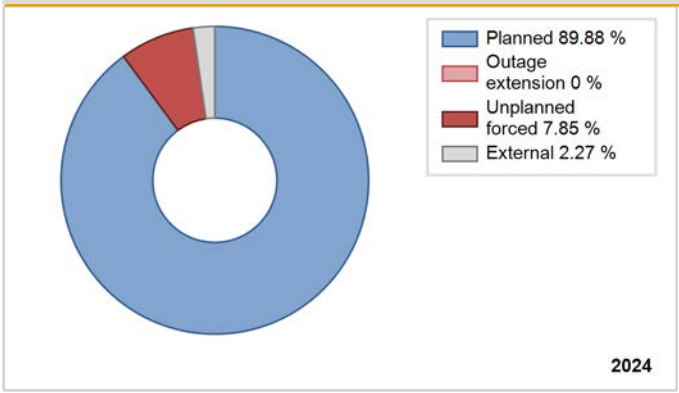
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2012	5400.28	5897	997	99.75	99.95	98.04	99.95	0.00	0.00	0.05	0.19
2013	3560.31	3569	1000	40.56	40.57	40.64	40.74	0.00	0.00	59.43	0.01
2014	8304.89	8518	998	96.01	96.24	94.99	97.24	0.52	0.51	3.26	0.23
2015	7405.24	7604	996	84.87	85.20	84.87	86.80	1.08	0.93	13.87	0.33
2016	6627.86	6718	997	75.68	75.87	75.68	76.48	0.00	0.00	24.13	0.19
2017	8699.48	8760	997	99.59	99.99	99.61	100.00	0.00	0.00	0.01	0.41
2018	6847.68	7011	996	78.48	79.21	78.48	80.03	0.25	0.20	20.60	0.72
2019	6889.15	7014	996	78.95	79.21	78.96	80.07	0.27	0.21	20.58	0.26
2020	8062.54	8127	996	92.10	99.99	92.16	92.52	0.01	0.01	0.00	7.89
2021	7316.90	7443	996	83.90	84.33	83.86	84.97	0.02	0.01	15.65	0.43
2022	7518.95	7655	996	86.20	86.57	86.18	87.39	0.62	0.54	12.90	0.36
2023	8715.76	8760	996	99.56	100.00	99.89	100.00	0.00	0.00	0.00	0.43
2024	7739.53	7858	982	88.48	88.74	89.72	89.46	1.01	0.90	10.35	0.26

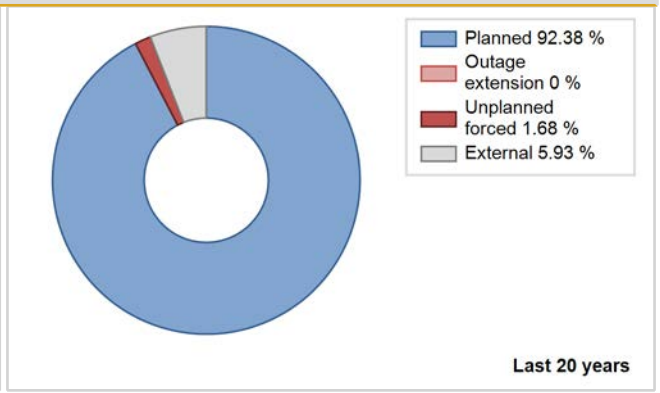
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2012 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		68			8	
C. Inspection, maintenance or repair combined with refuelling	857			1241		
E. Testing of plant systems or components				178		
J. Grid limitation, failure or grid unavailability						0
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						53
Subtotal	857	68		1419	8	53
Total	**925**			**1480**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2012 to 2024 Average hours lost per reactor-year
31. Turbine and auxiliaries	68	5
42. Electrical Power Supply Systems		2
Total	**68**	**7**

Highlights (2024)

Refueling and Maintenance : '24.05.02 ~ 06.07
Turbine-generator manual trip due to 2ND stage Manway gasket leakage of Moisture Separator Reheater B : '24.06.10 ~ 06.13

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2024 Operating Experience

KR-23 SHIN-WOLSONG-1 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1048 MWe
Reference unit power (net)	:	980 MWe

Key Dates

Construction Date	:	2007-11-20
Grid Date	:	2012-01-27
Commercial Date	:	2012-07-31
Age at end of year	:	12 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.9
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36.15
Average discharge burnup [MWd/t]	:	38829
Active core diameter [m]	:	3.81
Active core height/length [m]	:	3.124
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.69
Number of control rod assemblies	:	180
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

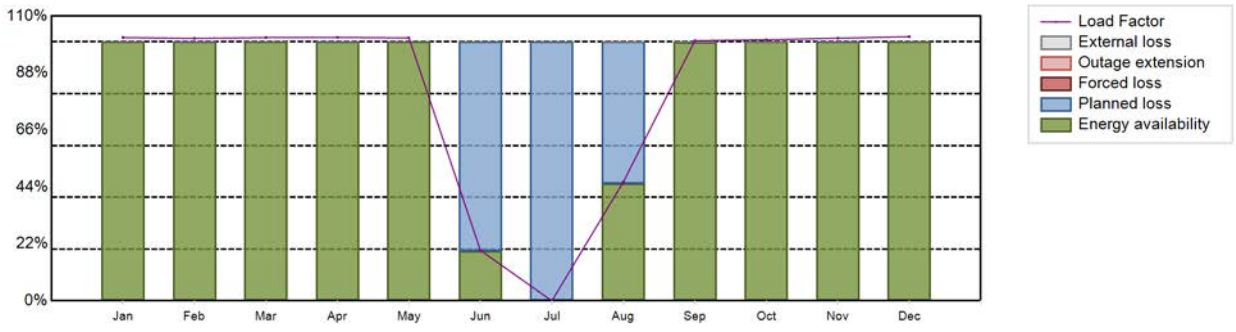
Operating coolant pressure [MPa]	:	17.237
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	7.14
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7008.44 GW(e).h
Energy Availability Factor (EAF)	:	80.28 %
Unit Capability Factor (UCF)	:	80.29 %
Load Factor (LF)	:	81.41 %
Operating Factor (OF)	:	80.86 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	19.71 %
Externally cause unavailability (XUF)	:	0.01 %
Total off-line time	:	1681 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	741.41	691.36	741.34	717.78	740.41	137.58	0.00	334.99	708.98	735.04	715.74	743.81	7008.44
EAF [%]	100.00	100.00	100.00	100.00	100.00	19.31	0.00	45.34	99.90	100.00	100.00	100.00	80.28
UCF [%]	100.00	100.00	100.00	100.00	100.00	19.31	0.00	45.35	100.00	100.00	100.00	100.00	80.29
LF [%]	101.68	101.36	101.68	101.73	101.55	19.50	0.00	45.94	100.48	100.81	101.44	102.01	81.41
OF [%]	100.00	100.00	100.00	100.00	100.00	21.39	0.00	50.13	100.00	100.00	100.00	100.00	80.86
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	80.69	100.00	54.65	0.00	0.00	0.00	0.00	19.71
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.01

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Historical Summary

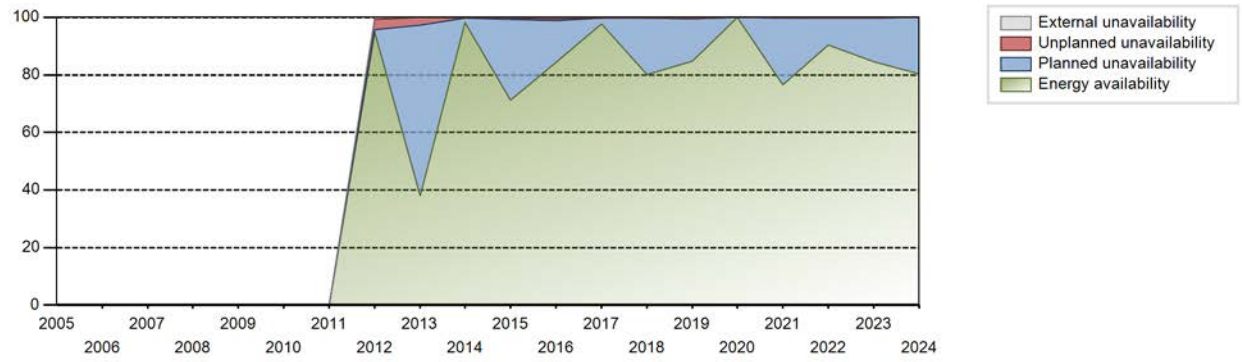
Lifetime energy generation	:	91190.31 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.5 %
Cumulative Energy Availability Factor (EAF)	:	82.62 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.41 %
Cumulative Unit Capability Factor (UCF)	:	82.88 %	Cumulative Planned Unavailability Factor (PUF)	:	16.71 %
Cumulative Load Factor (LF)	:	82.78 %	Cumulative Externally cause unavailability (XUF)	:	0.26 %
Cumulative Operating Factor (OF)	:	83.43 %			

Electricity Production (net) [GWh]



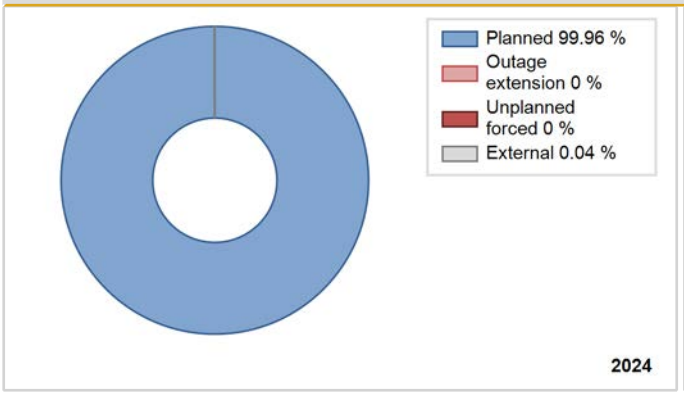
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2012	4964.62	6256	997	94.89	95.60	94.90	97.03	3.56	3.53	0.88	0.70
2013	3295.84	3353	991	37.93	37.94	37.97	38.28	6.51	2.64	59.42	0.01
2014	8611.78	8677	1000	98.27	98.54	98.31	99.05	0.00	0.00	1.46	0.27
2015	6217.67	6354	997	71.19	71.51	71.19	72.53	0.51	0.36	28.12	0.32
2016	7393.37	7522	997	84.42	84.81	84.42	85.63	0.76	0.65	14.54	0.39
2017	8553.53	8640	997	97.63	97.81	97.94	98.63	0.00	0.00	2.19	0.18
2018	7002.14	7097	997	80.08	80.35	80.17	81.02	0.00	0.00	19.65	0.27
2019	7404.26	7511	997	84.71	85.14	84.78	85.74	0.00	0.00	14.86	0.43
2020	8751.10	8784	997	99.86	99.99	99.93	100.00	0.01	0.01	0.01	0.13
2021	6699.21	6788	997	76.64	76.88	76.71	77.49	0.00	0.00	23.12	0.25
2022	7892.31	7954	997	90.27	90.61	90.37	90.80	0.00	0.00	9.39	0.34
2023	7395.95	7483	997	84.61	84.92	84.68	85.42	0.00	0.00	15.08	0.31
2024	7008.44	7103	980	80.28	80.29	81.41	80.86	0.00	0.00	19.71	0.01

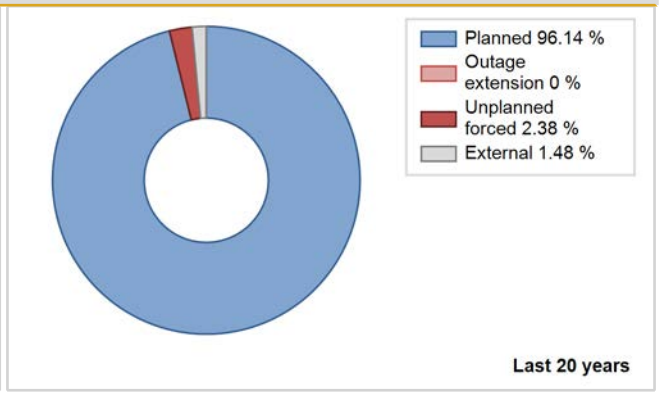
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2012 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					26	
C. Inspection, maintenance or repair combined with refuelling	1680			1428		
D. Inspection, maintenance or repair without refuelling				145		
Subtotal	1680			1573	26	
Total	**1680**			**1599**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2012 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		17
32. Feedwater and Main Steam System		8
Total		**25**

Highlights (2024)

Refueling and Maintenance(2024.6.7.~2024.8.16)

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2024 Operating Experience

KR-24 SHIN-WOLSONG-2 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	DHICKOPC (DOOSAN HEAVY INDUSTRIES & CONSTRUCTION CO.LTD./KOREA POWER ENGINEERING COMPANY/COMBUSTIONENGINEERING)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PWR / OPR-1000
Thermal power	:	2825 MWth
Gross electrical power	:	1048 MWe
Reference unit power (net)	:	976 MWe

Key Dates

Construction Date	:	2008-09-23
Grid Date	:	2015-02-26
Commercial Date	:	2015-07-24
Age at end of year	:	9 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.9
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	36.15
Average discharge burnup [MWd/t]	:	38829
Active core diameter [m]	:	3.81
Active core height/length [m]	:	3.124
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	17.69
Number of control rod assemblies	:	-
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

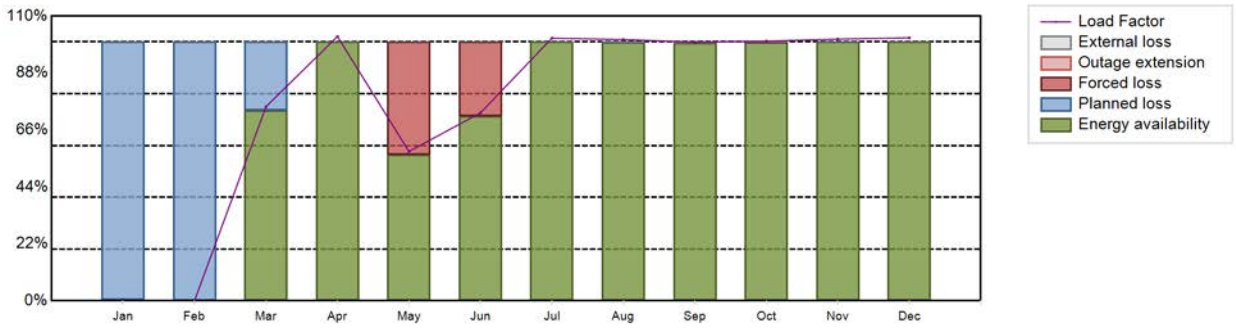
Operating coolant pressure [MPa]	:	17.237
Reactor outlet temperature [°C]	:	327.3
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	7.14
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	3
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6540.54 GW(e).h
Energy Availability Factor (EAF)	:	75.3 %
Unit Capability Factor (UCF)	:	75.35 %
Load Factor (LF)	:	76.29 %
Operating Factor (OF)	:	75.9 %

Forced Loss Rate (FLR)	:	7.41 %
Unplanned Capability Loss Factor (UCL)	:	6.03 %
Planned Unavailability Factor (PUF)	:	18.61 %
Externally cause unavailability (XUF)	:	0.05 %
Total off-line time	:	2117 hours

Annual Summary



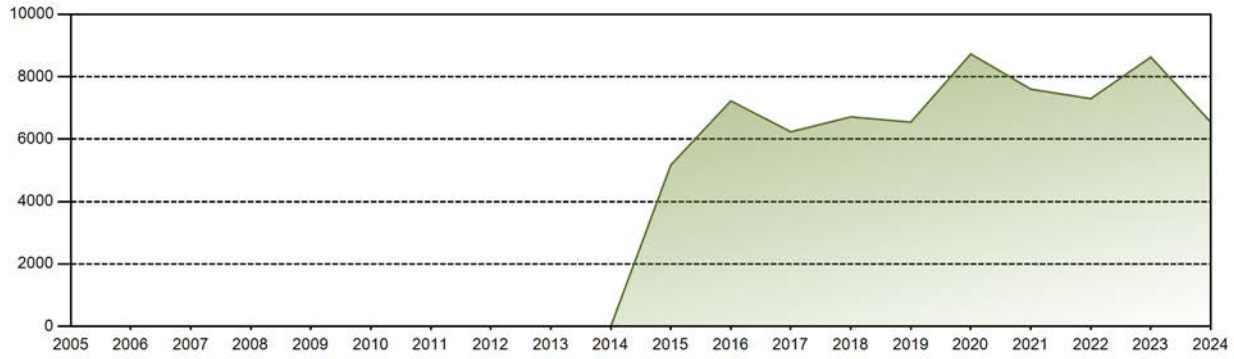
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	2.03	0.00	544.34	717.41	418.86	510.09	736.56	732.75	702.12	728.38	710.31	737.68	6540.54
EAF [%]	0.28	0.00	73.51	100.00	56.53	71.33	100.00	99.94	99.58	99.88	99.99	100.00	75.30
UCF [%]	0.28	0.00	73.51	100.00	56.53	71.33	100.00	99.99	100.00	99.99	99.99	100.00	75.35
LF [%]	0.28	0.00	74.96	102.09	57.68	72.59	101.43	100.91	99.92	100.31	101.08	101.59	76.29
OF [%]	1.34	0.00	81.45	100.00	56.59	68.61	100.00	100.00	100.00	100.00	100.00	100.00	75.90
FLR [%]	0.00	0.00	0.00	0.00	43.47	28.67	0.00	0.00	0.00	0.01	0.00	0.00	7.41
UCL [%]	0.00	0.00	0.00	0.00	43.47	28.67	0.00	0.00	0.00	0.01	0.00	0.00	6.03
PUF [%]	99.72	100.00	26.49	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	18.61
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.42	0.10	0.00	0.00	0.05

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Historical Summary

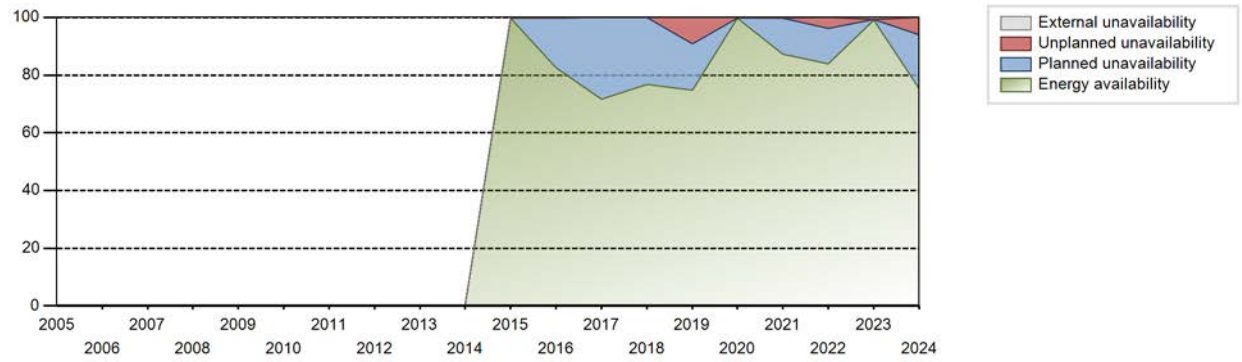
Lifetime energy generation	:	70679.24 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.35 %
Cumulative Energy Availability Factor (EAF)	:	84.22 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.03 %
Cumulative Unit Capability Factor (UCF)	:	84.41 %	Cumulative Planned Unavailability Factor (PUF)	:	13.56 %
Cumulative Load Factor (LF)	:	84.49 %	Cumulative Externally cause unavailability (XUF)	:	0.19 %
Cumulative Operating Factor (OF)	:	84.86 %			

Electricity Production (net) [GWh]



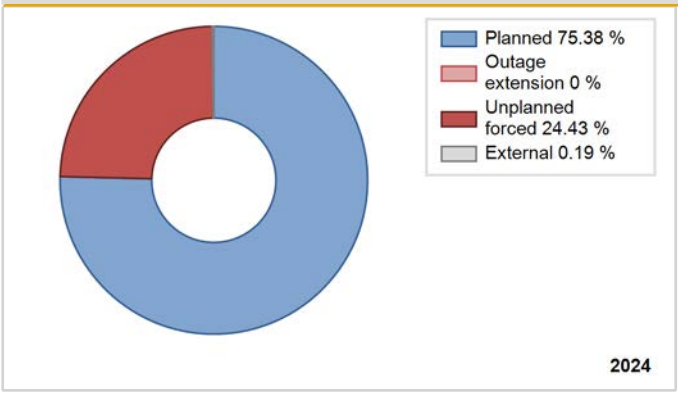
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2015	5169.24	5821	993	99.83	99.98	100.03	100.00	0.01	0.01	0.00	0.15
2016	7223.89	7328	993	82.55	82.78	82.82	83.42	0.03	0.02	17.20	0.22
2017	6234.20	6298	993	71.59	71.71	71.67	71.89	0.01	0.01	28.29	0.12
2018	6712.82	6783	993	76.83	76.88	77.17	77.43	0.00	0.00	23.12	0.05
2019	6544.76	6622	993	74.85	74.89	75.24	75.59	10.97	9.22	15.89	0.03
2020	8729.35	8784	993	99.82	99.91	100.08	100.00	0.08	0.08	0.00	0.09
2021	7600.23	7733	993	87.31	87.65	87.37	88.28	0.04	0.03	12.32	0.34
2022	7296.90	7433	993	83.85	83.90	83.89	84.85	4.31	3.78	12.32	0.06
2023	8627.32	8760	993	99.16	99.90	99.18	100.00	0.00	0.00	0.10	0.73
2024	6540.54	6667	976	75.30	75.35	76.29	75.90	7.41	6.03	18.61	0.05

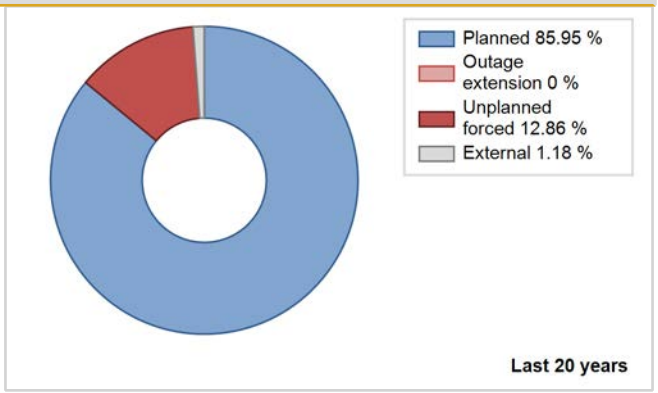
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2015 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		550			173	
C. Inspection, maintenance or repair combined with refuelling	1567			1157		
D. Inspection, maintenance or repair without refuelling				172		
Subtotal	1567	550		1329	173	
Total	**2117**			**1502**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2015 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		30
13. Reactor Auxiliary Systems	550	55
32. Feedwater and Main Steam System		78
Total	**550**	**163**

Highlights (2024)

Refueling and Maintenance(2024.1.1.~2024.3.6.)
Automatic Reactor scram due to RCP01B Stop(2024.5.18.~2024.6.8.)

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2024 Operating Experience

KR-4 WOLSONG-2 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	AECL/DHI (ATOMIC ENERGY OF CANADA LTD./DOOSAN HEAVY INDUSTRIES & CONSTRUCTION)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 6
Thermal power	:	2061 MWth
Gross electrical power	:	599 MWe
Reference unit power (net)	:	571 MWe

Key Dates

Construction Date	:	1992-09-25
Grid Date	:	1997-04-01
Commercial Date	:	1997-07-01
Age at end of year	:	27 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	0.72
Refuelling frequency [month]	:	NA
Part of the core refuelled [%]	:	NA
Average discharge burnup [MWd/t]	:	7500
Active core diameter [m]	:	7.69
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	4560
Fuel linear heat generation rate [kW/m]	:	0.1615
Number of control rod assemblies	:	21
Number of external reactor coolant loops	:	2
Coolant type	:	D2O

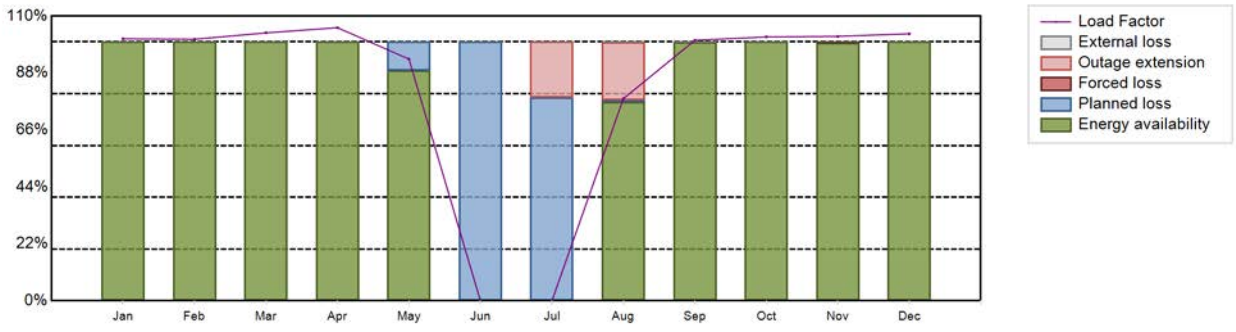
Operating coolant pressure [MPa]	:	10.5
Reactor outlet temperature [°C]	:	310
Number of SG	:	4
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.12
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	4.59
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	2
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4138.02 GW(e).h
Energy Availability Factor (EAF)	:	80.4 %
Unit Capability Factor (UCF)	:	80.41 %
Load Factor (LF)	:	82.5 %
Operating Factor (OF)	:	80.51 %

Forced Loss Rate (FLR)	:	0.03 %
Unplanned Capability Loss Factor (UCL)	:	3.75 %
Planned Unavailability Factor (PUF)	:	15.84 %
Externally cause unavailability (XUF)	:	0.01 %
Total off-line time	:	1712 hours

Annual Summary



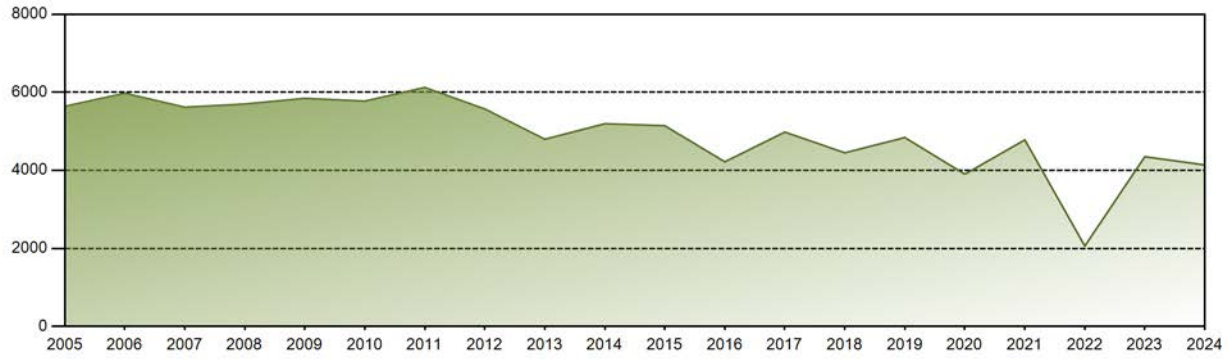
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	429.91	401.50	439.63	433.71	396.68	0.00	0.00	331.82	413.68	432.97	419.96	438.18	4138.02
EAF [%]	100.00	100.00	100.00	100.00	88.99	0.00	0.00	76.71	99.93	100.00	99.73	100.00	80.40
UCF [%]	100.00	100.00	100.00	100.00	88.99	0.00	0.00	76.79	100.00	100.00	99.73	100.00	80.41
LF [%]	101.20	101.03	103.48	105.49	93.37	0.00	0.00	78.11	100.62	101.92	102.15	103.14	82.50
OF [%]	100.00	100.00	100.00	100.00	89.25	0.00	0.00	77.42	100.00	100.00	100.00	100.00	80.51
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.03
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	21.51	22.48	0.00	0.00	0.27	0.00	3.75
PUF [%]	0.00	0.00	0.00	0.00	11.01	100.00	78.49	0.73	0.00	0.00	0.00	0.00	15.84
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.00	0.00	0.00	0.01

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Historical Summary

Lifetime energy generation	:	140630.65 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.24 %
Cumulative Energy Availability Factor (EAF)	:	87.53 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.01 %
Cumulative Unit Capability Factor (UCF)	:	88.63 %	Cumulative Planned Unavailability Factor (PUF)	:	9.36 %
Cumulative Load Factor (LF)	:	89.31 %	Cumulative Externally cause unavailability (XUF)	:	1.1 %
Cumulative Operating Factor (OF)	:	87.46 %			

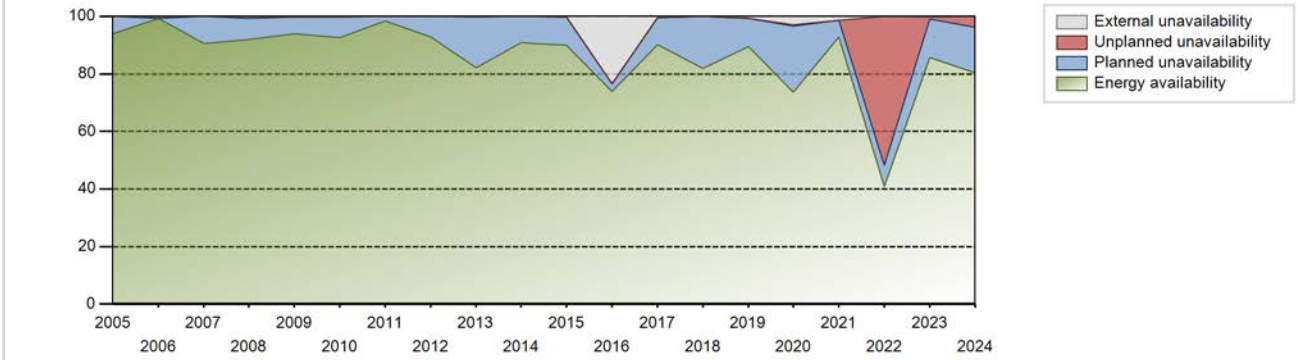
Electricity Production (net) [GWh]



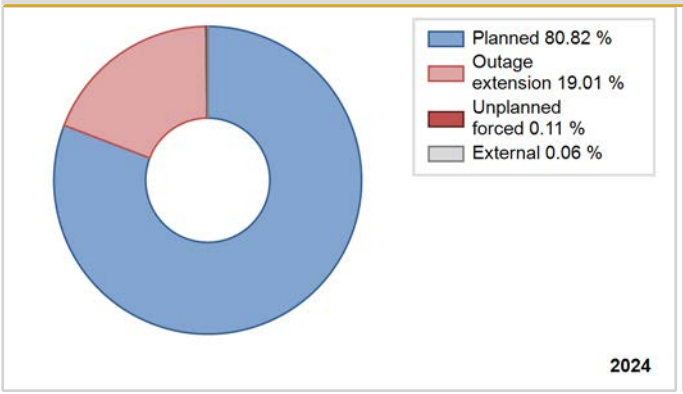
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1997	3294.95	5296	650	94.68	94.68	97.70	95.09	5.20	5.19	0.13	0.00
1998	4788.68	7144	650	81.01	81.02	84.10	81.55	0.00	0.00	18.98	0.00
1999	5211.77	7754	650	88.12	88.13	91.53	88.52	0.26	0.23	11.65	0.00
2000	5346.81	7843	650	91.49	91.49	93.65	89.29	0.07	0.06	8.45	0.00
2001	5585.43	8188	650	92.79	93.01	98.09	93.47	0.34	0.32	6.67	0.22
2002	5265.98	7717	650	87.66	87.66	92.48	88.09	0.00	0.00	12.34	0.00
2003	5480.58	8015	650	91.22	91.22	96.25	91.50	0.86	0.79	7.99	0.00
2004	5465.46	8015	650	90.88	90.91	95.72	91.25	0.00	0.00	9.09	0.03
2005	5641.29	8243	650	93.90	93.90	99.07	94.10	0.00	0.00	6.10	0.00
2006	5975.85	8711	684	99.34	99.34	99.73	99.44	0.65	0.65	0.01	0.00
2007	5618.82	7948	683	90.58	90.58	93.91	90.73	0.03	0.02	9.40	0.00
2008	5700.28	8081	710	91.96	92.10	91.40	92.00	0.56	0.52	7.38	0.14
2009	5845.94	8265	710	93.92	94.20	93.99	94.35	0.03	0.03	5.77	0.29
2010	5774.27	8152	710	92.67	92.96	92.84	93.06	0.00	0.00	7.04	0.29
2011	6124.72	8760	710	98.37	98.37	98.47	100.00	0.00	0.00	1.63	0.00
2012	5572.93	8187	673	92.76	92.76	94.27	93.20	0.00	0.00	7.24	0.00
2013	4797.42	7207	655	82.18	82.18	82.86	82.27	0.19	0.16	17.66	0.01
2014	5194.82	7954	650	90.78	90.78	90.83	90.80	0.00	0.00	9.22	0.00
2015	5143.35	7921	652	90.03	90.23	90.14	90.42	0.00	0.00	9.77	0.20
2016	4219.27	6525	647	73.90	97.43	74.24	74.28	0.00	0.00	2.57	23.53
2017	4981.05	7947	632	90.25	90.65	89.97	90.72	0.00	0.00	9.35	0.40
2018	4449.94	7190	611	81.97	82.00	83.14	82.08	0.00	0.00	18.00	0.02
2019	4840.92	7920	606	89.59	90.33	91.19	90.41	0.00	0.00	9.67	0.74
2020	3900.78	6558	596	73.73	76.64	74.51	74.66	0.52	0.40	22.95	2.91
2021	4781.06	8248	582	92.79	94.12	93.78	94.16	0.02	0.02	5.87	1.33
2022	2059.85	3578	569	40.78	40.79	41.33	40.84	0.00	51.67	7.55	0.01
2023	4350.62	7539	576	85.62	85.97	86.22	86.06	0.01	0.60	13.44	0.34
2024	4138.02	7072	571	80.40	80.41	82.50	80.51	0.03	3.75	15.84	0.01

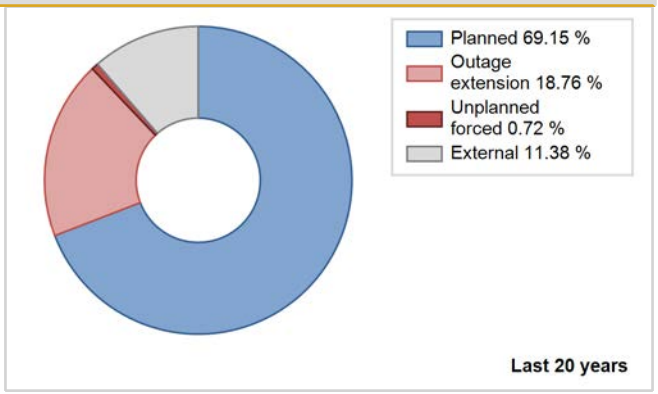
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1997 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		328			191	
C. Inspection, maintenance or repair combined with refuelling				155		
D. Inspection, maintenance or repair without refuelling	1384			669		
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						81
Subtotal	1384	328		824	192	83
Total	**1712**			**1099**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1997 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		2
13. Reactor Auxiliary Systems		1
16. Steam generation systems		165
31. Turbine and auxiliaries		3
32. Feedwater and Main Steam System		3
41. Main Generator Systems		1
42. Electrical Power Supply Systems	328	16
Total	**328**	**191**

Highlights (2024)

22th Overhaul(Inspection and maintenance, 2024-05-28~2024-08-08)

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2024 Operating Experience

KR-15 WOLSONG-3 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	AECL/DHI (ATOMIC ENERGY OF CANADA LTD./DOOSAN HEAVY INDUSTRIES & CONSTRUCTION)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 6
Thermal power	:	2061 MWth
Gross electrical power	:	624 MWe
Reference unit power (net)	:	595 MWe

Key Dates

Construction Date	:	1994-03-17
Grid Date	:	1998-03-25
Commercial Date	:	1998-07-01
Age at end of year	:	26 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	0.71
Refuelling frequency [month]	:	15
Part of the core refuelled [%]	:	96
Average discharge burnup [MWd/t]	:	7296
Active core diameter [m]	:	7.69
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	4560
Fuel linear heat generation rate [kW/m]	:	0.1615
Number of control rod assemblies	:	21
Number of external reactor coolant loops	:	2
Coolant type	:	D2O

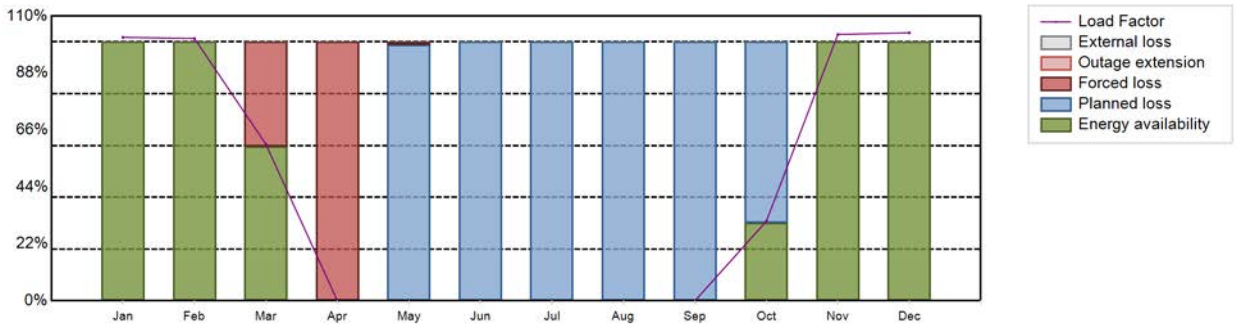
Operating coolant pressure [MPa]	:	10.5
Reactor outlet temperature [°C]	:	310
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.12
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	4.59
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	2
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2172.81 GW(e).h
Energy Availability Factor (EAF)	:	40.67 %
Unit Capability Factor (UCF)	:	40.67 %
Load Factor (LF)	:	41.57 %
Operating Factor (OF)	:	40.72 %

Forced Loss Rate (FLR)	:	22.36 %
Unplanned Capability Loss Factor (UCL)	:	11.71 %
Planned Unavailability Factor (PUF)	:	47.62 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	5207 hours

Annual Summary



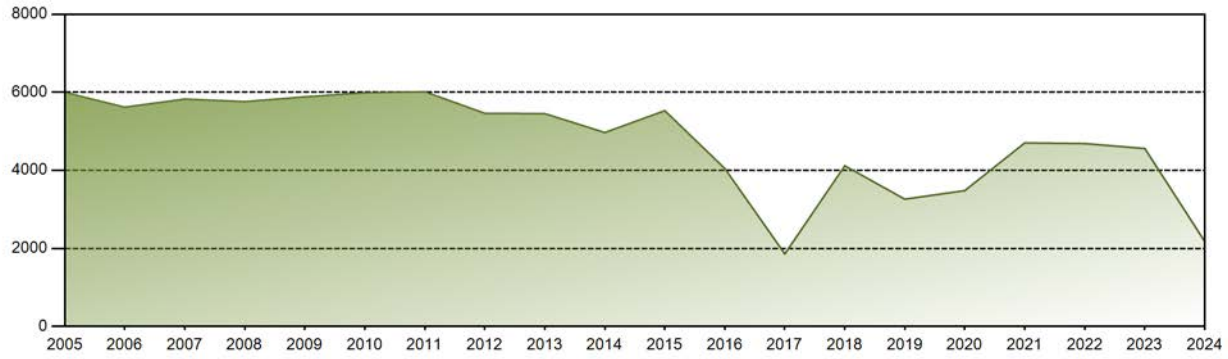
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	450.51	419.66	267.54	0.00	0.00	0.00	0.00	0.00	0.00	136.07	440.79	458.24	2172.81
EAF [%]	100.00	100.00	59.70	0.00	0.00	0.00	0.00	0.00	0.00	30.17	100.00	100.00	40.67
UCF [%]	100.00	100.00	59.70	0.00	0.00	0.00	0.00	0.00	0.00	30.17	100.00	100.00	40.67
LF [%]	101.77	101.34	60.44	0.00	0.00	0.00	0.00	0.00	0.00	30.74	102.89	103.51	41.57
OF [%]	100.00	100.00	59.68	0.00	0.00	0.00	0.00	0.00	0.00	30.78	100.00	100.00	40.72
FLR [%]	0.00	0.00	40.30	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.36
UCL [%]	0.00	0.00	40.30	100.00	1.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.71
PUF [%]	0.00	0.00	0.00	0.00	98.79	100.00	100.00	100.00	100.00	69.83	0.00	0.00	47.62
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	131988.6 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.23 %
Cumulative Energy Availability Factor (EAF)	:	83.87 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.75 %
Cumulative Unit Capability Factor (UCF)	:	85.09 %	Cumulative Planned Unavailability Factor (PUF)	:	11.16 %
Cumulative Load Factor (LF)	:	85.31 %	Cumulative Externally cause unavailability (XUF)	:	1.22 %
Cumulative Operating Factor (OF)	:	83.73 %			

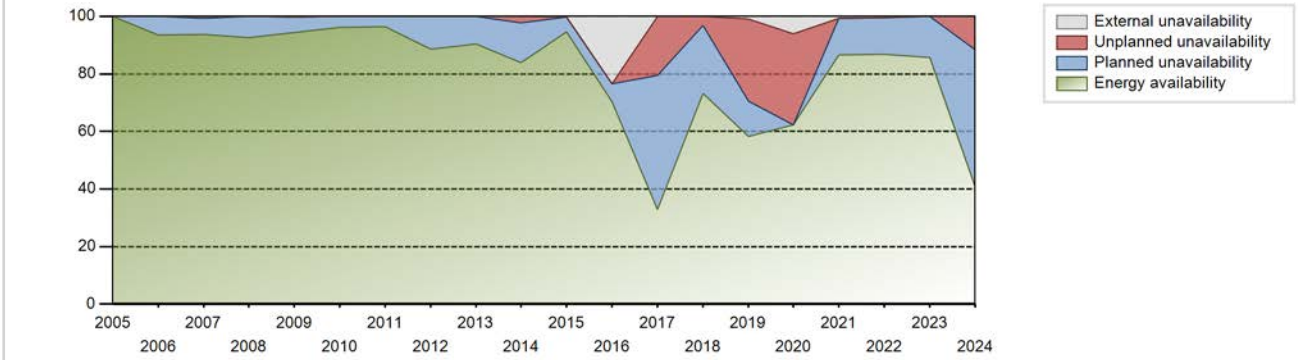
Electricity Production (net) [GWh]



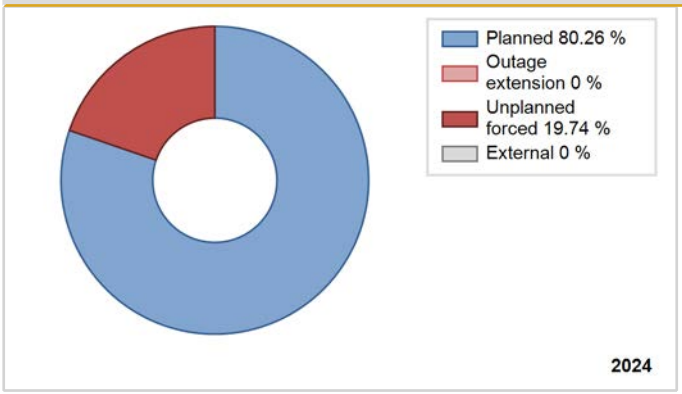
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1998	3460.26	5326	650	96.11	96.11	98.89	96.38	3.88	3.88	0.01	0.00
1999	4696.65	7008	650	80.23	80.24	82.48	80.00	0.00	0.00	19.76	0.00
2000	5925.22	8784	650	99.93	99.93	103.78	100.00	0.00	0.00	0.07	0.00
2001	4923.93	7409	650	85.32	85.32	86.48	84.58	3.17	2.79	11.89	0.00
2002	5043.33	8083	650	91.79	91.79	88.57	92.27	0.00	0.00	8.21	0.00
2003	5579.53	8176	650	93.06	93.06	97.99	93.33	0.07	0.06	6.88	0.00
2004	5540.29	8152	650	92.24	92.47	97.03	92.81	0.00	0.00	7.53	0.23
2005	5997.86	8760	650	100.00	100.00	105.34	100.00	0.00	0.00	0.00	0.00
2006	5617.76	8205	682	93.45	93.45	94.03	93.66	0.00	0.00	6.55	0.00
2007	5826.59	8239	681	93.78	93.78	97.67	94.05	0.65	0.61	5.61	0.00
2008	5761.08	8129	707	92.63	92.71	92.77	92.54	0.00	0.00	7.29	0.08
2009	5882.54	8287	707	94.34	94.50	94.98	94.60	0.00	0.00	5.50	0.15
2010	5986.43	8433	707	96.19	96.25	96.66	96.27	0.00	0.00	3.75	0.06
2011	6014.37	8477	707	96.45	96.50	97.11	96.77	0.00	0.00	3.50	0.05
2012	5460.60	7827	686	88.70	88.70	90.62	89.11	0.00	0.00	11.30	0.00
2013	5453.06	7937	684	90.39	90.50	91.01	90.61	0.00	0.00	9.50	0.11
2014	4968.56	7371	665	83.99	83.99	85.29	84.14	2.67	2.30	13.71	0.00
2015	5528.96	8313	665	94.72	94.88	94.91	94.90	0.00	0.00	5.12	0.16
2016	4046.37	6216	651	70.41	93.83	70.76	70.77	0.00	0.00	6.17	23.42
2017	1857.46	2890	648	32.82	32.87	32.72	32.99	38.40	20.49	46.64	0.06
2018	4116.18	6432	641	73.18	73.19	73.30	73.42	4.07	3.11	23.70	0.01
2019	3261.26	5184	630	58.19	59.08	59.09	59.18	14.56	28.61	12.31	0.89
2020	3480.85	5542	627	62.27	68.35	63.20	63.09	0.00	31.58	0.07	6.08
2021	4704.12	7665	607	86.65	87.42	88.47	87.50	0.00	0.00	12.58	0.78
2022	4686.17	7665	605	86.88	87.39	88.42	87.50	0.00	0.00	12.61	0.52
2023	4559.74	7522	601	85.65	85.76	86.61	85.87	0.00	0.00	14.24	0.11
2024	2172.81	3577	595	40.67	40.67	41.57	40.72	22.36	11.71	47.62	0.00

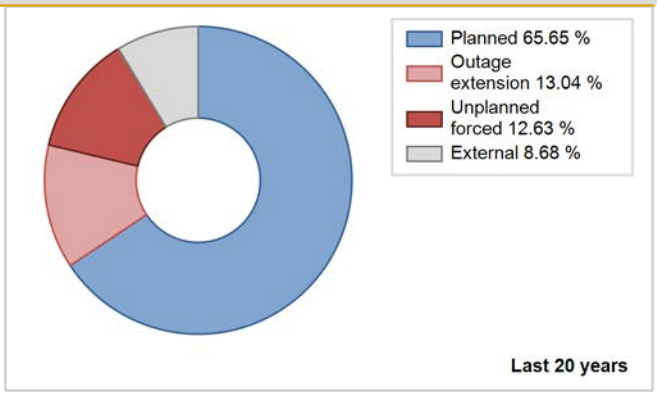
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1998 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					300	
C. Inspection, maintenance or repair combined with refuelling				190		
D. Inspection, maintenance or repair without refuelling	4178			818		
J. Grid limitation, failure or grid unavailability						1
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						97
P. Fire		1029			40	
Subtotal	4178	1029		1008	340	98
Total	**5207**			**1446**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1998 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		8
14. Safety Systems		80
15. Reactor Cooling Systems		34
16. Steam generation systems		169
21. Fuel Handling and Storage Facilities		2
35. All other I&C Systems		9
Total		**302**

Highlights (2024)

Unpalanned Shutdown due to fire on a BUB(3.19 12:09 ~ 5.1 9:00)
& Inspection and Maintenance(2024.5.1 09:00 ~ 10.22 10:32)

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2024 Operating Experience

KR-16 WOLSONG-4 KOREA, REPUBLIC OF



Status at end of year	:	**Operational**
Operator	:	KHNP (Korea Hydro and Nuclear Power Co.)
Owner	:	KHNP (Korea Hydro and Nuclear Power Co.)
Reactor Supplier	:	AECL/DHI (ATOMIC ENERGY OF CANADA LTD./DOOSAN HEAVY INDUSTRIES & CONSTRUCTION)
Turbine Supplier	:	DHICGE (Doosan Heavy Industries & Construction and General Electric)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 6
Thermal power	:	2061 MWth
Gross electrical power	:	589 MWe
Reference unit power (net)	:	569 MWe

Key Dates

Construction Date	:	1994-07-22
Grid Date	:	1999-05-21
Commercial Date	:	1999-10-01
Age at end of year	:	25 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	0.71
Refuelling frequency [month]	:	15
Part of the core refuelled [%]	:	96
Average discharge burnup [MWd/t]	:	7296
Active core diameter [m]	:	7.69
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	4560
Fuel linear heat generation rate [kW/m]	:	0.1615
Number of control rod assemblies	:	21
Number of external reactor coolant loops	:	2
Coolant type	:	D2O

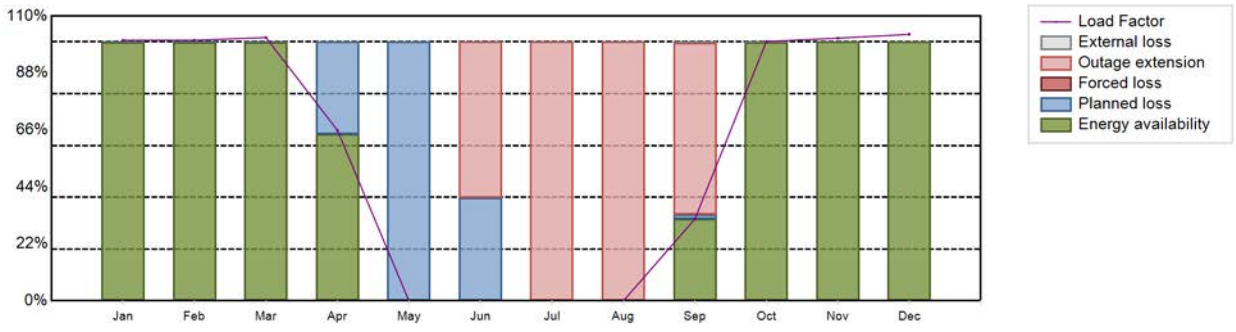
Operating coolant pressure [MPa]	:	10.5
Reactor outlet temperature [°C]	:	310
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.12
Secondary systems		
Number of turbine-generators per unit/reactor	:	4
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	4.59
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	2
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2929.56 GW(e).h
Energy Availability Factor (EAF)	:	57.85 %
Unit Capability Factor (UCF)	:	57.89 %
Load Factor (LF)	:	58.61 %
Operating Factor (OF)	:	58.14 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	27.31 %
Planned Unavailability Factor (PUF)	:	14.8 %
Externally cause unavailability (XUF)	:	0.04 %
Total off-line time	:	3677 hours

Annual Summary



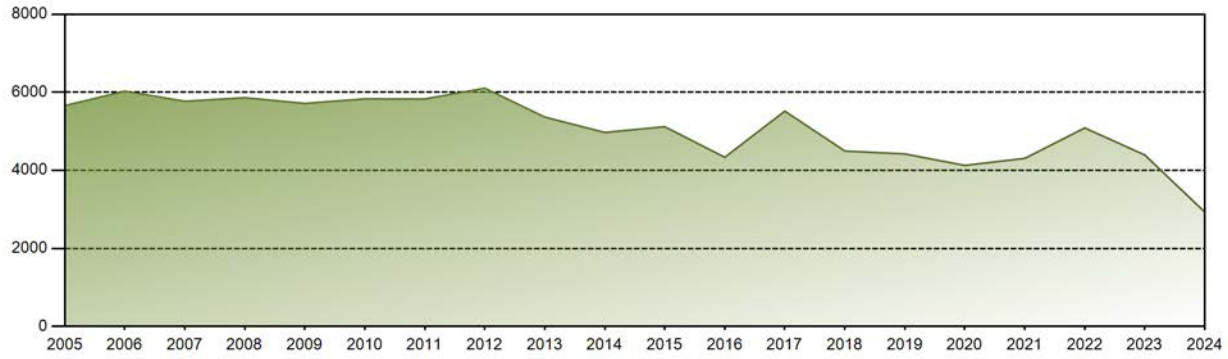
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	426.09	398.47	430.52	269.81	0.00	0.00	0.00	0.00	129.41	423.97	415.65	435.64	2929.56
EAF [%]	99.95	99.95	99.98	64.37	0.00	0.00	0.00	0.00	31.59	99.94	100.00	100.00	57.85
UCF [%]	99.95	99.95	99.98	64.37	0.00	0.00	0.00	0.00	32.04	100.00	100.00	100.00	57.89
LF [%]	100.65	100.62	101.70	65.86	0.00	0.00	0.00	0.00	31.59	100.15	101.46	102.91	58.61
OF [%]	100.00	100.00	100.00	65.28	0.00	0.00	0.00	0.00	34.03	100.00	100.00	100.00	58.14
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	60.28	100.00	100.00	66.25	0.00	0.00	0.00	27.31
PUF [%]	0.05	0.05	0.02	35.63	100.00	39.72	0.00	0.00	1.71	0.00	0.00	0.00	14.80
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.06	0.00	0.00	0.04

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Historical Summary

Lifetime energy generation	:	133426.05 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.11 %
Cumulative Energy Availability Factor (EAF)	:	89.44 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.17 %
Cumulative Unit Capability Factor (UCF)	:	90.19 %	Cumulative Planned Unavailability Factor (PUF)	:	8.64 %
Cumulative Load Factor (LF)	:	91.13 %	Cumulative Externally cause unavailability (XUF)	:	0.75 %
Cumulative Operating Factor (OF)	:	89.49 %			

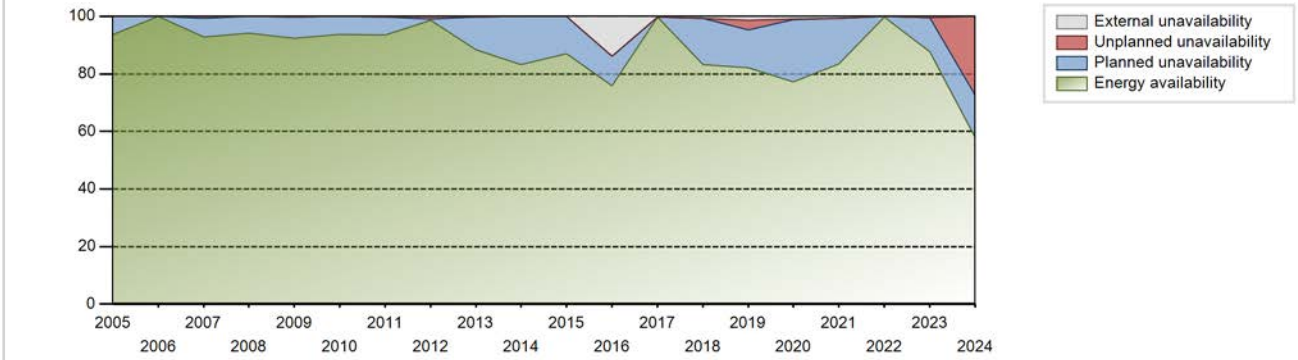
Electricity Production (net) [GWh]



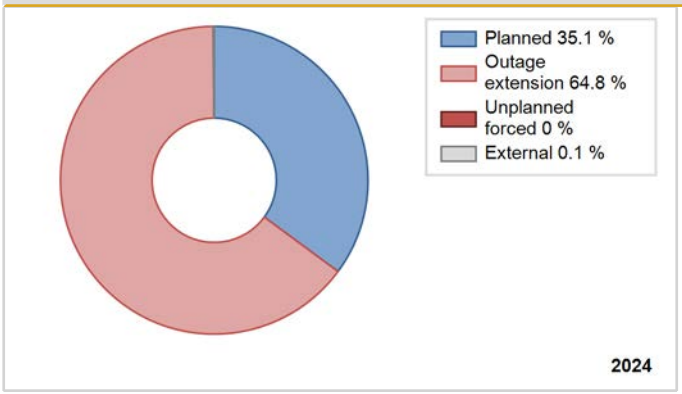
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1999	1489.23	2208	650	99.89	99.89	103.76	100.00	0.00	0.00	0.11	0.00
2000	5423.32	8033	650	91.36	91.36	94.99	91.45	0.10	0.09	8.55	0.00
2001	5493.17	8110	650	92.58	92.58	96.47	92.58	0.09	0.09	7.33	0.00
2002	5448.11	7971	650	90.80	90.80	95.68	90.99	0.00	0.00	9.20	0.00
2003	5601.86	8225	650	93.49	93.49	98.38	93.89	0.12	0.11	6.40	0.00
2004	5620.95	8209	650	93.17	93.17	98.45	93.45	0.00	0.00	6.83	0.00
2005	5657.87	8254	650	93.79	93.79	99.37	94.22	0.00	0.00	6.21	0.00
2006	6028.31	8760	685	100.00	100.00	100.46	100.00	0.00	0.00	0.00	0.00
2007	5770.36	8157	685	92.80	92.80	96.16	93.12	0.66	0.61	6.59	0.00
2008	5861.40	8271	708	94.15	94.23	94.25	94.16	0.00	0.00	5.77	0.08
2009	5714.06	8079	708	92.41	92.67	92.13	92.23	0.00	0.00	7.33	0.26
2010	5831.20	8218	708	93.70	93.76	94.02	93.81	0.00	0.00	6.24	0.06
2011	5828.85	8215	708	93.51	93.71	93.98	93.78	0.00	0.00	6.29	0.20
2012	6105.67	8702	694	98.60	98.60	100.16	99.07	1.00	1.00	0.40	0.00
2013	5364.39	7761	688	88.30	88.47	89.01	88.60	0.00	0.00	11.53	0.17
2014	4970.75	7307	669	83.30	83.30	84.82	83.41	0.02	0.02	16.68	0.00
2015	5117.75	7636	669	87.07	87.07	87.33	87.17	0.00	0.00	12.93	0.00
2016	4334.90	6720	653	75.91	89.83	75.57	76.50	0.00	0.00	10.17	13.92
2017	5517.85	8760	635	99.63	100.00	99.20	100.00	0.00	0.00	0.00	0.37
2018	4494.93	7354	622	83.24	83.87	82.50	83.95	0.00	0.00	16.13	0.62
2019	4420.51	7310	609	82.07	83.34	82.86	83.45	0.15	3.41	13.25	1.27
2020	4126.51	6872	600	77.26	78.12	78.30	78.23	0.45	0.35	21.53	0.85
2021	4307.32	7376	575	83.44	84.05	85.51	84.20	0.10	0.08	15.87	0.62
2022	5086.51	8760	574	99.78	99.87	101.16	100.00	0.00	0.00	0.13	0.08
2023	4392.97	7739	567	87.76	88.20	88.44	88.34	0.06	0.05	11.75	0.44
2024	2929.56	5107	569	57.85	57.89	58.61	58.14	0.00	27.31	14.80	0.04

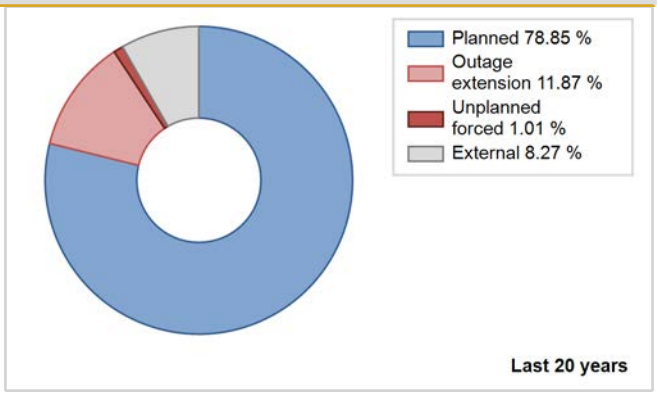
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1999 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					19	
C. Inspection, maintenance or repair combined with refuelling				78		
D. Inspection, maintenance or repair without refuelling	1284			687		
J. Grid limitation, failure or grid unavailability						2
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						47
Z. Other		2399			96	
Subtotal	1284	2399		765	115	49
Total	**3683**			**929**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1999 to 2024
	Hours Lost	Average hours lost per reactor-year
13. Reactor Auxiliary Systems		2
15. Reactor Cooling Systems		12
16. Steam generation systems		0
21. Fuel Handling and Storage Facilities		3
31. Turbine and auxiliaries		0
41. Main Generator Systems		1
42. Electrical Power Supply Systems		2
Total		**20**

Highlights (2024)

Inspection and Maintenance(2024.4.20 09:00 ~ 9.21. 04:01)

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2024 Operating Experience

MX-1 LAGUNA VERDE-1 MEXICO



Status at end of year	:	**Operational**
Operator	:	CFE (COMISION FEDERAL DE ELECTRICIDAD)
Owner	:	CFE (COMISION FEDERAL DE ELECTRICIDAD)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-5
Thermal power	:	2317 MWth
Gross electrical power	:	805 MWe
Reference unit power (net)	:	777 MWe

Key Dates

Construction Date	:	1976-09-27
Grid Date	:	1989-04-09
Commercial Date	:	1990-07-25
Age at end of year	:	35 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.81
Refuelling frequency [month]	:	17.5
Part of the core refuelled [%]	:	28.83
Average discharge burnup [MWd/t]	:	42635.75
Active core diameter [m]	:	3.62
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	444
Fuel linear heat generation rate [kW/m]	:	16.06
Number of control rod assemblies	:	109
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

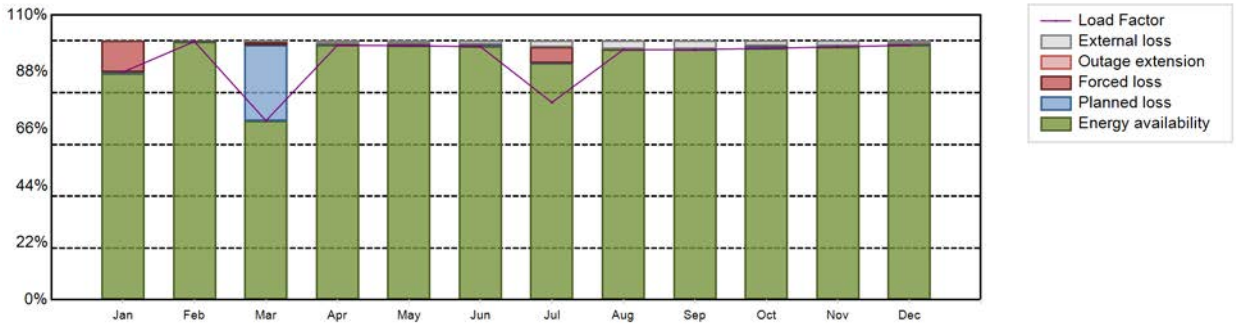
Operating coolant pressure [MPa]	:	7.2
Reactor outlet temperature [°C]	:	278
Number of SG	:	NA
Containment type	:	Double
Containment design pressure [MPa]	:	0.31
Secondary systems		
Number of turbine-generators per unit/reactor	:	3
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.51
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6328.76 GW(e).h
Energy Availability Factor (EAF)	:	93.97 %
Unit Capability Factor (UCF)	:	95.43 %
Load Factor (LF)	:	92.73 %
Operating Factor (OF)	:	95.45 %

Forced Loss Rate (FLR)	:	1.8 %
Unplanned Capability Loss Factor (UCL)	:	1.75 %
Planned Unavailability Factor (PUF)	:	2.82 %
Externally cause unavailability (XUF)	:	1.46 %
Total off-line time	:	400 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	508.49	539.60	399.91	550.07	567.25	547.17	440.84	558.38	540.48	561.40	546.87	568.31	6328.76
EAF [%]	87.56	99.58	69.18	98.32	98.13	97.81	91.49	96.59	96.61	97.11	97.75	98.31	93.97
UCF [%]	87.56	99.58	69.55	99.44	99.28	99.29	93.82	99.59	99.64	98.91	99.75	99.53	95.43
LF [%]	87.96	99.78	69.18	98.32	98.13	97.81	76.26	96.59	96.61	97.11	97.75	98.31	92.73
OF [%]	91.80	100.00	72.72	100.00	100.00	100.00	81.72	100.00	100.00	100.00	100.00	100.00	95.45
FLR [%]	12.13	0.03	1.72	0.24	0.34	0.18	6.18	0.14	0.21	0.01	0.00	0.00	1.80
UCL [%]	12.09	0.03	1.22	0.24	0.34	0.18	6.18	0.14	0.21	0.01	0.00	0.00	1.75
PUF [%]	0.35	0.39	29.23	0.31	0.38	0.54	0.00	0.27	0.15	1.07	0.25	0.47	2.82
XUF [%]	0.00	0.00	0.38	1.12	1.16	1.48	2.33	3.00	3.03	1.80	1.99	1.22	1.46

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Historical Summary

Lifetime energy generation	:	164600.82 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.34 %
Cumulative Energy Availability Factor (EAF)	:	80.89 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.93 %
Cumulative Unit Capability Factor (UCF)	:	82.24 %	Cumulative Planned Unavailability Factor (PUF)	:	9.83 %
Cumulative Load Factor (LF)	:	78.99 %	Cumulative Externally cause unavailability (XUF)	:	1.35 %
Cumulative Operating Factor (OF)	:	84.18 %			

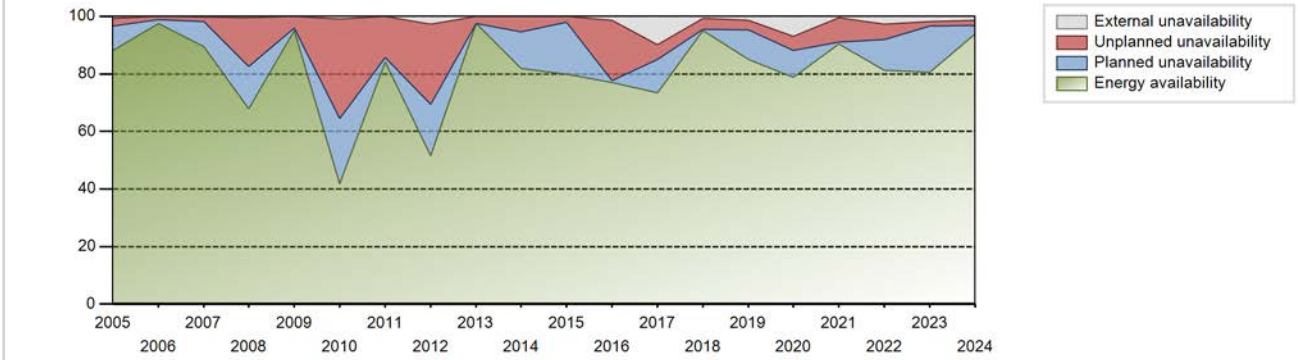
Electricity Production (net) [GWh]



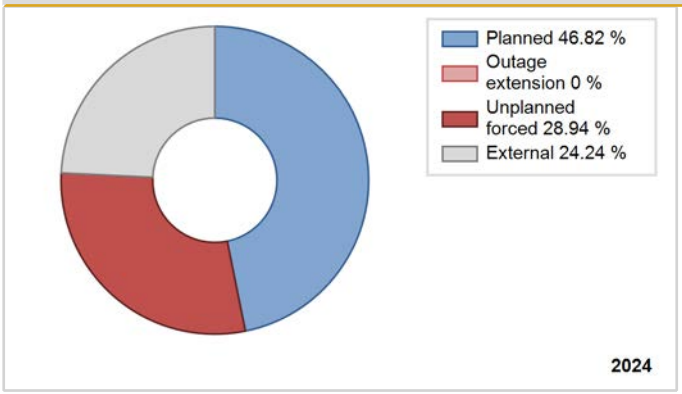
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1990	2775.82	5370	640	87.58	87.58	86.55	96.68	11.65	11.55	0.87	0.00
1991	4062.09	7022	640	74.45	74.45	72.45	80.16	2.12	1.61	23.94	0.00
1992	3746.44	7024	654	70.41	70.41	65.22	79.96	16.16	13.57	16.02	0.00
1993	4724.42	7851	654	90.57	90.57	82.46	89.62	8.80	8.74	0.68	0.00
1994	4061.96	7095	628	73.84	77.82	73.84	80.99	10.85	9.47	12.71	3.99
1995	4154.06	7128	628	75.51	78.07	75.51	81.37	10.00	8.67	13.26	2.56
1996	3442.34	6628	655	68.80	68.81	59.83	75.46	8.93	6.75	24.44	0.01
1997	5218.80	8577	615	95.87	95.97	96.87	97.91	3.71	3.70	0.33	0.10
1998	4412.45	7359	655	81.67	82.19	76.90	84.01	8.24	7.38	10.43	0.52
1999	4450.97	7466	670	81.47	82.84	75.79	85.23	6.08	5.36	11.80	1.36
2000	4577.65	7409	645	80.27	80.56	80.80	84.35	5.08	4.31	15.13	0.29
2001	4144.30	6808	645	73.16	74.88	73.35	77.72	9.31	7.68	17.43	1.72
2002	4196.25	6876	680	75.83	76.41	70.44	78.49	5.49	10.73	12.87	0.58
2003	5415.44	8642	680	97.60	97.94	90.91	98.65	1.69	1.69	0.37	0.34
2004	4168.90	6818	680	75.16	75.94	69.79	77.62	4.48	11.20	12.86	0.78
2005	5007.75	7884	680	88.20	88.82	84.07	90.00	2.94	2.69	8.49	0.61
2006	5529.73	8624	680	97.55	97.55	92.83	98.45	1.20	1.19	1.26	0.00
2007	5027.19	7963	680	89.41	89.62	84.39	90.90	1.82	1.66	8.71	0.22
2008	3797.81	6169	650	67.88	68.38	66.52	70.23	3.83	16.89	14.73	0.50
2009	5454.49	8534	650	95.01	95.01	95.79	97.42	4.20	4.17	0.83	0.00
2010	1886.55	3391	650	41.69	42.59	33.13	38.71	15.71	34.61	22.80	0.90
2011	4921.75	7598	650	84.20	84.30	86.44	86.74	14.51	14.31	1.39	0.10
2012	3418.65	5209	765	51.49	54.22	51.53	59.30	11.86	27.76	18.02	2.72
2013	5719.46	8585	665	97.44	97.46	98.18	98.00	2.41	2.40	0.13	0.03
2014	4875.98	7461	665	81.84	81.84	83.71	85.18	5.41	5.42	12.74	0.00
2015	4741.77	7033	665	79.88	79.91	81.41	80.29	0.87	2.07	18.02	0.03
2016	5096.56	6716	777	77.02	78.38	77.45	76.46	0.49	21.00	0.61	1.36
2017	5014.49	7454	777	73.49	83.38	73.67	85.09	3.15	5.03	11.59	9.90
2018	6496.56	8523	777	95.17	95.89	95.45	97.29	3.84	3.83	0.28	0.72
2019	5803.84	7754	777	85.13	86.42	85.27	88.52	1.66	3.35	10.23	1.29
2020	5394.16	7629	777	78.80	85.69	79.03	86.85	0.57	4.99	9.32	6.88
2021	6164.50	8035	777	90.45	90.99	90.58	91.73	8.48	8.44	0.57	0.55
2022	5537.79	7432	777	81.17	83.89	81.36	84.84	1.90	5.25	10.86	2.71
2023	5449.45	7349	777	80.50	82.23	80.06	83.89	1.94	1.74	16.03	1.72
2024	6328.76	8384	777	93.97	95.43	92.73	95.45	1.80	1.75	2.82	1.46

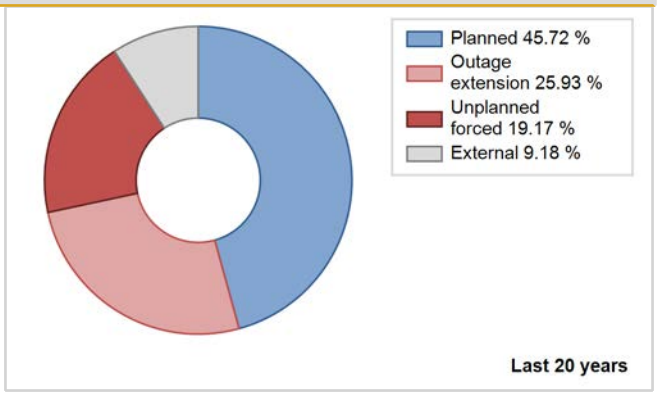
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1990 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		98			497	
B. Refuelling without maintenance				21		
C. Inspection, maintenance or repair combined with refuelling				704	16	
D. Inspection, maintenance or repair without refuelling	203			148		
E. Testing of plant systems or components				61	4	
J. Grid limitation, failure or grid unavailability			99			32
L. Human factor related					77	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
Z. Other					31	
Subtotal	203	98	99	934	625	34
Total	**400**			**1593**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1990 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		9
12. Reactor I&C Systems		82
13. Reactor Auxiliary Systems		42
14. Safety Systems		5
15. Reactor Cooling Systems		22
17. Safety I&C Systems (excluding reactor I&C)		3
21. Fuel Handling and Storage Facilities		65
31. Turbine and auxiliaries		93
32. Feedwater and Main Steam System	98	67
33. Circulating Water System		1
34. Miscellaneous Systems		0
35. All other I&C Systems		18
41. Main Generator Systems		15
42. Electrical Power Supply Systems	99	157
Total	**197**	**579**

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2024 Operating Experience

MX-2 LAGUNA VERDE-2 MEXICO



Status at end of year	:	**Operational**
Operator	:	CFE (COMISION FEDERAL DE ELECTRICIDAD)
Owner	:	CFE (COMISION FEDERAL DE ELECTRICIDAD)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-5
Thermal power	:	2317 MWth
Gross electrical power	:	803 MWe
Reference unit power (net)	:	775 MWe

Key Dates

Construction Date	:	1977-05-31
Grid Date	:	1994-11-10
Commercial Date	:	1995-04-09
Age at end of year	:	30 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.88
Refuelling frequency [month]	:	17.5
Part of the core refuelled [%]	:	32.43
Average discharge burnup [MWd/t]	:	45314.13
Active core diameter [m]	:	3.62
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	444
Fuel linear heat generation rate [kW/m]	:	16.06
Number of control rod assemblies	:	109
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

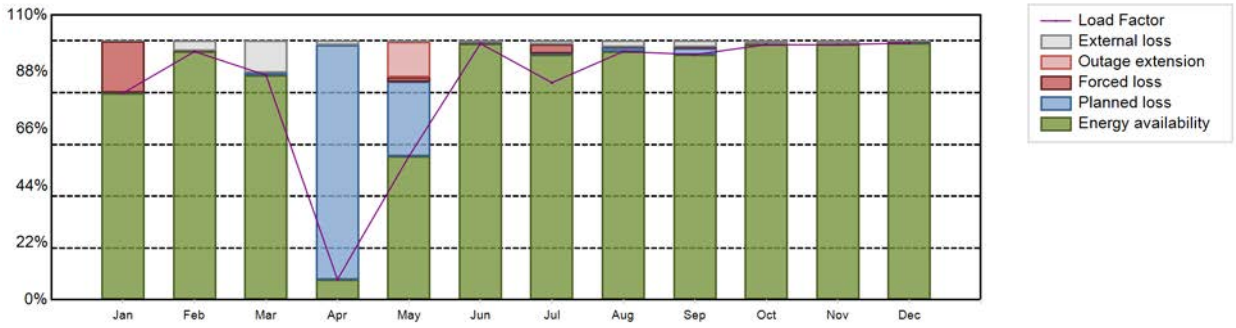
Operating coolant pressure [MPa]	:	7.2
Reactor outlet temperature [°C]	:	278
Number of SG	:	NA
Containment type	:	Double
Containment design pressure [MPa]	:	0.31
Secondary systems		
Number of turbine-generators per unit/reactor	:	3
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	6.15
Output voltage [kV]	:	22
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5649.01 GW(e).h
Energy Availability Factor (EAF)	:	83.89 %
Unit Capability Factor (UCF)	:	86.21 %
Load Factor (LF)	:	82.98 %
Operating Factor (OF)	:	87.12 %

Forced Loss Rate (FLR)	:	2.5 %
Unplanned Capability Loss Factor (UCL)	:	3.37 %
Planned Unavailability Factor (PUF)	:	10.42 %
Externally cause unavailability (XUF)	:	2.32 %
Total off-line time	:	1131 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	460.30	517.14	500.39	43.86	319.79	552.24	483.65	552.93	528.62	568.31	549.72	572.06	5649.01
EAF [%]	79.75	95.87	86.78	7.86	55.46	98.97	94.68	95.89	94.73	98.56	98.52	99.21	83.89
UCF [%]	80.00	99.83	98.99	9.47	55.89	99.60	95.95	98.33	97.09	99.63	99.70	99.64	86.21
LF [%]	79.83	95.87	86.78	7.86	55.46	98.97	83.88	95.89	94.73	98.56	98.52	99.21	82.98
OF [%]	82.93	100.00	100.00	10.00	60.48	100.00	91.67	100.00	100.00	100.00	100.00	100.00	87.12
FLR [%]	19.80	0.17	0.00	0.00	2.85	0.04	3.62	0.22	0.62	0.01	0.00	0.12	2.50
UCL [%]	19.75	0.17	0.00	0.00	15.33	0.04	3.60	0.22	0.61	0.01	0.00	0.12	3.37
PUF [%]	0.25	0.00	1.01	90.53	28.78	0.36	0.45	1.45	2.30	0.36	0.30	0.24	10.42
XUF [%]	0.25	3.96	12.21	1.61	0.43	0.63	1.27	2.44	2.36	1.07	1.18	0.42	2.32

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Historical Summary

Lifetime energy generation	:	149315.48 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.55 %
Cumulative Energy Availability Factor (EAF)	:	83.17 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.65 %
Cumulative Unit Capability Factor (UCF)	:	84.21 %	Cumulative Planned Unavailability Factor (PUF)	:	10.14 %
Cumulative Load Factor (LF)	:	81.5 %	Cumulative Externally cause unavailability (XUF)	:	1.03 %
Cumulative Operating Factor (OF)	:	86.66 %			

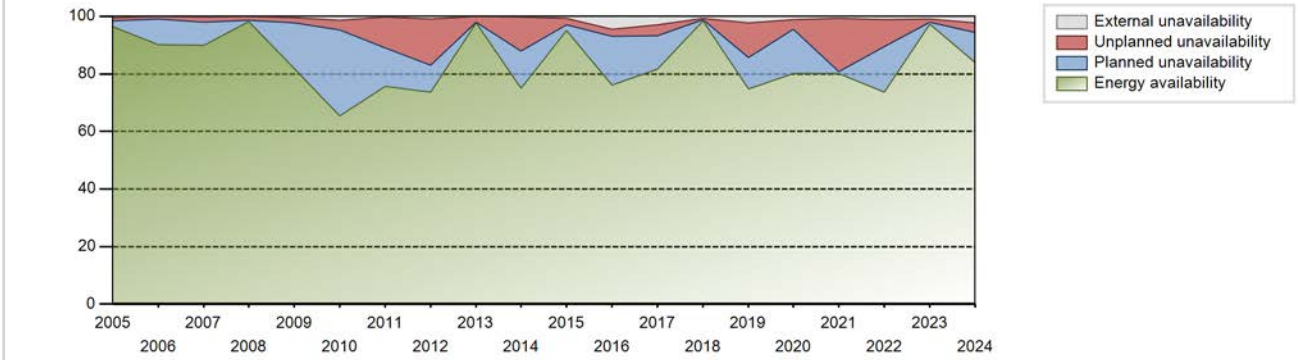
Electricity Production (net) [GWh]



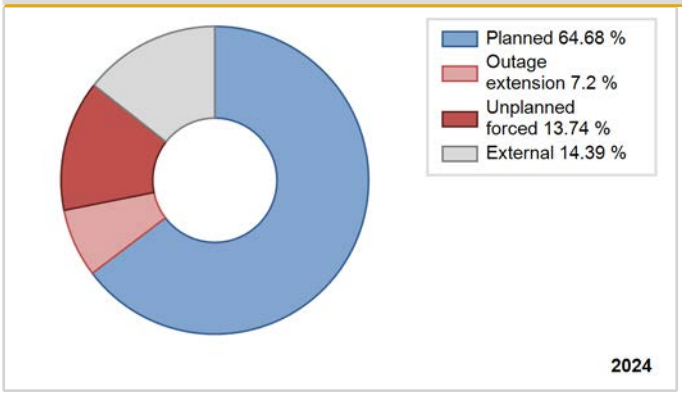
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1995	3379.40	5687	628	84.48	85.92	84.48	89.28	7.13	6.59	7.49	1.44
1996	3668.41	6657	619	70.97	71.67	67.47	75.79	3.52	2.61	25.71	0.71
1997	4805.53	7897	627	88.94	89.04	87.49	90.15	0.58	0.52	10.44	0.10
1998	4411.90	7609	655	83.02	85.58	76.89	86.86	1.14	0.98	13.44	2.56
1999	5110.57	8459	668	92.29	93.25	87.32	96.56	4.61	4.51	2.24	0.96
2000	3339.07	5865	645	56.63	58.56	58.93	66.77	29.16	24.10	17.34	1.93
2001	4228.06	6952	645	74.74	74.80	74.83	79.36	7.10	5.72	19.48	0.06
2002	5161.00	8273	680	91.49	91.54	86.63	94.43	6.98	7.69	0.77	0.05
2003	4604.83	7359	680	82.15	82.49	77.30	84.01	3.94	4.40	13.11	0.34
2004	4578.18	7449	680	82.97	83.80	76.65	84.80	0.49	3.32	12.88	0.82
2005	5310.30	8611	680	96.48	96.90	89.15	98.30	1.10	1.08	2.02	0.42
2006	4870.21	8003	680	90.25	90.34	81.76	91.36	0.97	0.88	8.78	0.09
2007	4920.19	8013	680	89.94	90.13	82.60	91.47	1.94	1.79	8.09	0.19
2008	5560.95	8730	650	98.29	98.29	97.40	99.39	1.27	1.27	0.44	0.00
2009	4653.65	7386	650	81.93	82.40	81.73	84.32	2.15	1.81	15.79	0.48
2010	3705.88	6289	650	65.40	66.85	65.08	71.79	2.96	3.30	29.85	1.44
2011	4391.62	7111	650	75.73	75.95	77.13	81.18	7.95	10.68	13.37	0.22
2012	4993.39	6854	765	73.60	74.46	74.31	78.03	3.76	16.14	9.41	0.86
2013	5657.68	8522	665	97.76	97.79	97.12	97.28	2.06	2.05	0.16	0.03
2014	4435.62	6705	665	74.95	75.25	76.15	76.55	6.61	11.68	13.07	0.30
2015	6442.96	8600	775	94.98	95.59	94.91	98.18	2.46	2.42	2.00	0.61
2016	5175.73	7194	775	76.05	80.56	76.03	81.90	2.96	2.46	16.98	4.51
2017	5557.43	7526	775	81.66	84.57	81.86	85.91	3.33	3.89	11.54	2.91
2018	6703.77	8726	775	98.48	99.16	98.74	99.61	0.45	0.45	0.38	0.68
2019	5076.89	7096	775	74.68	76.97	74.78	81.00	9.78	12.08	10.95	2.29
2020	5470.11	7435	775	80.23	81.31	80.36	84.65	3.99	3.38	15.31	1.08
2021	5441.04	7372	775	80.04	80.66	80.15	84.16	10.84	18.50	0.84	0.62
2022	5001.67	7089	775	73.62	74.74	73.67	80.92	8.72	9.46	15.80	1.12
2023	6594.14	8721	775	97.38	98.27	97.13	99.55	1.21	1.20	0.53	0.89
2024	5649.01	7653	775	83.89	86.21	82.98	87.12	2.50	3.37	10.42	2.32

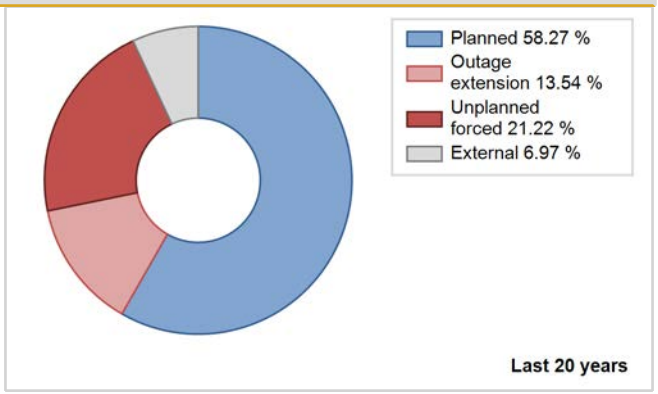
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1995 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		228			319	
B. Refuelling without maintenance				21		
C. Inspection, maintenance or repair combined with refuelling	840			712		
D. Inspection, maintenance or repair without refuelling				20		
E. Testing of plant systems or components				30		
J. Grid limitation, failure or grid unavailability			62			7
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						5
Z. Other					40	
Subtotal	840	228	62	783	360	12
Total	**1130**			**1155**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1995 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		6
12. Reactor I&C Systems		26
13. Reactor Auxiliary Systems		18
14. Safety Systems		2
15. Reactor Cooling Systems		4
16. Steam generation systems		2
21. Fuel Handling and Storage Facilities		16
31. Turbine and auxiliaries		77
32. Feedwater and Main Steam System	102	40
33. Circulating Water System		10
34. Miscellaneous Systems		3
35. All other I&C Systems		1
41. Main Generator Systems	127	29
42. Electrical Power Supply Systems	62	89
Total	**291**	**323**

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2024 Operating Experience

NL-2 BORSSELE NETHERLANDS, KINGDOM OF THE



Status at end of year	:	**Operational**
Operator	:	EPZ (N.V. ELEKTRICITEITS-PRODUKTIEMAATSCHAPPIJ ZUID-NEDERLAND)
Owner	:	EPZ (N.V. ELEKTRICITEITS-PRODUKTIEMAATSCHAPPIJ ZUID-NEDERLAND)
Reactor Supplier	:	S/KWU (SIEMENS/KRAFTWERK UNION, AG.)
Turbine Supplier	:	S/KWU (SIEMENS/KRAFTWERK UNION, AG.)

Reactor Unit Details

Reactor type and model	:	PWR / KWU 2LP
Thermal power	:	1366 MWth
Gross electrical power	:	515 MWe
Reference unit power (net)	:	482 MWe

Key Dates

Construction Date	:	1969-07-01
Grid Date	:	1973-07-04
Commercial Date	:	1973-10-26
Age at end of year	:	51 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2/MOX
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.4
Refuelling frequency [month]	:	11
Part of the core refuelled [%]	:	23
Average discharge burnup [MWd/t]	:	39000
Active core diameter [m]	:	2.676
Active core height/length [m]	:	2.65
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	20.26
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

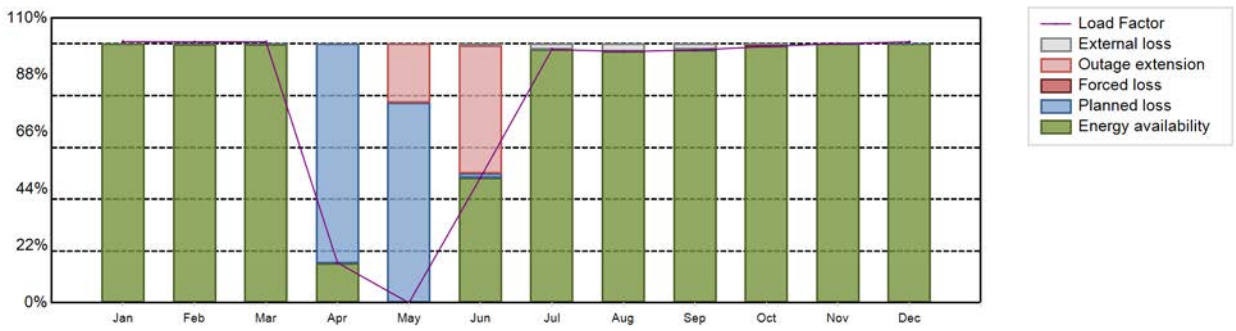
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	313
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.49
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	5.75
Output voltage [kV]	:	21
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	5
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3384.56 GW(e).h
Energy Availability Factor (EAF)	:	79.63 %
Unit Capability Factor (UCF)	:	80.31 %
Load Factor (LF)	:	79.94 %
Operating Factor (OF)	:	80.59 %

Forced Loss Rate (FLR)	:	0.08 %
Unplanned Capability Loss Factor (UCL)	:	6.03 %
Planned Unavailability Factor (PUF)	:	13.66 %
Externally cause unavailability (XUF)	:	0.68 %
Total off-line time	:	1705 hours

Annual Summary



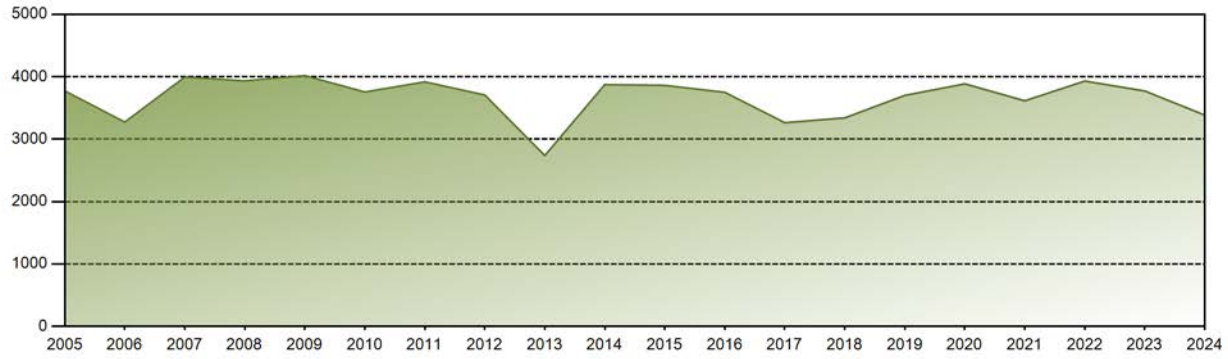
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	361.85	338.08	361.02	53.90	0.00	167.68	350.92	348.03	338.71	355.52	347.49	361.37	3384.56
EAF [%]	100.00	99.95	99.94	15.33	0.00	48.32	97.85	97.05	97.60	99.01	99.99	99.99	79.63
UCF [%]	100.00	99.95	99.94	15.33	0.00	48.91	99.90	100.00	99.61	99.50	99.99	99.99	80.31
LF [%]	100.90	100.78	100.81	15.53	0.00	48.32	97.85	97.05	97.60	99.01	100.13	100.77	79.94
OF [%]	100.00	100.00	100.00	15.83	0.00	50.69	100.00	100.00	100.00	100.00	100.00	100.00	80.59
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.50	0.00	0.00	0.08
UCL [%]	0.00	0.00	0.00	0.00	22.72	49.31	0.00	0.00	0.32	0.50	0.00	0.00	6.03
PUF [%]	0.00	0.05	0.06	84.67	77.28	1.78	0.10	0.00	0.07	0.00	0.01	0.01	13.66
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.60	2.04	2.95	2.01	0.49	0.00	0.00	0.68

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Historical Summary

Lifetime energy generation	:	174613.2 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.95 %
Cumulative Energy Availability Factor (EAF)	:	85.02 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.05 %
Cumulative Unit Capability Factor (UCF)	:	85.49 %	Cumulative Planned Unavailability Factor (PUF)	:	10.46 %
Cumulative Load Factor (LF)	:	84.66 %	Cumulative Externally cause unavailability (XUF)	:	0.48 %
Cumulative Operating Factor (OF)	:	86.31 %			

Electricity Production (net) [GWh]

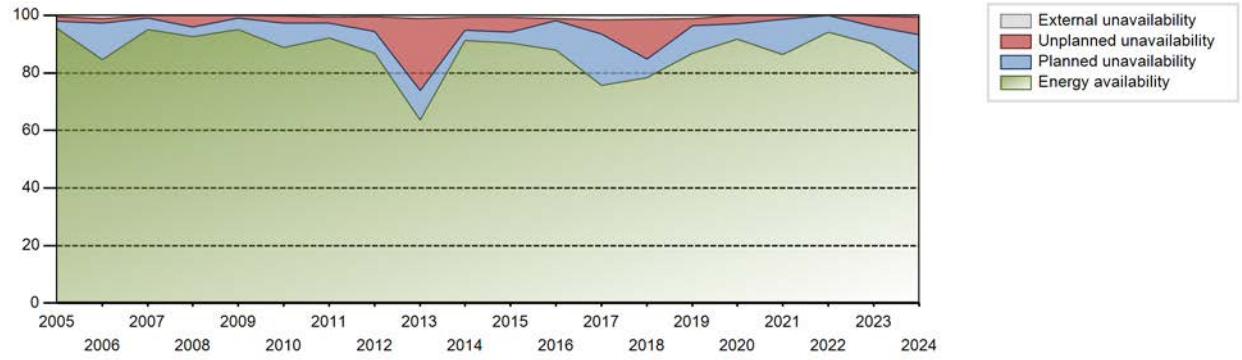


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1973	665.30	2682	448	47.75	47.75	47.72	71.31	52.25	52.25	0.00	0.00
1974	2993.70	6840	477	71.63	71.63	71.64	78.08	12.52	10.25	18.12	0.00
1975	2776.90	6494	447	70.83	70.83	70.92	74.13	4.64	3.45	25.72	0.00
1976	3274.40	7521	450	82.76	82.76	82.84	85.62	6.12	5.40	11.84	0.00
1977	3142.40	7318	450	80.38	80.38	79.72	83.54	0.00	0.00	19.62	0.00
1978	3424.10	7997	445	88.37	88.37	87.84	91.29	0.19	0.16	11.47	0.00
1979	2900.00	6785	445	83.48	83.48	74.39	77.45	4.96	4.36	12.16	0.00
1980	3593.00	8496	447	92.85	92.85	91.51	96.72	0.00	0.00	7.15	0.00
1981	3048.30	7094	447	78.79	78.79	77.85	80.98	0.35	0.28	20.93	0.00
1982	3315.90	7489	452	83.86	83.86	83.74	85.49	0.38	0.32	15.83	0.00
1983	3050.00	6959	452	76.92	76.92	77.03	79.44	15.15	13.73	9.35	0.00
1984	3062.00	6895	452	76.65	76.65	77.12	78.49	11.71	10.16	13.19	0.00
1985	3261.15	7299	452	81.94	83.28	82.36	83.32	0.01	0.01	16.71	1.35
1986	3574.00	8053	452	89.93	91.58	90.26	91.93	0.69	0.64	7.78	1.65
1987	2950.93	6756	452	74.24	76.64	74.53	77.12	5.35	4.33	19.03	2.40
1988	3032.55	6763	452	76.17	76.17	76.38	76.99	0.69	0.53	23.30	0.00
1989	3421.85	7711	452	87.05	87.05	86.42	88.03	0.83	0.73	12.22	0.00
1990	2885.86	6636	452	74.09	74.09	72.88	75.75	0.01	0.01	25.91	0.00
1991	2728.53	6221	452	69.24	69.29	68.91	71.02	23.33	21.09	9.62	0.05
1992	2830.34	6412	452	80.59	82.86	71.29	73.00	0.66	0.55	16.59	2.27
1993	3328.15	7376	452	83.59	84.27	84.05	84.20	6.31	5.68	10.05	0.68
1994	3321.97	7489	452	84.10	84.75	83.90	85.49	3.51	3.09	12.16	0.65
1995	3386.75	7654	452	86.84	87.08	85.53	87.37	5.56	5.13	7.79	0.25
1996	3520.28	7978	452	88.15	88.27	88.66	90.82	2.91	2.64	9.09	0.12
1997					Data not provided						
1998					"						
1999	3604.20	8363	449	94.19	94.19	91.63	95.47	0.94	0.89	4.91	0.00
2000	3698.96	8262	449	93.09	93.89	93.79	94.06	2.38	2.29	3.82	0.80
2001	3746.67	8404	449	94.61	94.61	95.26	95.94	0.21	0.20	5.19	0.00
2002	3686.89	8284	450	93.36	93.80	93.53	94.57	0.10	1.23	4.97	0.44
2003	3788.31	8431	450	95.31	95.31	96.10	96.24	1.09	1.44	3.25	0.00
2004	3604.69	8073	450	91.09	91.09	91.19	91.91	1.19	2.26	6.65	0.00
2005	3771.93	8430	450	95.49	95.92	95.69	96.23	1.65	1.61	2.47	0.43
2006	3272.61	7542	482	84.57	85.70	82.52	86.10	1.72	1.50	12.80	1.14
2007	3993.87	8346	482	95.12	95.23	94.59	95.27	0.34	0.78	3.99	0.11
2008	3933.64	8161	482	92.55	92.55	92.91	92.91	0.04	4.14	3.31	0.00
2009	4017.67	8352	482	95.08	95.13	95.15	95.34	0.92	0.90	3.96	0.05

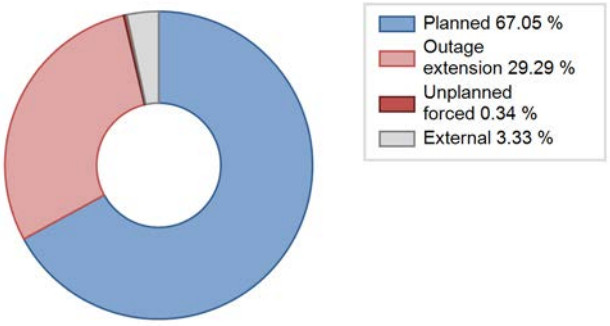
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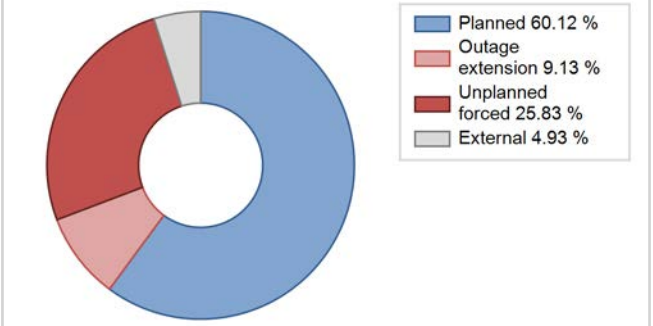
2010	3754.88	7807	482	88.86	89.09	88.93	89.12	1.78	2.55	8.36	0.23
2011	3917.24	8092	482	92.08	92.86	92.77	92.37	1.53	1.89	5.25	0.78
2012	3706.68	7722	482	86.89	87.43	87.55	87.91	5.52	5.10	7.47	0.54
2013	2736.93	5737	482	63.71	64.84	64.81	65.48	26.51	25.02	10.15	1.12
2014	3873.51	8054	482	91.18	91.95	91.75	91.95	1.23	4.35	3.70	0.77
2015	3861.63	8020	482	90.48	91.27	91.47	91.56	3.86	5.03	3.70	0.78
2016	3749.81	7836	482	87.85	89.11	88.58	89.22	0.63	0.67	10.22	1.26
2017	3263.18	6672	482	75.60	77.23	77.28	76.16	5.93	4.87	17.90	1.63
2018	3340.53	6997	482	78.30	79.70	79.13	79.88	12.43	13.88	6.41	1.41
2019	3700.71	7769	482	86.84	88.05	87.66	88.70	2.64	2.39	9.56	1.22
2020	3885.68	8100	482	91.69	91.79	91.78	92.21	2.93	2.77	5.44	0.10
2021	3614.16	7956	482	86.45	86.45	85.60	90.82	1.48	1.30	12.24	0.00
2022	3930.57	8265	482	94.13	94.13	93.10	94.36	0.03	0.02	5.85	0.00
2023	3771.24	7955	482	89.83	90.11	89.31	90.80	1.52	3.62	6.27	0.28
2024	3384.56	7079	482	79.63	80.31	79.94	80.59	0.08	6.03	13.66	0.68

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1973 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		524			231	
B. Refuelling without maintenance				21		
C. Inspection, maintenance or repair combined with refuelling	575			712	18	
D. Inspection, maintenance or repair without refuelling				37		
E. Testing of plant systems or components					17	
F. Major backfitting, refurbishment or upgrading activities with refuelling				20		
H. Nuclear regulatory requirements					2	
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					4	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
Z. Other	606			25	3	
Subtotal	1181	524		815	275	6
Total		**1705**			**1096**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1973 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		29
13. Reactor Auxiliary Systems		9
14. Safety Systems		26
15. Reactor Cooling Systems		19
16. Steam generation systems		29
31. Turbine and auxiliaries	524	27
32. Feedwater and Main Steam System		27
33. Circulating Water System		7
34. Miscellaneous Systems		22
41. Main Generator Systems		41
42. Electrical Power Supply Systems		16
Total	**524**	**254**

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2024 Operating Experience

PK-2 CHASNUPP-1 PAKISTAN



Status at end of year	:	**Operational**
Operator	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Owner	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Reactor Supplier	:	CNNC (CHINA NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	STW (Shanghai Turbine Works)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-300
Thermal power	:	999 MWth
Gross electrical power	:	325 MWe
Reference unit power (net)	:	300 MWe

Key Dates

Construction Date	:	1993-08-01
Grid Date	:	2000-06-13
Commercial Date	:	2000-09-15
Age at end of year	:	24 years

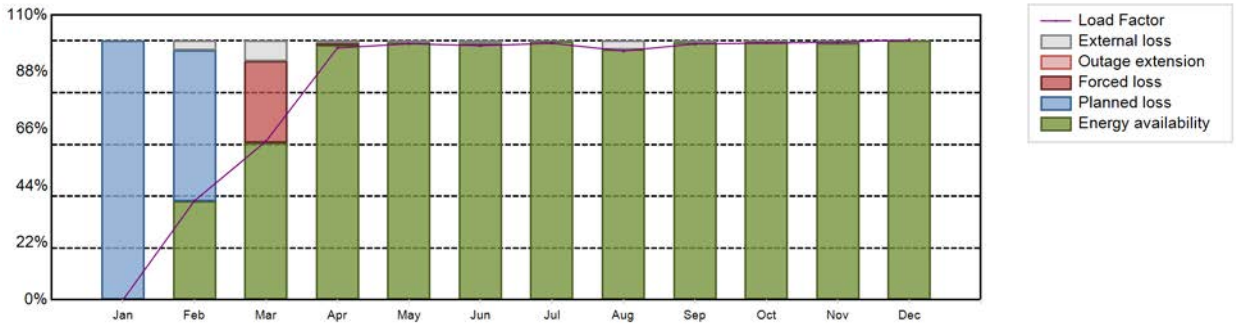
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.4
Refuelling frequency [month]	:	14
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	30000
Active core diameter [m]	:	2.486
Active core height/length [m]	:	2.9
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	13.59
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.2
Reactor outlet temperature [°C]	:	315.5
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.26
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	5.34
Output voltage [kV]	:	20
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2168.94 GW(e).h
Energy Availability Factor (EAF)	:	82.52 %
Unit Capability Factor (UCF)	:	84.15 %
Load Factor (LF)	:	82.31 %
Operating Factor (OF)	:	84.71 %
Forced Loss Rate (FLR)	:	3.13 %
Unplanned Capability Loss Factor (UCL)	:	2.72 %
Planned Unavailability Factor (PUF)	:	13.12 %
Externally cause unavailability (XUF)	:	1.63 %
Total off-line time	:	1343 hours

Annual Summary



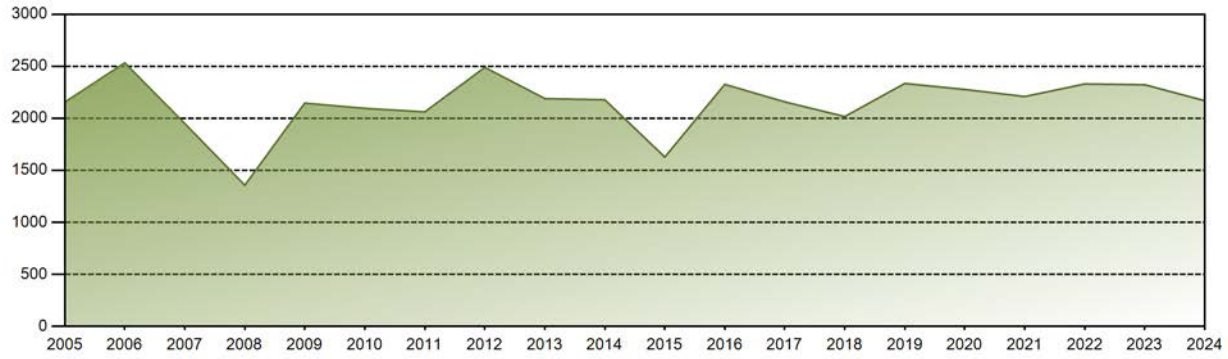
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	79.88	136.66	210.11	220.74	212.03	221.13	214.57	213.42	221.46	214.89	224.05	2168.94
EAF [%]	0.00	38.09	60.76	98.33	99.40	98.81	99.83	96.61	99.35	99.25	99.09	100.00	82.52
UCF [%]	0.00	41.63	68.65	99.22	100.00	99.98	100.00	100.00	100.00	99.65	100.00	100.00	84.15
LF [%]	0.00	38.26	61.23	97.27	98.90	98.16	99.07	96.13	98.81	99.22	99.48	100.38	82.31
OF [%]	0.00	46.26	69.76	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	84.71
FLR [%]	0.00	0.00	31.35	0.78	0.00	0.02	0.00	0.00	0.00	0.01	0.00	0.00	3.13
UCL [%]	0.00	0.00	31.35	0.78	0.00	0.02	0.00	0.00	0.00	0.01	0.00	0.00	2.72
PUF [%]	100.00	58.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	13.12
XUF [%]	0.00	3.54	7.89	0.89	0.60	1.17	0.17	3.39	0.65	0.40	0.91	0.00	1.63

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Historical Summary

Lifetime energy generation	:	50167.25 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.48 %
Cumulative Energy Availability Factor (EAF)	:	79.14 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.28 %
Cumulative Unit Capability Factor (UCF)	:	79.74 %	Cumulative Planned Unavailability Factor (PUF)	:	12.98 %
Cumulative Load Factor (LF)	:	78.19 %	Cumulative Externally cause unavailability (XUF)	:	0.6 %
Cumulative Operating Factor (OF)	:	81.2 %			

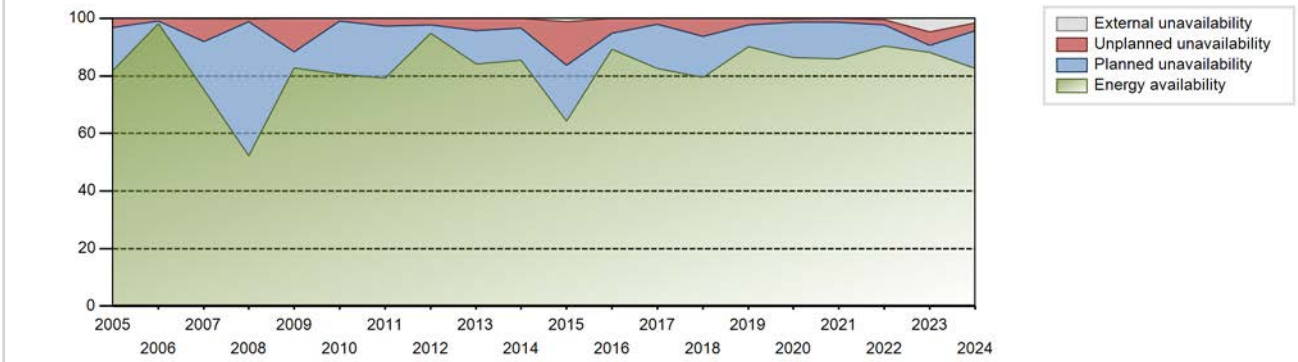
Electricity Production (net) [GWh]



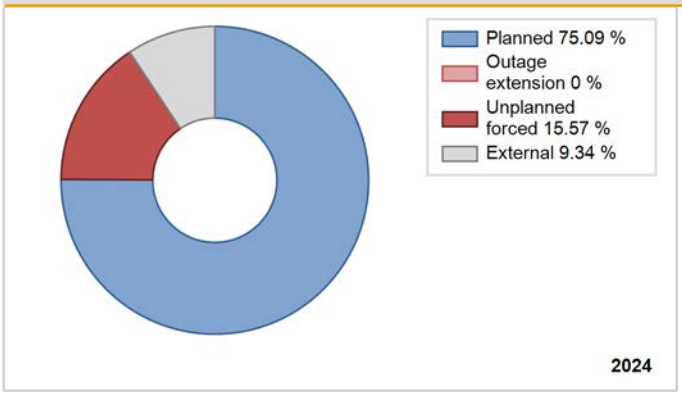
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2000	529.15	1860	300	72.19	72.19	68.69	72.43	19.54	17.53	10.28	0.00
2001	1581.75	5918	300	60.06	62.44	60.19	67.56	37.40	37.31	0.25	2.38
2002	1356.00	4790	300	52.25	53.69	51.60	54.68	20.87	16.73	29.58	1.44
2003	1809.80	6879	300	68.85	68.85	68.87	78.53	21.84	24.04	7.11	0.00
2004	1750.71	5949	300	66.35	68.12	66.44	67.73	4.20	13.12	18.76	1.77
2005	2155.19	7458	300	81.92	81.92	82.01	85.14	3.83	3.26	14.82	0.00
2006	2532.91	8569	300	98.19	98.19	96.38	97.82	0.91	0.90	0.91	0.00
2007	1949.13	6669	300	75.22	75.55	74.17	76.13	2.98	7.76	16.69	0.33
2008	1356.45	4795	300	52.25	52.40	51.47	54.59	1.70	0.90	46.69	0.15
2009	2145.87	7379	300	82.80	82.82	81.65	84.24	10.86	11.69	5.49	0.02
2010	2095.76	7160	300	80.66	80.66	79.75	81.74	0.96	0.96	18.37	0.00
2011	2061.67	7008	300	79.31	79.31	78.45	80.00	3.04	2.83	17.87	0.00
2012	2489.25	8370	300	94.74	94.79	94.46	95.29	2.34	2.27	2.94	0.05
2013	2189.64	7481	300	84.04	84.04	83.32	85.40	4.53	4.38	11.59	0.00
2014	2178.22	7434	300	85.57	85.61	82.89	84.86	3.64	3.23	11.16	0.04
2015	1627.53	5831	300	64.28	65.44	61.93	66.56	3.33	15.04	19.52	1.17
2016	2326.46	8291	300	89.27	89.27	88.28	94.39	0.82	5.23	5.50	0.00
2017	2157.86	7391	300	82.53	82.55	82.11	84.37	2.48	2.10	15.36	0.01
2018	2017.02	6950	300	79.42	79.52	76.75	79.34	7.15	6.12	14.36	0.10
2019	2335.20	7907	300	90.23	90.33	88.86	90.26	2.44	2.26	7.41	0.10
2020	2277.56	7682	300	86.43	86.65	86.43	87.45	1.31	1.15	12.20	0.22
2021	2209.57	7546	300	85.84	85.89	84.08	86.14	1.46	1.27	12.84	0.05
2022	2330.60	8020	300	90.46	90.99	88.68	91.55	1.92	1.78	7.23	0.53
2023	2322.68	8131	300	88.11	92.80	88.38	92.82	4.86	4.74	2.45	4.70
2024	2168.94	7441	300	82.52	84.15	82.31	84.71	3.13	2.72	13.12	1.63

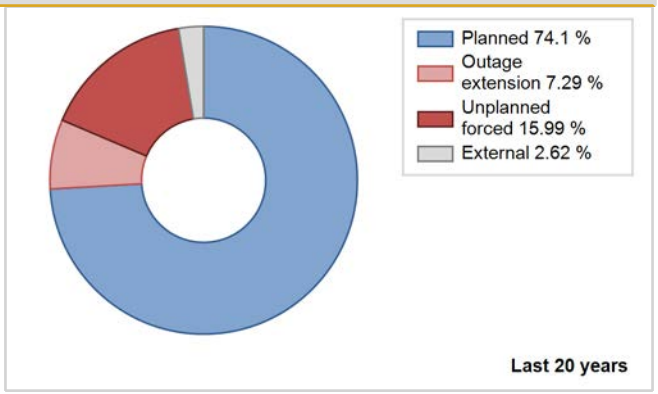
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2000 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		225			475	
C. Inspection, maintenance or repair combined with refuelling	1118			995	6	
D. Inspection, maintenance or repair without refuelling				56		
E. Testing of plant systems or components				3	1	
J. Grid limitation, failure or grid unavailability						83
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						13
L. Human factor related					5	
P. Fire					5	
Z. Other					19	
Subtotal	1118	225		1054	511	96
Total	**1343**			**1661**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2000 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		37
12. Reactor I&C Systems		25
13. Reactor Auxiliary Systems		6
14. Safety Systems		34
15. Reactor Cooling Systems		105
16. Steam generation systems		6
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		119
32. Feedwater and Main Steam System		39
33. Circulating Water System		7
35. All other I&C Systems		2
41. Main Generator Systems	225	39
42. Electrical Power Supply Systems		85
Total	**225**	**506**

Highlights (2024)

--Plant remained in Refueling Outage (RFO-16) for 46.59 days. [actual outage is from 23-12-2023 (0538) to 16-02-2024 (1423)]
--Plant faced 2 Auto Scrams due to "Generator Protection Actuated at loss of excitation" on 14th march 2024 (1745 hrs) and 18th march 2024 (0405 hrs)

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2024 Operating Experience

PK-3 CHASNUPP-2 PAKISTAN



Status at end of year	:	**Operational**
Operator	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Owner	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Reactor Supplier	:	CNNC (CHINA NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	STC (Shanghai Turbine Co.)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-300
Thermal power	:	999 MWth
Gross electrical power	:	325 MWe
Reference unit power (net)	:	300 MWe

Key Dates

Construction Date	:	2005-12-28
Grid Date	:	2011-03-14
Commercial Date	:	2011-05-18
Age at end of year	:	13 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.4
Refuelling frequency [month]	:	14
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	32000
Active core diameter [m]	:	2.486
Active core height/length [m]	:	2.9
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	13.59
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

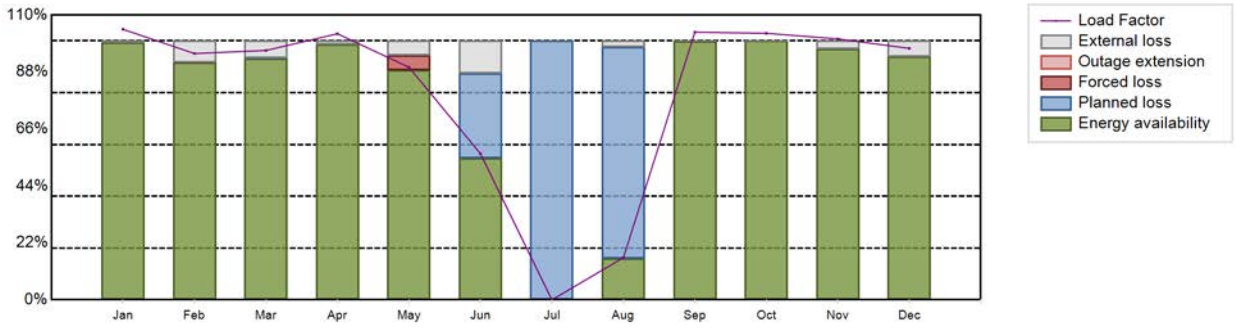
Operating coolant pressure [MPa]	:	15.2
Reactor outlet temperature [°C]	:	315.5
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.26
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	5.34
Output voltage [kV]	:	20
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2115.05 GW(e).h
Energy Availability Factor (EAF)	:	77.55 %
Unit Capability Factor (UCF)	:	81.41 %
Load Factor (LF)	:	80.26 %
Operating Factor (OF)	:	81.86 %

Forced Loss Rate (FLR)	:	0.59 %
Unplanned Capability Loss Factor (UCL)	:	0.48 %
Planned Unavailability Factor (PUF)	:	18.11 %
Externally cause unavailability (XUF)	:	3.86 %
Total off-line time	:	1593 hours

Annual Summary



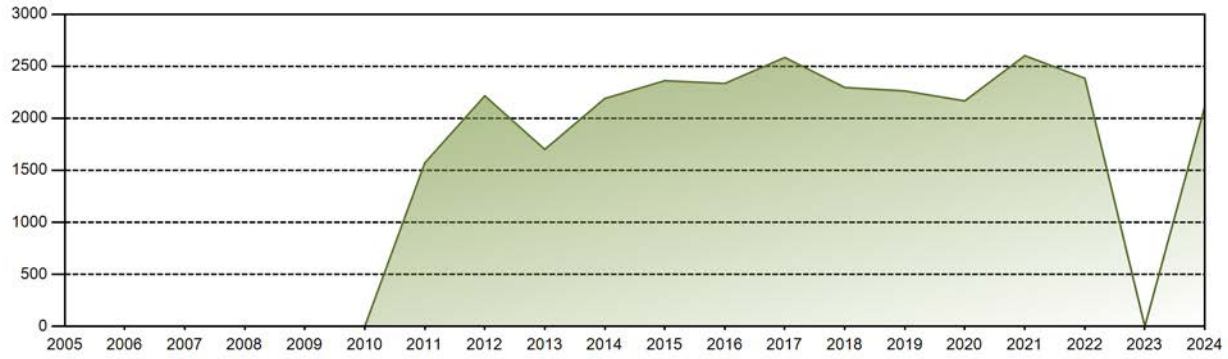
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	233.20	198.61	214.98	221.98	200.50	122.00	0.00	36.33	223.27	229.75	217.69	216.74	2115.05
EAF [%]	99.43	91.58	93.12	98.60	88.62	54.66	0.00	16.03	99.89	99.99	96.90	93.91	77.55
UCF [%]	100.00	99.97	99.62	100.00	94.31	67.23	0.00	18.31	100.00	100.00	100.00	100.00	81.41
LF [%]	104.48	95.12	96.32	102.77	89.83	56.48	0.00	16.28	103.37	102.93	100.78	97.10	80.26
OF [%]	100.00	100.00	100.00	100.00	95.03	68.06	0.00	21.77	100.00	100.00	100.00	100.00	81.86
FLR [%]	0.00	0.03	0.00	0.00	5.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59
UCL [%]	0.00	0.03	0.00	0.00	5.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48
PUF [%]	0.00	0.00	0.38	0.00	0.00	32.77	100.00	81.69	0.00	0.00	0.00	0.00	18.11
XUF [%]	0.57	8.39	6.49	1.40	5.69	12.57	0.00	2.28	0.11	0.01	3.10	6.09	3.86

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Historical Summary

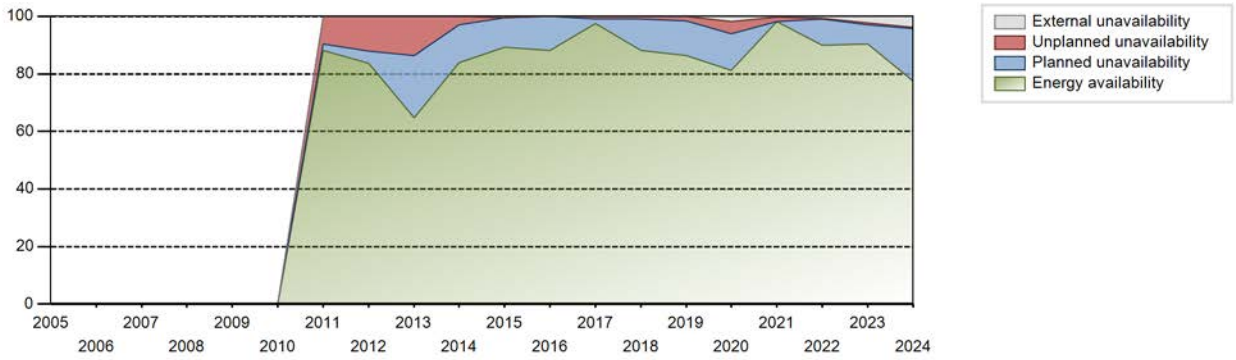
Lifetime energy generation	:	31249.61 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.91 %
Cumulative Energy Availability Factor (EAF)	:	86.18 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.3 %
Cumulative Unit Capability Factor (UCF)	:	86.88 %	Cumulative Planned Unavailability Factor (PUF)	:	9.82 %
Cumulative Load Factor (LF)	:	86.73 %	Cumulative Externally cause unavailability (XUF)	:	0.7 %
Cumulative Operating Factor (OF)	:	87.85 %			

Electricity Production (net) [GWh]



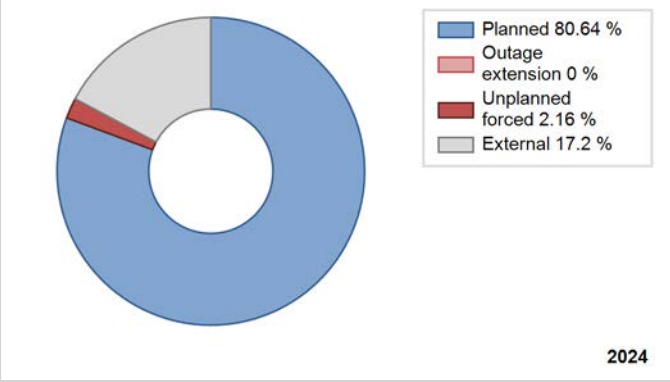
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2011	1570.98	5766	300	88.25	88.25	85.28	86.94	7.81	9.56	2.19	0.00
2012	2215.76	7864	300	83.74	83.77	84.08	89.53	12.44	11.96	4.27	0.03
2013	1700.82	6308	300	64.68	64.68	64.72	72.01	7.80	13.73	21.59	0.00
2014	2190.36	7546	300	83.93	83.93	83.35	86.14	3.49	3.04	13.03	0.00
2015	2361.48	7855	300	89.21	89.74	89.86	89.67	0.02	0.02	10.24	0.54
2016	2335.43	7718	300	88.18	88.18	88.62	87.86	0.00	0.00	11.82	0.00
2017	2584.57	8520	300	97.61	97.61	98.35	97.26	0.87	0.86	1.53	0.00
2018	2296.39	7679	300	88.15	88.16	87.38	87.66	1.05	0.94	10.91	0.00
2019	2263.06	7573	300	86.37	86.41	86.11	86.45	1.79	1.57	12.02	0.04
2020	2167.47	7379	300	81.33	83.13	82.25	84.01	4.82	4.21	12.66	1.80
2021	2602.18	8493	300	98.19	98.41	99.02	96.95	1.54	1.54	0.05	0.22
2022	2384.89	7902	300	89.90	90.53	90.75	90.21	0.39	0.35	9.12	0.63
2023	Data not provided										
2024	2115.05	7191	300	77.55	81.41	80.26	81.86	0.59	0.48	18.11	3.86

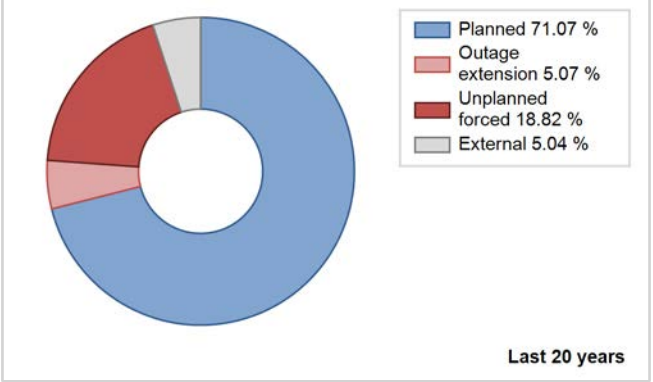
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2011 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		37			252	
C. Inspection, maintenance or repair combined with refuelling	1557			751		
D. Inspection, maintenance or repair without refuelling				8		
J. Grid limitation, failure or grid unavailability						67
Subtotal	1557	37		759	252	67
Total	**1594**			**1078**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2011 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		23
15. Reactor Cooling Systems		61
16. Steam generation systems		15
31. Turbine and auxiliaries		38
32. Feedwater and Main Steam System		9
33. Circulating Water System		3
41. Main Generator Systems		38
42. Electrical Power Supply Systems	37	60
Total	**37**	**247**

Highlights (2024)

--Plant faced 01 Automatic SCRAM while critical due to Reactor trip on Turbine Trip due to isolation of Main Transformer. [11-May-2024, 0746 hrs.]

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2024 Operating Experience

PK-4 CHASNUPP-3 PAKISTAN



Status at end of year	:	**Operational**
Operator	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Owner	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Reactor Supplier	:	CNNC (CHINA NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	STC (Shanghai Turbine Co.)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-300
Thermal power	:	999 MWth
Gross electrical power	:	340 MWe
Reference unit power (net)	:	315 MWe

Key Dates

Construction Date	:	2011-05-28
Grid Date	:	2016-10-15
Commercial Date	:	2016-12-06
Age at end of year	:	8 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.4
Refuelling frequency [month]	:	14
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	32000
Active core diameter [m]	:	2.486
Active core height/length [m]	:	2.9
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	13.59
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

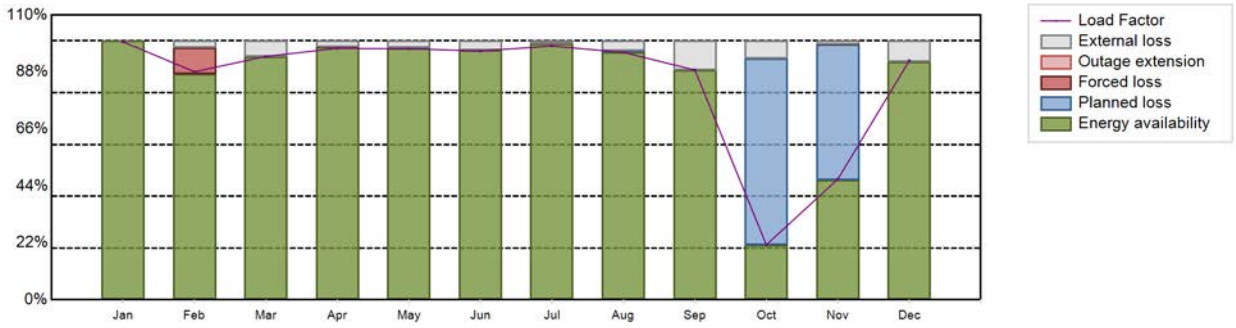
Operating coolant pressure [MPa]	:	15.2
Reactor outlet temperature [°C]	:	315.5
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.26
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	5.34
Output voltage [kV]	:	20
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2339.61 GW(e).h
Energy Availability Factor (EAF)	:	84.58 %
Unit Capability Factor (UCF)	:	88.75 %
Load Factor (LF)	:	84.56 %
Operating Factor (OF)	:	89.74 %

Forced Loss Rate (FLR)	:	0.91 %
Unplanned Capability Loss Factor (UCL)	:	0.82 %
Planned Unavailability Factor (PUF)	:	10.43 %
Externally cause unavailability (XUF)	:	4.17 %
Total off-line time	:	901 hours

Annual Summary



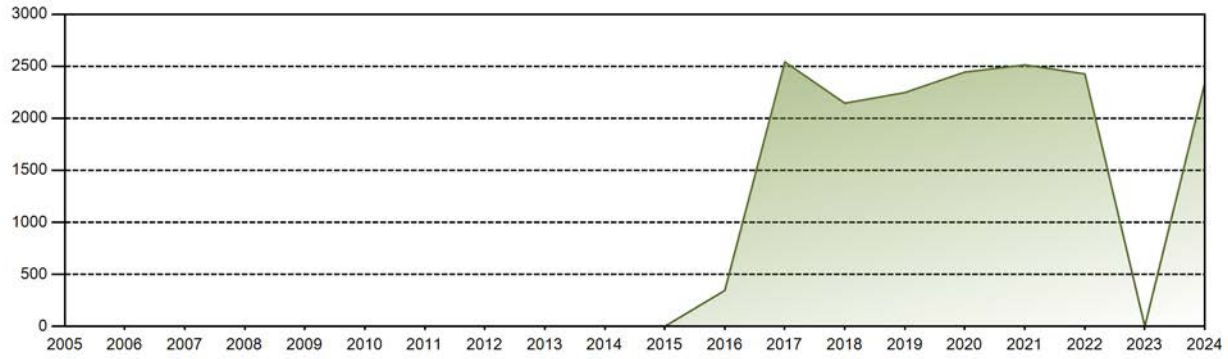
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	233.59	193.10	220.37	220.29	227.21	217.98	229.68	223.97	201.29	49.81	105.77	216.55	2339.61
EAF [%]	100.00	87.32	93.83	97.60	97.23	96.42	98.75	95.76	88.65	21.10	46.33	91.81	84.58
UCF [%]	100.00	89.90	100.00	99.85	99.95	100.00	100.00	99.52	100.00	27.99	47.61	100.00	88.75
LF [%]	99.67	88.08	94.03	97.13	96.95	96.11	98.00	95.57	88.75	21.25	46.63	92.40	84.56
OF [%]	100.00	95.11	100.00	100.00	100.00	100.00	100.00	100.00	100.00	30.38	51.53	100.00	89.74
FLR [%]	0.00	10.10	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.91
UCL [%]	0.00	10.10	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.82
PUF [%]	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.48	0.00	72.01	52.34	0.00	10.43
XUF [%]	0.00	2.58	6.17	2.26	2.72	3.58	1.25	3.76	11.35	6.89	1.27	8.19	4.17

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Historical Summary

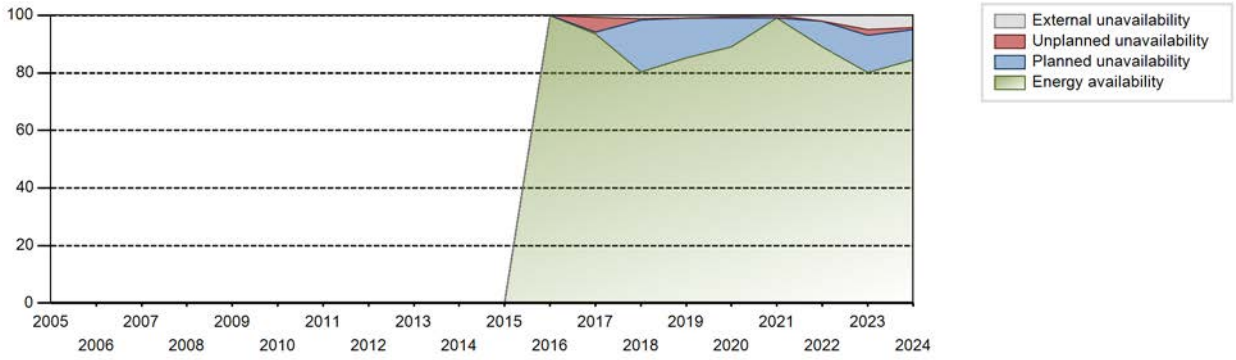
Lifetime energy generation	:	19227.98 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.33 %
Cumulative Energy Availability Factor (EAF)	:	87.76 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.21 %
Cumulative Unit Capability Factor (UCF)	:	89.56 %	Cumulative Planned Unavailability Factor (PUF)	:	9.23 %
Cumulative Load Factor (LF)	:	85.57 %	Cumulative Externally cause unavailability (XUF)	:	1.8 %
Cumulative Operating Factor (OF)	:	89.85 %			

Electricity Production (net) [GWh]

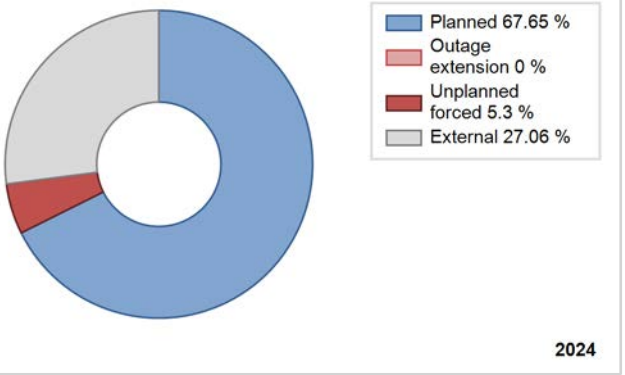


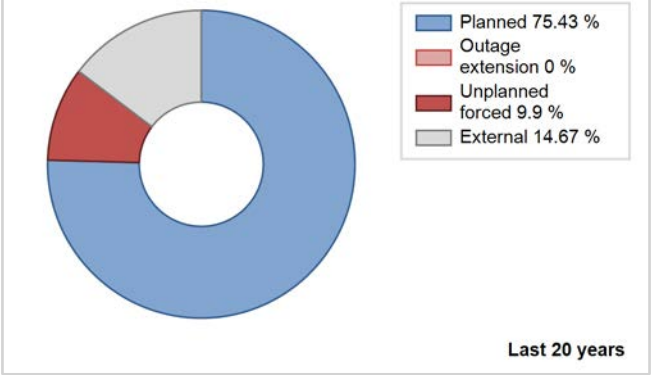
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	344.98	1436	315	100.00	100.00	97.84	100.00	0.00	0.00	0.00	0.00
2017	2542.08	8256	315	93.53	94.13	92.12	94.25	5.36	5.33	0.54	0.60
2018	2145.22	7152	315	80.37	81.52	77.74	81.64	0.66	0.54	17.94	1.16
2019	2247.57	7508	315	85.26	86.16	81.45	85.71	0.00	0.00	13.84	0.90
2020	2444.19	7931	315	89.15	89.70	88.33	90.29	0.49	0.44	9.86	0.55
2021	2513.45	8649	315	99.02	99.16	91.09	98.73	0.73	0.73	0.11	0.14
2022	2426.79	8071	315	89.05	91.08	87.95	92.13	0.04	0.03	8.88	2.03
2023	Data not provided										
2024	2339.61	7883	315	84.58	88.75	84.56	89.74	0.91	0.82	10.43	4.17

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		34			89	
C. Inspection, maintenance or repair combined with refuelling	867			763		
J. Grid limitation, failure or grid unavailability						42
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						6
Subtotal	867	34		763	89	48
Total	**901**			**900**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		21
15. Reactor Cooling Systems		4
16. Steam generation systems		34
31. Turbine and auxiliaries		22
33. Circulating Water System		3
41. Main Generator Systems	34	4
Total	**34**	**88**

Highlights (2024)

-- Plant Faced 01 trip on generator differential protection actuation. (15 Feb 2024 (0257 hrs.))

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2024 Operating Experience

PK-5 CHASNUPP-4 PAKISTAN



Status at end of year	:	**Operational**
Operator	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Owner	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Reactor Supplier	:	CNNC (CHINA NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	STC (Shanghai Turbine Co.)

Reactor Unit Details

Reactor type and model	:	PWR / CNP-300
Thermal power	:	999 MWth
Gross electrical power	:	340 MWe
Reference unit power (net)	:	313 MWe

Key Dates

Construction Date	:	2011-12-18
Grid Date	:	2017-06-25
Commercial Date	:	2017-09-19
Age at end of year	:	7 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.4
Refuelling frequency [month]	:	14
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	32000
Active core diameter [m]	:	2.486
Active core height/length [m]	:	2.9
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	13.59
Number of control rod assemblies	:	34
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

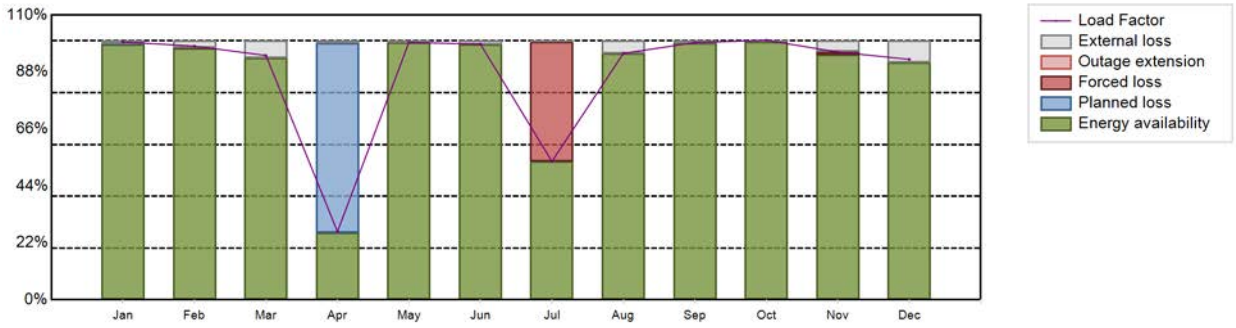
Operating coolant pressure [MPa]	:	15.2
Reactor outlet temperature [°C]	:	315.5
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.26
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	5.34
Output voltage [kV]	:	20
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2414.18 GW(e).h
Energy Availability Factor (EAF)	:	87.26 %
Unit Capability Factor (UCF)	:	89.95 %
Load Factor (LF)	:	87.81 %
Operating Factor (OF)	:	90.65 %

Forced Loss Rate (FLR)	:	4.29 %
Unplanned Capability Loss Factor (UCL)	:	4.03 %
Planned Unavailability Factor (PUF)	:	6.02 %
Externally cause unavailability (XUF)	:	2.7 %
Total off-line time	:	821 hours

Annual Summary



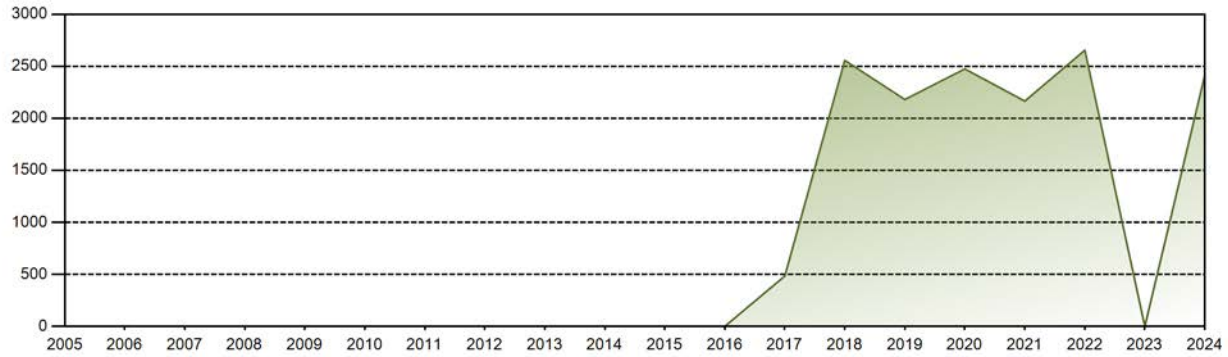
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	231.94	213.46	219.81	59.40	231.52	222.54	124.53	221.66	223.91	233.44	215.67	216.30	2414.18
EAF [%]	98.64	97.03	93.45	26.02	99.25	98.72	53.45	95.10	99.05	99.52	94.74	91.76	87.26
UCF [%]	99.65	99.64	100.00	26.97	100.00	100.00	53.78	100.00	100.00	100.00	98.92	100.00	89.95
LF [%]	99.60	97.99	94.39	26.36	99.42	98.75	53.47	95.19	99.36	100.24	95.70	92.88	87.81
OF [%]	100.00	100.00	100.00	31.39	100.00	100.00	56.05	100.00	100.00	100.00	100.00	100.00	90.65
FLR [%]	0.00	0.36	0.00	0.00	0.00	0.00	46.22	0.00	0.00	0.00	1.08	0.00	4.29
UCL [%]	0.00	0.36	0.00	0.00	0.00	0.00	46.22	0.00	0.00	0.00	1.08	0.00	4.03
PUF [%]	0.35	0.00	0.00	73.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.02
XUF [%]	1.01	2.62	6.55	0.95	0.75	1.28	0.33	4.90	0.95	0.48	4.18	8.24	2.70

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Historical Summary

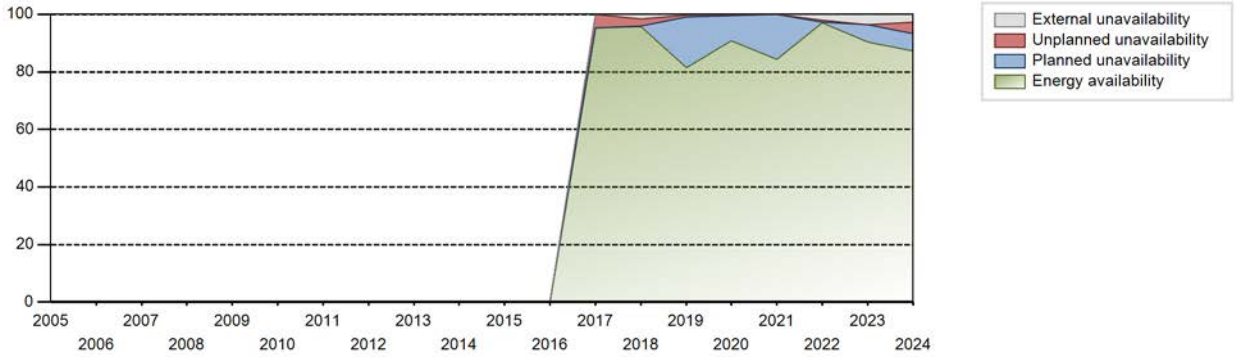
Lifetime energy generation	:	17425.34 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.4 %
Cumulative Energy Availability Factor (EAF)	:	89.78 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.3 %
Cumulative Unit Capability Factor (UCF)	:	91.23 %	Cumulative Planned Unavailability Factor (PUF)	:	7.47 %
Cumulative Load Factor (LF)	:	86.34 %	Cumulative Externally cause unavailability (XUF)	:	1.45 %
Cumulative Operating Factor (OF)	:	89.43 %			

Electricity Production (net) [GWh]

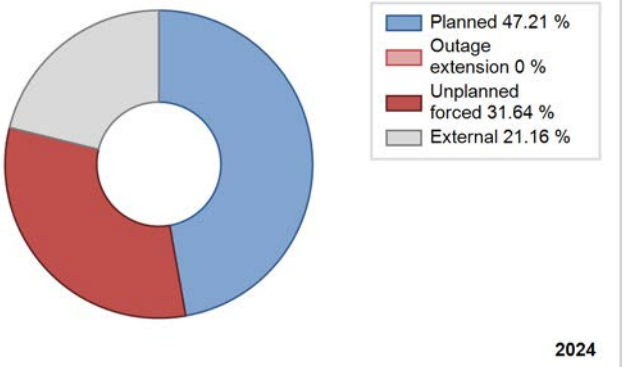


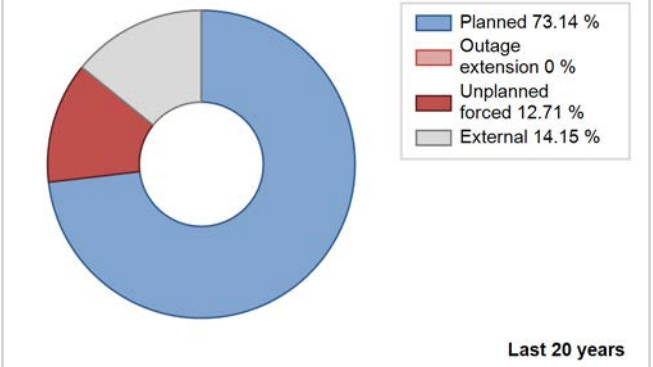
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2017	484.17	1946	313	95.21	95.22	35.01	38.13	4.78	4.78	0.00	0.01
2018	2557.08	8452	313	95.74	97.25	93.26	96.48	2.63	2.63	0.12	1.51
2019	2181.00	7237	313	81.52	81.88	79.54	82.61	0.80	0.66	17.46	0.36
2020	2474.85	8068	313	90.76	91.09	90.01	91.85	0.05	0.05	8.86	0.34
2021	2165.43	7407	313	84.32	84.42	78.98	84.55	0.00	0.00	15.58	0.11
2022	2654.75	8673	313	97.10	99.04	96.82	99.01	0.83	0.83	0.13	1.94
2023	Data not provided										
2024	2414.18	7963	313	87.26	89.95	87.81	90.65	4.29	4.03	6.02	2.70

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2017 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		327			94	
C. Inspection, maintenance or repair combined with refuelling	494			621		
J. Grid limitation, failure or grid unavailability						207
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						6
Subtotal	494	327		621	94	213
Total	**821**			**928**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2017 to 2024 Average hours lost per reactor-year
15. Reactor Cooling Systems		3
16. Steam generation systems		0
31. Turbine and auxiliaries	327	59
41. Main Generator Systems		27
Total	**327**	**89**

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2024 Operating Experience

PK-6 KANUPP-2 PAKISTAN



Status at end of year	:	**Operational**
Operator	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Owner	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Reactor Supplier	:	CZEC (China Zhongyuan Engineering Corporation)
Turbine Supplier	:	STC (Shanghai Turbine Co.)

Reactor Unit Details

Reactor type and model	:	PWR / ACP-1000
Thermal power	:	3060 MWth
Gross electrical power	:	1100 MWe
Reference unit power (net)	:	1017 MWe

Key Dates

Construction Date	:	2015-08-20
Grid Date	:	2021-03-18
Commercial Date	:	2021-05-21
Age at end of year	:	3 years

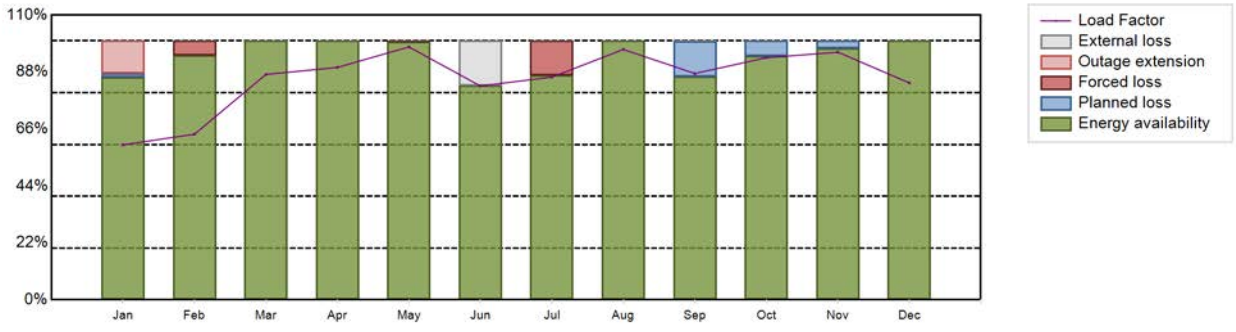
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7630.13 GW(e).h	Forced Loss Rate (FLR)	:	1.64 %
Energy Availability Factor (EAF)	:	93.93 %	Unplanned Capability Loss Factor (UCL)	:	2.66 %
Unit Capability Factor (UCF)	:	95.37 %	Planned Unavailability Factor (PUF)	:	1.97 %
Load Factor (LF)	:	85.41 %	Externally cause unavailability (XUF)	:	1.44 %
Operating Factor (OF)	:	96.28 %	Total off-line time	:	327 hours

Annual Summary



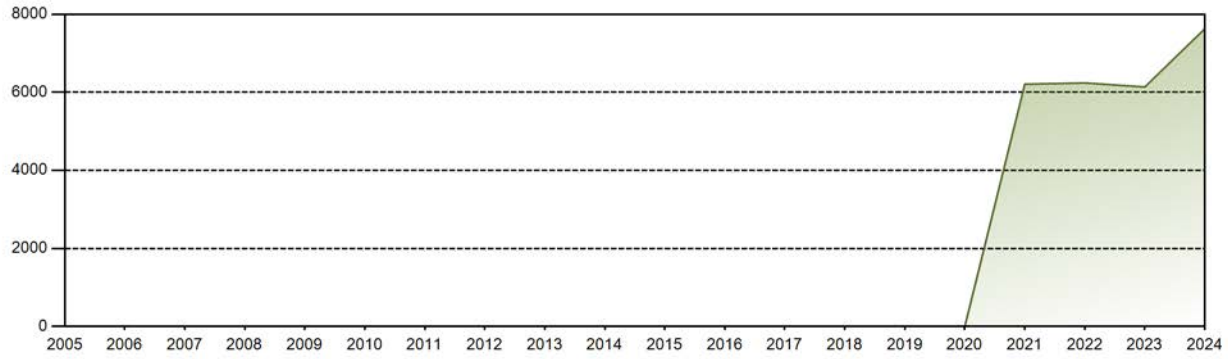
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	452.98	452.81	658.75	657.26	739.00	604.79	650.91	731.68	640.09	707.48	700.42	633.96	7630.13
EAF [%]	85.86	94.49	100.00	100.00	99.55	82.62	86.80	100.00	86.28	94.21	97.08	100.00	93.93
UCF [%]	85.86	94.49	100.00	100.00	99.55	100.00	86.80	100.00	86.52	94.21	97.08	100.00	95.37
LF [%]	59.87	63.97	87.06	89.76	97.67	82.59	86.03	96.70	87.42	93.50	95.65	83.79	85.41
OF [%]	87.37	94.97	100.00	100.00	100.00	85.56	87.37	100.00	100.00	100.00	100.00	100.00	96.28
FLR [%]	0.00	5.51	0.00	0.00	0.45	0.00	13.20	0.00	0.00	0.00	0.00	0.00	1.64
UCL [%]	12.57	5.51	0.00	0.00	0.45	0.00	13.20	0.00	0.00	0.00	0.00	0.00	2.66
PUF [%]	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.48	5.79	2.92	0.00	1.97
XUF [%]	0.00	0.00	0.00	0.00	0.00	17.38	0.00	0.00	0.23	0.00	0.00	0.00	1.44

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Historical Summary

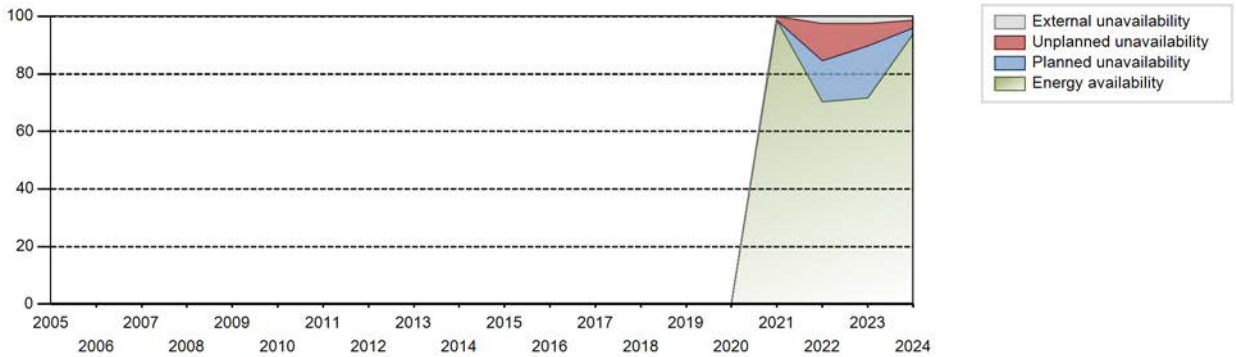
Lifetime energy generation	:	26216.18 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.08 %
Cumulative Energy Availability Factor (EAF)	:	81.91 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.72 %
Cumulative Unit Capability Factor (UCF)	:	83.71 %	Cumulative Planned Unavailability Factor (PUF)	:	9.58 %
Cumulative Load Factor (LF)	:	78.7 %	Cumulative Externally cause unavailability (XUF)	:	1.8 %
Cumulative Operating Factor (OF)	:	84.35 %			

Electricity Production (net) [GWh]

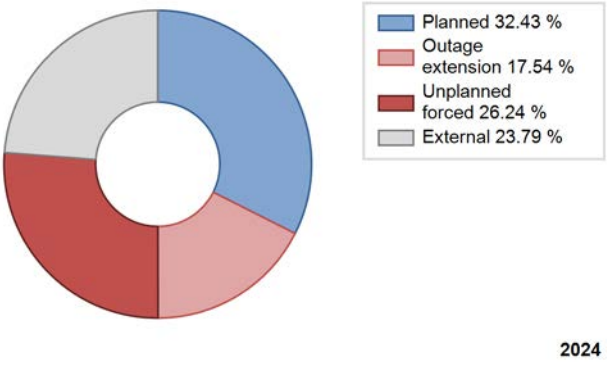


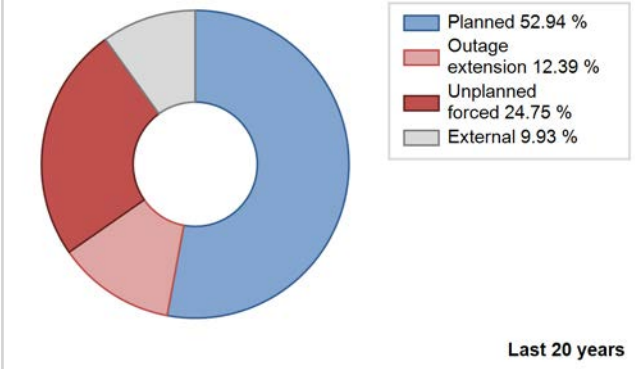
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2021	6208.89	5910	1014	98.64	98.64	98.78	96.42	1.36	1.36	0.00	0.00
2022	6240.36	6540	1017	70.32	72.91	70.05	74.66	11.90	12.80	14.30	2.59
2023	6136.80	6570	1017	71.67	74.08	68.88	75.00	4.91	7.84	18.08	2.41
2024	7630.13	8457	1017	93.93	95.37	85.41	96.28	1.64	2.66	1.97	1.44

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2021 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		117			285	
C. Inspection, maintenance or repair combined with refuelling				773		
H. Nuclear regulatory requirements					168	
J. Grid limitation, failure or grid unavailability						84
L. Human factor related		105			32	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			118			33
Subtotal		222	118	773	485	117
Total		**340**			**1375**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2021 to 2024 Average hours lost per reactor-year
15. Reactor Cooling Systems		14
16. Steam generation systems		157
17. Safety I&C Systems (excluding reactor I&C)		6
31. Turbine and auxiliaries	24	63
32. Feedwater and Main Steam System	128	128
41. Main Generator Systems		67
42. Electrical Power Supply Systems		36
Total	**152**	**471**

Highlights (2024)

RFO-2 for K-2 ends on 2024-01-04.
2024-02-13 Reactor Trip on ATWS signal due to actuation of deaerator level signal.
2024-06-09 Reactor tip due to inrush of shoal of jelly fish in pumping station
2024-07-26 Turbine trip followed by Reactor trip due to turbine bearing absolute vibration protection.

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2024 Operating Experience

PK-7 KANUPP-3 PAKISTAN

Status at end of year	:	**Operational**
Operator	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Owner	:	PAEC (PAKISTAN ATOMIC ENERGY COMMISSION)
Reactor Supplier	:	CZEC (China Zhongyuan Engineering Corporation)
Turbine Supplier	:	STC (Shanghai Turbine Co.)



Reactor Unit Details

Reactor type and model	:	PWR / ACP-1000
Thermal power	:	3060 MWth
Gross electrical power	:	1100 MWe
Reference unit power (net)	:	1017 MWe

Key Dates

Construction Date	:	2016-05-31
Grid Date	:	2022-03-04
Commercial Date	:	2022-04-18
Age at end of year	:	2 years

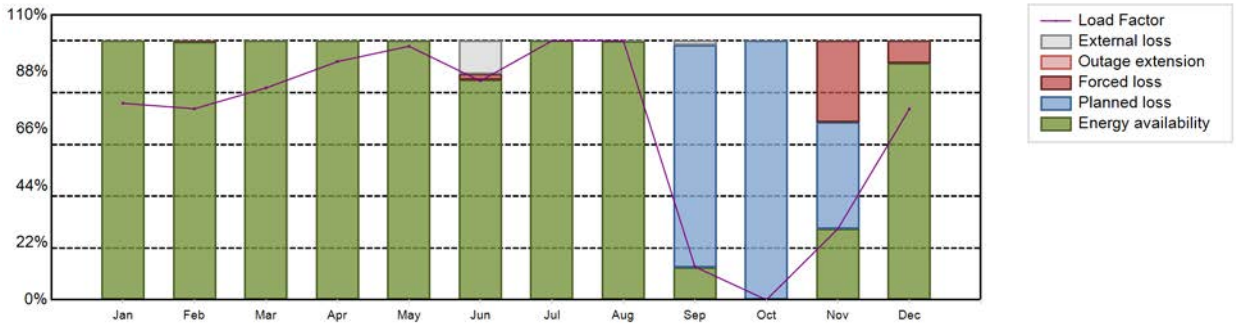
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6114.94 GW(e).h	Forced Loss Rate (FLR)	:	4.32 %
Energy Availability Factor (EAF)	:	76.43 %	Unplanned Capability Loss Factor (UCL)	:	3.5 %
Unit Capability Factor (UCF)	:	77.62 %	Planned Unavailability Factor (PUF)	:	18.88 %
Load Factor (LF)	:	68.45 %	Externally cause unavailability (XUF)	:	1.19 %
Operating Factor (OF)	:	77.87 %	Total off-line time	:	1944 hours

Annual Summary



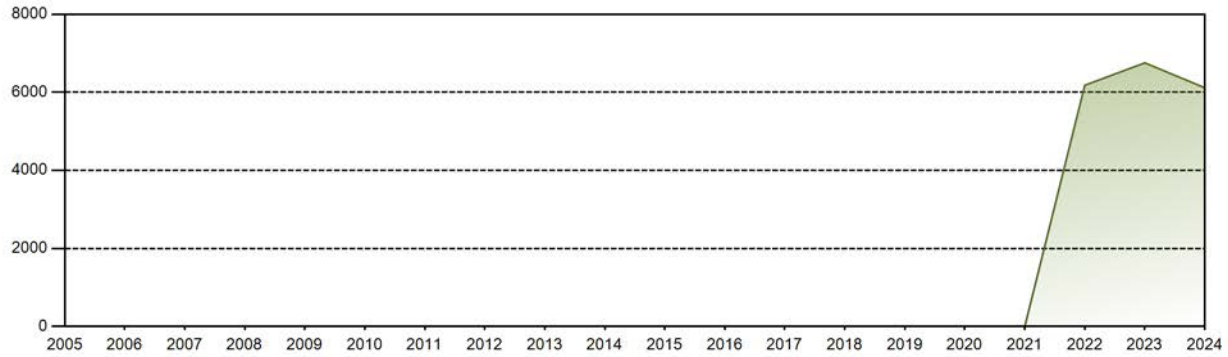
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	574.51	522.38	619.03	673.64	741.05	619.05	756.65	756.65	93.68	0.00	200.77	557.51	6114.94
EAF [%]	100.00	99.67	100.00	100.00	100.00	85.01	100.00	99.86	12.50	0.00	27.49	91.47	76.43
UCF [%]	100.00	99.67	100.00	100.00	100.00	97.77	100.00	100.00	14.18	0.00	27.49	91.47	77.62
LF [%]	75.93	73.80	81.81	92.00	97.94	84.54	100.00	100.00	12.79	0.00	27.42	73.68	68.45
OF [%]	100.00	100.00	100.00	100.00	100.00	88.06	100.00	100.00	14.17	0.00	34.72	96.51	77.87
FLR [%]	0.00	0.33	0.00	0.00	0.00	2.23	0.00	0.00	0.00	0.00	53.30	8.53	4.32
UCL [%]	0.00	0.33	0.00	0.00	0.00	2.23	0.00	0.00	0.00	0.00	31.38	8.53	3.50
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85.82	100.00	41.13	0.00	18.88
XUF [%]	0.00	0.00	0.00	0.00	0.00	12.76	0.00	0.14	1.68	0.00	0.00	0.00	1.19

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Historical Summary

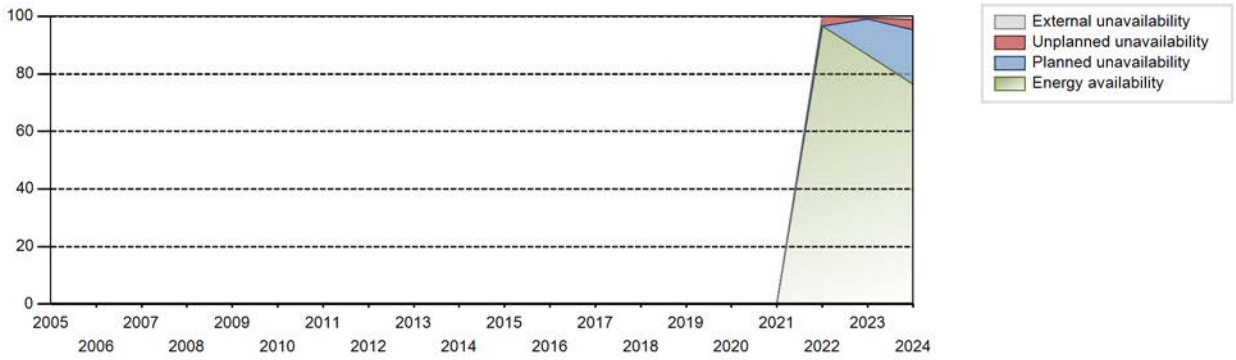
Lifetime energy generation	:	19052.56 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.66 %
Cumulative Energy Availability Factor (EAF)	:	85.31 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.38 %
Cumulative Unit Capability Factor (UCF)	:	85.9 %	Cumulative Planned Unavailability Factor (PUF)	:	11.72 %
Cumulative Load Factor (LF)	:	76.62 %	Cumulative Externally cause unavailability (XUF)	:	0.6 %
Cumulative Operating Factor (OF)	:	84.17 %			

Electricity Production (net) [GWh]

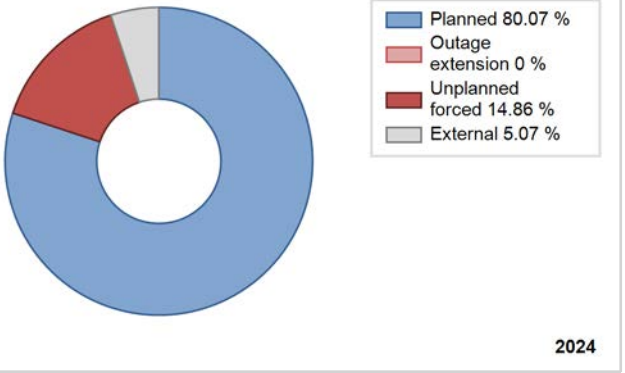


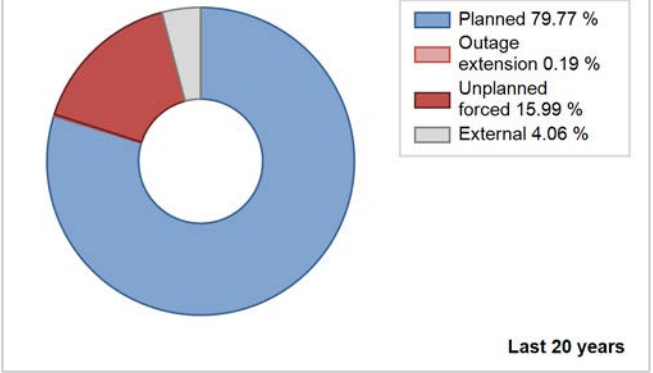
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2022	6181.90	6287	1017	96.55	96.55	89.98	91.24	3.45	3.45	0.00	0.00
2023	6755.72	7510	1017	86.67	87.07	75.83	85.73	0.52	0.52	12.41	0.40
2024	6114.94	6840	1017	76.43	77.62	68.45	77.87	4.32	3.50	18.88	1.19

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2022 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		209			126	
C. Inspection, maintenance or repair combined with refuelling	1648			1011		
J. Grid limitation, failure or grid unavailability						189
L. Human factor related					20	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			85			43
Subtotal	1648	209	85	1011	146	232
Total		**1942**			**1389**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2022 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems	28	10
15. Reactor Cooling Systems	26	9
17. Safety I&C Systems (excluding reactor I&C)		10
32. Feedwater and Main Steam System	155	73
41. Main Generator Systems		35
Total	**209**	**137**

Highlights (2024)

09/June/2024 :Jelly fish attack leading to unavailability of circulating water pumps and subsequent reactor trip by manual scram.

RFO-2 (05/Sep/2024) to (12-Nov-2024)

28/Nov/2024: Reactor trip (Auto scram) on Power Range High Negative Flux Rate

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2024 Operating Experience

RO-1 CERNAVODA-1 ROMANIA



Status at end of year	:	**Operational**
Operator	:	SNN (SOCIETATEA NATIONALA NUCLEARELECTRICA, S.A.)
Owner	:	MECMA (Ministerul Economiei, Comertului si mediului de Afaceri)
Reactor Supplier	:	AECL (ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	G.E. (General Electric)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 6
Thermal power	:	2180 MWth
Gross electrical power	:	706 MWe
Reference unit power (net)	:	650 MWe

Key Dates

Construction Date	:	1983-03-31
Grid Date	:	1996-07-11
Commercial Date	:	1996-12-02
Age at end of year	:	28 years

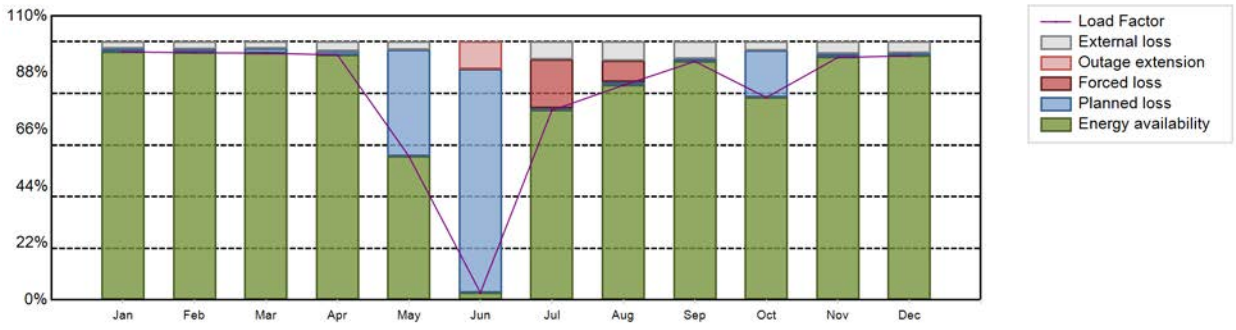
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	0.71
Refuelling frequency [month]	:	NA
Part of the core refuelled [%]	:	NA
Average discharge burnup [MWd/t]	:	7100
Active core diameter [m]	:	6.123
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	4560
Fuel linear heat generation rate [kW/m]	:	42.9
Number of control rod assemblies	:	65
Number of external reactor coolant loops	:	2
Coolant type	:	D2O
Operating coolant pressure [MPa]	:	9.99
Reactor outlet temperature [°C]	:	310
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.1241
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	4.551
Output voltage [kV]	:	24
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	4552.18 GW(e).h	Forced Loss Rate (FLR)	:	2.66 %
Energy Availability Factor (EAF)	:	79.84 %	Unplanned Capability Loss Factor (UCL)	:	3.16 %
Unit Capability Factor (UCF)	:	83.84 %	Planned Unavailability Factor (PUF)	:	12.99 %
Load Factor (LF)	:	79.73 %	Externally cause unavailability (XUF)	:	4 %
Operating Factor (OF)	:	85.26 %	Total off-line time	:	1295 hours
Equivalent non-electrical energy generated (NEG)	:	16.13 GW(e).h			

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	464.57	433.30	461.63	444.12	269.16	13.11	355.18	402.12	432.36	379.76	439.54	457.34	4552.18
EAF [%]	96.21	95.92	95.72	95.02	55.73	2.81	73.54	83.27	92.50	78.53	94.06	94.71	79.84
UCF [%]	98.86	98.70	98.40	98.70	58.79	2.81	80.40	90.56	99.00	81.93	98.74	99.04	83.84
LF [%]	96.07	95.78	95.58	94.90	55.66	2.80	73.44	83.15	92.39	78.42	93.92	94.57	79.73
OF [%]	100.00	100.00	100.00	100.00	59.54	4.44	82.39	92.07	100.00	84.43	100.00	100.00	85.26
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.09	18.91	8.43	0.00	0.00	0.00	0.00	2.66
UCL [%]	0.00	0.00	0.00	0.00	0.00	10.60	18.75	8.34	0.00	0.00	0.00	0.00	3.16
PUF [%]	1.14	1.30	1.60	1.30	41.21	86.60	0.84	1.10	1.00	18.07	1.26	0.96	12.99
XUF [%]	2.65	2.78	2.69	3.68	3.06	0.00	6.86	7.29	6.50	3.40	4.69	4.33	4.00

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Historical Summary

Lifetime energy generation	:	144554.33 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.18 %
Cumulative Energy Availability Factor (EAF)	:	89.39 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.32 %
Cumulative Unit Capability Factor (UCF)	:	90.65 %	Cumulative Planned Unavailability Factor (PUF)	:	7.03 %
Cumulative Load Factor (LF)	:	89.65 %	Cumulative Externally cause unavailability (XUF)	:	1.25 %
Cumulative Operating Factor (OF)	:	91.14 %			

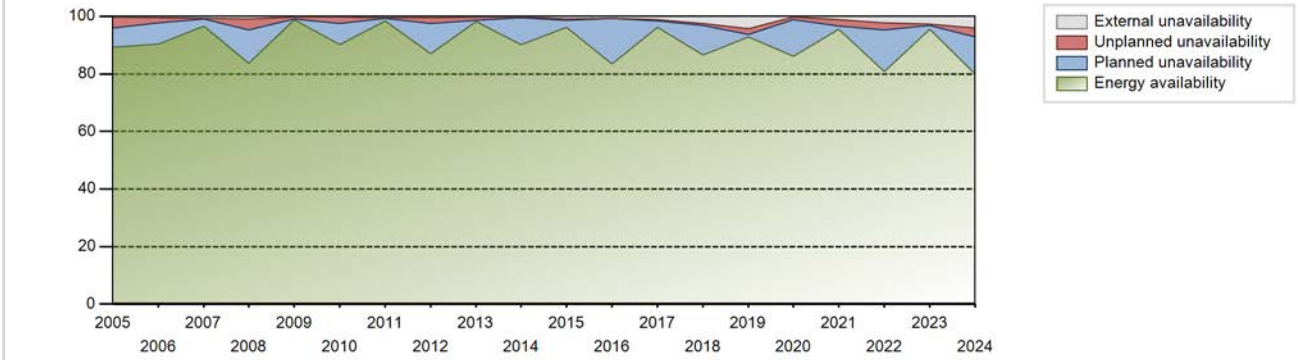
Electricity Production (net) [GWh]



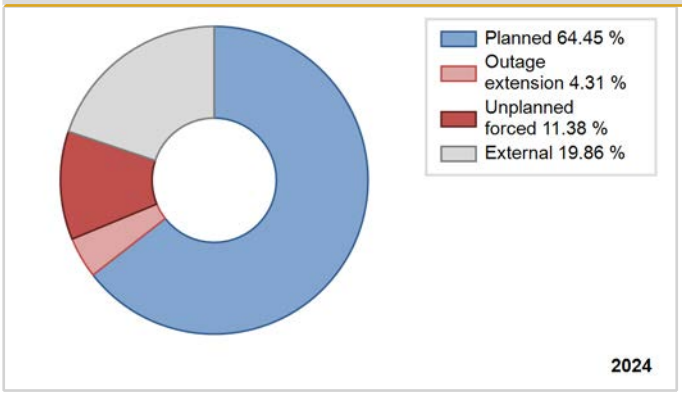
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1996	1186.44	2686	647	94.44	94.44	99.60	100.00	3.52	3.45	2.11	0.00
1997	4953.29	7753	646	86.74	87.32	87.53	88.50	9.94	9.64	3.05	0.58
1998	4908.68	7585	655	85.22	85.81	85.55	86.59	4.44	3.99	10.20	0.60
1999	4813.03	7389	654	83.50	83.76	83.93	84.35	8.13	7.42	8.82	0.27
2000	5053.35	7791	655	87.57	87.89	87.83	88.70	5.23	4.85	7.26	0.31
2001	5049.86	7717	655	87.52	88.24	88.01	88.09	0.96	0.85	10.91	0.72
2002	5106.22	7854	655	88.65	89.07	88.99	89.66	5.09	4.78	6.15	0.42
2003	4541.42	7024	655	78.68	86.69	79.15	80.18	0.57	0.96	12.35	8.01
2004	5142.31	7892	655	89.10	89.39	89.38	89.85	1.15	2.91	7.70	0.29
2005	5112.96	7878	655	89.28	89.58	89.11	89.93	4.05	3.79	6.63	0.30
2006	5177.96	7987	655	90.29	90.76	90.24	91.18	2.05	1.90	7.34	0.48
2007	5518.35	8527	655	96.51	97.13	96.18	97.34	0.34	0.33	2.55	0.61
2008	4805.48	7411	650	83.76	84.58	84.16	84.37	0.11	3.84	11.58	0.82
2009	5661.65	8709	650	98.94	99.17	99.43	99.42	0.73	0.72	0.11	0.23
2010	5167.23	7982	650	90.15	90.52	90.75	91.12	2.33	2.16	7.32	0.37
2011	5633.14	8694	650	98.43	98.93	98.93	99.25	0.19	0.18	0.89	0.50
2012	4948.20	7652	650	87.11	87.50	86.66	87.11	2.24	2.01	10.49	0.39
2013	5622.01	8681	650	98.24	98.55	98.74	99.10	1.00	1.00	0.45	0.31
2014	5164.38	8032	650	90.21	90.45	90.70	91.69	0.33	0.30	9.25	0.25
2015	5504.93	8612	650	96.10	97.02	96.68	98.31	0.54	0.53	2.45	0.93
2016	4765.82	7489	650	83.39	84.04	83.47	85.26	0.16	0.14	15.82	0.65
2017	5485.44	8637	650	96.13	97.21	96.34	98.60	0.52	0.51	2.28	1.08
2018	4928.50	7920	650	86.60	89.05	86.56	90.41	0.82	0.73	10.22	2.45
2019	5292.67	8600	650	92.81	97.11	92.95	98.17	1.97	1.95	0.94	4.30
2020	4963.25	7666	650	86.13	86.46	86.93	87.27	0.12	0.77	12.77	0.33
2021	5450.51	8588	650	95.51	96.61	95.72	98.04	2.42	2.39	1.00	1.09
2022	4606.58	7394	650	80.90	83.22	80.90	84.41	1.78	2.46	14.32	2.32
2023	5410.94	8695	650	95.51	98.10	95.03	99.26	0.66	0.65	1.24	2.59
2024	4552.18	7489	650	79.84	83.84	79.73	85.26	2.66	3.16	12.99	4.00

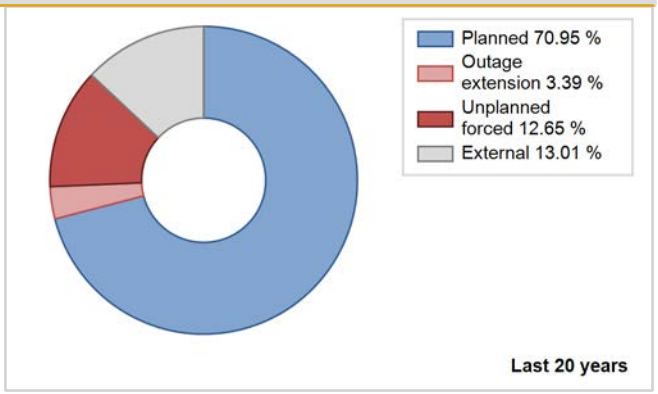
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1996 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		290			156	
C. Inspection, maintenance or repair combined with refuelling				2		
D. Inspection, maintenance or repair without refuelling	912			559		
E. Testing of plant systems or components					2	
J. Grid limitation, failure or grid unavailability						4
L. Human factor related					14	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						31
Z. Other	115			4	4	
Subtotal	1027	290		565	176	35
Total	**1317**			**776**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1996 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		29
13. Reactor Auxiliary Systems		7
14. Safety Systems		3
15. Reactor Cooling Systems		6
16. Steam generation systems		6
21. Fuel Handling and Storage Facilities		7
31. Turbine and auxiliaries	0	31
32. Feedwater and Main Steam System	230	31
33. Circulating Water System		37
34. Miscellaneous Systems		13
41. Main Generator Systems		19
42. Electrical Power Supply Systems	59	19
Total	**289**	**210**

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2024 Operating Experience

RO-2 CERNAVODA-2 ROMANIA



Status at end of year	:	**Operational**
Operator	:	SNN (SOCIETATEA NATIONALA NUCLEARELECTRICA, S.A.)
Owner	:	MECMA (Ministerul Economiei, Comertului si mediului de Afaceri)
Reactor Supplier	:	AECL (ATOMIC ENERGY OF CANADA, LTD.)
Turbine Supplier	:	G.E. (General Electric)

Reactor Unit Details

Reactor type and model	:	PHWR / CANDU 6
Thermal power	:	2180 MWth
Gross electrical power	:	705 MWe
Reference unit power (net)	:	650 MWe

Key Dates

Construction Date	:	1983-07-01
Grid Date	:	2007-08-07
Commercial Date	:	2007-11-01
Age at end of year	:	17 years

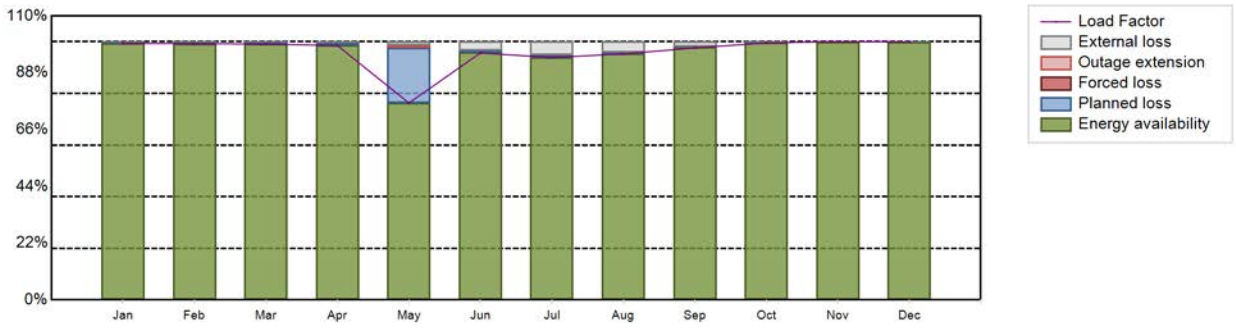
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Horizontal
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	D2O
Average fuel enrichment [% of U235]	:	0.71
Refuelling frequency [month]	:	NA
Part of the core refuelled [%]	:	NA
Average discharge burnup [MWd/t]	:	7100
Active core diameter [m]	:	6.123
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	4560
Fuel linear heat generation rate [kW/m]	:	42.9
Number of control rod assemblies	:	65
Number of external reactor coolant loops	:	2
Coolant type	:	D2O
Operating coolant pressure [MPa]	:	9.99
Reactor outlet temperature [°C]	:	310
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.1241
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	4.551
Output voltage [kV]	:	24
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	5491.55 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	96.18 %	Unplanned Capability Loss Factor (UCL)	:	0.08 %
Unit Capability Factor (UCF)	:	97.56 %	Planned Unavailability Factor (PUF)	:	2.36 %
Load Factor (LF)	:	96.18 %	Externally cause unavailability (XUF)	:	1.38 %
Operating Factor (OF)	:	98.36 %	Total off-line time	:	144 hours
Equivalent non-electrical energy generated (NEG)	:	13.27 GW(e).h			

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	480.75	449.19	478.55	461.13	368.95	447.71	454.12	460.89	456.87	482.15	468.24	483.00	5491.55
EAF [%]	99.31	99.16	99.08	98.56	76.40	95.78	94.03	95.43	97.76	99.53	99.82	99.77	96.18
UCF [%]	99.37	99.24	99.29	98.89	77.77	99.09	99.13	99.41	99.66	99.62	99.82	99.77	97.56
LF [%]	99.41	99.29	99.09	98.53	76.29	95.66	93.90	95.30	97.62	99.57	100.05	99.88	96.18
OF [%]	100.00	100.00	100.00	100.00	80.65	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.36
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
PUF [%]	0.63	0.76	0.71	1.11	21.26	0.91	0.87	0.59	0.34	0.38	0.18	0.23	2.36
XUF [%]	0.06	0.07	0.21	0.33	1.37	3.30	5.11	3.98	1.90	0.09	0.00	0.00	1.38

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Historical Summary

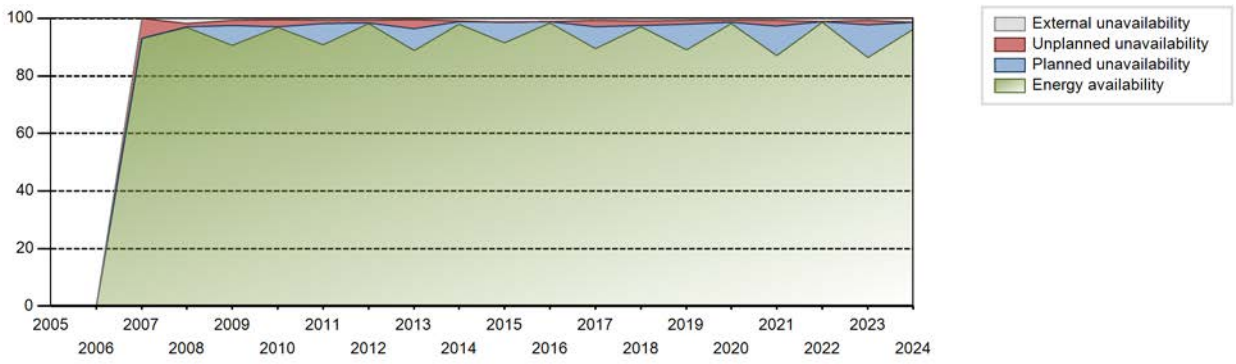
Lifetime energy generation	:	92339.16 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.22 %
Cumulative Energy Availability Factor (EAF)	:	93.64 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.27 %
Cumulative Unit Capability Factor (UCF)	:	94.51 %	Cumulative Planned Unavailability Factor (PUF)	:	4.22 %
Cumulative Load Factor (LF)	:	93.7 %	Cumulative Externally cause unavailability (XUF)	:	0.87 %
Cumulative Operating Factor (OF)	:	95.04 %			

Electricity Production (net) [GWh]



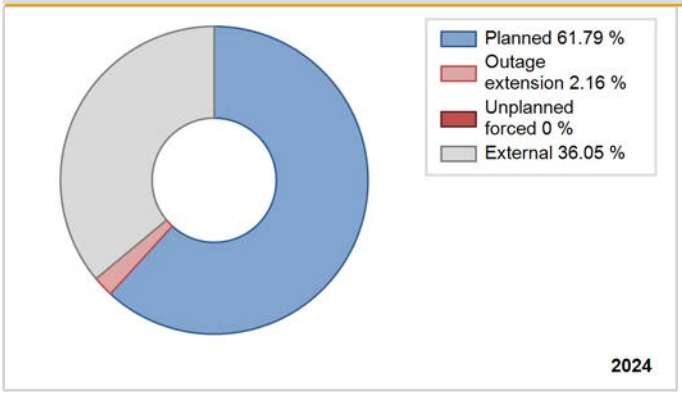
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2007	1560.20	2729	650	93.03	93.03	93.24	94.19	6.91	6.91	0.06	0.00
2008	5528.11	8669	650	96.85	98.63	96.82	98.69	1.24	1.24	0.13	1.78
2009	5158.25	8044	650	90.62	91.32	90.59	91.83	2.02	1.89	6.79	0.70
2010	5537.52	8551	650	96.92	97.33	97.25	97.61	2.53	2.52	0.14	0.42
2011	5177.84	8052	650	90.75	91.50	90.93	91.92	1.19	1.10	7.40	0.75
2012	5615.32	8701	650	98.11	98.78	98.35	99.06	1.04	1.04	0.19	0.67
2013	5073.74	7905	650	88.80	89.21	89.11	90.24	3.44	3.18	7.61	0.41
2014	5589.30	8680	650	97.95	98.80	98.16	99.09	0.31	0.31	0.90	0.85
2015	5204.74	8179	650	91.50	92.84	91.41	93.37	0.00	0.00	7.16	1.34
2016	5622.38	8784	650	98.51	99.66	98.47	100.00	0.00	0.00	0.34	1.14
2017	5094.71	7963	650	89.38	90.07	89.48	90.90	2.37	2.19	7.74	0.69
2018	5530.84	8658	650	97.17	98.16	97.13	98.84	1.43	1.43	0.42	0.99
2019	5075.54	7910	650	89.05	89.72	89.14	90.30	0.00	1.34	8.94	0.67
2020	5611.82	8737	650	98.21	98.96	98.29	99.46	0.65	0.65	0.39	0.75
2021	4950.65	7742	650	87.08	87.73	86.95	88.39	2.00	2.11	10.16	0.65
2022	5615.46	8760	650	98.53	99.63	98.62	100.00	0.00	0.00	0.37	1.10
2023	4901.20	7686	650	86.26	86.95	86.08	87.74	1.77	1.65	11.40	0.68
2024	5491.55	8640	650	96.18	97.56	96.18	98.36	0.00	0.08	2.36	1.38

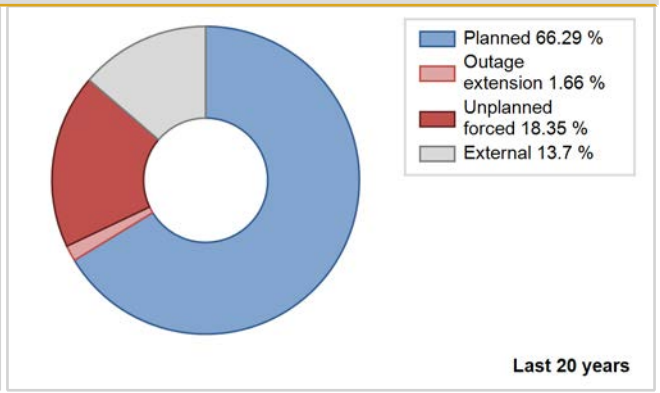
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2007 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					85	
D. Inspection, maintenance or repair without refuelling				326		
E. Testing of plant systems or components					2	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					8	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
Z. Other	137	7		8	0	
Subtotal	137	7		334	95	5
Total	**144**			**434**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2007 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		13
13. Reactor Auxiliary Systems		7
15. Reactor Cooling Systems		7
16. Steam generation systems		2
21. Fuel Handling and Storage Facilities		11
31. Turbine and auxiliaries		15
32. Feedwater and Main Steam System	7	6
41. Main Generator Systems		17
42. Electrical Power Supply Systems		14
Total	**7**	**99**

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2024 Operating Experience

RU-151 AKADEMIK LOMONOSOV-1 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KALUGA (JSC "Kaluga turbine plant" 32, Glagoleva Street, Kaluga, 248021, Russia)

Reactor Unit Details

Reactor type and model	:	PWR / KLT-40S 'Floating'
Thermal power	:	150 MWth
Gross electrical power	:	35 MWe
Reference unit power (net)	:	32 MWe

Key Dates

Construction Date	:	2007-04-15
Grid Date	:	2019-12-19
Commercial Date	:	2020-05-22
Age at end of year	:	5 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	Other
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	14.1
Refuelling frequency [month]	:	29
Part of the core refuelled [%]	:	100
Average discharge burnup [MWd/t]	:	68700
Active core diameter [m]	:	1.220
Active core height/length [m]	:	1.2
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	14
Number of control rod assemblies	:	11
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

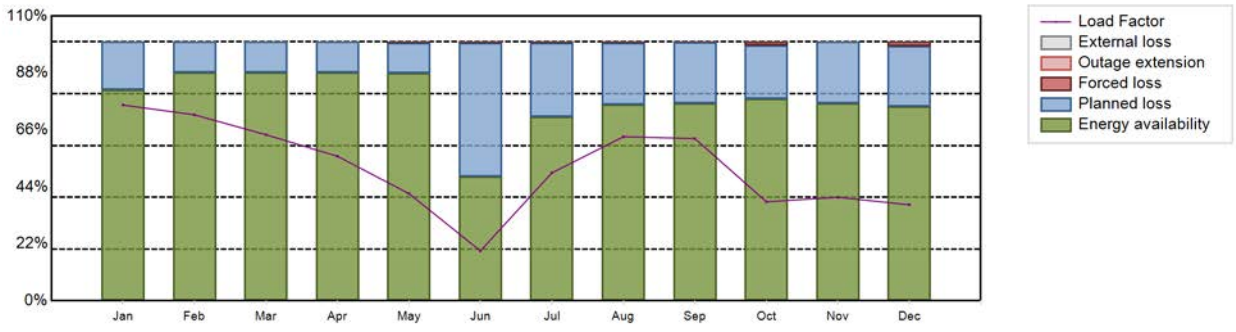
Operating coolant pressure [MPa]	:	12.7
Reactor outlet temperature [°C]	:	316
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.4
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	NA
HP cylinder inlet steam pressure [MPa]	:	3.43
Output voltage [kV]	:	10.5
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	144.91 GW(e).h
Energy Availability Factor (EAF)	:	77.86 %
Unit Capability Factor (UCF)	:	77.86 %
Load Factor (LF)	:	51.55 %
Operating Factor (OF)	:	94.93 %

Forced Loss Rate (FLR)	:	0.5 %
Unplanned Capability Loss Factor (UCL)	:	0.39 %
Planned Unavailability Factor (PUF)	:	21.74 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	445 hours

Annual Summary



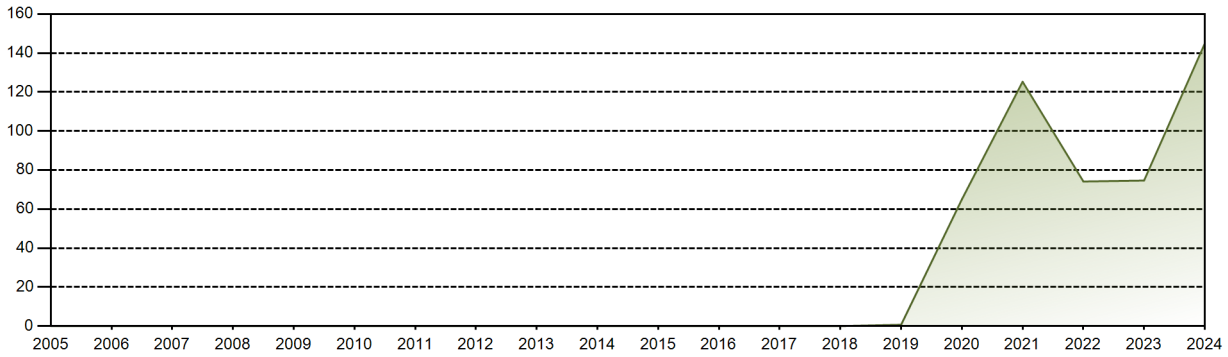
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	18.00	16.00	15.28	12.87	9.87	4.45	11.77	15.09	14.44	9.11	9.22	8.83	144.91
EAF [%]	81.52	88.12	88.13	88.13	87.91	47.96	71.15	75.91	76.24	78.04	76.25	74.96	77.86
UCF [%]	81.52	88.12	88.13	88.13	87.91	47.96	71.15	75.91	76.24	78.04	76.25	74.96	77.86
LF [%]	75.61	71.85	64.16	55.84	41.44	19.31	49.43	63.37	62.68	38.26	40.00	37.09	51.55
OF [%]	100.00	100.00	100.00	100.00	100.00	56.81	100.00	100.00	100.00	81.99	100.00	100.00	94.93
FLR [%]	0.00	0.00	0.00	0.00	0.43	0.83	0.53	0.65	0.06	1.61	0.00	2.19	0.50
UCL [%]	0.00	0.00	0.00	0.00	0.38	0.40	0.38	0.50	0.05	1.28	0.00	1.68	0.39
PUF [%]	18.48	11.88	11.87	11.88	11.71	51.64	28.47	23.59	23.72	20.69	23.75	23.37	21.74
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

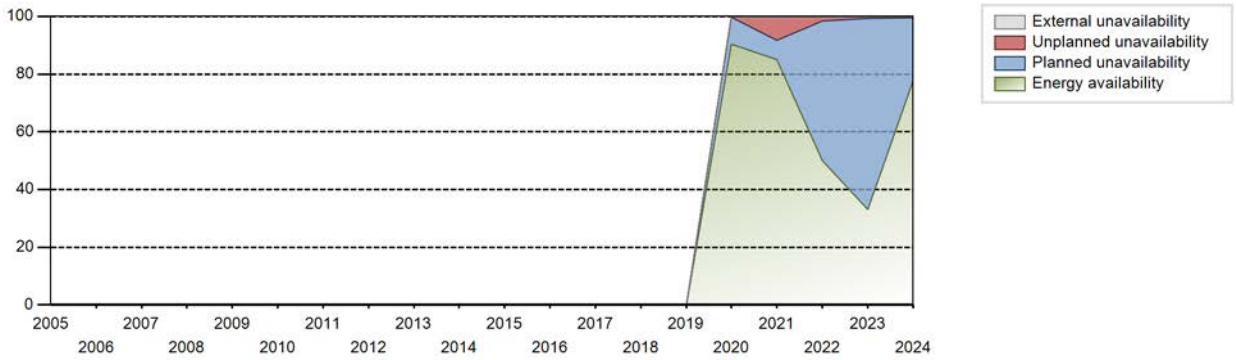
Lifetime energy generation	:	484.55 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.6 %
Cumulative Energy Availability Factor (EAF)	:	65.2 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.43 %
Cumulative Unit Capability Factor (UCF)	:	65.2 %	Cumulative Planned Unavailability Factor (PUF)	:	32.37 %
Cumulative Load Factor (LF)	:	36.24 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	76.2 %			

Electricity Production (net) [GWh]

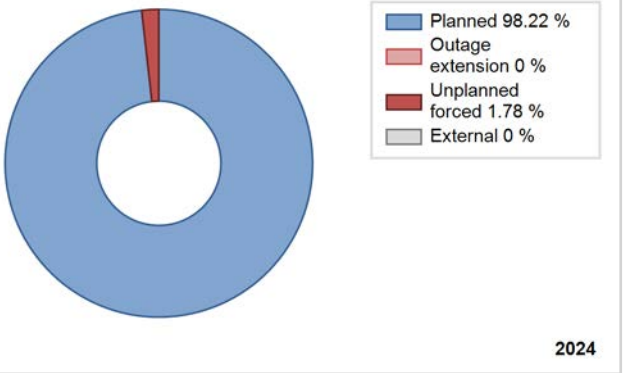


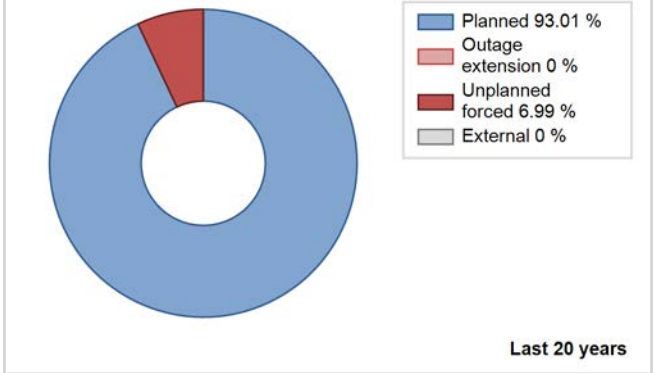
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2020	64.94	5138	32	90.38	90.38	28.76	71.63	0.30	0.27	9.34	0.00
2021	125.26	7104	32	85.08	85.08	44.69	81.10	8.98	8.39	6.53	0.00
2022	74.13	6367	32	50.04	50.04	26.44	72.68	2.89	1.49	48.47	0.00
2023	74.63	5143	32	33.02	33.02	26.62	58.71	2.16	0.73	66.25	0.00
2024	144.91	8339	32	77.86	77.86	51.55	94.93	0.50	0.39	21.74	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2020 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		39			216	
C. Inspection, maintenance or repair combined with refuelling				775		
D. Inspection, maintenance or repair without refuelling	312			467		
J. Grid limitation, failure or grid unavailability						44
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			126			204
L. Human factor related					3	
Z. Other				175		
Subtotal	312	39	126	1417	219	248
Total		**477**			**1884**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2020 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems	19	9
16. Steam generation systems		148
31. Turbine and auxiliaries	9	14
32. Feedwater and Main Steam System		19
33. Circulating Water System		7
41. Main Generator Systems	12	2
42. Electrical Power Supply Systems		1
Total	**40**	**200**

Highlights (2024)

The unit was in the routine maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-152 AKADEMIK LOMONOSOV-2 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KALUGA (JSC "Kaluga turbine plant" 32, Glagoleva Street, Kaluga, 248021, Russia)

Reactor Unit Details

Reactor type and model	:	PWR / KLT-40S 'Floating'
Thermal power	:	150 MWth
Gross electrical power	:	35 MWe
Reference unit power (net)	:	32 MWe

Key Dates

Construction Date	:	2007-04-15
Grid Date	:	2019-12-19
Commercial Date	:	2020-05-22
Age at end of year	:	5 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	Other
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	14.1
Refuelling frequency [month]	:	29
Part of the core refuelled [%]	:	100
Average discharge burnup [MWd/t]	:	68700
Active core diameter [m]	:	1.220
Active core height/length [m]	:	1.2
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	14
Number of control rod assemblies	:	11
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

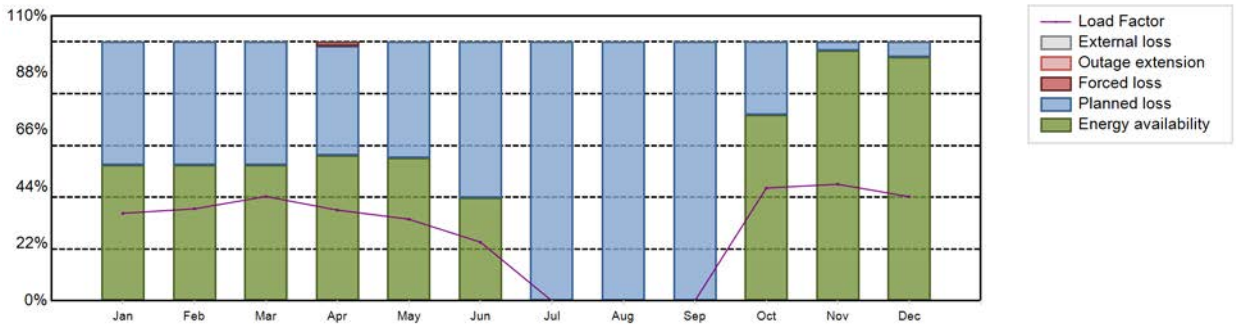
Operating coolant pressure [MPa]	:	12.7
Reactor outlet temperature [°C]	:	316
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.4
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	NA
HP cylinder inlet steam pressure [MPa]	:	3.43
Output voltage [kV]	:	10.5
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	76.69 GW(e).h
Energy Availability Factor (EAF)	:	47.54 %
Unit Capability Factor (UCF)	:	47.54 %
Load Factor (LF)	:	27.28 %
Operating Factor (OF)	:	69.77 %

Forced Loss Rate (FLR)	:	0.28 %
Unplanned Capability Loss Factor (UCL)	:	0.13 %
Planned Unavailability Factor (PUF)	:	52.33 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	2655 hours

Annual Summary



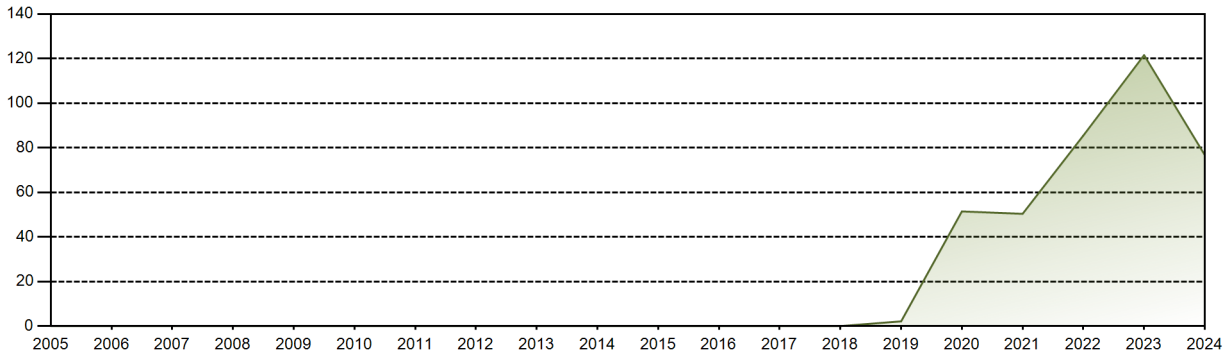
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	8.05	7.91	9.59	8.07	7.51	5.22	0.00	0.00	0.00	10.38	10.37	9.58	76.69
EAF [%]	52.50	52.50	52.50	56.06	55.09	39.74	0.00	0.00	0.00	71.79	96.64	94.06	47.54
UCF [%]	52.50	52.50	52.50	56.06	55.09	39.74	0.00	0.00	0.00	71.79	96.64	94.06	47.54
LF [%]	33.83	35.53	40.28	35.05	31.53	22.68	0.00	0.00	0.00	43.58	45.03	40.22	27.28
OF [%]	100.00	100.00	100.00	95.42	100.00	70.56	0.00	0.00	0.00	72.85	100.00	100.00	69.77
FLR [%]	0.00	0.00	0.00	2.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28
UCL [%]	0.00	0.00	0.00	1.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
PUF [%]	47.50	47.50	47.50	42.30	44.91	60.26	100.00	100.00	100.00	28.21	3.36	5.94	52.33
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

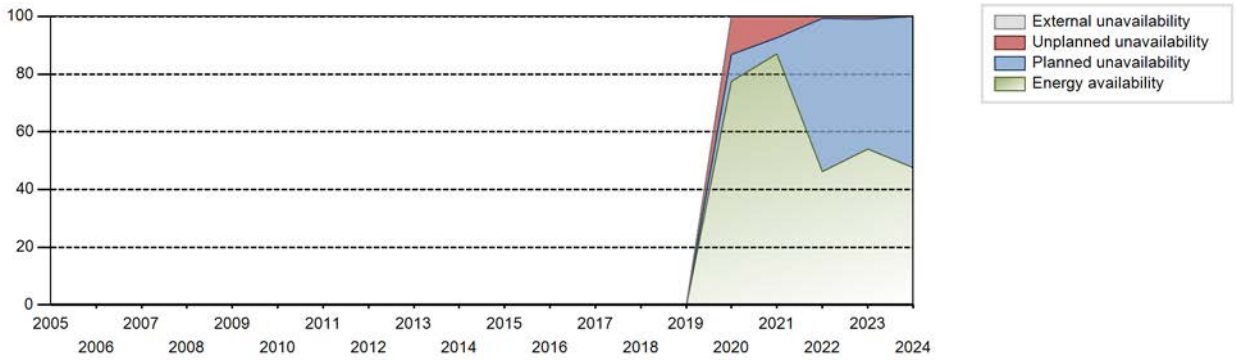
Lifetime energy generation	:	387.63 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.73 %
Cumulative Energy Availability Factor (EAF)	:	61.14 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.72 %
Cumulative Unit Capability Factor (UCF)	:	61.14 %	Cumulative Planned Unavailability Factor (PUF)	:	35.14 %
Cumulative Load Factor (LF)	:	28.01 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	62.47 %			

Electricity Production (net) [GWh]

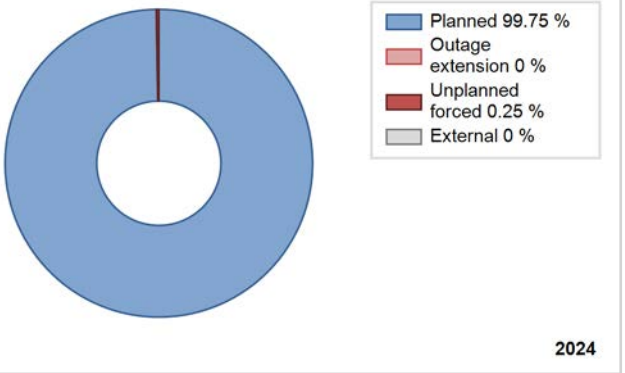


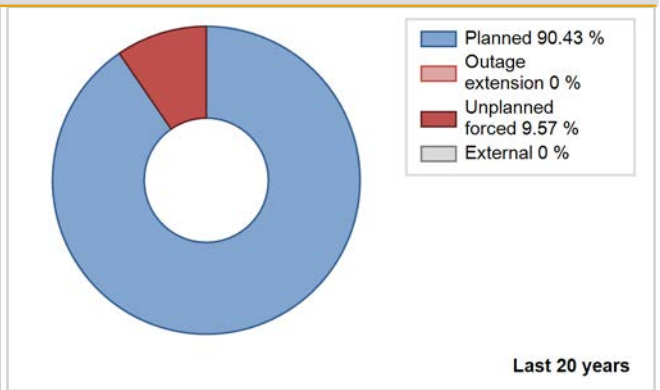
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2020	51.44	3942	32	77.36	77.36	15.99	38.32	14.66	13.29	9.35	0.00
2021	50.36	2265	32	87.11	87.11	17.97	25.86	7.93	7.51	5.39	0.00
2022	85.48	6956	32	46.34	46.34	30.50	79.41	1.44	0.68	52.99	0.00
2023	121.54	7793	32	54.12	54.12	43.36	88.96	1.73	0.95	44.93	0.00
2024	76.69	6129	32	47.54	47.54	27.28	69.77	0.28	0.13	52.33	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2020 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		16			333	
C. Inspection, maintenance or repair combined with refuelling	2626			573		
D. Inspection, maintenance or repair without refuelling				711		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1262
L. Human factor related					4	
Subtotal	2626	16		1284	337	1262
Total	**2642**			**2883**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2020 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems	16	3
16. Steam generation systems		256
31. Turbine and auxiliaries		5
32. Feedwater and Main Steam System		16
33. Circulating Water System		16
41. Main Generator Systems		1
42. Electrical Power Supply Systems		7
Total	**16**	**304**

Highlights (2024)

The unit was in the intermediate maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-96 BALAKOVO-1 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1980-12-01
Grid Date	:	1985-12-28
Commercial Date	:	1986-05-23
Age at end of year	:	39 years

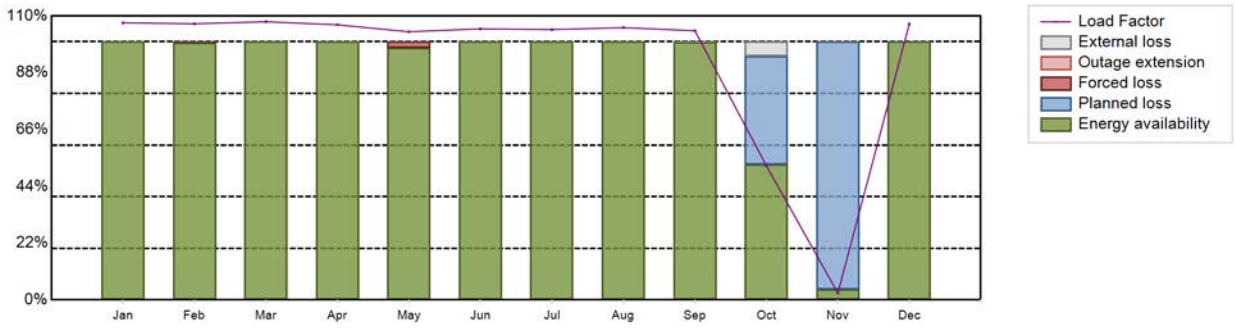
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	7749.29 GW(e).h	Forced Loss Rate (FLR)	:	0.24 %
Energy Availability Factor (EAF)	:	87.89 %	Unplanned Capability Loss Factor (UCL)	:	0.22 %
Unit Capability Factor (UCF)	:	88.36 %	Planned Unavailability Factor (PUF)	:	11.42 %
Load Factor (LF)	:	92.86 %	Externally cause unavailability (XUF)	:	0.47 %
Operating Factor (OF)	:	88.64 %	Total off-line time	:	998 hours
Equivalent non-electrical energy generated (NEG)	:	4.11 GW(e).h			

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	758.71	707.30	761.68	728.91	734.23	718.20	740.24	745.40	713.27	367.61	18.23	755.50	7749.29
EAF [%]	100.00	99.69	100.00	100.00	97.74	100.00	100.00	100.00	99.97	52.51	3.98	100.00	87.89
UCF [%]	100.00	99.69	100.00	100.00	97.74	100.00	100.00	100.00	100.00	58.07	3.98	100.00	88.36
LF [%]	107.34	106.97	107.77	106.57	103.88	105.00	104.73	105.46	104.28	52.01	2.67	106.89	92.86
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	58.06	4.72	100.00	88.64
FLR [%]	0.00	0.31	0.00	0.00	2.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
UCL [%]	0.00	0.31	0.00	0.00	2.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.93	96.02	0.00	11.42
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	5.56	0.00	0.00	0.47

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Historical Summary

Lifetime energy generation	:	245685.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.79 %
Cumulative Energy Availability Factor (EAF)	:	75.95 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.83 %
Cumulative Unit Capability Factor (UCF)	:	77.58 %	Cumulative Planned Unavailability Factor (PUF)	:	16.59 %
Cumulative Load Factor (LF)	:	75.88 %	Cumulative Externally cause unavailability (XUF)	:	1.62 %
Cumulative Operating Factor (OF)	:	77.92 %			

Electricity Production (net) [GWh]

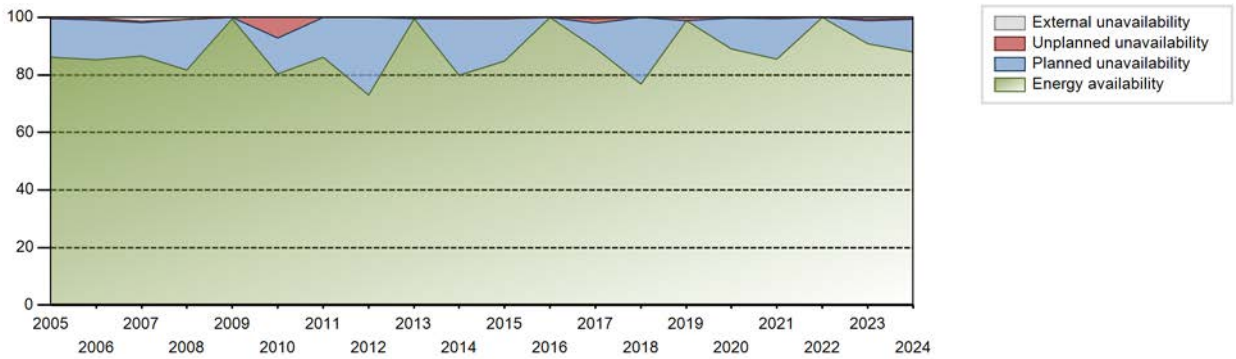


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	4868.03	6082	950	64.85	64.85	64.46	69.51	17.62	13.87	21.28	0.00
1987	4703.68	5302	1000	57.40	57.40	53.70	60.53	25.51	19.66	22.95	0.00
1988	6476.87	7207	950	80.93	80.93	77.62	82.05	6.99	6.08	12.99	0.00
1989	4473.90	5141	950	56.34	56.37	53.76	58.69	32.94	27.69	15.95	0.03
1990	739.06	887	950	9.09	9.09	8.88	10.13	56.91	12.01	78.90	0.00
1991	4951.60	5780	950	59.85	60.19	59.50	65.98	24.74	19.79	20.02	0.35
1992	6352.28	7666	950	76.31	76.38	76.11	87.26	23.62	23.62	0.00	0.07
1993	3326.09	4230	950	39.88	46.10	39.97	48.29	24.25	14.76	39.14	6.22
1994	1759.54	2307	950	77.30	77.30	21.14	26.34	22.70	22.70	0.00	0.00
1995	2017.98	4810	950	28.57	28.57	24.25	54.91	62.91	48.46	22.97	0.00
1996	4872.54	5913	950	59.00	86.47	58.39	67.32	0.82	0.72	12.81	27.47
1997	4728.99	5818	950	57.24	60.37	56.83	66.42	1.49	0.91	38.72	3.13
1998	4329.83	5671	950	52.16	55.84	52.03	64.74	4.87	2.86	41.30	3.68
1999	5141.31	6337	950	62.09	65.56	61.78	72.34	0.25	0.16	34.28	3.47
2000	7247.37	7705	950	86.49	87.54	86.85	87.72	2.30	2.06	10.40	1.05
2001	7407.90	8041	950	88.19	91.57	89.02	91.79	1.55	1.44	6.98	3.38
2002	6785.73	7501	950	80.48	86.52	81.54	85.63	0.00	0.00	13.48	6.04
2003	7032.19	7460	950	83.12	84.71	84.50	85.16	0.75	0.64	14.64	1.60
2004	6626.43	6901	950	78.00	78.22	79.41	78.56	0.00	0.00	21.78	0.22
2005	7312.72	7638	950	86.24	86.58	87.86	87.18	0.18	0.15	13.27	0.34
2006	7276.97	7517	950	85.24	85.49	87.44	85.81	0.70	0.60	13.91	0.25
2007	7397.29	7731	950	86.54	87.98	88.89	88.25	0.39	0.34	11.68	1.44
2008	6810.23	7283	950	81.73	82.41	81.61	82.91	0.00	0.00	17.59	0.68
2009	7948.45	8760	950	99.61	99.74	95.51	100.00	0.00	0.00	0.26	0.13
2010	6843.30	7069	950	80.31	80.43	82.23	80.70	0.00	7.09	12.48	0.12
2011	7469.27	7573	950	86.15	86.25	89.76	86.46	0.03	0.03	13.73	0.10
2012	6322.13	6424	950	72.90	73.02	75.76	73.13	0.00	0.00	26.98	0.12
2013	8766.85	8726	950	99.58	99.58	105.35	99.61	0.42	0.42	0.00	0.00
2014	7012.47	7077	950	79.98	80.50	84.25	80.78	0.09	0.07	19.43	0.51
2015	7392.01	7481	950	84.74	85.21	88.82	85.40	0.02	0.02	14.77	0.47
2016	8880.23	8784	950	99.94	99.94	106.42	100.00	0.06	0.06	0.00	0.00
2017	7699.56	7887	950	89.31	89.82	92.52	90.03	1.64	1.50	8.69	0.50
2018	6656.19	6737	950	76.80	76.80	79.98	76.91	0.00	0.00	23.20	0.00
2019	8783.41	8662	950	98.87	98.87	105.54	98.88	1.13	1.13	0.00	0.00
2020	7533.32	7842	950	88.96	88.96	90.28	89.28	0.18	0.16	10.87	0.00
2021	7475.86	7532	950	85.51	85.74	89.83	85.98	0.33	0.28	13.98	0.23
2022	8788.05	8760	950	99.96	99.96	105.60	100.00	0.04	0.04	0.00	0.00

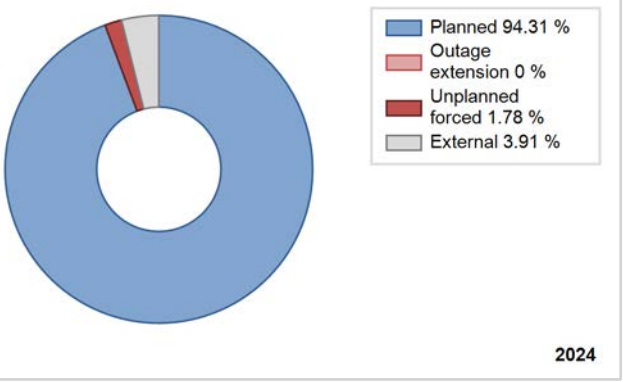
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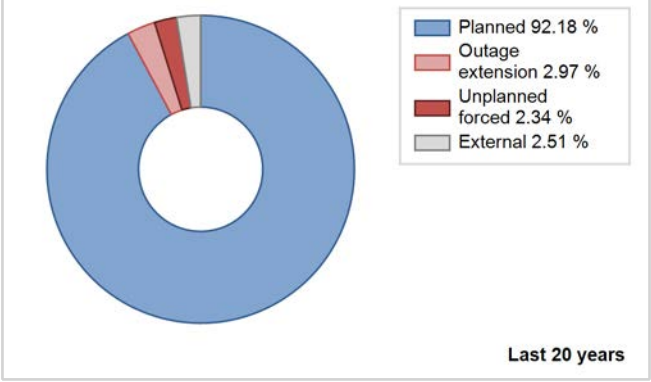
2023	7943.10	8049	950	90.81	91.43	95.45	91.88	0.63	0.58	7.99	0.62
2024	7749.29	7786	950	87.89	88.36	92.86	88.64	0.24	0.22	11.42	0.47

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					280	
C. Inspection, maintenance or repair combined with refuelling	998			1190	10	
D. Inspection, maintenance or repair without refuelling				237		
E. Testing of plant systems or components				1	1	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						125
L. Human factor related					7	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						63
Z. Other					20	
Subtotal	998			1428	318	189
Total	**998**			**1935**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		2
13. Reactor Auxiliary Systems		2
14. Safety Systems		0
15. Reactor Cooling Systems		10
16. Steam generation systems		87
17. Safety I&C Systems (excluding reactor I&C)		3
31. Turbine and auxiliaries		40
32. Feedwater and Main Steam System		10
33. Circulating Water System		3
34. Miscellaneous Systems		23
35. All other I&C Systems		7
41. Main Generator Systems		77
42. Electrical Power Supply Systems		18
Total		**282**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the overhaul. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-97 BALAKOVO-2 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1981-08-01
Grid Date	:	1987-10-08
Commercial Date	:	1988-01-18
Age at end of year	:	37 years

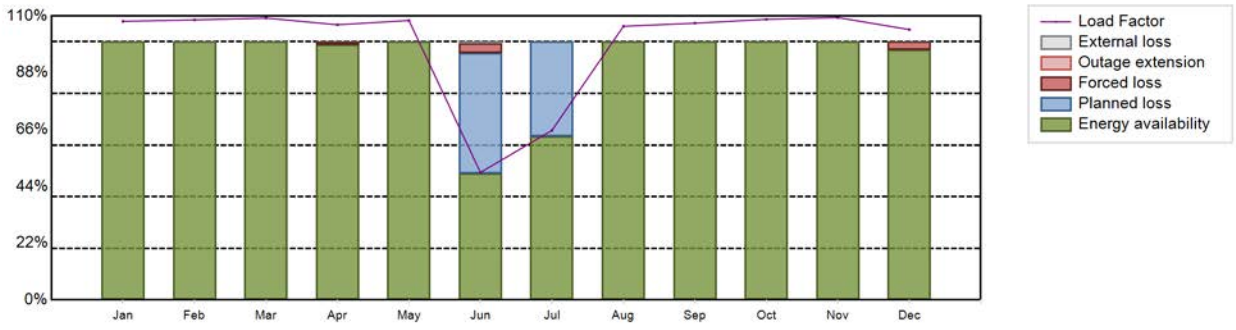
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	16
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	322
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	40000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6
Active core height/length [m]	:	3.53	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	17.6	Number of main condensate pumps	:	-
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	8286.54 GW(e).h	Forced Loss Rate (FLR)	:	0.71 %
Energy Availability Factor (EAF)	:	92.37 %	Unplanned Capability Loss Factor (UCL)	:	0.66 %
Unit Capability Factor (UCF)	:	92.42 %	Planned Unavailability Factor (PUF)	:	6.92 %
Load Factor (LF)	:	99.3 %	Externally cause unavailability (XUF)	:	0.05 %
Operating Factor (OF)	:	93.11 %	Total off-line time	:	605 hours
Equivalent non-electrical energy generated (NEG)	:	4.87 GW(e).h			

Annual Summary



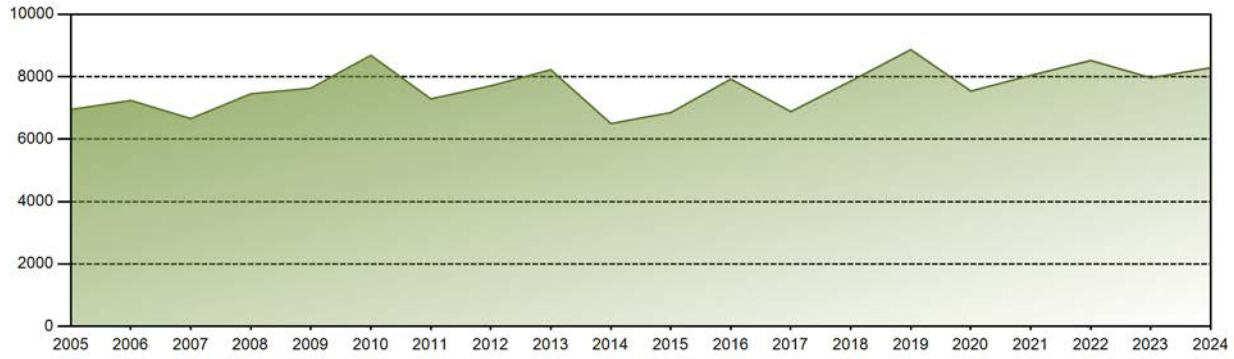
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	762.79	717.20	771.66	729.04	765.10	337.77	464.14	749.16	733.17	768.16	748.17	740.19	8286.54
EAF [%]	100.00	100.00	100.00	98.84	100.00	48.99	63.49	100.00	100.00	100.00	100.00	96.90	92.37
UCF [%]	100.00	100.00	100.00	98.84	100.00	49.64	63.49	100.00	100.00	100.00	100.00	96.90	92.42
LF [%]	107.92	108.47	109.18	106.59	108.25	49.38	65.67	105.99	107.19	108.68	109.38	104.72	99.30
OF [%]	100.00	100.00	100.00	100.00	100.00	53.33	63.84	100.00	100.00	100.00	100.00	100.00	93.11
FLR [%]	0.00	0.00	0.00	1.16	0.00	6.93	0.00	0.00	0.00	0.00	0.00	3.10	0.71
UCL [%]	0.00	0.00	0.00	1.16	0.00	3.69	0.00	0.00	0.00	0.00	0.00	3.10	0.66
PUF [%]	0.00	0.00	0.00	0.00	0.00	46.67	36.51	0.00	0.00	0.00	0.00	0.00	6.92
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.05

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Historical Summary

Lifetime energy generation	:	237979.07 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.49 %
Cumulative Energy Availability Factor (EAF)	:	75.6 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.4 %
Cumulative Unit Capability Factor (UCF)	:	77.73 %	Cumulative Planned Unavailability Factor (PUF)	:	16.87 %
Cumulative Load Factor (LF)	:	76.92 %	Cumulative Externally cause unavailability (XUF)	:	2.13 %
Cumulative Operating Factor (OF)	:	79.44 %			

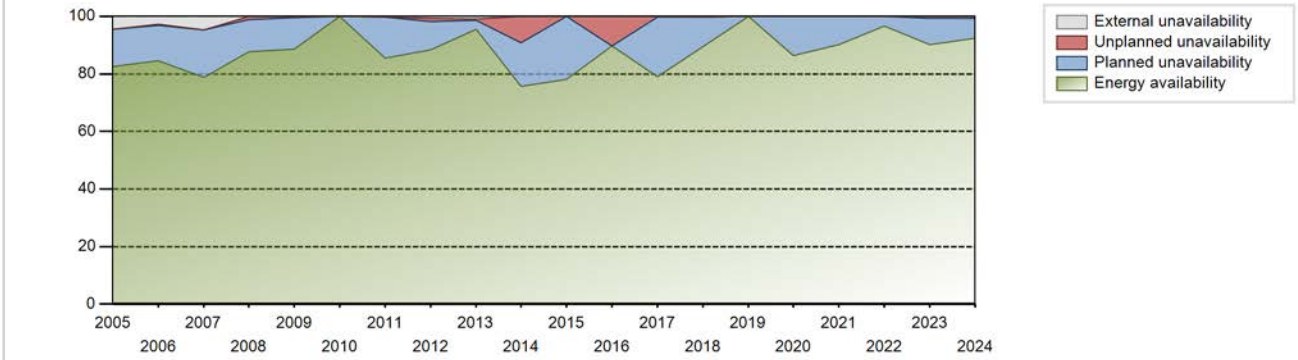
Electricity Production (net) [GWh]



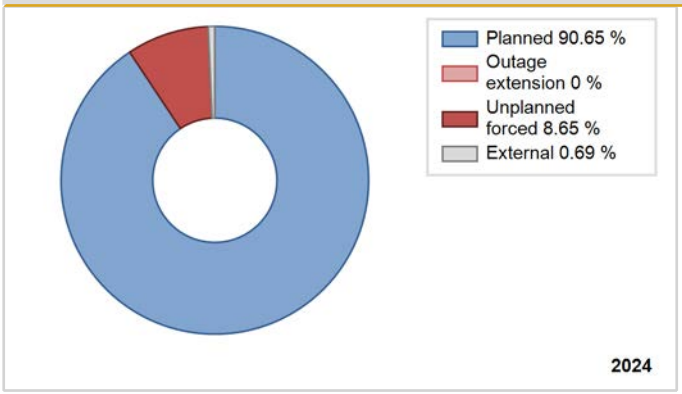
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	5978.43	6928	950	75.49	75.49	70.63	77.66	6.59	5.33	19.18	0.00
1989	6703.63	7626	950	84.75	84.77	80.55	87.05	9.33	8.72	6.51	0.02
1990	5476.67	6165	950	66.35	66.53	65.81	70.38	15.71	12.40	21.07	0.18
1991	4308.38	4845	950	51.23	51.52	51.77	55.31	10.81	6.25	42.23	0.29
1992	5958.20	6601	950	70.60	70.60	71.39	75.14	9.39	7.32	22.08	0.00
1993	3776.17	4147	950	44.25	46.97	45.38	47.34	38.44	29.33	23.69	2.72
1994	4778.52	8020	950	73.08	83.53	57.42	91.55	12.39	11.81	4.66	10.45
1995	2204.81	3261	950	30.13	30.13	26.49	37.23	27.40	11.37	58.50	0.00
1996	2227.25	2604	950	26.71	26.71	26.69	29.64	66.37	52.71	20.58	0.00
1997	4015.92	6158	950	55.66	63.92	48.26	70.30	27.93	24.77	11.31	8.26
1998	3293.76	4984	950	40.24	50.96	39.58	56.89	0.11	0.05	48.98	10.72
1999	2927.12	3942	950	35.40	40.27	35.17	45.00	0.00	0.00	59.73	4.87
2000	5730.07	7646	950	68.89	83.21	68.67	87.04	1.61	1.36	15.43	14.32
2001	6678.82	7415	950	79.86	83.90	80.25	84.65	0.82	0.70	15.40	4.05
2002	6756.53	7408	950	80.40	84.43	81.19	84.57	2.74	2.38	13.19	4.03
2003	6171.76	6467	950	72.70	73.99	74.16	73.82	0.03	0.02	25.99	1.29
2004	7010.41	7514	950	82.36	85.00	84.01	85.54	0.72	0.62	14.38	2.64
2005	6948.86	7688	950	82.48	86.92	83.49	87.75	0.00	0.00	13.08	4.44
2006	7237.48	7710	950	84.59	87.38	86.97	88.01	0.41	0.36	12.26	2.79
2007	6657.18	7327	950	78.71	83.46	79.99	83.64	0.00	0.00	16.54	4.75
2008	7451.24	7750	950	87.71	87.82	89.29	88.23	1.21	1.07	11.11	0.11
2009	7630.69	7797	950	88.63	88.78	91.69	89.01	0.28	0.25	10.97	0.15
2010	8683.93	8760	950	99.86	100.00	104.35	100.00	0.00	0.00	0.00	0.14
2011	7288.41	7531	950	85.42	85.76	87.59	85.98	0.00	0.00	14.24	0.35
2012	7706.49	7829	950	88.30	88.99	92.35	89.13	1.35	1.22	9.79	0.70
2013	8222.79	8509	950	95.56	96.54	98.81	97.13	0.45	0.44	3.02	0.98
2014	6497.72	6672	950	75.62	75.62	78.07	76.16	10.92	9.27	15.11	0.00
2015	6850.26	6845	950	78.02	78.03	82.32	78.14	0.00	0.00	21.97	0.01
2016	7922.42	7900	950	89.79	89.79	94.94	89.94	10.21	10.21	0.00	0.00
2017	6880.73	6972	950	79.07	79.07	82.68	79.59	0.40	0.31	20.61	0.00
2018	7858.92	7874	950	89.46	89.82	94.44	89.89	0.00	0.00	10.18	0.36
2019	8867.45	8760	950	100.00	100.00	106.55	100.00	0.00	0.00	0.00	0.00
2020	7538.45	7590	950	86.37	86.37	90.34	86.41	0.00	0.00	13.63	0.00
2021	8043.86	7913	950	90.15	90.25	96.66	90.33	0.00	0.00	9.75	0.11
2022	8519.78	8472	950	96.64	96.64	102.38	96.71	0.02	0.02	3.33	0.00
2023	7964.89	7967	950	90.25	90.25	95.71	90.95	0.69	0.63	9.12	0.00
2024	8286.54	8179	950	92.37	92.42	99.30	93.11	0.71	0.66	6.92	0.05

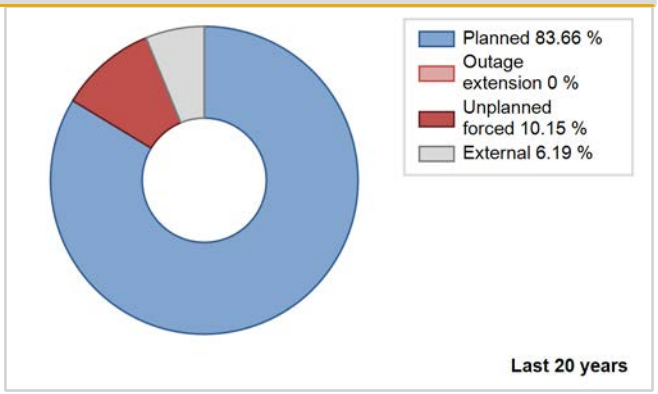
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					310	
C. Inspection, maintenance or repair combined with refuelling	605			1316	74	
D. Inspection, maintenance or repair without refuelling				81		
J. Grid limitation, failure or grid unavailability						1
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						6
L. Human factor related					3	
Z. Other					12	
Subtotal	605			1397	399	7
Total	**605**			**1803**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1988 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		6
15. Reactor Cooling Systems		6
16. Steam generation systems		216
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		1
32. Feedwater and Main Steam System		15
35. All other I&C Systems		2
41. Main Generator Systems		62
42. Electrical Power Supply Systems		1
Total		**311**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the intermediate maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-98 BALAKOVO-3 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KALUGA (JSC "Kaluga turbine plant" 32, Glagoleva Street, Kaluga, 248021, Russia)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1982-11-01
Grid Date	:	1988-12-25
Commercial Date	:	1989-04-08
Age at end of year	:	36 years

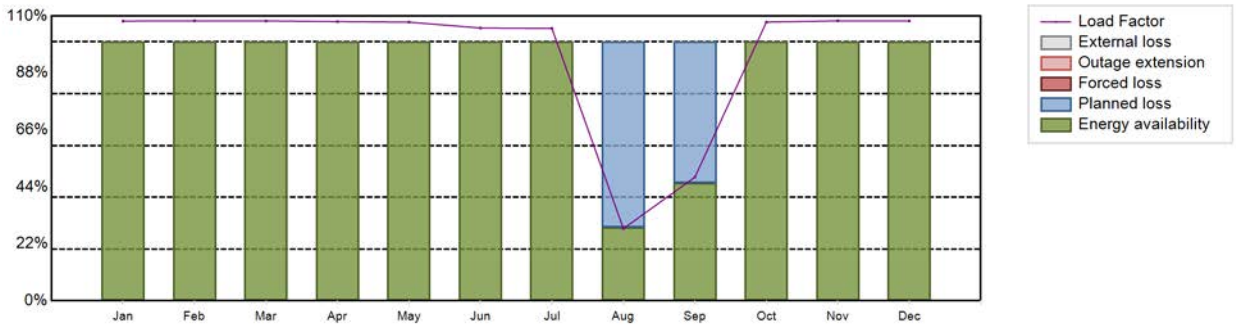
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	7993.63 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	89.46 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	89.46 %	Planned Unavailability Factor (PUF)	:	10.54 %
Load Factor (LF)	:	95.79 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	89.56 %	Total off-line time	:	917 hours
Equivalent non-electrical energy generated (NEG)	:	4.51 GW(e).h			

Annual Summary



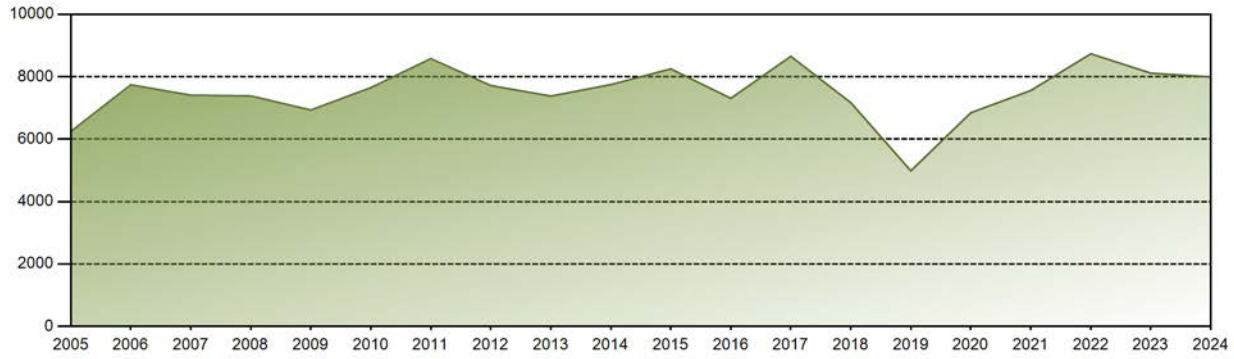
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	763.66	714.85	764.09	737.59	760.66	720.75	743.60	197.18	326.70	760.86	739.57	764.13	7993.63
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	28.37	45.48	100.00	100.00	100.00	89.46
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	28.37	45.48	100.00	100.00	100.00	89.46
LF [%]	108.04	108.11	108.11	107.83	107.62	105.37	105.21	27.90	47.76	107.65	108.12	108.11	95.79
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	29.03	45.97	100.00	100.00	100.00	89.56
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71.63	54.52	0.00	0.00	0.00	10.54
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	235988.65 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.68 %
Cumulative Energy Availability Factor (EAF)	:	77.89 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.22 %
Cumulative Unit Capability Factor (UCF)	:	80.53 %	Cumulative Planned Unavailability Factor (PUF)	:	17.25 %
Cumulative Load Factor (LF)	:	78.86 %	Cumulative Externally cause unavailability (XUF)	:	2.64 %
Cumulative Operating Factor (OF)	:	81.68 %			

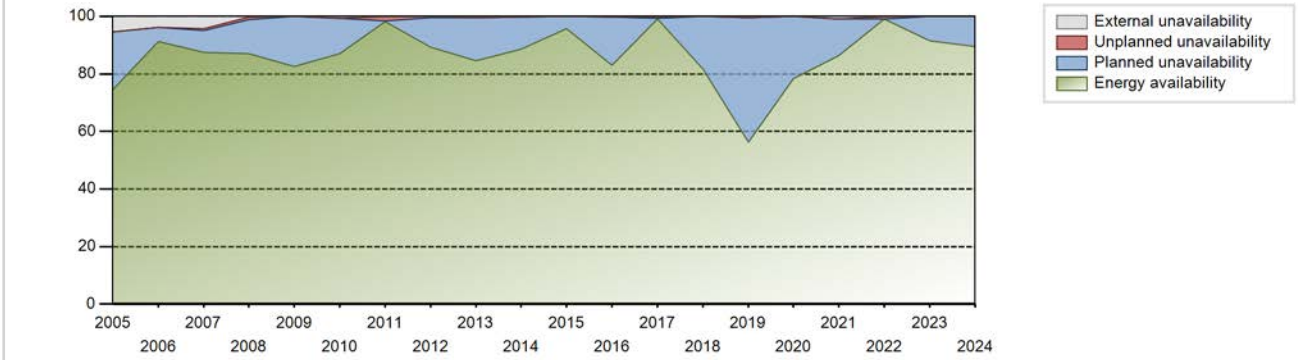
Electricity Production (net) [GWh]



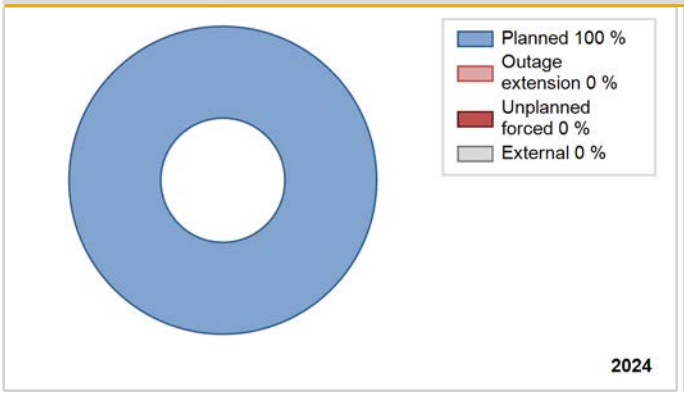
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	6621.41	7792	950	88.36	88.36	87.44	91.12	6.11	5.75	5.90	0.00
1990	5718.71	6696	950	67.84	68.04	68.72	76.44	13.53	10.65	21.31	0.19
1991	5403.35	6124	950	64.23	67.13	64.93	69.91	12.68	9.75	23.13	2.90
1992	5545.43	6202	950	64.77	66.42	66.45	70.60	17.40	14.00	19.59	1.65
1993	4378.64	5461	950	52.73	61.63	52.62	62.34	13.51	9.63	28.74	8.90
1994	3340.14	5389	950	70.66	70.69	40.14	61.52	10.93	8.68	20.64	0.03
1995	2674.65	5511	950	47.52	53.12	32.14	62.91	20.77	13.93	32.95	5.60
1996	5315.40	7085	950	64.26	75.94	63.70	80.66	1.93	1.49	22.57	11.68
1997	2058.79	3395	950	25.29	38.78	24.74	38.76	0.58	0.22	60.99	13.49
1998	5348.52	7136	950	64.42	73.01	64.27	81.46	0.09	0.06	26.93	8.59
1999	5457.98	6552	950	65.61	71.98	65.59	74.79	0.16	0.12	27.91	6.37
2000	6482.85	7327	950	77.18	82.00	77.69	83.41	1.10	0.91	17.09	4.82
2001	6050.74	6927	950	72.10	78.65	72.71	79.08	0.15	0.12	21.23	6.55
2002	6926.31	7478	950	81.99	85.35	83.23	85.37	0.01	0.01	14.64	3.36
2003	7016.14	7471	950	83.19	85.05	84.31	85.29	0.10	0.09	14.86	1.86
2004	7227.76	7607	950	85.13	86.38	86.61	86.60	0.07	0.06	13.56	1.25
2005	6244.44	7060	950	74.50	79.90	75.04	80.59	0.00	0.00	20.10	5.40
2006	7741.84	8354	950	91.38	95.30	93.03	95.37	0.00	0.00	4.70	3.92
2007	7407.10	8050	950	87.59	91.82	89.01	91.89	0.68	0.63	7.56	4.23
2008	7384.34	7693	950	86.99	87.15	88.49	87.58	1.09	0.96	11.89	0.16
2009	6932.73	7276	950	82.56	82.63	83.31	83.06	0.00	0.00	17.37	0.08
2010	7649.62	7710	950	87.13	87.75	91.92	88.01	0.00	0.00	12.25	0.63
2011	8579.15	8627	950	98.26	98.26	103.10	98.49	1.61	1.61	0.13	0.00
2012	7716.23	7854	950	89.32	89.34	92.47	89.41	0.59	0.53	10.13	0.02
2013	7378.17	7481	950	84.53	84.94	88.66	85.40	0.11	0.10	14.97	0.41
2014	7746.92	7827	950	88.55	88.82	93.08	89.34	0.00	0.00	11.18	0.26
2015	8250.27	8415	950	95.78	95.78	99.14	96.06	0.06	0.06	4.16	0.00
2016	7307.38	7331	950	82.96	83.26	87.57	83.46	0.00	0.00	16.74	0.30
2017	8653.43	8727	950	99.16	99.48	103.98	99.62	0.41	0.40	0.11	0.32
2018	7167.75	7163	950	81.59	81.71	86.13	81.77	0.00	0.00	18.29	0.12
2019	4983.36	4979	950	56.33	56.84	59.88	56.84	0.00	0.00	43.16	0.51
2020	6845.49	6880	950	78.34	78.34	82.03	78.32	0.00	0.00	21.66	0.00
2021	7559.14	7634	950	86.26	87.09	90.83	87.15	0.00	0.00	12.91	0.82
2022	8734.40	8674	950	98.99	98.99	104.96	99.02	1.01	1.01	0.00	0.00
2023	8113.04	8030	950	91.47	91.61	97.49	91.67	0.00	0.00	8.39	0.14
2024	7993.63	7867	950	89.46	89.46	95.79	89.56	0.00	0.00	10.54	0.00

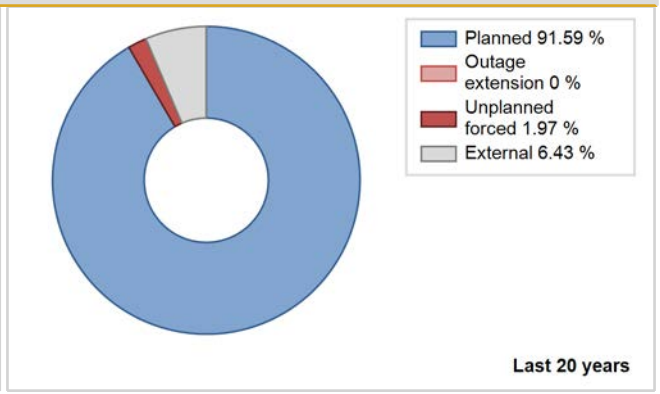
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					68	
C. Inspection, maintenance or repair combined with refuelling	917			1317	18	
D. Inspection, maintenance or repair without refuelling				150		
E. Testing of plant systems or components					1	
J. Grid limitation, failure or grid unavailability						1
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						41
L. Human factor related					5	
Z. Other					2	
Subtotal	917			1467	94	42
Total	**917**			**1603**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1989 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		21
13. Reactor Auxiliary Systems		0
15. Reactor Cooling Systems		4
16. Steam generation systems		1
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		8
32. Feedwater and Main Steam System		6
33. Circulating Water System		6
34. Miscellaneous Systems		5
35. All other I&C Systems		4
41. Main Generator Systems		4
42. Electrical Power Supply Systems		11
Total		**72**

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Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the overhaul. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-99 BALAKOVO-4 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KALUGA (JSC "Kaluga turbine plant" 32, Glagoleva Street, Kaluga, 248021, Russia)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1984-04-01
Grid Date	:	1993-04-11
Commercial Date	:	1993-12-22
Age at end of year	:	31 years

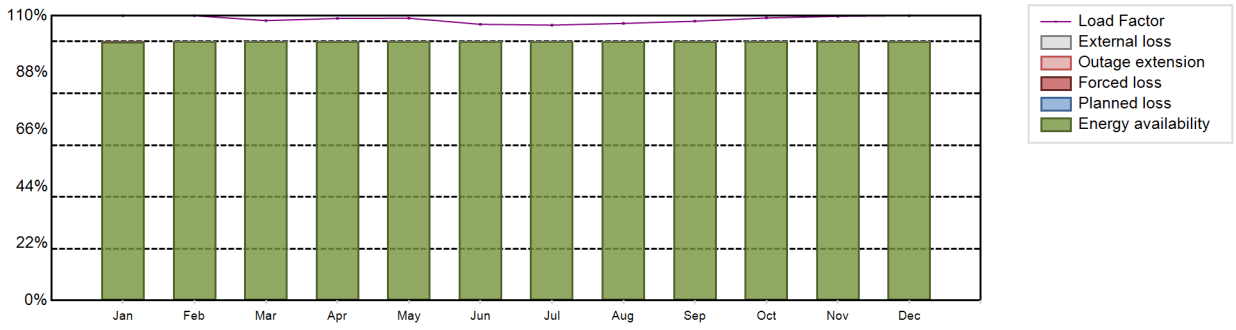
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	9059.53 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	108.56 %
Operating Factor (OF)	:	100 %
Equivalent non-electrical energy generated (NEG)	:	6.46 GW(e).h
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	0 hours

Annual Summary



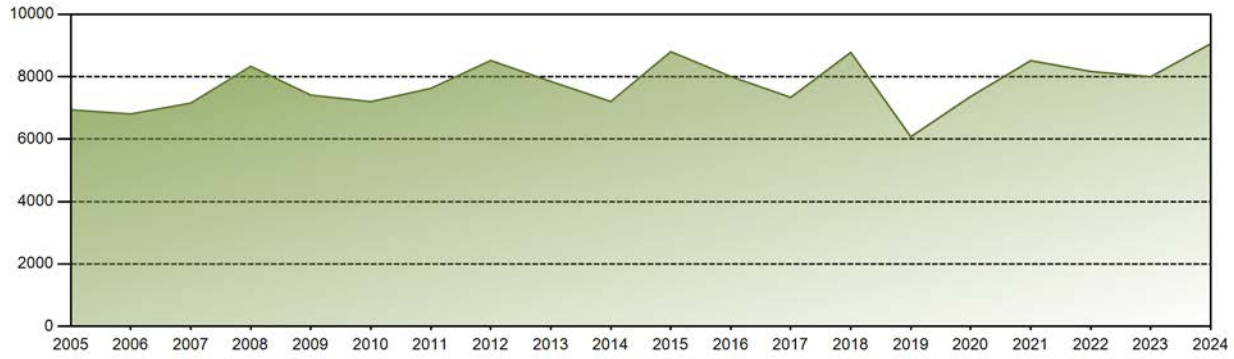
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	777.30	727.31	764.09	745.02	770.55	729.59	751.83	756.38	737.87	771.36	750.77	777.45	9059.53
EAF [%]	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	109.97	110.00	108.11	108.92	109.02	106.66	106.37	107.01	107.88	109.13	109.76	110.00	108.56
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	222066.09 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.22 %
Cumulative Energy Availability Factor (EAF)	:	82.19 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.05 %
Cumulative Unit Capability Factor (UCF)	:	84.98 %	Cumulative Planned Unavailability Factor (PUF)	:	13.97 %
Cumulative Load Factor (LF)	:	84.59 %	Cumulative Externally cause unavailability (XUF)	:	2.8 %
Cumulative Operating Factor (OF)	:	86.08 %			

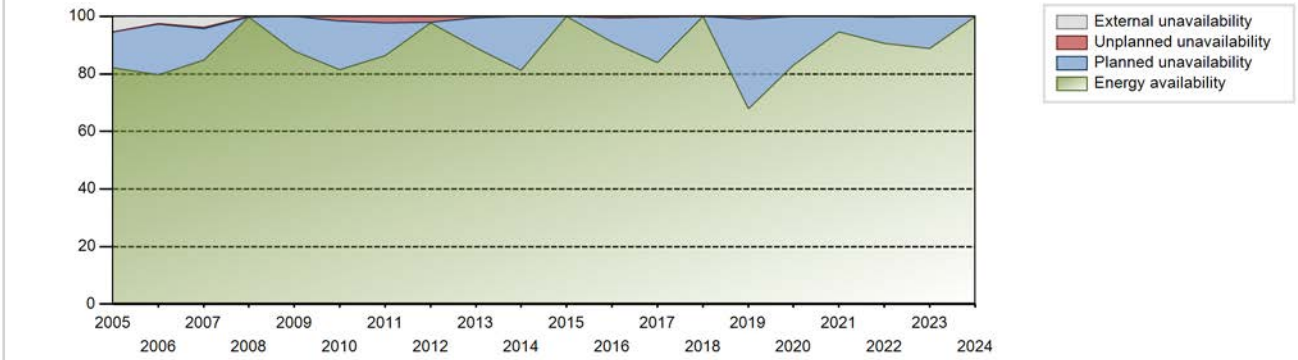
Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1993	3676.28	5206	950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1994	3828.53	4604	950	48.45	69.54	46.00	52.56	1.58	1.12	29.34	21.09
1995	5609.99	8760	950	86.46	88.72	67.41	100.00	11.28	11.28	0.00	2.26
1996	4545.55	6652	950	55.47	59.85	54.47	75.73	13.90	9.66	30.49	4.39
1997	4637.72	6637	950	59.64	71.29	55.73	75.76	0.16	0.11	28.60	11.65
1998	5042.49	6936	950	60.89	71.31	60.59	79.18	0.00	0.00	28.69	10.42
1999	5803.91	7268	950	69.59	77.55	69.74	82.97	0.37	0.29	22.17	7.95
2000	6665.85	7216	950	78.95	80.96	79.88	82.15	0.78	0.63	18.40	2.01
2001	6578.09	7354	950	78.30	83.91	79.04	83.95	0.47	0.40	15.69	5.61
2002	6292.92	6723	950	72.80	77.28	75.62	76.75	0.20	0.16	22.57	4.47
2003	7223.84	7541	950	84.64	85.84	86.80	86.08	0.50	0.43	13.73	1.20
2004	7022.94	7540	950	82.51	85.37	84.16	85.84	0.45	0.39	14.24	2.86
2005	6938.28	7699	950	82.14	87.62	83.36	87.88	0.00	0.00	12.38	5.48
2006	6805.35	7230	950	79.61	82.20	81.78	82.53	0.08	0.07	17.74	2.58
2007	7153.35	7787	950	84.70	88.53	85.96	88.89	0.40	0.36	11.11	3.83
2008	8330.42	8779	950	99.71	99.73	99.83	99.94	0.14	0.14	0.13	0.02
2009	7409.95	7727	950	87.83	87.83	89.02	88.19	0.00	0.00	12.17	0.00
2010	7199.69	7168	950	81.35	81.35	86.51	81.83	2.02	1.68	16.97	0.00
2011	7625.20	7619	950	86.42	86.42	91.64	86.98	2.50	2.22	11.36	0.00
2012	8517.84	8608	950	97.72	97.72	102.07	98.00	2.08	2.07	0.20	0.00
2013	7847.25	7847	950	89.13	89.13	94.30	89.58	0.61	0.54	10.33	0.00
2014	7204.52	7173	950	81.27	81.36	86.56	81.87	0.00	0.00	18.64	0.09
2015	8800.05	8757	950	100.00	100.00	105.74	99.97	0.00	0.00	0.00	0.00
2016	8006.24	8045	950	91.07	91.58	95.94	91.59	0.00	0.00	8.42	0.52
2017	7336.59	7386	950	83.99	84.24	88.16	84.32	0.00	0.00	15.76	0.25
2018	8777.02	8760	950	99.97	99.97	105.47	100.00	0.00	0.00	0.03	0.00
2019	6075.81	5952	950	67.76	67.76	73.01	67.95	1.15	0.88	31.36	0.00
2020	7368.35	7307	950	83.11	83.11	88.30	83.19	0.03	0.02	16.87	0.00
2021	8516.23	8296	950	94.64	94.64	102.33	94.70	0.00	0.00	5.36	0.00
2022	8167.11	7962	950	90.70	90.76	98.14	90.89	0.15	0.13	9.11	0.05
2023	7999.26	7797	950	88.81	88.81	96.12	89.01	0.01	0.01	11.18	0.00
2024	9059.53	8784	950	100.00	100.00	108.56	100.00	0.00	0.00	0.00	0.00

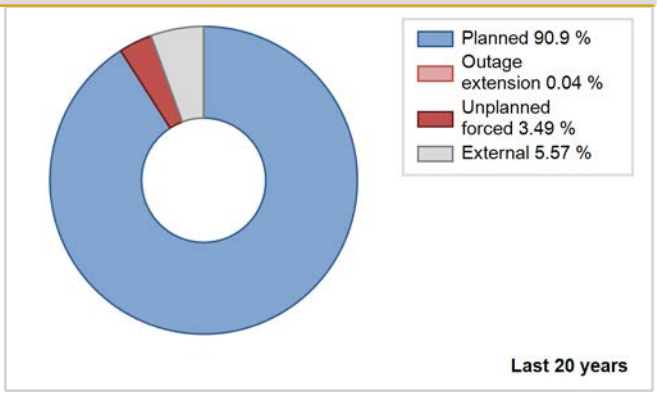
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1993 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					24	
C. Inspection, maintenance or repair combined with refuelling				1116		
D. Inspection, maintenance or repair without refuelling				15		
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						11
L. Human factor related					0	
Z. Other						54
Subtotal				1131	24	65
Total		**0**			**1220**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1993 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		1
15. Reactor Cooling Systems		1
16. Steam generation systems		6
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		8
35. All other I&C Systems		1
41. Main Generator Systems		2
42. Electrical Power Supply Systems		3
Total		**24**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-21 BELOYARSK-3 RUSSIA



Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	LMZ (JOINT-STOCK COMPANY "LENINGRADSKIY METALLICHESKIY ZAVOD")

Reactor Unit Details

Reactor type and model	:	FBR / BN-600
Thermal power	:	1470 MWth
Gross electrical power	:	600 MWe
Reference unit power (net)	:	560 MWe

Key Dates

Construction Date	:	1969-01-01
Grid Date	:	1980-04-08
Commercial Date	:	1981-11-01
Age at end of year	:	44 years

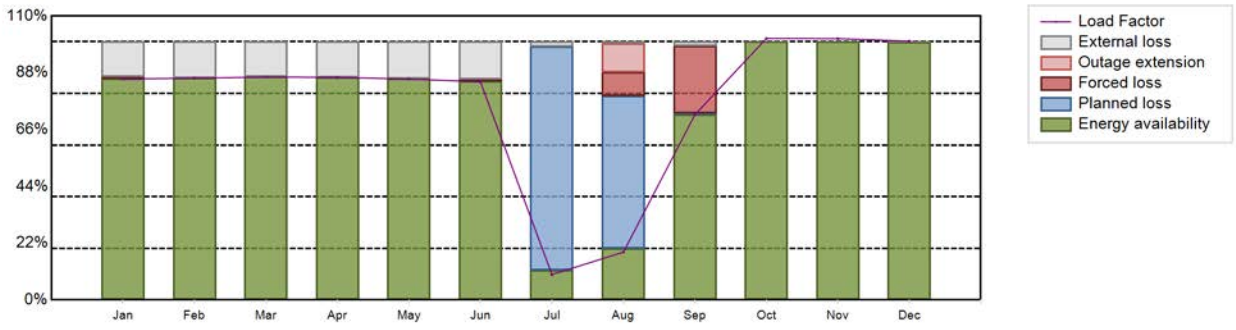
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	-
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	-
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	5
Part of the core refuelled [%]	:	30
Average discharge burnup [MWd/t]	:	100000
Active core diameter [m]	:	2.05
Active core height/length [m]	:	1.03
Number of fissile fuel assemblies/bundles	:	369
Fuel linear heat generation rate [kW/m]	:	38
Number of control rod assemblies	:	19
Number of external reactor coolant loops	:	3
Coolant type	:	Na
Operating coolant pressure [MPa]	:	8.8
Reactor outlet temperature [°C]	:	550
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	3
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	13
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	3751 GW(e).h
Energy Availability Factor (EAF)	:	76.3 %
Unit Capability Factor (UCF)	:	83.59 %
Load Factor (LF)	:	76.25 %
Operating Factor (OF)	:	86.9 %
Equivalent non-electrical energy generated (NEG)	:	99.34 GW(e).h
Forced Loss Rate (FLR)	:	3.54 %
Unplanned Capability Loss Factor (UCL)	:	4.02 %
Planned Unavailability Factor (PUF)	:	12.39 %
Externally cause unavailability (XUF)	:	7.29 %
Total off-line time	:	1151 hours

Annual Summary



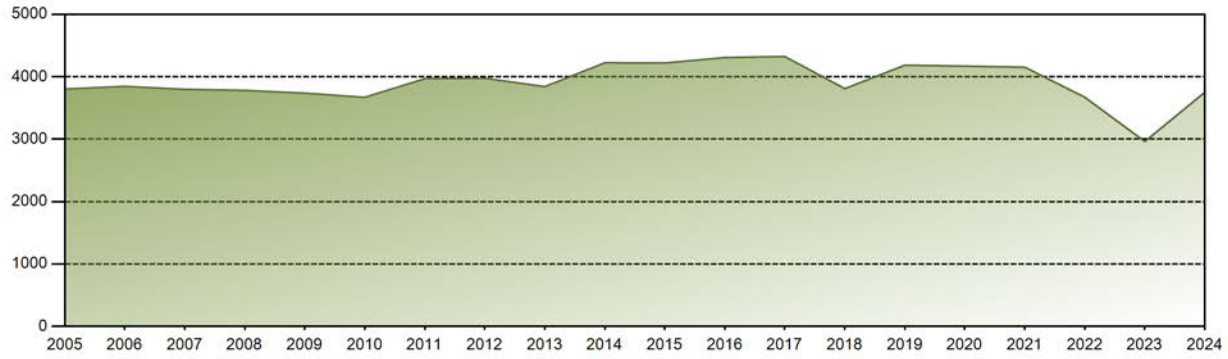
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	356.53	334.83	359.74	347.62	356.45	340.72	40.97	77.19	289.23	421.89	408.13	417.69	3751.00
EAF [%]	85.61	85.96	86.36	86.19	85.64	84.74	11.44	19.93	71.76	100.00	100.00	99.74	76.30
UCF [%]	99.19	100.00	100.00	100.00	99.83	99.19	13.25	20.51	73.38	100.00	100.00	100.00	83.59
LF [%]	85.57	85.91	86.34	86.22	85.55	84.50	9.83	18.53	71.73	101.26	101.22	100.25	76.25
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	14.65	30.65	100.00	100.00	100.00	100.00	86.90
FLR [%]	0.81	0.00	0.00	0.00	0.17	0.81	0.00	30.69	26.29	0.00	0.00	0.00	3.54
UCL [%]	0.81	0.00	0.00	0.00	0.17	0.81	0.00	20.37	26.17	0.00	0.00	0.00	4.02
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	86.75	59.13	0.44	0.00	0.00	0.00	12.39
XUF [%]	13.59	14.04	13.64	13.81	14.19	14.44	1.80	0.57	1.62	0.00	0.00	0.26	7.29

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Historical Summary

Lifetime energy generation	:	163667.04 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.59 %
Cumulative Energy Availability Factor (EAF)	:	75.45 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.92 %
Cumulative Unit Capability Factor (UCF)	:	76.1 %	Cumulative Planned Unavailability Factor (PUF)	:	20.98 %
Cumulative Load Factor (LF)	:	75.96 %	Cumulative Externally cause unavailability (XUF)	:	0.65 %
Cumulative Operating Factor (OF)	:	78.62 %			

Electricity Production (net) [GWh]

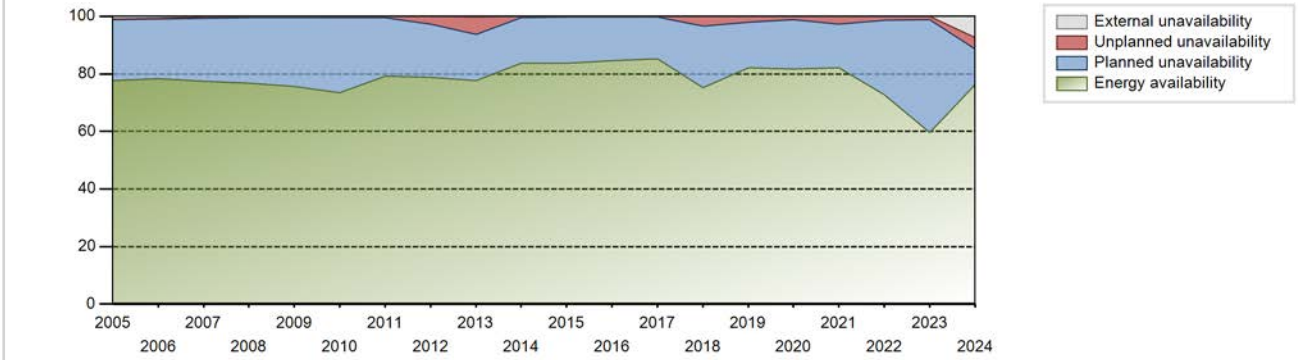


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	Data not provided										
1982	2771.00	5555	560	59.25	59.25	56.49	63.41	11.50	7.70	33.05	0.00
1983	3545.21	6737	560	72.72	73.35	72.27	76.91	3.71	2.82	23.83	0.63
1984	3584.11	6848	560	73.29	73.29	72.86	77.96	5.70	4.43	22.28	0.00
1985	3561.83	6544	560	72.85	72.85	72.61	74.70	2.47	1.85	25.30	0.00
1986	3600.73	6818	560	73.82	74.28	73.40	77.83	4.78	3.73	21.99	0.46
1987	3894.99	6714	600	75.93	75.93	74.11	76.64	2.64	2.05	22.02	0.00
1988	3762.19	6810	560	76.97	76.97	76.48	77.53	0.38	0.30	22.74	0.00
1989	3694.43	6800	560	76.95	76.95	75.31	77.63	1.21	0.94	22.10	0.00
1990	3198.00	6627	560	65.85	66.65	65.19	75.65	11.05	8.28	25.07	0.79
1991	3394.00	6631	560	63.57	63.57	69.19	75.70	13.75	10.14	26.29	0.00
1992	4094.97	7449	560	82.82	83.06	83.26	84.81	0.34	0.28	16.66	0.24
1993	3914.92	7065	560	79.49	79.57	79.81	80.65	7.18	6.15	14.28	0.07
1994	3810.67	6977	560	78.78	78.92	77.68	79.65	0.90	0.71	20.37	0.14
1995	3413.27	6953	560	70.70	72.28	69.58	79.37	9.36	7.46	20.26	1.57
1996	3722.33	7010	560	76.32	78.07	75.67	79.80	1.72	1.37	20.57	1.75
1997	3545.80	6596	560	72.97	74.58	72.28	75.30	0.00	0.00	25.42	1.61
1998	2335.33	4385	560	47.67	49.23	47.61	50.06	38.80	31.21	19.55	1.56
1999	3720.99	6972	560	76.18	77.96	75.85	79.59	4.10	3.34	18.71	1.78
2000	3565.82	6820	560	72.49	75.49	72.49	77.64	0.31	0.23	24.27	3.00
2001	3891.10	7214	560	79.90	80.72	79.32	82.35	1.24	1.01	18.27	0.82
2002	3774.40	7069	560	77.30	79.34	76.94	80.70	2.14	1.74	18.93	2.04
2003	3693.28	6836	560	75.74	76.81	75.29	78.04	0.91	0.71	22.48	1.07
2004	3927.64	7185	560	80.02	80.81	79.85	81.80	0.78	0.64	18.56	0.78
2005	3802.75	6977	560	77.76	78.77	77.52	79.65	0.09	0.07	21.16	1.02
2006	3844.94	7001	560	78.38	79.02	78.38	79.92	0.36	0.29	20.69	0.65
2007	3798.42	7089	560	77.52	77.80	77.43	80.92	0.46	0.36	21.84	0.28
2008	3781.03	6918	560	76.85	76.95	76.87	78.76	0.47	0.36	22.69	0.10
2009	3736.60	6734	560	75.58	75.61	76.17	76.87	0.49	0.37	24.01	0.03
2010	3669.75	6541	560	73.51	73.56	74.81	74.67	0.73	0.54	25.90	0.05
2011	3968.73	7141	560	79.17	79.17	80.91	81.53	0.71	0.57	20.26	0.00
2012	3975.50	7250	560	78.84	78.84	80.82	82.54	1.62	2.69	18.47	0.00
2013	3841.06	7398	560	77.62	77.80	78.30	84.45	7.27	6.10	16.11	0.18
2014	4222.91	7455	560	83.77	83.77	86.07	85.09	0.58	0.49	15.75	0.00
2015	4220.16	7414	560	83.78	83.78	86.03	84.63	0.39	0.33	15.89	0.00
2016	4307.17	7517	560	84.66	84.66	87.56	85.58	0.41	0.35	14.98	0.00
2017	4323.23	7548	560	85.36	85.36	88.13	86.16	0.32	0.27	14.36	0.00

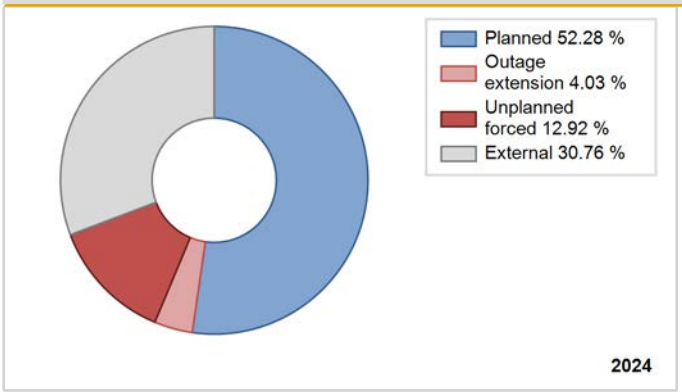
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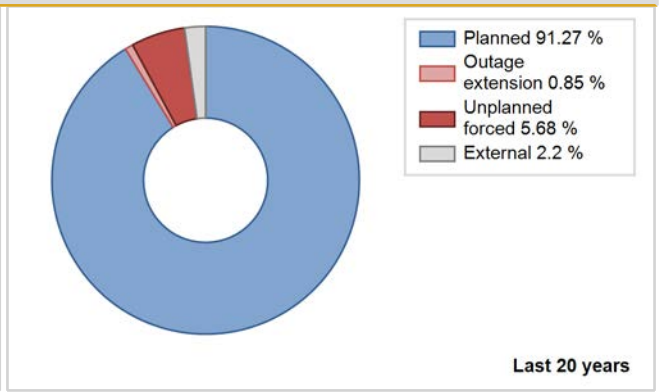
2018	3809.52	6911	560	75.28	75.28	77.66	78.89	3.23	3.38	21.34	0.00
2019	4184.26	7453	560	82.22	82.22	85.30	85.08	1.95	2.15	15.63	0.00
2020	4169.76	7338	560	81.60	81.60	84.77	83.54	1.47	1.22	17.19	0.00
2021	4152.25	7484	560	82.23	82.23	84.64	85.43	3.10	2.63	15.14	0.00
2022	3670.83	6590	560	72.84	72.84	74.83	75.23	1.80	1.33	25.83	0.00
2023	2961.93	5356	560	59.52	59.52	60.38	61.14	1.73	1.05	39.44	0.00
2024	3751.00	7633	560	76.30	83.59	76.25	86.90	3.54	4.02	12.39	7.29

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					110	
C.	Inspection, maintenance or repair combined with refuelling	1067			1337		
D.	Inspection, maintenance or repair without refuelling				390	5	
H.	Nuclear regulatory requirements					1	
J.	Grid limitation, failure or grid unavailability						2
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L.	Human factor related					1	
T.	Heat supply (on-site to support next unit or desalination and off-site distribution)						0
Z.	Other		84			2	
Subtotal		1067	84		1727	119	3
Total			**1151**			**1849**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		2
13. Reactor Auxiliary Systems		11
15. Reactor Cooling Systems		26
21. Fuel Handling and Storage Facilities		62
31. Turbine and auxiliaries		1
32. Feedwater and Main Steam System		2
35. All other I&C Systems		4
42. Electrical Power Supply Systems		1
Total		**112**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the routine maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-116 BELOYARSK-4 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	AEM (Atomenergomash)



Reactor Unit Details

Reactor type and model	:	FBR / BN-800
Thermal power	:	2100 MWth
Gross electrical power	:	885 MWe
Reference unit power (net)	:	820 MWe

Key Dates

Construction Date	:	2006-07-18
Grid Date	:	2015-12-10
Commercial Date	:	2016-10-31
Age at end of year	:	9 years

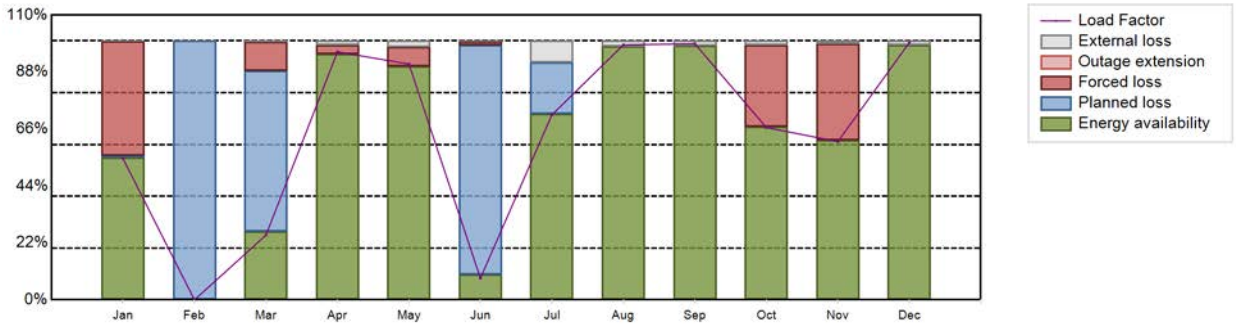
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	1.65
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	547
Fuel material	:	UO2/PuO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	6	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	2.56	HP cylinder inlet steam pressure [MPa]	:	13
Active core height/length [m]	:	0.88	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	565	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	38	Number of main condensate pumps	:	-
Number of control rod assemblies	:	16	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	NA	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4649.14 GW(e).h	Forced Loss Rate (FLR)	:	14.7 %
Energy Availability Factor (EAF)	:	64.57 %	Unplanned Capability Loss Factor (UCL)	:	11.44 %
Unit Capability Factor (UCF)	:	66.38 %	Planned Unavailability Factor (PUF)	:	22.18 %
Load Factor (LF)	:	64.55 %	Externally cause unavailability (XUF)	:	1.81 %
Operating Factor (OF)	:	74.04 %	Total off-line time	:	2280 hours

Annual Summary



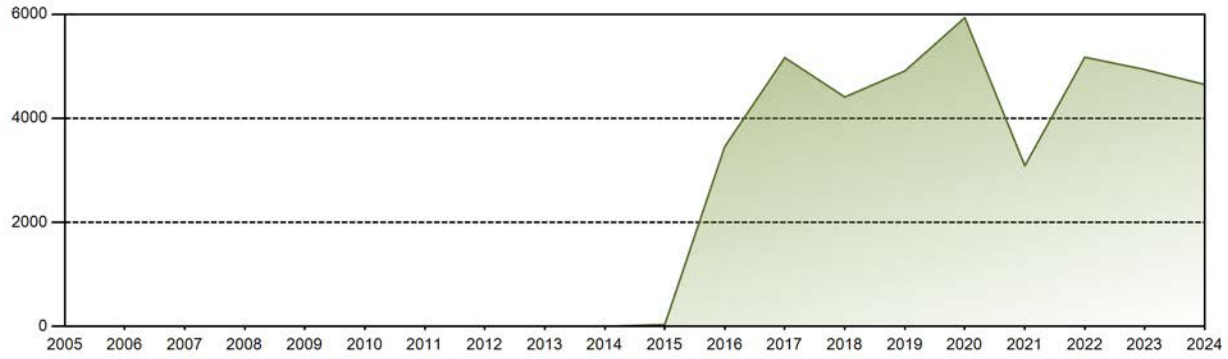
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	332.97	0.00	152.46	565.23	555.70	49.45	435.90	600.72	583.82	405.92	360.81	606.16	4649.14
EAF [%]	55.03	0.07	26.32	94.88	90.27	9.73	71.71	97.88	98.20	66.85	61.60	98.38	64.57
UCF [%]	55.05	0.07	26.80	96.44	92.70	9.98	80.15	100.00	100.00	68.59	62.63	100.00	66.38
LF [%]	54.58	0.00	24.99	95.74	91.09	8.38	71.45	98.47	98.88	66.54	61.11	99.36	64.55
OF [%]	100.00	0.29	40.32	100.00	100.00	12.92	82.26	100.00	100.00	76.21	71.39	100.00	74.04
FLR [%]	44.62	0.00	29.33	3.56	7.30	11.26	0.00	0.00	0.00	31.41	37.37	0.00	14.70
UCL [%]	44.35	0.00	11.12	3.56	7.30	1.27	0.00	0.00	0.00	31.41	37.37	0.00	11.44
PUF [%]	0.60	99.93	62.07	0.00	0.00	88.76	19.85	0.00	0.00	0.00	0.00	0.00	22.18
XUF [%]	0.02	0.00	0.48	1.56	2.43	0.24	8.44	2.12	1.80	1.74	1.03	1.62	1.81

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Historical Summary

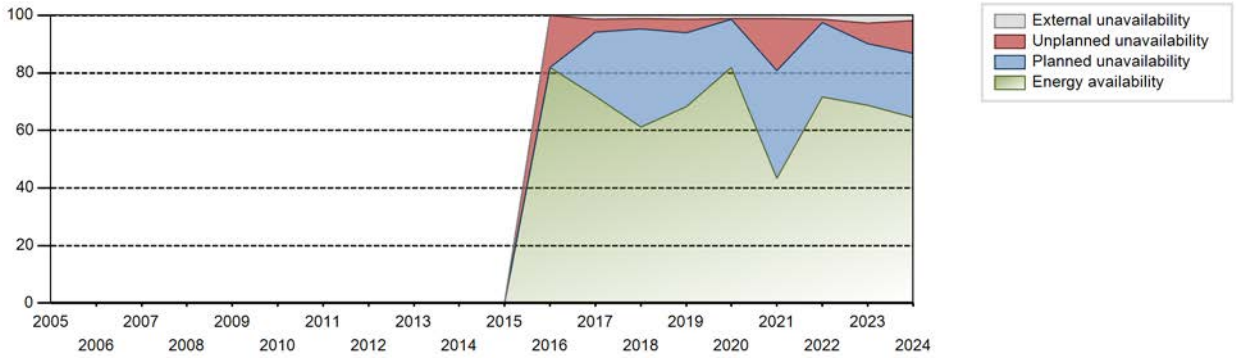
Lifetime energy generation	:	41757.92 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8 %
Cumulative Energy Availability Factor (EAF)	:	66.75 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.6 %
Cumulative Unit Capability Factor (UCF)	:	68.19 %	Cumulative Planned Unavailability Factor (PUF)	:	25.21 %
Cumulative Load Factor (LF)	:	66.86 %	Cumulative Externally cause unavailability (XUF)	:	1.43 %
Cumulative Operating Factor (OF)	:	71.48 %			

Electricity Production (net) [GWh]

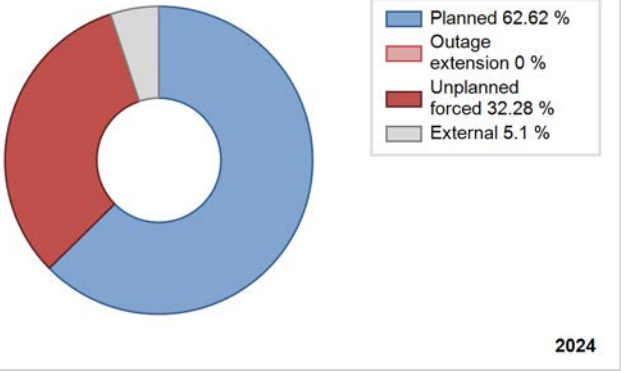


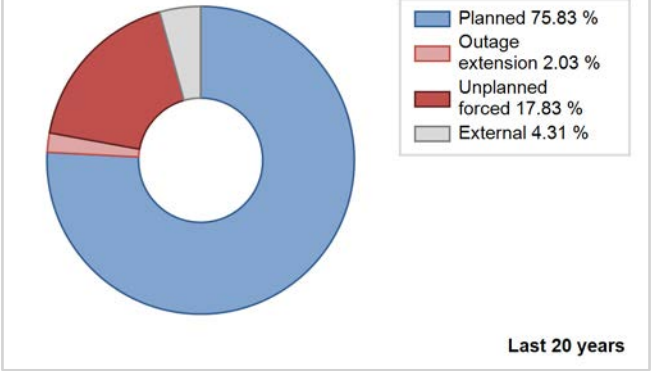
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	3456.96	5453	820	81.92	81.92	81.96	96.45	18.08	18.08	0.00	0.00
2017	5165.75	6551	820	71.81	73.11	71.91	74.78	1.71	4.59	22.30	1.29
2018	4408.98	5680	820	61.25	62.29	61.38	64.84	5.45	3.59	34.12	1.04
2019	4909.25	6196	820	68.26	69.65	68.34	70.73	3.35	4.61	25.74	1.39
2020	5934.14	7373	820	81.92	82.98	82.39	83.94	0.45	0.38	16.64	1.06
2021	3087.27	4049	820	43.31	44.47	42.98	46.22	28.75	17.95	37.58	1.15
2022	5174.47	6710	820	71.64	72.91	72.04	76.60	1.54	1.14	25.95	1.28
2023	4937.40	6697	820	68.68	71.35	68.74	76.45	9.20	7.23	21.42	2.67
2024	4649.14	6504	820	64.57	66.38	64.55	74.04	14.70	11.44	22.18	1.81

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2016 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		383			356	
C. Inspection, maintenance or repair combined with refuelling	1896			1826		
D. Inspection, maintenance or repair without refuelling				325		
Subtotal	1896	383		2151	356	
Total		**2279**			**2507**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2016 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	383	62
12. Reactor I&C Systems		27
14. Safety Systems		8
15. Reactor Cooling Systems		138
31. Turbine and auxiliaries		51
32. Feedwater and Main Steam System		6
41. Main Generator Systems		26
42. Electrical Power Supply Systems		6
Total	**383**	**324**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the routine maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-142 BILIBINO-2 RUSSIA



Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	LWGR / EGP-6
Thermal power	:	62 MWth
Gross electrical power	:	12 MWe
Reference unit power (net)	:	11 MWe

Key Dates

Construction Date	:	1970-01-01
Grid Date	:	1974-12-30
Commercial Date	:	1975-02-01
Age at end of year	:	50 years

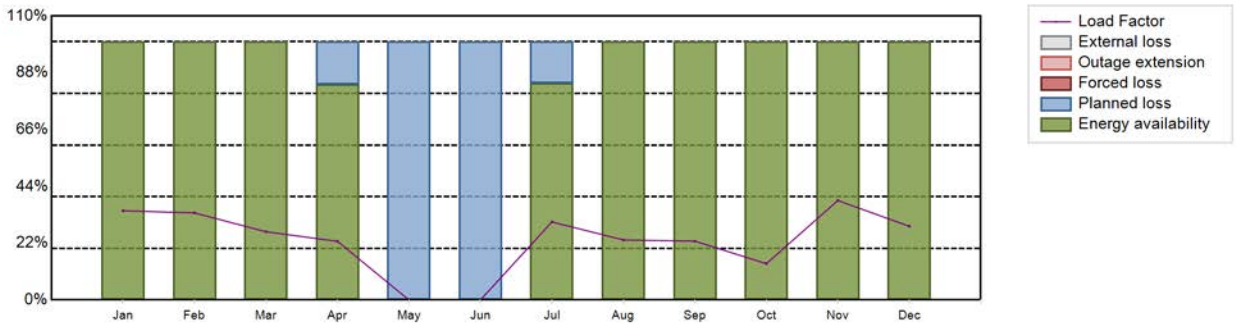
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	3000
Active core diameter [m]	:	4.1
Active core height/length [m]	:	3
Number of fissile fuel assemblies/bundles	:	273
Fuel linear heat generation rate [kW/m]	:	27
Number of control rod assemblies	:	-
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	6
Reactor outlet temperature [°C]	:	280
Number of SG	:	NA
Containment type	:	NA
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	22.09 GW(e).h
Energy Availability Factor (EAF)	:	80.62 %
Unit Capability Factor (UCF)	:	80.62 %
Load Factor (LF)	:	22.86 %
Operating Factor (OF)	:	80.62 %
Equivalent non-electrical energy generated (NEG)	:	16.45 GW(e).h
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	19.38 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1702 hours

Annual Summary



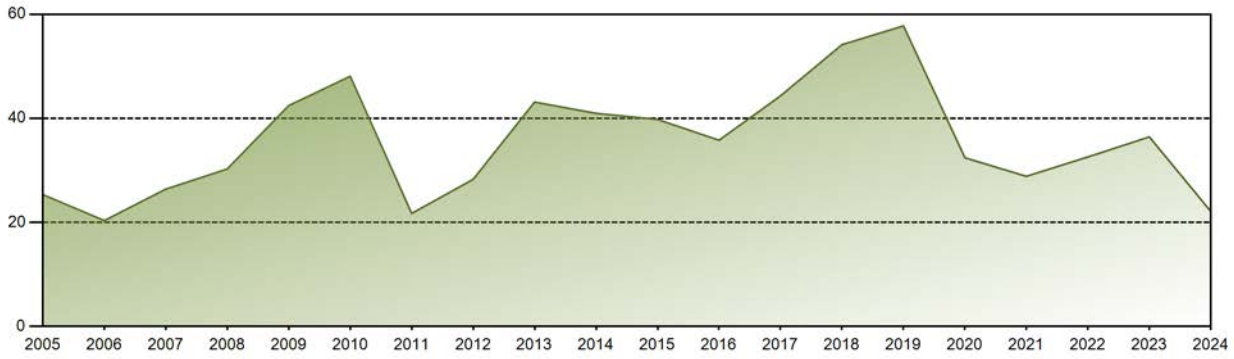
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	2.83	2.58	2.16	1.80	0.00	0.00	2.47	1.90	1.80	1.15	3.05	2.33	22.09
EAF [%]	100.00	100.00	100.00	83.42	0.00	0.00	84.02	100.00	100.00	100.00	100.00	100.00	80.62
UCF [%]	100.00	100.00	100.00	83.42	0.00	0.00	84.02	100.00	100.00	100.00	100.00	100.00	80.62
LF [%]	34.56	33.73	26.42	22.73	0.00	0.00	30.22	23.24	22.78	14.06	38.52	28.53	22.86
OF [%]	100.00	100.00	100.00	83.47	0.00	0.00	84.01	100.00	100.00	100.00	100.00	100.00	80.62
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	16.58	100.00	100.00	15.98	0.00	0.00	0.00	0.00	0.00	19.38
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	2366.41 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.7 %
Cumulative Energy Availability Factor (EAF)	:	73.64 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.41 %
Cumulative Unit Capability Factor (UCF)	:	81.78 %	Cumulative Planned Unavailability Factor (PUF)	:	16.8 %
Cumulative Load Factor (LF)	:	50.55 %	Cumulative Externally cause unavailability (XUF)	:	8.14 %
Cumulative Operating Factor (OF)	:	79.68 %			

Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	63.76	7365	10	88.97	94.67	78.14	90.14	1.31	1.26	4.07	5.70
1976	66.10	7901	10	83.67	89.44	75.25	89.95	1.10	0.99	9.56	5.77
1977	57.04	7865	10	81.34	90.50	65.12	89.78	0.05	0.05	9.46	9.16
1978	60.61	7929	10	94.81	94.81	69.19	90.51	0.00	0.00	5.19	0.00
1979	69.85	8170	10	88.17	92.93	79.74	93.26	0.08	0.07	7.00	4.76
1980	44.05	5666	10	59.82	62.73	50.15	64.50	35.24	34.13	3.14	2.91
1981	41.36	6520	10	70.39	73.15	47.21	74.43	4.87	3.74	23.11	2.76
1982	63.92	7028	10	79.24	79.24	72.97	80.23	0.00	0.00	20.76	0.00
1983	73.76	7880	10	86.92	90.06	84.20	89.95	1.96	1.80	8.14	3.14
1984	77.63	7891	10	88.51	89.32	88.38	89.83	0.29	0.26	10.41	0.81
1985	78.00	7940	10	88.57	90.29	89.04	90.64	0.46	0.42	9.29	1.73
1986	76.34	7679	10	84.69	87.04	87.14	87.66	0.03	0.02	12.93	2.35
1987	88.42	7794	12	89.10	89.10	84.12	88.97	0.00	0.00	10.90	0.00
1988	75.07	7927	11	90.84	90.84	77.69	90.24	0.64	0.58	8.57	0.00
1989	74.81	7943	11	91.38	91.38	77.64	90.67	0.34	0.31	8.31	0.00
1990	72.62	7274	11	84.57	84.57	75.36	83.04	3.23	2.83	12.61	0.00
1991	57.83	4821	11	64.92	64.92	60.02	55.03	20.10	16.33	18.74	0.00
1992	68.24	7857	11	89.91	89.91	70.63	89.45	0.10	0.09	9.99	0.00
1993	52.45	7072	11	62.17	81.86	54.43	80.73	1.69	1.41	16.73	19.69
1994	47.83	6763	11	77.31	78.74	49.64	77.20	2.81	2.28	18.98	1.43
1995	45.45	8677	11	97.19	99.19	47.16	99.05	0.69	0.69	0.12	2.00
1996	16.83	2894	11	33.47	33.47	17.42	32.95	2.84	0.98	65.55	0.00
1997	44.11	8050	11	87.71	92.70	45.78	91.89	0.36	0.34	6.97	4.99
1998	18.16	3727	11	23.30	42.91	18.85	42.55	0.07	0.03	57.06	19.61
1999	54.16	7355	11	64.09	84.73	56.21	83.96	0.45	0.39	14.88	20.64
2000	48.46	6656	11	56.35	78.15	50.15	75.77	0.22	0.17	21.68	21.80
2001	56.71	7439	11	65.81	85.23	58.86	84.92	0.00	0.00	14.77	19.42
2002	30.02	5744	11	38.39	66.40	31.16	65.57	0.00	0.00	33.60	28.01
2003	33.25	7162	11	44.48	82.22	34.51	81.76	0.00	0.00	17.78	37.74
2004	17.92	5851	11	27.23	70.29	18.55	66.61	0.00	0.00	29.71	43.05
2005	25.33	7351	11	38.19	84.94	26.29	83.92	0.03	0.03	15.03	46.76
2006	20.34	7248	11	32.71	84.22	21.11	82.74	0.00	0.00	15.78	51.52
2007	26.38	7478	11	39.89	86.70	27.37	85.37	0.00	0.00	13.30	46.80
2008	30.27	6490	11	78.78	78.78	31.33	73.88	0.00	0.00	21.22	0.00
2009	42.44	7388	11	86.12	86.12	44.04	84.34	0.89	0.78	13.10	0.00
2010	48.08	7627	11	88.09	88.09	49.89	87.07	0.75	0.66	11.25	0.00
2011	21.71	4977	11	84.38	84.38	22.53	56.82	1.45	1.24	14.38	0.00

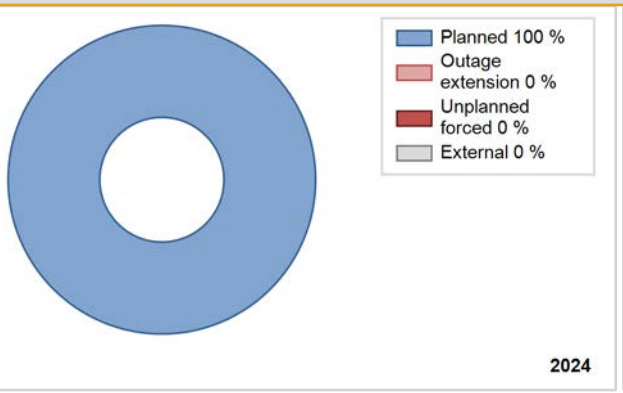
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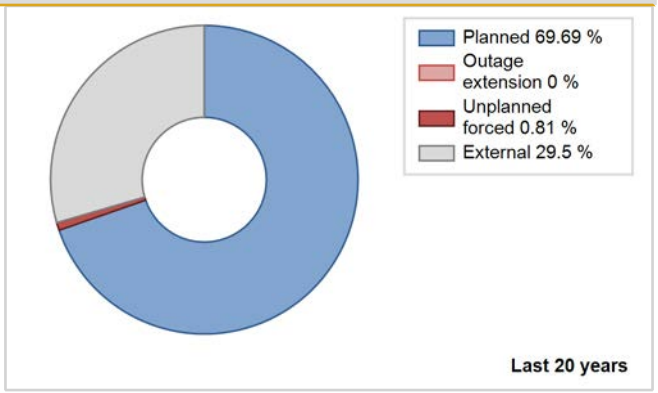
2012	28.27	5461	11	72.73	72.73	29.26	62.17	0.05	0.04	27.24	0.00
2013	43.12	6904	11	85.84	85.84	44.75	78.81	0.00	0.00	14.16	0.00
2014	40.96	6457	11	84.92	84.92	42.51	73.71	0.00	0.00	15.08	0.00
2015	39.78	6331	11	73.73	73.73	41.28	72.27	0.44	0.32	25.95	0.00
2016	35.79	6506	11	75.88	75.88	37.04	74.07	0.86	0.66	23.46	0.00
2017	44.31	7393	11	85.12	85.12	45.98	84.39	0.00	0.00	14.88	0.00
2018	54.16	7383	11	84.99	84.99	56.20	84.28	0.00	0.00	15.01	0.00
2019	57.78	7398	11	85.16	85.16	59.97	84.45	0.00	0.00	14.84	0.00
2020	32.42	6429	11	74.40	74.40	33.55	73.19	0.00	0.00	25.60	0.00
2021	28.85	7051	11	85.10	85.10	29.94	80.49	0.00	0.00	14.90	0.00
2022	32.58	7214	11	82.42	82.42	33.81	82.35	0.00	0.00	17.58	0.00
2023	36.43	7780	11	89.52	89.52	37.80	88.81	0.26	0.23	10.25	0.00
2024	22.09	7082	11	80.62	80.62	22.86	80.62	0.00	0.00	19.38	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1975 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					99	
B. Refuelling without maintenance				8		
C. Inspection, maintenance or repair combined with refuelling	1702			1420	60	
D. Inspection, maintenance or repair without refuelling				95		
E. Testing of plant systems or components				7		
J. Grid limitation, failure or grid unavailability						12
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						107
L. Human factor related					5	
Z. Other				4		
Subtotal	1702			1534	164	119
Total	**1702**			**1817**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		51
12. Reactor I&C Systems		9
14. Safety Systems		0
15. Reactor Cooling Systems		5
16. Steam generation systems		4
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		15
32. Feedwater and Main Steam System		6
33. Circulating Water System		0
34. Miscellaneous Systems		3
41. Main Generator Systems		5
Total		**99**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the overhaul. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-143 BILIBINO-3 RUSSIA



Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	LWGR / EGP-6
Thermal power	:	62 MWth
Gross electrical power	:	12 MWe
Reference unit power (net)	:	11 MWe

Key Dates

Construction Date	:	1970-01-01
Grid Date	:	1975-12-22
Commercial Date	:	1976-02-01
Age at end of year	:	49 years

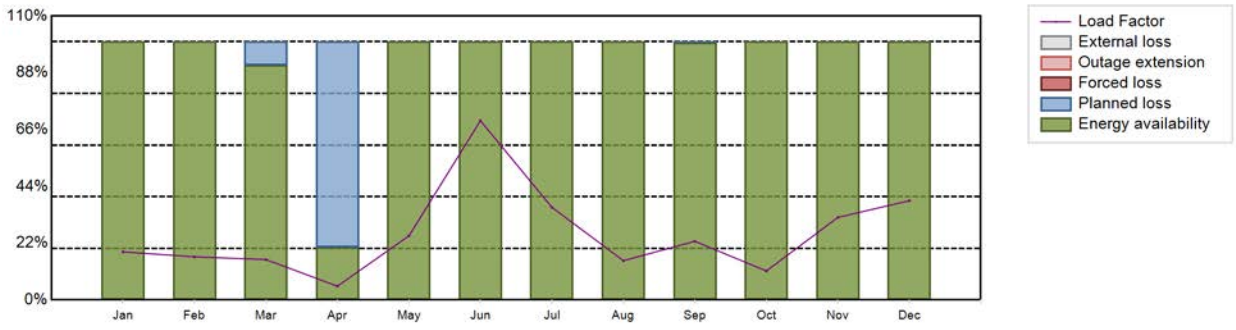
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	3000
Active core diameter [m]	:	4.1
Active core height/length [m]	:	3
Number of fissile fuel assemblies/bundles	:	273
Fuel linear heat generation rate [kW/m]	:	27
Number of control rod assemblies	:	-
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	6
Reactor outlet temperature [°C]	:	280
Number of SG	:	NA
Containment type	:	NA
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	24.62 GW(e).h
Energy Availability Factor (EAF)	:	92.68 %
Unit Capability Factor (UCF)	:	92.68 %
Load Factor (LF)	:	25.48 %
Operating Factor (OF)	:	92.63 %
Equivalent non-electrical energy generated (NEG)	:	19.13 GW(e).h
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	7.32 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	647 hours

Annual Summary



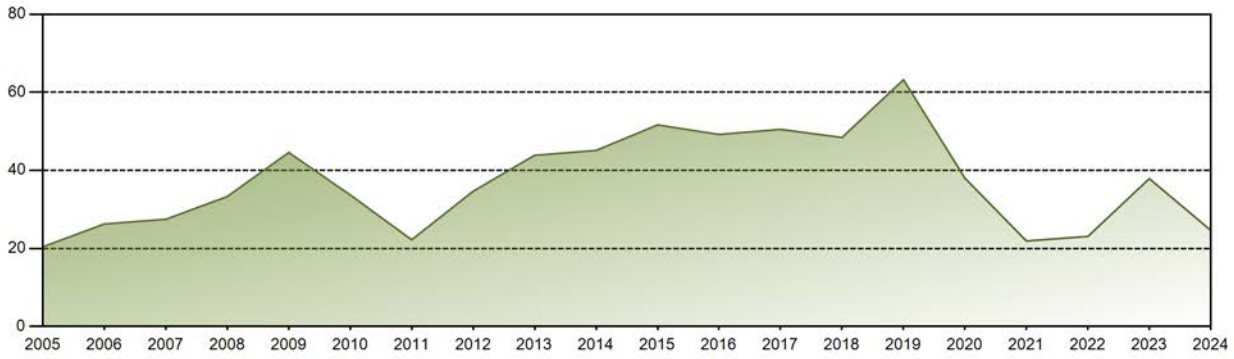
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1.52	1.28	1.28	0.42	2.03	5.50	2.94	1.25	1.80	0.92	2.53	3.15	24.62
EAF [%]	100.00	100.00	91.03	20.34	100.00	100.00	100.00	100.00	99.65	100.00	100.00	100.00	92.68
UCF [%]	100.00	100.00	91.03	20.34	100.00	100.00	100.00	100.00	99.65	100.00	100.00	100.00	92.68
LF [%]	18.63	16.72	15.65	5.35	24.84	69.44	35.87	15.22	22.71	11.23	31.97	38.44	25.48
OF [%]	100.00	100.00	90.59	20.28	100.00	100.00	100.00	100.00	99.58	100.00	100.00	100.00	92.63
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	8.97	79.66	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	7.32
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	2400.63 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.58 %
Cumulative Energy Availability Factor (EAF)	:	74.01 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.48 %
Cumulative Unit Capability Factor (UCF)	:	82.19 %	Cumulative Planned Unavailability Factor (PUF)	:	17.33 %
Cumulative Load Factor (LF)	:	52.27 %	Cumulative Externally cause unavailability (XUF)	:	8.18 %
Cumulative Operating Factor (OF)	:	80.56 %			

Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1976	51.20	6655	10	83.33	90.55	62.19	77.39	2.85	2.65	6.80	7.21
1977	46.50	7533	10	78.21	92.83	53.08	85.99	0.39	0.36	6.81	14.62
1978	61.86	7514	10	86.25	86.25	70.61	85.78	0.01	0.01	13.74	0.00
1979	62.12	7837	10	82.45	88.94	70.92	89.46	0.16	0.14	10.92	6.49
1980	79.43	8130	10	90.99	92.18	90.42	92.55	0.00	0.00	7.82	1.20
1981	89.78	8480	10	96.64	96.64	102.49	96.80	0.13	0.12	3.24	0.00
1982	79.34	8323	10	94.83	94.83	90.57	95.01	0.00	0.00	5.17	0.00
1983	72.81	7782	10	85.31	88.85	83.11	88.84	0.34	0.31	10.85	3.54
1984	76.48	7876	10	87.36	89.14	87.07	89.66	0.48	0.43	10.42	1.79
1985	69.83	7119	10	78.48	80.33	79.72	81.27	0.00	0.00	19.67	1.85
1986	77.11	8001	10	87.71	91.02	88.03	91.34	0.66	0.60	8.38	3.31
1987	89.09	7801	12	89.09	89.09	84.75	89.05	0.00	0.00	10.91	0.00
1988	76.71	7815	11	89.47	89.47	79.39	88.97	0.57	0.51	10.02	0.00
1989	74.26	7756	11	89.05	89.46	77.06	88.54	0.00	0.00	10.54	0.40
1990	73.74	8024	11	91.12	91.98	76.53	91.60	6.83	6.75	1.28	0.86
1991	66.19	6749	11	76.59	78.08	68.69	77.04	1.34	1.06	20.86	1.50
1992	70.92	7727	11	79.70	79.70	73.40	87.97	0.40	0.32	19.98	0.00
1993	52.59	7218	11	61.50	83.21	54.58	82.40	0.16	0.13	16.66	21.71
1994	44.71	6342	11	71.96	73.69	46.39	72.40	0.00	0.00	26.31	1.73
1995	17.30	3293	11	34.90	38.15	17.95	37.59	9.46	3.99	57.86	3.26
1996	52.62	7142	11	82.27	82.27	54.46	81.31	6.51	5.73	12.00	0.00
1997	25.83	3769	11	42.86	42.86	26.80	43.03	0.86	0.37	56.77	0.00
1998	23.16	4200	11	29.11	49.13	24.04	47.95	0.00	0.00	50.87	20.02
1999	51.44	6607	11	59.91	75.85	53.38	75.42	0.12	0.09	24.06	15.94
2000	45.23	7569	11	54.84	86.83	46.81	86.17	0.00	0.00	13.17	31.99
2001	53.94	7383	11	62.96	84.88	55.98	84.28	0.00	0.00	15.12	21.91
2002	30.73	6250	11	39.39	71.50	31.90	71.35	0.00	0.00	28.50	32.11
2003	35.42	7097	11	46.72	81.51	36.75	81.02	0.00	0.00	18.49	34.79
2004	31.09	7166	11	42.00	85.77	32.18	81.58	0.00	0.00	14.23	43.77
2005	20.37	6102	11	30.86	71.09	21.14	69.66	0.00	0.00	28.91	40.23
2006	26.25	6542	11	36.94	76.74	27.24	74.68	0.00	0.00	23.26	39.80
2007	27.45	7257	11	38.64	85.73	28.49	82.84	0.00	0.00	14.27	47.09
2008	33.28	7335	11	85.73	85.73	34.44	83.50	0.07	0.06	14.20	0.00
2009	44.57	7972	11	91.43	91.43	46.25	91.00	0.00	0.00	8.57	0.00
2010	33.69	6035	11	77.50	77.50	34.96	68.89	0.00	0.00	22.50	0.00
2011	22.19	4885	11	87.96	87.96	23.03	55.76	0.00	0.00	12.04	0.00
2012	34.63	7253	11	86.71	86.71	35.84	82.57	0.00	0.00	13.29	0.00

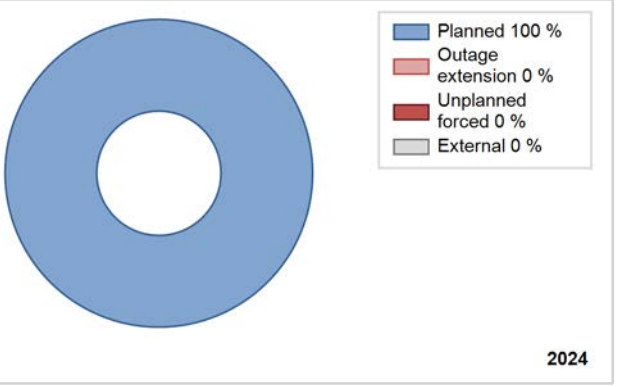
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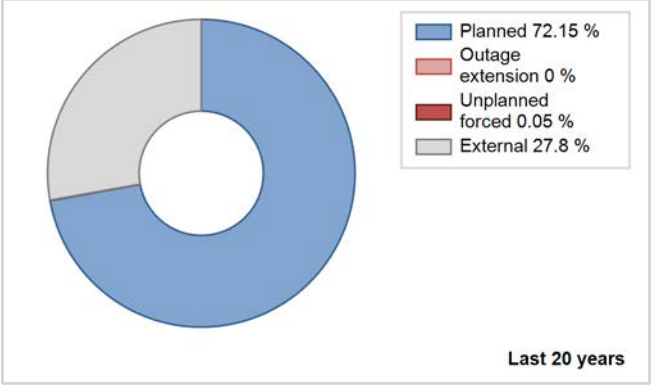
2013	43.85	7436	11	85.64	85.64	45.51	84.89	0.00	0.00	14.36	0.00
2014	45.10	6615	11	76.67	76.67	46.80	75.51	0.00	0.00	23.33	0.00
2015	51.64	7337	11	85.10	85.10	53.60	83.76	0.00	0.00	14.90	0.00
2016	49.20	7410	11	85.10	85.10	50.92	84.36	0.00	0.00	14.90	0.00
2017	50.50	7377	11	84.93	84.93	52.41	84.21	0.00	0.00	15.07	0.00
2018	48.41	6626	11	76.75	76.75	50.24	75.64	0.00	0.00	23.25	0.00
2019	63.23	7849	11	90.08	90.08	65.62	89.60	0.00	0.00	9.92	0.00
2020	38.00	7380	11	84.73	84.73	39.33	84.02	0.21	0.18	15.09	0.00
2021	21.89	6747	11	80.29	80.29	22.72	77.02	0.00	0.00	19.71	0.00
2022	23.07	6294	11	71.85	71.85	23.94	71.85	0.00	0.00	28.15	0.00
2023	37.87	8134	11	93.28	93.28	39.30	92.85	0.00	0.00	6.72	0.00
2024	24.62	8137	11	92.68	92.68	25.48	92.63	0.00	0.00	7.32	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1976 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					42	
C. Inspection, maintenance or repair combined with refuelling	644			1314		
D. Inspection, maintenance or repair without refuelling				233		
E. Testing of plant systems or components	3			6		
J. Grid limitation, failure or grid unavailability						32
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						94
Z. Other				10	1	
Subtotal	647			1563	43	126
Total	**647**			**1732**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1976 to 2024
	Hours Lost	Average hours lost per reactor-year
13. Reactor Auxiliary Systems		1
15. Reactor Cooling Systems		12
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		7
33. Circulating Water System		0
34. Miscellaneous Systems		12
Total		**42**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the intermediate maintenance outage. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-144 BILIBINO-4 RUSSIA



Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	LWGR / EGP-6
Thermal power	:	62 MWth
Gross electrical power	:	12 MWe
Reference unit power (net)	:	11 MWe

Key Dates

Construction Date	:	1970-01-01
Grid Date	:	1976-12-27
Commercial Date	:	1977-01-01
Age at end of year	:	48 years

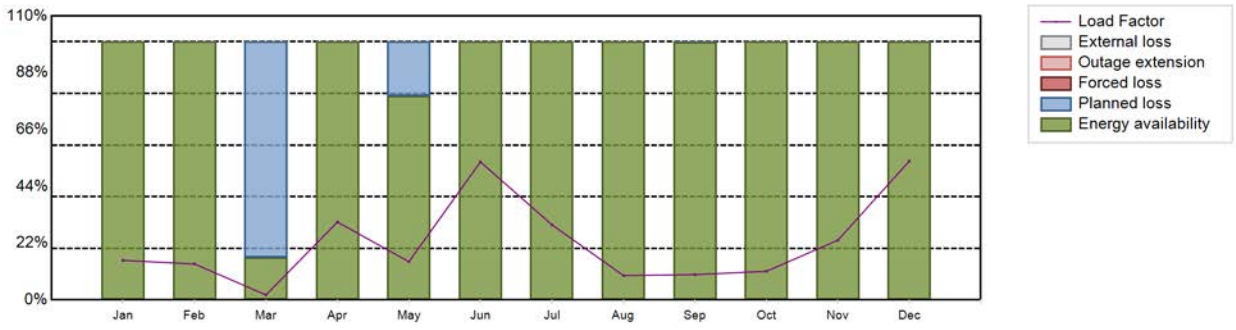
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	3000
Active core diameter [m]	:	4.1
Active core height/length [m]	:	3
Number of fissile fuel assemblies/bundles	:	273
Fuel linear heat generation rate [kW/m]	:	27
Number of control rod assemblies	:	-
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	6
Reactor outlet temperature [°C]	:	280
Number of SG	:	NA
Containment type	:	NA
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	21.4 GW(e).h
Energy Availability Factor (EAF)	:	91.13 %
Unit Capability Factor (UCF)	:	91.13 %
Load Factor (LF)	:	22.15 %
Operating Factor (OF)	:	91.05 %
Equivalent non-electrical energy generated (NEG)	:	23.7 GW(e).h
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	8.87 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	786 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1.25	1.07	0.16	2.39	1.21	4.24	2.38	0.77	0.78	0.91	1.83	4.40	21.40
EAF [%]	100.00	100.00	16.57	100.00	78.90	100.00	100.00	100.00	99.81	100.00	100.00	100.00	91.13
UCF [%]	100.00	100.00	16.57	100.00	78.90	100.00	100.00	100.00	99.81	100.00	100.00	100.00	91.13
LF [%]	15.33	13.95	1.97	30.16	14.82	53.47	29.13	9.46	9.81	11.09	23.13	53.80	22.15
OF [%]	100.00	100.00	16.53	100.00	77.96	100.00	100.00	100.00	99.86	100.00	100.00	100.00	91.05
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	83.43	0.00	21.10	0.00	0.00	0.00	0.19	0.00	0.00	0.00	8.87
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	2237.52 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.6 %
Cumulative Energy Availability Factor (EAF)	:	72.7 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.49 %
Cumulative Unit Capability Factor (UCF)	:	80.5 %	Cumulative Planned Unavailability Factor (PUF)	:	19.01 %
Cumulative Load Factor (LF)	:	50.57 %	Cumulative Externally cause unavailability (XUF)	:	7.81 %
Cumulative Operating Factor (OF)	:	78.47 %			

Electricity Production (net) [GWh]

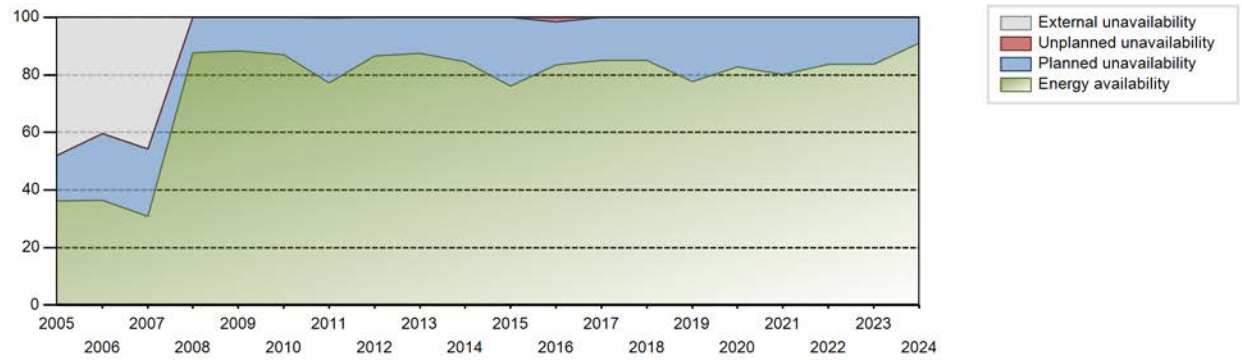


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1977	52.65	7392	10	82.89	93.56	60.10	84.38	0.28	0.27	6.17	10.67
1978	58.30	7827	10	91.06	91.06	66.55	89.35	0.01	0.01	8.93	0.00
1979	74.46	7552	10	83.88	85.52	85.00	86.21	0.20	0.17	14.31	1.64
1980	77.62	8347	10	92.91	94.77	88.37	95.03	0.05	0.05	5.18	1.86
1981	78.26	7734	10	86.61	87.69	89.33	88.29	0.80	0.71	11.60	1.08
1982	77.61	7976	10	90.71	90.71	88.59	91.05	0.00	0.00	9.29	0.00
1983	75.53	7923	10	86.88	89.97	86.23	90.45	0.11	0.10	9.94	3.09
1984	79.01	7744	10	86.77	87.57	89.95	88.16	0.08	0.07	12.36	0.80
1985	81.23	7919	10	89.53	90.33	92.73	90.40	1.23	1.13	8.55	0.79
1986	74.54	7083	10	79.84	79.90	85.09	80.86	0.01	0.01	20.09	0.06
1987	95.55	8154	12	93.26	93.26	90.89	93.08	0.22	0.20	6.54	0.00
1988	75.85	7617	11	87.34	87.34	78.50	86.71	0.86	0.76	11.90	0.00
1989	71.37	7853	11	93.22	93.22	74.06	89.65	0.25	0.24	6.54	0.00
1990	75.29	7588	11	86.36	87.22	78.13	86.62	5.48	5.06	7.73	0.86
1991	61.32	6139	11	69.89	71.43	63.64	70.08	0.00	0.00	28.57	1.54
1992	69.84	7756	11	87.82	87.82	72.28	88.30	1.22	1.08	11.10	0.00
1993	56.00	6918	11	64.39	80.22	58.12	78.97	0.82	0.66	19.11	15.83
1994	38.46	5266	11	61.82	61.99	39.91	60.11	9.18	6.27	31.75	0.17
1995	29.88	5083	11	62.73	63.94	31.01	58.03	0.53	0.34	35.72	1.21
1996	35.18	5109	11	59.13	59.13	36.41	58.16	1.36	0.81	40.06	0.00
1997	15.13	2490	11	28.42	37.04	15.70	28.42	0.00	0.00	62.96	8.61
1998	37.29	5510	11	44.52	63.14	38.70	62.90	0.00	0.00	36.86	18.62
1999	28.69	3993	11	34.77	46.74	29.77	45.58	6.39	3.19	50.07	11.97
2000	55.85	7740	11	64.20	88.68	57.80	88.11	0.04	0.03	11.29	24.48
2001	35.44	5931	11	43.17	68.01	36.78	67.71	0.00	0.00	31.99	24.84
2002	33.12	6419	11	46.34	73.76	34.37	73.28	0.00	0.00	26.24	27.42
2003	24.52	5849	11	34.04	67.51	25.45	66.77	0.00	0.00	32.49	33.47
2004	26.10	7303	11	36.71	83.90	27.01	83.14	0.00	0.00	16.10	47.19
2005	24.95	7300	11	36.29	84.32	25.89	83.33	0.00	0.00	15.68	48.03
2006	25.22	6626	11	36.44	76.86	26.18	75.64	0.00	0.00	23.14	40.42
2007	19.57	5983	11	30.89	76.55	20.31	68.30	0.00	0.00	23.45	45.65
2008	29.55	7023	11	87.66	87.66	30.59	79.95	0.10	0.09	12.25	0.00
2009	42.14	7663	11	88.40	88.40	43.74	87.48	0.14	0.12	11.48	0.00
2010	37.48	7272	11	86.93	86.93	38.90	83.01	0.00	0.00	13.07	0.00
2011	32.79	5944	11	77.29	77.29	34.03	67.85	0.21	0.16	22.55	0.00
2012	24.50	5886	11	86.69	86.69	25.36	67.01	0.03	0.03	13.28	0.00
2013	45.48	7472	11	87.40	87.40	47.19	85.30	0.00	0.00	12.60	0.00

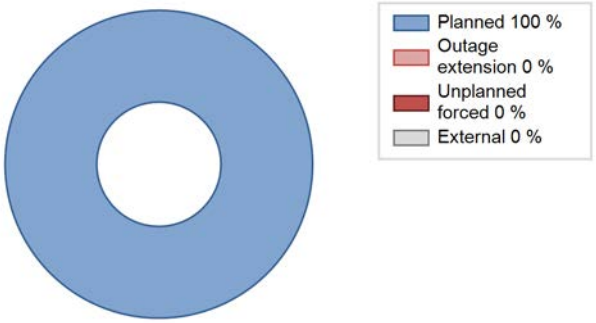
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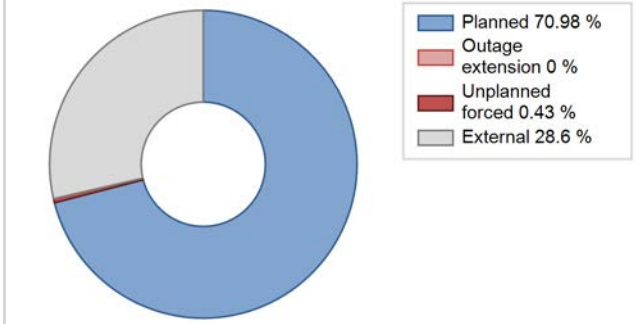
2014	45.89	7187	11	84.56	84.56	47.63	82.04	0.00	0.00	15.44	0.00
2015	40.59	6307	11	76.02	76.02	42.12	72.00	0.00	0.00	23.98	0.00
2016	43.53	7163	11	83.57	83.57	45.05	81.55	1.87	1.59	14.84	0.00
2017	46.22	7395	11	85.13	85.13	47.97	84.42	0.00	0.00	14.87	0.00
2018	54.77	7392	11	85.09	85.09	56.84	84.38	0.00	0.00	14.91	0.00
2019	50.73	6705	11	77.60	77.60	52.65	76.54	0.00	0.00	22.40	0.00
2020	38.06	7194	11	82.72	82.72	39.39	81.90	0.00	0.00	17.28	0.00
2021	22.23	6890	11	80.19	80.19	23.07	78.65	0.00	0.00	19.81	0.00
2022	27.07	7324	11	83.61	83.61	28.09	83.61	0.00	0.00	16.39	0.00
2023	34.45	7253	11	83.59	83.59	35.75	82.80	0.00	0.00	16.41	0.00
2024	21.40	7998	11	91.13	91.13	22.15	91.05	0.00	0.00	8.87	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1977 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					46	
C. Inspection, maintenance or repair combined with refuelling	786			1413		
D. Inspection, maintenance or repair without refuelling				322		
E. Testing of plant systems or components	1			7		
J. Grid limitation, failure or grid unavailability						41
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						98
L. Human factor related					0	
Z. Other					1	
Subtotal	787			1742	47	139
Total	**787**			**1928**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1977 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		9
13. Reactor Auxiliary Systems		5
15. Reactor Cooling Systems		1
31. Turbine and auxiliaries		4
32. Feedwater and Main Steam System		10
33. Circulating Water System		4
41. Main Generator Systems		12
Total		**45**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the intermediate maintenance outage and routine maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-30 KALININ-1 RUSSIA



Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-338
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1977-02-01
Grid Date	:	1984-05-09
Commercial Date	:	1985-06-12
Age at end of year	:	40 years

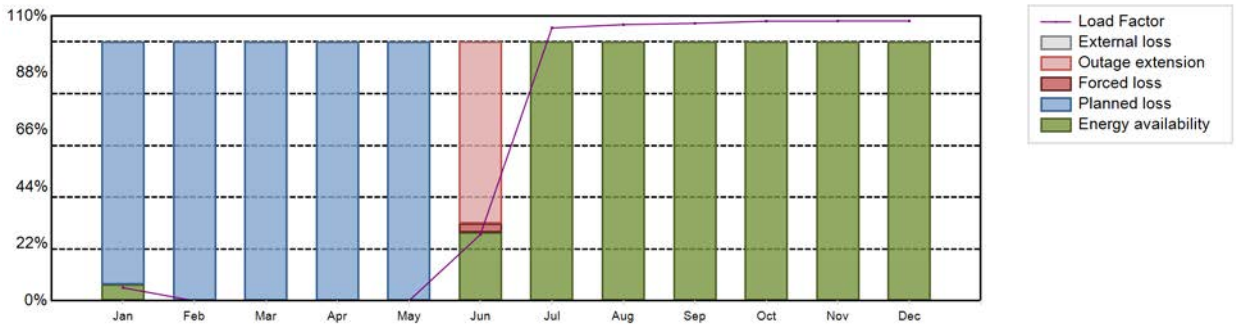
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Confinement
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	4709.53 GW(e).h
Energy Availability Factor (EAF)	:	52.97 %
Unit Capability Factor (UCF)	:	52.97 %
Load Factor (LF)	:	56.44 %
Operating Factor (OF)	:	53.32 %
Equivalent non-electrical energy generated (NEG)	:	13.41 GW(e).h
Forced Loss Rate (FLR)	:	0.52 %
Unplanned Capability Loss Factor (UCL)	:	6.04 %
Planned Unavailability Factor (PUF)	:	40.99 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	4100 hours

Annual Summary



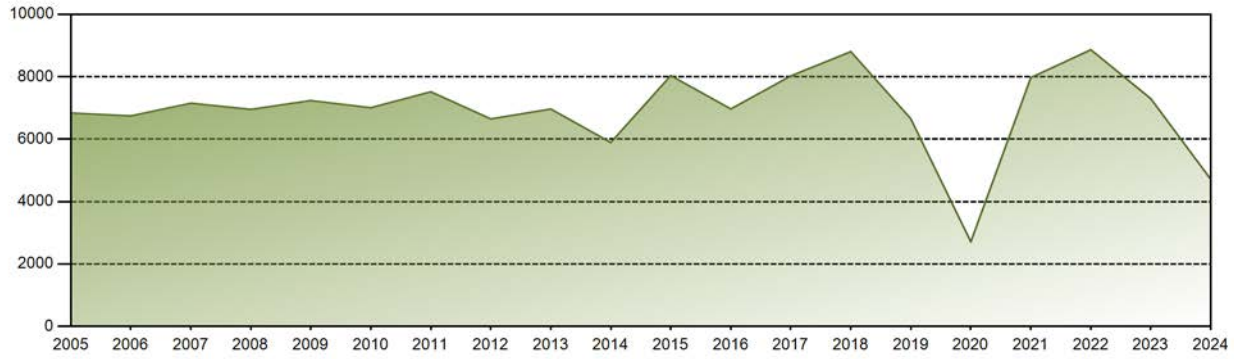
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	35.82	0.00	0.00	0.00	0.00	175.10	744.92	753.98	733.09	763.43	739.13	764.06	4709.53
EAF [%]	6.32	0.00	0.00	0.00	0.00	26.36	100.00	100.00	100.00	100.00	100.00	100.00	52.97
UCF [%]	6.32	0.00	0.00	0.00	0.00	26.36	100.00	100.00	100.00	100.00	100.00	100.00	52.97
LF [%]	5.07	0.00	0.00	0.00	0.00	25.60	105.39	106.68	107.18	108.01	108.06	108.10	56.44
OF [%]	7.26	0.00	0.00	0.00	0.00	29.72	100.00	100.00	100.00	100.00	100.00	100.00	53.32
FLR [%]	0.00	0.00	0.00	0.00	0.00	11.44	0.00	0.00	0.00	0.00	0.00	0.00	0.52
UCL [%]	0.00	0.00	0.00	0.00	0.00	73.64	0.00	0.00	0.00	0.00	0.00	0.00	6.04
PUF [%]	93.68	100.00	100.00	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.99
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	256732.66 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.27 %
Cumulative Energy Availability Factor (EAF)	:	74.8 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.52 %
Cumulative Unit Capability Factor (UCF)	:	75.42 %	Cumulative Planned Unavailability Factor (PUF)	:	19.07 %
Cumulative Load Factor (LF)	:	77.01 %	Cumulative Externally cause unavailability (XUF)	:	0.61 %
Cumulative Operating Factor (OF)	:	77.32 %			

Electricity Production (net) [GWh]

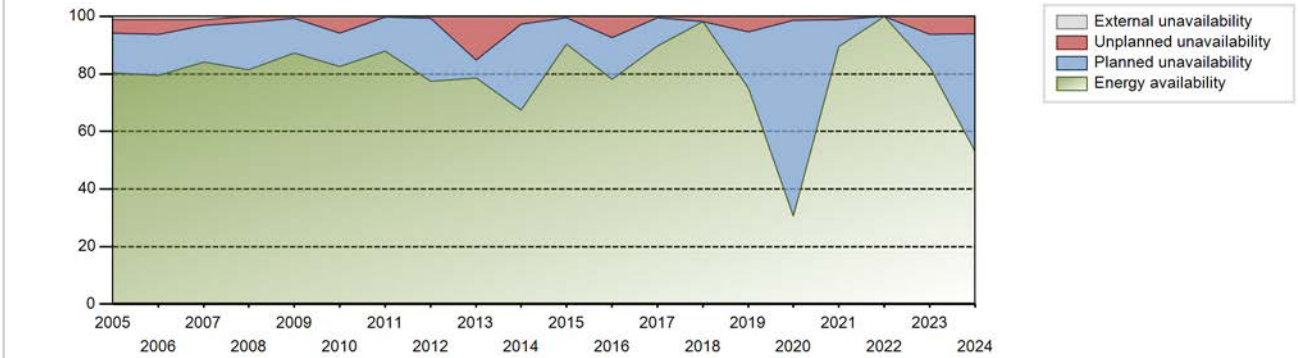


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	4487.64	5824	950	58.28	58.28	57.38	60.38	10.99	7.20	34.52	0.00
1986	5297.73	5946	950	62.85	62.85	63.66	67.88	28.18	24.65	12.50	0.00
1987	6842.49	6972	1000	78.71	78.71	78.11	79.59	7.76	6.62	14.67	0.00
1988	5891.61	6187	950	70.12	70.12	70.60	70.43	9.61	7.45	22.43	0.00
1989	6129.71	6396	950	71.91	71.94	73.66	73.01	10.20	8.17	19.89	0.03
1990	5192.31	5435	950	61.53	61.56	62.39	62.04	3.54	2.26	36.18	0.03
1991	6482.72	7161	950	77.09	78.06	77.90	81.75	11.66	10.30	11.64	0.97
1992	6781.35	7388	950	80.33	80.36	81.27	84.12	12.02	10.98	8.66	0.03
1993	4927.21	6133	950	59.38	66.61	59.21	70.01	5.55	3.91	29.48	7.23
1994	4437.58	5440	950	54.09	54.37	53.32	62.10	16.02	10.37	35.26	0.29
1995	4699.05	6265	950	56.75	57.00	56.47	71.52	26.12	20.15	22.85	0.25
1996	4431.67	5628	950	53.22	53.31	53.11	64.07	19.08	12.57	34.11	0.09
1997	5197.08	6195	950	63.23	65.00	62.45	70.72	5.59	3.85	31.16	1.77
1998	6100.97	6937	950	73.04	73.33	73.31	79.19	6.48	5.08	21.59	0.29
1999	5775.11	6589	950	69.32	73.06	69.40	75.22	5.65	4.37	22.56	3.74
2000	6289.72	6784	950	75.00	76.79	75.37	77.23	3.54	2.82	20.39	1.79
2001	6627.54	7020	950	78.18	79.37	79.64	80.14	5.67	4.77	15.86	1.19
2002	7248.38	7568	950	84.66	86.10	87.10	86.39	0.27	0.23	13.66	1.44
2003	7155.92	7408	950	83.10	83.75	85.99	84.57	4.40	3.85	12.40	0.65
2004	6936.97	7179	950	80.69	81.55	83.13	81.73	2.57	2.15	16.30	0.86
2005	6836.33	7219	950	80.39	81.50	82.14	82.40	4.45	4.78	13.72	1.11
2006	6743.58	7112	950	79.48	80.58	81.03	81.19	4.77	5.16	14.26	1.10
2007	7150.35	7491	950	84.04	85.24	85.92	85.51	2.14	1.87	12.90	1.20
2008	6953.55	7209	950	81.53	81.53	83.33	82.07	2.44	2.04	16.43	0.00
2009	7234.70	7669	950	87.27	87.27	86.93	87.55	0.70	0.62	12.11	0.00
2010	7006.14	7175	950	82.65	82.74	84.19	81.91	6.45	5.71	11.55	0.09
2011	7516.88	7727	950	87.91	87.91	90.34	88.22	0.22	0.19	11.89	0.00
2012	6648.33	6833	950	77.49	77.49	79.67	77.79	0.94	0.74	21.77	0.00
2013	6963.99	6915	950	78.67	78.67	83.68	78.94	6.17	15.31	6.03	0.00
2014	5892.14	6035	950	67.51	67.51	70.79	68.88	3.79	2.66	29.83	0.00
2015	8036.64	7931	950	90.46	90.46	96.57	90.54	0.64	0.58	8.96	0.00
2016	6966.43	6876	950	78.17	78.17	83.48	78.28	8.56	7.32	14.52	0.00
2017	8025.20	7856	950	89.63	89.63	96.43	89.68	0.00	0.53	9.84	0.00
2018	8802.94	8643	950	98.20	98.21	105.78	98.66	1.79	1.79	0.00	0.01
2019	6650.32	6595	950	75.05	75.10	79.91	75.29	6.64	5.34	19.56	0.05
2020	2709.37	2703	950	30.56	30.56	32.47	30.77	4.41	1.41	68.03	0.00
2021	7970.06	7849	950	89.44	89.49	95.77	89.60	1.34	1.21	9.30	0.05

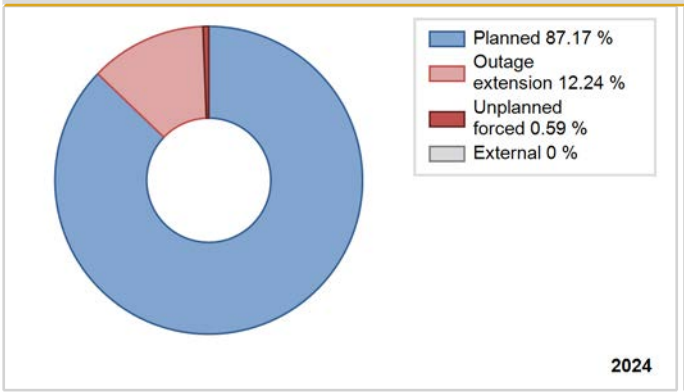
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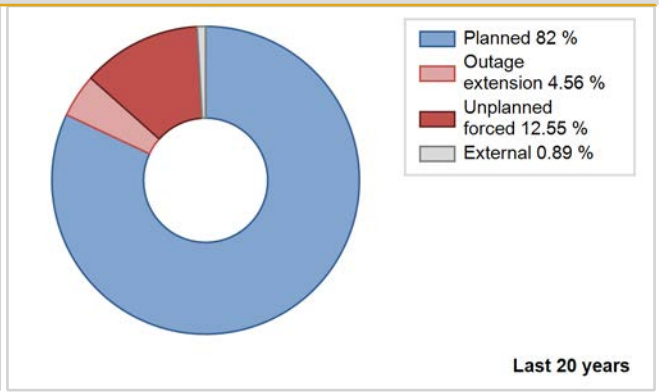
2022	8863.93	8760	950	100.00	100.00	106.51	100.00	0.00	0.00	0.00	0.00
2023	7295.91	7299	950	82.46	82.46	87.67	83.32	7.06	6.26	11.28	0.00
2024	4709.53	4684	950	52.97	52.97	56.44	53.32	0.52	6.04	40.99	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		506			280	
C. Inspection, maintenance or repair combined with refuelling	3497			1539	27	
D. Inspection, maintenance or repair without refuelling	98			99	1	
E. Testing of plant systems or components					1	
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					6	
Z. Other					32	
Subtotal	3595	506		1638	347	2
Total	**4101**			**1987**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		32
12. Reactor I&C Systems		12
13. Reactor Auxiliary Systems		3
15. Reactor Cooling Systems		9
16. Steam generation systems		34
17. Safety I&C Systems (excluding reactor I&C)		5
31. Turbine and auxiliaries		23
32. Feedwater and Main Steam System		19
34. Miscellaneous Systems		2
35. All other I&C Systems		6
41. Main Generator Systems		114
42. Electrical Power Supply Systems	506	28
Total	**506**	**287**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the intermediate maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-31 KALININ-2 RUSSIA



Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-338
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1982-02-01
Grid Date	:	1986-12-03
Commercial Date	:	1987-03-03
Age at end of year	:	38 years

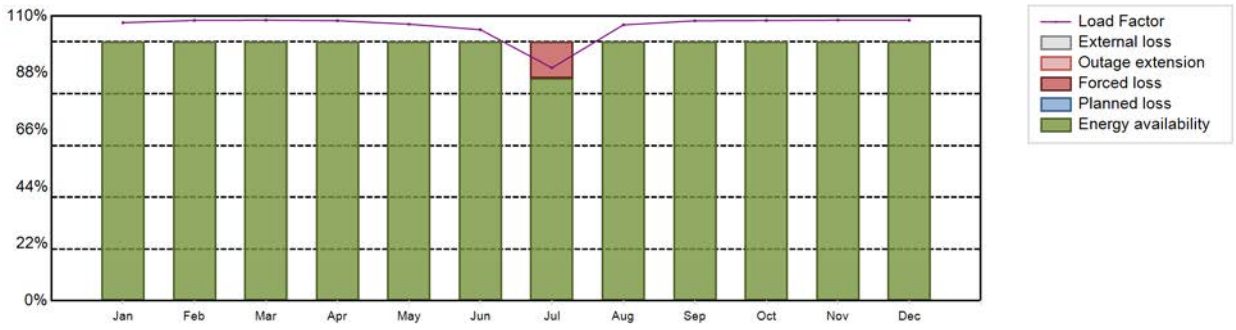
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Confinement
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	8854.84 GW(e).h
Energy Availability Factor (EAF)	:	98.81 %
Unit Capability Factor (UCF)	:	98.81 %
Load Factor (LF)	:	106.11 %
Operating Factor (OF)	:	98.96 %
Equivalent non-electrical energy generated (NEG)	:	80.37 GW(e).h
Forced Loss Rate (FLR)	:	1.19 %
Unplanned Capability Loss Factor (UCL)	:	1.19 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	91 hours

Annual Summary



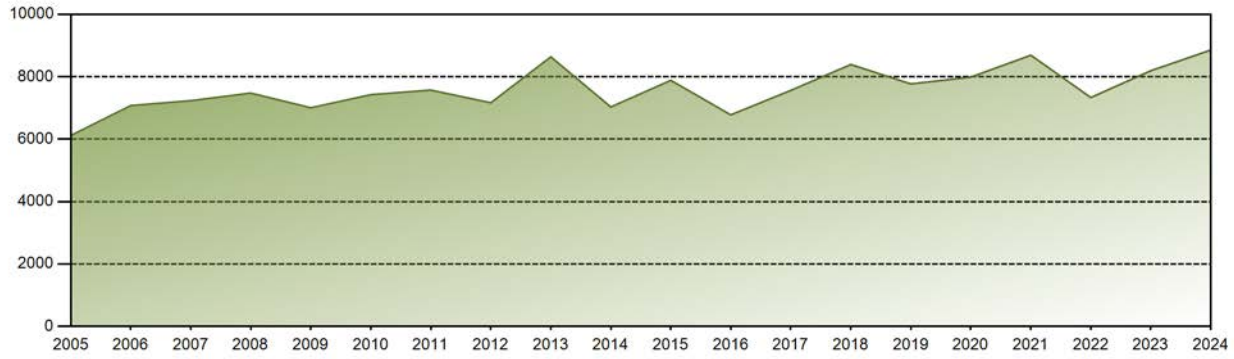
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	759.29	716.14	766.14	740.12	755.18	716.34	636.04	753.29	739.72	765.22	741.33	766.04	8854.84
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	85.98	100.00	100.00	100.00	100.00	100.00	98.81
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	85.98	100.00	100.00	100.00	100.00	100.00	98.81
LF [%]	107.43	108.31	108.40	108.20	106.84	104.73	89.99	106.58	108.15	108.26	108.38	108.38	106.11
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	87.77	100.00	100.00	100.00	100.00	100.00	98.96
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	14.02	0.00	0.00	0.00	0.00	0.00	1.19
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	14.02	0.00	0.00	0.00	0.00	0.00	1.19
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	258591.05 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.46 %
Cumulative Energy Availability Factor (EAF)	:	78.78 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.78 %
Cumulative Unit Capability Factor (UCF)	:	80.53 %	Cumulative Planned Unavailability Factor (PUF)	:	14.69 %
Cumulative Load Factor (LF)	:	81.83 %	Cumulative Externally cause unavailability (XUF)	:	1.75 %
Cumulative Operating Factor (OF)	:	83.75 %			

Electricity Production (net) [GWh]

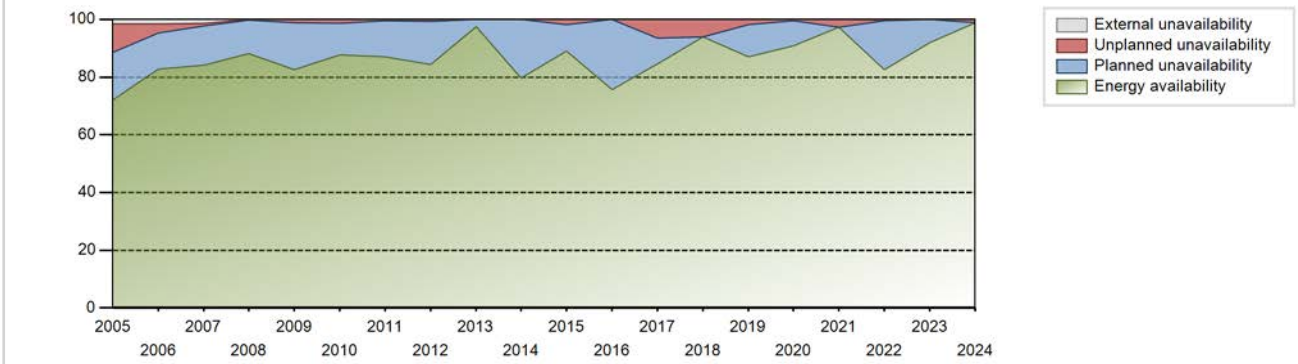


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	6494.00	7605	1000	86.27	86.27	79.18	87.96	9.13	8.67	5.07	0.00
1988	5829.43	6446	950	71.67	71.67	69.86	73.38	9.64	7.64	20.68	0.00
1989	6580.49	7034	950	78.45	78.45	79.07	80.30	5.86	4.88	16.67	0.00
1990	6788.16	7083	950	79.45	79.45	81.57	80.86	5.85	4.94	15.61	0.00
1991	4729.67	5154	950	49.79	49.79	56.83	58.84	30.08	21.42	28.79	0.00
1992	5496.31	6145	950	65.70	65.70	65.87	69.96	5.58	3.88	30.42	0.00
1993	5862.30	7078	950	51.91	56.45	70.44	80.80	28.07	22.03	21.52	4.54
1994	4463.77	6989	950	54.87	54.87	53.64	79.78	31.92	25.73	19.41	0.00
1995	5769.75	7283	950	69.48	72.40	69.33	83.14	15.96	13.75	13.85	2.92
1996	4595.17	7501	950	56.02	78.42	55.07	85.39	2.81	2.26	19.31	22.40
1997	3880.64	6117	950	47.25	62.67	46.63	69.83	2.47	1.59	35.74	15.42
1998	4946.65	6839	950	59.67	59.98	59.44	78.07	26.91	22.08	17.93	0.31
1999	6379.25	7155	950	76.21	80.03	76.66	81.68	0.26	0.21	19.76	3.82
2000	6418.74	7441	950	76.26	83.57	76.92	84.71	0.55	0.46	15.97	7.32
2001	6708.99	7070	950	79.16	80.00	80.62	80.71	2.26	1.85	18.15	0.84
2002	7003.43	7554	950	82.66	85.76	84.16	86.23	1.00	0.86	13.37	3.10
2003	7329.54	7541	950	85.33	85.89	88.07	86.08	0.77	0.67	13.45	0.55
2004	7398.23	7674	950	86.68	87.11	88.66	87.36	0.11	0.10	12.79	0.44
2005	6116.27	6476	950	72.11	73.62	73.49	73.92	11.86	9.90	16.48	1.51
2006	7074.89	7400	950	82.73	84.26	85.01	84.47	3.63	3.18	12.56	1.53
2007	7231.43	7539	950	84.16	85.49	86.90	86.06	1.16	1.00	13.51	1.33
2008	7474.79	7756	950	88.19	88.19	89.57	88.30	0.25	0.22	11.59	0.00
2009	7004.16	7248	950	82.51	82.51	84.16	82.74	1.50	1.26	16.23	0.00
2010	7423.50	7595	950	87.77	87.77	89.20	86.70	1.51	1.34	10.89	0.00
2011	7570.61	7675	950	86.98	86.98	90.98	87.62	0.63	0.55	12.47	0.00
2012	7164.85	7464	950	84.47	84.47	85.86	84.97	0.93	0.79	14.74	0.00
2013	8635.13	8552	950	97.57	97.57	103.76	97.63	0.00	0.00	2.43	0.00
2014	7030.39	6984	950	79.59	79.59	84.47	79.72	0.00	0.00	20.41	0.00
2015	7883.15	7805	950	88.94	88.94	94.73	89.10	2.10	1.90	9.16	0.00
2016	6776.88	6664	950	75.75	75.75	81.21	75.87	0.00	0.00	24.25	0.00
2017	7562.08	7439	950	84.68	84.71	90.87	84.92	1.93	6.54	8.75	0.03
2018	8390.72	8224	950	93.84	93.86	100.83	93.88	6.14	6.14	0.00	0.01
2019	7769.30	7721	950	87.05	87.05	93.36	88.14	1.94	1.73	11.23	0.00
2020	7987.59	8031	950	90.80	90.80	95.72	91.43	0.52	0.48	8.73	0.00
2021	8688.57	8645	950	97.24	97.24	104.40	98.69	2.76	2.76	0.00	0.00
2022	7334.10	7262	950	82.50	82.78	88.13	82.90	0.21	0.18	17.04	0.28
2023	8191.96	8067	950	91.93	92.01	98.44	92.09	0.00	0.00	7.99	0.08

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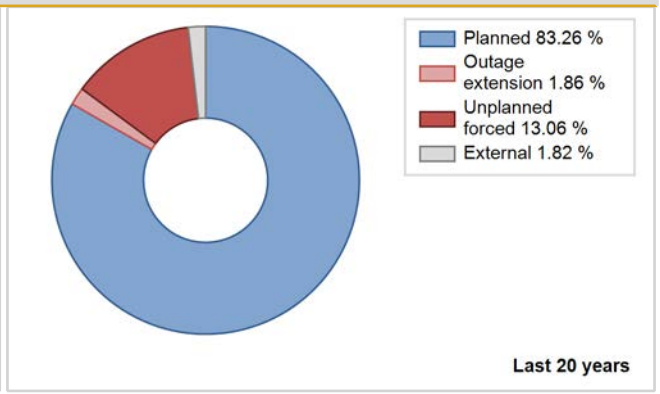
2024	8854.84	8693	950	98.81	98.81	106.11	98.96	1.19	1.19	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		91			168	
C. Inspection, maintenance or repair combined with refuelling				1161	6	
D. Inspection, maintenance or repair without refuelling				62		
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					14	
Z. Other					3	
Subtotal		91		1223	191	3
Total		**91**			**1417**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1987 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		5
12. Reactor I&C Systems		17
15. Reactor Cooling Systems	91	33
16. Steam generation systems		4
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		27
32. Feedwater and Main Steam System		6
34. Miscellaneous Systems		7
35. All other I&C Systems		6
41. Main Generator Systems		65
42. Electrical Power Supply Systems		4
Total	**91**	**176**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-36 KALININ-3 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	FAEA (Federal Atomic Energy Agency)



Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1985-10-01
Grid Date	:	2004-12-16
Commercial Date	:	2005-11-08
Age at end of year	:	20 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

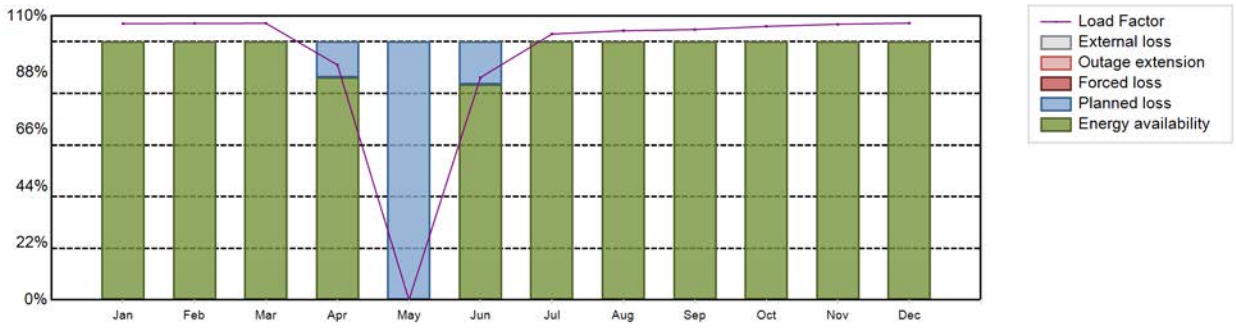
Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Confinement
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	7852.18 GW(e).h
Energy Availability Factor (EAF)	:	89.06 %
Unit Capability Factor (UCF)	:	89.06 %
Load Factor (LF)	:	94.1 %
Operating Factor (OF)	:	89.15 %
Equivalent non-electrical energy generated (NEG)	:	18.85 GW(e).h

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	10.94 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	953 hours

Annual Summary



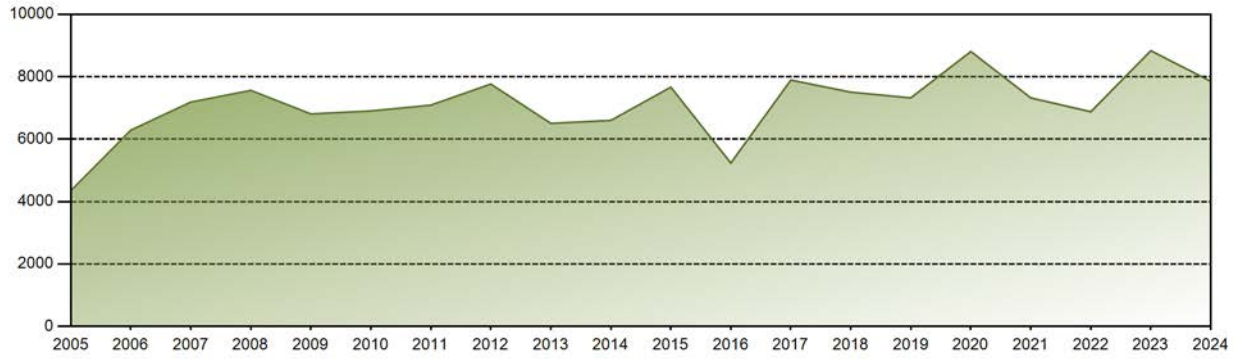
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	756.36	708.16	757.30	622.68	0.00	589.14	727.93	736.96	716.44	748.90	730.58	757.71	7852.18
EAF [%]	100.00	100.00	100.00	86.29	0.00	83.52	100.00	100.00	100.00	100.00	100.00	100.00	89.06
UCF [%]	100.00	100.00	100.00	86.29	0.00	83.52	100.00	100.00	100.00	100.00	100.00	100.00	89.06
LF [%]	107.01	107.10	107.14	91.03	0.00	86.13	102.99	104.27	104.74	105.96	106.81	107.20	94.10
OF [%]	100.00	100.00	100.00	86.81	0.00	84.17	100.00	100.00	100.00	100.00	100.00	100.00	89.15
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	13.71	100.00	16.48	0.00	0.00	0.00	0.00	0.00	0.00	10.94
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

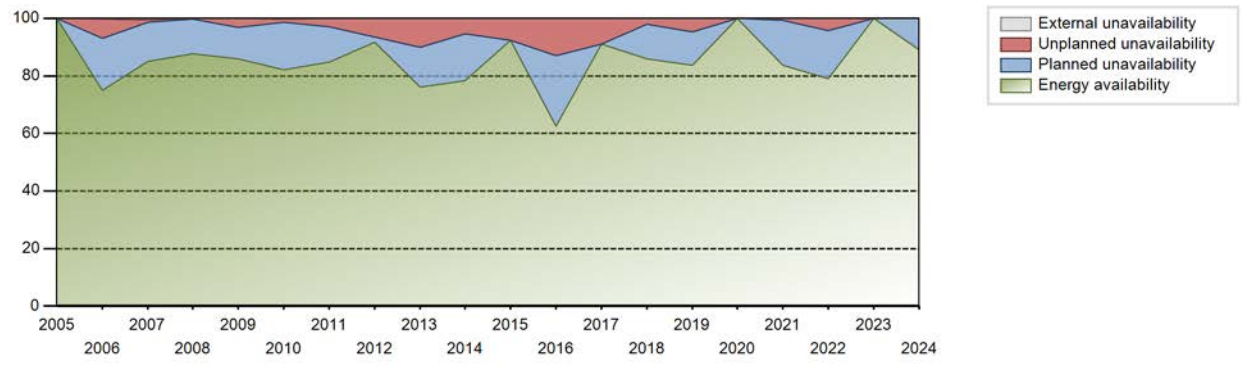
Lifetime energy generation	:	142355.96 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.38 %
Cumulative Energy Availability Factor (EAF)	:	85.07 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.07 %
Cumulative Unit Capability Factor (UCF)	:	85.15 %	Cumulative Planned Unavailability Factor (PUF)	:	10.79 %
Cumulative Load Factor (LF)	:	87.34 %	Cumulative Externally cause unavailability (XUF)	:	0.08 %
Cumulative Operating Factor (OF)	:	85.54 %			

Electricity Production (net) [GWh]



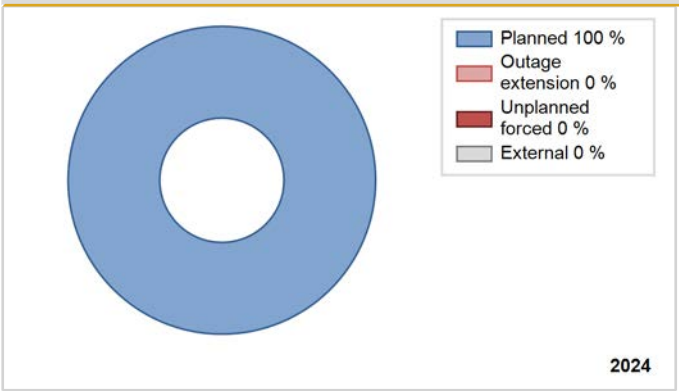
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2005	4345.70	5686	950	100.00	100.00	100.84	100.00	0.00	0.00	0.00	0.00
2006	6287.23	6692	950	74.90	75.20	75.55	76.39	5.71	6.62	18.18	0.29
2007	7185.22	7505	950	84.96	85.51	86.34	85.67	0.91	0.81	13.68	0.55
2008	7561.73	7737	950	87.74	87.78	90.62	88.08	0.18	0.16	12.06	0.03
2009	6806.52	7553	950	85.96	85.96	81.79	86.22	3.61	3.22	10.82	0.00
2010	6902.21	7248	950	82.13	82.44	82.94	82.74	1.25	1.04	16.52	0.31
2011	7088.32	7427	950	84.82	84.85	85.19	84.79	0.59	2.84	12.31	0.04
2012	7765.07	8091	950	91.78	91.78	93.05	92.11	6.68	6.57	1.65	0.01
2013	6505.71	6698	950	76.18	76.18	78.17	76.46	1.31	10.15	13.67	0.00
2014	6599.48	6918	950	78.27	78.27	79.29	78.96	5.79	5.33	16.40	0.00
2015	7665.20	8196	950	92.28	92.28	92.11	93.56	7.67	7.67	0.05	0.00
2016	5233.15	5612	950	62.43	62.43	62.71	63.89	10.35	13.02	24.55	0.00
2017	7892.37	7990	950	91.11	91.11	94.84	91.21	8.89	8.89	0.00	0.00
2018	7504.45	7558	950	85.85	85.95	90.18	86.28	2.29	2.01	12.04	0.10
2019	7322.22	7362	950	83.69	83.76	87.99	84.04	4.44	4.74	11.50	0.07
2020	8807.69	8784	950	100.00	100.00	105.55	100.00	0.00	0.00	0.00	0.00
2021	7321.23	7369	950	83.73	83.78	87.97	84.12	0.70	0.59	15.64	0.05
2022	6877.28	6929	950	78.94	79.00	82.64	79.10	5.09	4.24	16.76	0.06
2023	8833.38	8760	950	99.97	99.97	106.14	100.00	0.03	0.03	0.00	0.00
2024	7852.18	7831	950	89.06	89.06	94.10	89.15	0.00	0.00	10.94	0.00

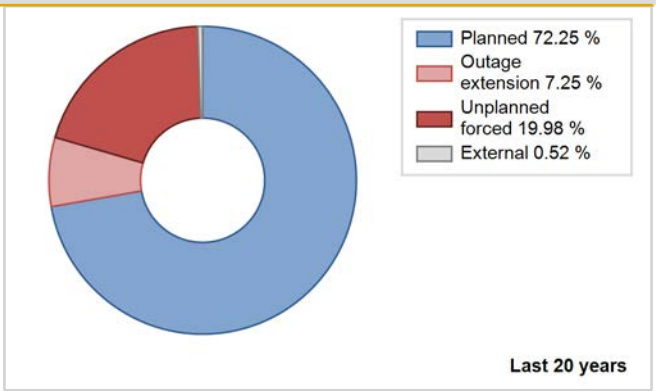
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2005 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					305	
C. Inspection, maintenance or repair combined with refuelling	954			932	9	
D. Inspection, maintenance or repair without refuelling				15		
E. Testing of plant systems or components				0	2	
H. Nuclear regulatory requirements					4	
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					2	
Z. Other					11	
Subtotal	954			947	333	2
Total	**954**			**1282**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2005 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		11
13. Reactor Auxiliary Systems		9
15. Reactor Cooling Systems		4
16. Steam generation systems		3
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		49
32. Feedwater and Main Steam System		9
33. Circulating Water System		1
35. All other I&C Systems		1
41. Main Generator Systems		135
42. Electrical Power Supply Systems		96
Total		**319**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the overhaul. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-37 KALININ-4 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KALUGA (JSC "Kaluga turbine plant" 32, Glagoleva Street, Kaluga, 248021, Russia)



Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1986-08-01
Grid Date	:	2011-11-24
Commercial Date	:	2012-12-25
Age at end of year	:	13 years

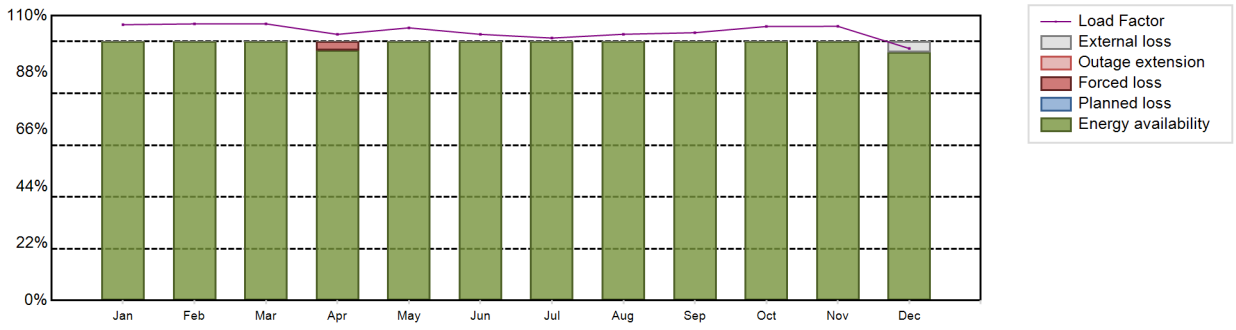
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	1.05
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	8675.88 GW(e).h
Energy Availability Factor (EAF)	:	99.38 %
Unit Capability Factor (UCF)	:	99.73 %
Load Factor (LF)	:	103.97 %
Operating Factor (OF)	:	99.77 %
Equivalent non-electrical energy generated (NEG)	:	23.42 GW(e).h
Forced Loss Rate (FLR)	:	0.27 %
Unplanned Capability Loss Factor (UCL)	:	0.27 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0.35 %
Total off-line time	:	20 hours

Annual Summary



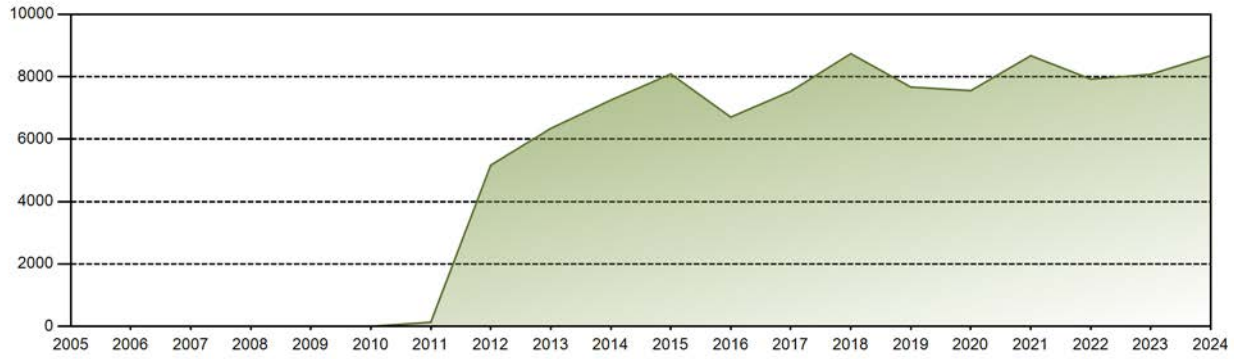
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	752.88	706.40	755.22	703.02	744.31	703.11	716.39	726.83	707.53	747.95	724.38	687.85	8675.88
EAF [%]	100.00	100.00	100.00	96.73	100.00	100.00	100.00	100.00	100.00	100.00	100.00	95.86	99.38
UCF [%]	100.00	100.00	100.00	96.73	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.73
LF [%]	106.52	106.84	106.85	102.78	105.31	102.79	101.36	102.83	103.44	105.82	105.90	97.32	103.97
OF [%]	100.00	100.00	100.00	97.22	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.77
FLR [%]	0.00	0.00	0.00	3.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
UCL [%]	0.00	0.00	0.00	3.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.14	0.35

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Historical Summary

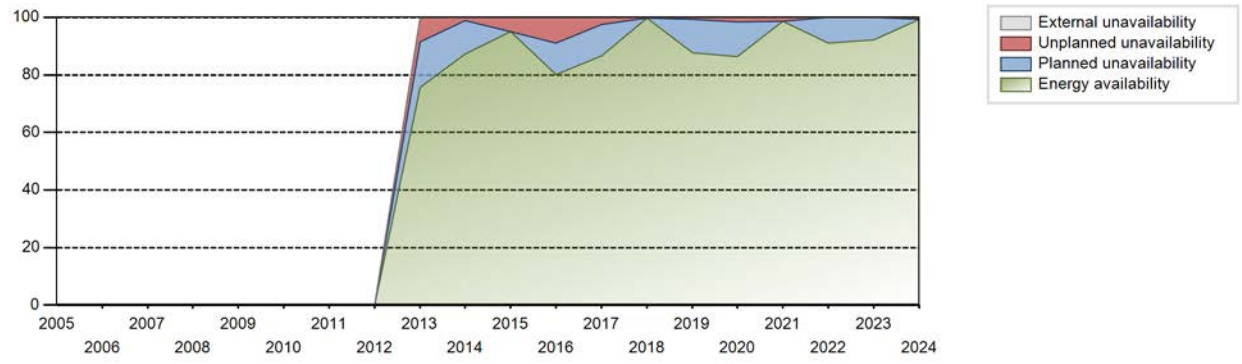
Lifetime energy generation	:	98564.4 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.29 %
Cumulative Energy Availability Factor (EAF)	:	89.98 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.5 %
Cumulative Unit Capability Factor (UCF)	:	90.02 %	Cumulative Planned Unavailability Factor (PUF)	:	7.49 %
Cumulative Load Factor (LF)	:	93.29 %	Cumulative Externally cause unavailability (XUF)	:	0.03 %
Cumulative Operating Factor (OF)	:	90.4 %			

Electricity Production (net) [GWh]



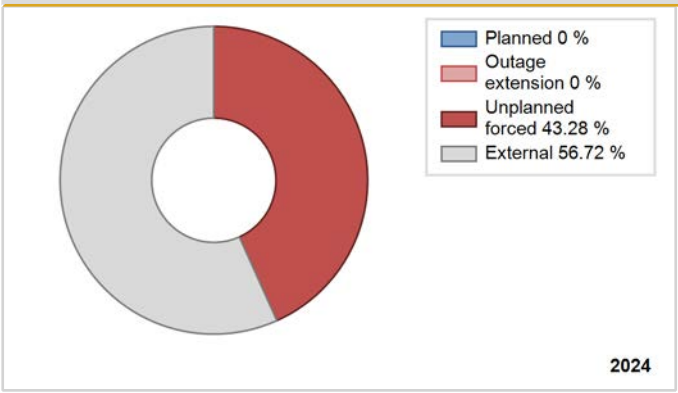
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2012	5166.49	6858	950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	6342.91	6662	950	75.72	75.73	76.22	76.05	6.89	8.42	15.85	0.02
2014	7249.38	7691	950	87.21	87.21	87.10	87.79	1.23	1.08	11.71	0.00
2015	8086.65	8346	950	95.01	95.01	97.17	95.27	4.99	4.99	0.00	0.00
2016	6704.20	7255	950	80.15	80.15	80.34	82.59	9.83	8.96	10.89	0.00
2017	7535.97	7490	950	86.52	86.52	90.55	85.50	0.92	2.39	11.09	0.00
2018	8736.46	8760	950	99.76	99.76	104.98	100.00	0.24	0.24	0.00	0.00
2019	7668.87	7745	950	87.66	87.66	92.15	88.41	0.70	0.61	11.72	0.00
2020	7553.71	7638	950	86.28	86.28	90.52	86.95	1.93	1.69	12.02	0.00
2021	8673.29	8657	950	98.71	98.71	104.22	98.82	1.29	1.29	0.00	0.00
2022	7923.02	7987	950	91.15	91.15	95.21	91.18	0.02	0.02	8.84	0.00
2023	8076.94	8100	950	92.27	92.27	97.06	92.47	0.03	0.02	7.71	0.00
2024	8675.88	8764	950	99.38	99.73	103.97	99.77	0.27	0.27	0.00	0.35

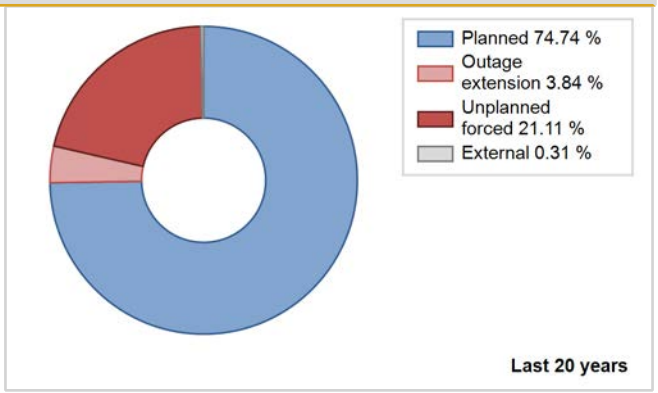
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2012 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		20			180	
C. Inspection, maintenance or repair combined with refuelling				643		
D. Inspection, maintenance or repair without refuelling				11		
L. Human factor related					6	
Subtotal		20		654	186	
Total		**20**			**840**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2012 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		11
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries	20	60
32. Feedwater and Main Steam System		7
33. Circulating Water System		2
35. All other I&C Systems		1
41. Main Generator Systems		55
42. Electrical Power Supply Systems		33
Total	**20**	**171**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-12 KOLA-1 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-230
Thermal power	:	1375 MWth
Gross electrical power	:	440 MWe
Reference unit power (net)	:	411 MWe

Key Dates

Construction Date	:	1970-05-01
Grid Date	:	1973-06-29
Commercial Date	:	1973-12-28
Age at end of year	:	51 years

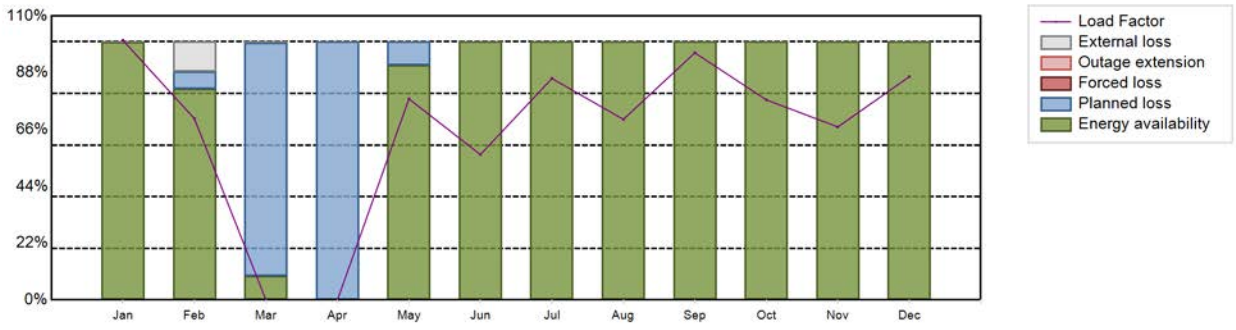
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	12.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	300
Fuel material	:	UO2	Number of SG	:	6
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	28600	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	2.88	HP cylinder inlet steam pressure [MPa]	:	4.4
Active core height/length [m]	:	2.5	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	349	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	13.1	Number of main condensate pumps	:	-
Number of control rod assemblies	:	37	Number of FW pumps for full power operation	:	4
Number of external reactor coolant loops	:	6	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	2372.14 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	81.88 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	82.84 %	Planned Unavailability Factor (PUF)	:	17.16 %
Load Factor (LF)	:	65.71 %	Externally cause unavailability (XUF)	:	0.96 %
Operating Factor (OF)	:	80.15 %	Total off-line time	:	1744 hours
Equivalent non-electrical energy generated (NEG)	:	0 GW(e).h			

Annual Summary



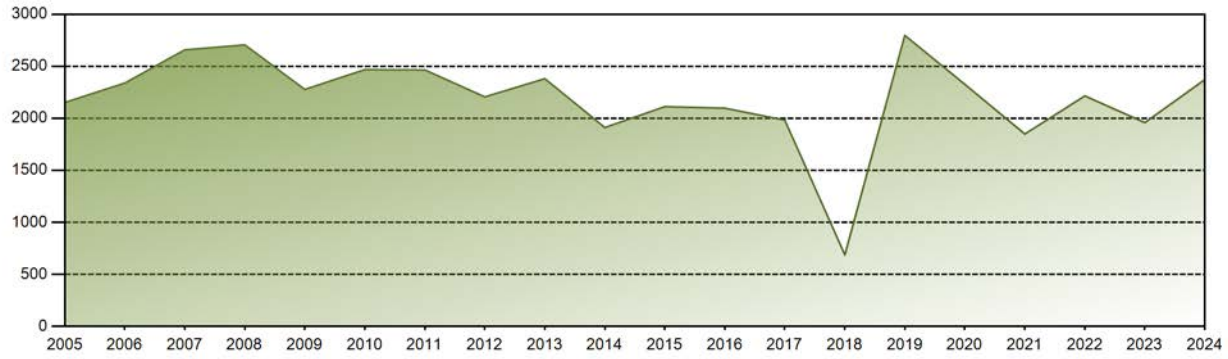
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	307.45	200.75	0.00	0.00	238.11	166.63	262.31	213.91	283.25	236.94	198.30	264.47	2372.14
EAF [%]	99.77	81.65	9.33	0.01	90.91	100.00	100.00	100.00	100.00	100.00	100.00	100.00	81.88
UCF [%]	100.00	93.10	9.69	0.01	90.91	100.00	100.00	100.00	100.00	100.00	100.00	100.00	82.84
LF [%]	100.55	70.18	0.00	0.00	77.87	56.31	85.78	69.96	95.72	77.49	67.01	86.49	65.71
OF [%]	100.00	100.00	1.48	0.00	95.16	64.58	100.00	100.00	100.00	100.00	100.00	100.00	80.15
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	6.90	90.31	99.99	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.16
XUF [%]	0.23	11.46	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96

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Historical Summary

Lifetime energy generation	:	117675.3 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.51 %
Cumulative Energy Availability Factor (EAF)	:	72.92 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.05 %
Cumulative Unit Capability Factor (UCF)	:	77.78 %	Cumulative Planned Unavailability Factor (PUF)	:	20.17 %
Cumulative Load Factor (LF)	:	63.55 %	Cumulative Externally cause unavailability (XUF)	:	4.86 %
Cumulative Operating Factor (OF)	:	79.16 %			

Electricity Production (net) [GWh]

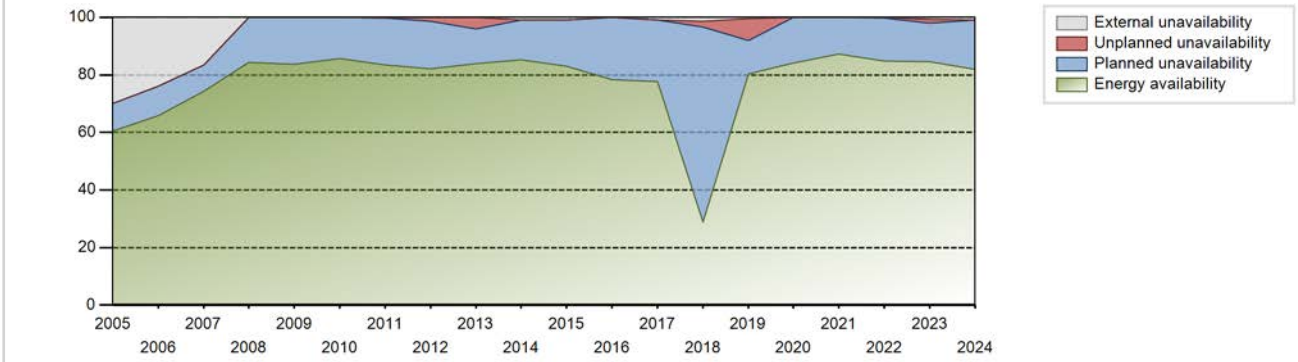


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1973	918.20	4180	411	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1974	1990.06	8463	411	79.22	79.22	55.27	96.61	0.90	0.72	20.06	0.01
1975	1015.76	5426	411	50.91	50.94	28.21	61.94	1.27	0.66	48.40	0.03
1976	2421.71	8247	411	74.05	74.17	67.08	93.89	0.97	0.73	25.10	0.12
1977	2101.05	7462	411	76.38	76.40	58.36	85.18	6.73	5.52	18.09	0.01
1978	2978.78	8074	411	82.58	82.60	82.74	92.17	1.55	1.30	16.10	0.02
1979	2435.60	6232	411	64.63	64.65	67.65	71.14	2.14	1.41	33.94	0.02
1980	3466.37	8072	411	90.90	91.05	96.02	91.89	0.33	0.30	8.65	0.15
1981	2870.79	7448	411	80.94	80.95	79.74	85.02	2.81	2.34	16.71	0.01
1982	2848.07	7875	411	85.52	85.52	79.11	89.90	1.80	1.56	12.91	0.01
1983	3217.37	7884	411	88.25	88.27	89.36	90.00	0.19	0.17	11.57	0.02
1984	3112.02	8060	411	84.90	84.92	86.20	91.76	1.41	1.22	13.87	0.01
1985	2388.76	6001	411	67.02	67.05	66.35	68.50	0.61	0.41	32.54	0.03
1986	2805.84	8074	411	85.08	85.08	77.93	92.17	5.88	5.32	9.60	0.00
1987	3268.23	7972	440	86.00	86.00	84.79	91.00	0.96	0.83	13.17	0.00
1988	2925.01	7482	411	82.67	82.73	81.02	85.18	6.53	5.78	11.49	0.06
1989	2675.48	6731	411	75.44	76.23	74.31	76.84	1.18	0.91	22.86	0.79
1990	2735.50	6838	411	75.95	75.95	75.98	78.06	2.00	1.55	22.50	0.00
1991	2773.12	6965	411	77.27	77.27	77.02	79.51	7.17	5.97	16.76	0.00
1992	2271.37	6651	411	63.44	63.70	62.92	75.73	17.65	13.65	22.65	0.26
1993	1992.62	5663	411	56.14	59.56	55.35	64.65	14.77	10.32	30.11	3.42
1994	1971.62	5359	411	56.50	58.63	54.76	61.18	7.34	4.65	36.72	2.13
1995	1581.37	5398	411	62.24	62.24	43.92	61.62	5.06	3.32	34.44	0.00
1996	1409.96	4466	411	46.43	47.44	39.05	50.84	6.51	3.30	49.26	1.00
1997	2404.12	7942	411	88.48	88.48	66.77	90.66	5.02	4.68	6.84	0.00
1998	1291.73	5658	411	37.66	59.27	35.88	64.59	12.77	8.68	32.05	21.61
1999	2028.49	7355	411	58.01	86.57	56.34	83.96	0.97	0.85	12.58	28.56
2000	1298.85	4643	411	37.17	84.13	35.98	52.86	0.80	0.68	15.19	46.96
2001	2243.22	7098	411	63.27	81.60	62.31	81.03	0.91	0.75	17.65	18.33
2002	1841.48	5660	411	51.65	68.90	51.15	64.61	0.00	0.00	31.10	17.25
2003	2164.00	6444	411	60.41	75.51	60.11	73.56	0.73	0.55	23.94	15.10
2004	2440.48	7326	411	68.21	83.64	67.60	83.40	0.00	0.00	16.36	15.43
2005	2151.67	6901	411	60.60	90.57	59.76	78.78	0.01	0.01	9.43	29.97
2006	2338.66	7661	411	65.95	89.94	64.96	87.45	0.00	0.00	10.06	23.98
2007	2658.02	7740	411	74.43	90.96	73.83	88.36	0.00	0.00	9.04	16.53
2008	2705.75	7397	411	84.34	84.34	74.95	84.21	0.00	0.00	15.66	0.00
2009	2277.43	7333	411	83.76	83.77	63.26	83.71	0.00	0.00	16.23	0.01

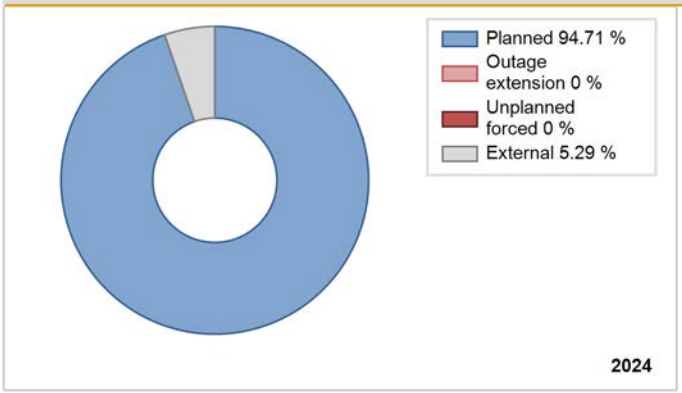
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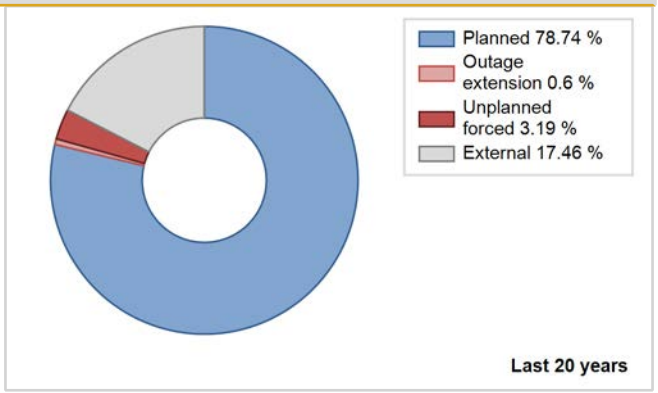
2010	2467.97	7912	411	85.79	85.82	68.55	90.32	0.00	0.00	14.18	0.03
2011	2465.32	7870	411	83.47	83.62	68.48	89.85	0.00	0.00	16.38	0.15
2012	2205.74	7021	411	82.24	82.24	61.10	79.93	1.67	1.39	16.37	0.00
2013	2380.88	7811	411	83.98	83.98	66.13	89.17	4.60	4.05	11.97	0.00
2014	1911.66	7536	411	85.18	86.19	53.09	86.02	0.00	0.00	13.81	1.01
2015	2112.22	7373	411	83.10	84.00	58.67	84.17	0.01	0.01	15.99	0.91
2016	2097.80	6386	411	78.45	78.45	58.11	72.70	0.00	0.00	21.55	0.00
2017	1982.33	7025	411	77.78	78.62	55.06	80.19	0.00	0.00	21.38	0.84
2018	688.02	2652	411	28.92	30.25	19.11	30.27	5.22	1.97	67.78	1.33
2019	2796.96	7740	411	80.24	80.62	77.69	88.36	6.14	7.61	11.77	0.38
2020	2327.08	7193	411	84.03	84.03	64.46	81.89	0.07	0.05	15.92	0.00
2021	1849.44	6406	411	87.16	87.16	51.37	73.13	0.00	0.00	12.84	0.00
2022	2215.25	7356	411	84.90	84.90	61.53	83.97	0.26	0.22	14.88	0.00
2023	1958.53	6571	411	84.54	85.22	54.40	75.01	1.56	1.35	13.43	0.67
2024	2372.14	7040	411	81.88	82.84	65.71	80.15	0.00	0.00	17.16	0.96

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1973 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					47	
C. Inspection, maintenance or repair combined with refuelling	1359			1471	3	
D. Inspection, maintenance or repair without refuelling				70		
F. Major backfitting, refurbishment or upgrading activities with refuelling				51		
J. Grid limitation, failure or grid unavailability						37
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			278			160
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						4
Z. Other					8	
Subtotal	1359		278	1592	59	203
Total		**1637**			**1854**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1973 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		6
13. Reactor Auxiliary Systems		3
15. Reactor Cooling Systems		13
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		6
34. Miscellaneous Systems		12
35. All other I&C Systems		1
41. Main Generator Systems		1
42. Electrical Power Supply Systems		3
Total		**48**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the overhaul. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-13 KOLA-2 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-230
Thermal power	:	1375 MWth
Gross electrical power	:	440 MWe
Reference unit power (net)	:	411 MWe

Key Dates

Construction Date	:	1970-05-01
Grid Date	:	1974-12-09
Commercial Date	:	1975-02-21
Age at end of year	:	50 years

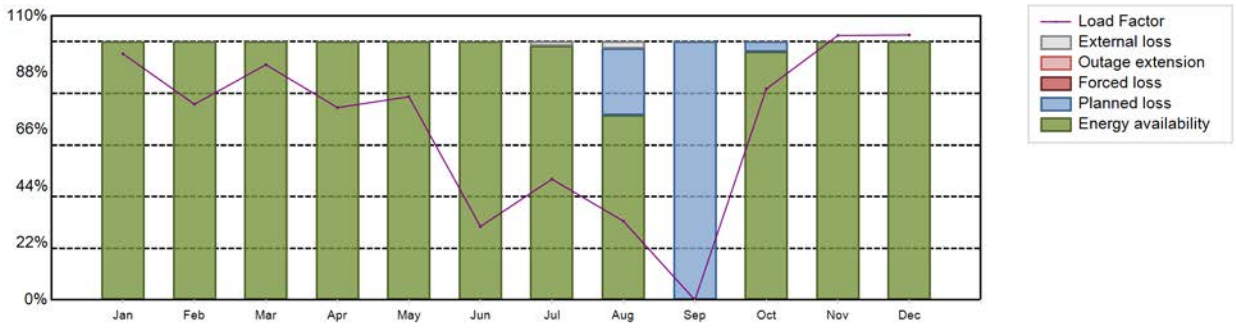
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	28600
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.1
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.5
Reactor outlet temperature [°C]	:	300
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	4.4
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	2435.67 GW(e).h
Energy Availability Factor (EAF)	:	88.94 %
Unit Capability Factor (UCF)	:	89.29 %
Load Factor (LF)	:	67.47 %
Operating Factor (OF)	:	86.35 %
Equivalent non-electrical energy generated (NEG)	:	0 GW(e).h
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	10.71 %
Externally cause unavailability (XUF)	:	0.35 %
Total off-line time	:	1199 hours

Annual Summary



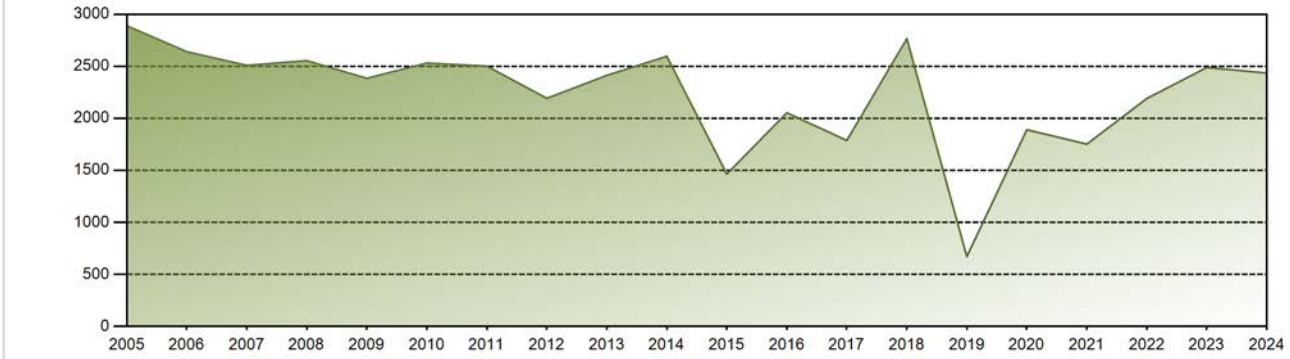
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	291.53	216.81	278.62	220.49	240.66	84.20	143.03	93.38	0.00	250.05	303.08	313.83	2435.67
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	98.43	71.60	0.01	96.11	100.00	100.00	88.94
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	74.20	0.01	96.11	100.00	100.00	89.29
LF [%]	95.34	75.79	91.12	74.51	78.70	28.45	46.78	30.54	0.00	81.77	102.42	102.63	67.47
OF [%]	100.00	100.00	100.00	100.00	100.00	66.53	100.00	70.16	0.00	97.85	100.00	100.00	86.35
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.80	99.99	3.89	0.00	0.00	10.71
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	1.57	2.60	0.00	0.00	0.00	0.00	0.35

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Historical Summary

Lifetime energy generation	:	115048.29 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.49 %
Cumulative Energy Availability Factor (EAF)	:	73.77 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2 %
Cumulative Unit Capability Factor (UCF)	:	78.03 %	Cumulative Planned Unavailability Factor (PUF)	:	19.98 %
Cumulative Load Factor (LF)	:	63.97 %	Cumulative Externally cause unavailability (XUF)	:	4.26 %
Cumulative Operating Factor (OF)	:	77.14 %			

Electricity Production (net) [GWh]

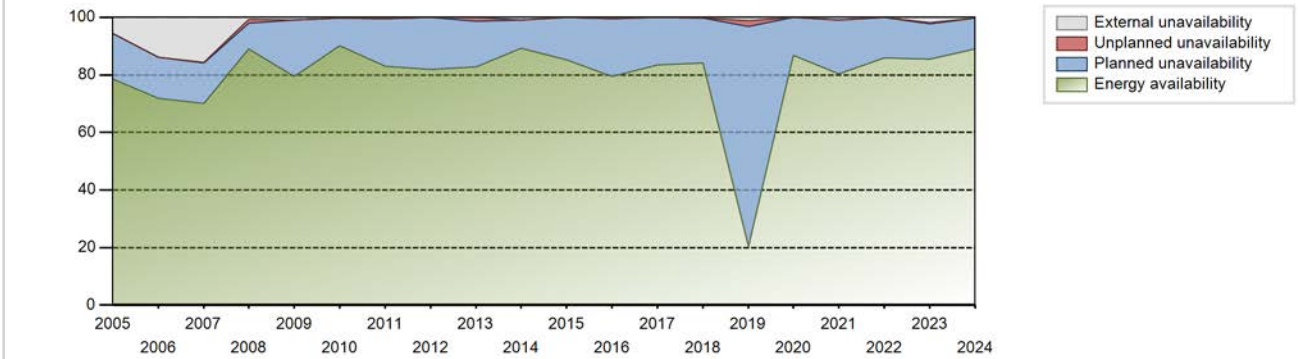


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	1383.07	6449	411	88.23	88.23	37.48	73.97	3.66	3.35	8.41	0.00
1976	1943.15	7083	411	70.82	70.82	53.82	80.64	0.74	0.53	28.65	0.00
1977	2627.24	7038	411	76.90	77.05	72.97	80.34	1.10	0.85	22.09	0.15
1978	2982.47	7576	411	82.71	82.71	82.84	86.48	0.67	0.56	16.73	0.00
1979	3057.59	7663	411	82.40	83.51	84.92	87.48	3.13	2.70	13.79	1.11
1980	3266.85	7966	411	85.80	85.99	90.49	90.69	0.71	0.62	13.40	0.19
1981	3146.68	8225	411	87.78	87.78	87.40	93.89	2.81	2.54	9.68	0.00
1982	2462.96	6742	411	71.24	71.24	68.41	76.96	3.13	2.30	26.46	0.00
1983	3072.64	7963	411	85.27	85.30	85.34	90.90	3.18	2.80	11.90	0.03
1984	3034.45	8079	411	86.75	86.76	84.05	91.97	1.97	1.74	11.50	0.00
1985	3055.56	7872	411	84.90	84.94	84.87	89.86	3.18	2.79	12.27	0.04
1986	2844.15	7405	411	79.74	79.78	79.00	84.53	4.19	3.49	16.73	0.04
1987	3345.38	7900	440	89.59	89.59	86.79	90.18	0.58	0.52	9.89	0.00
1988	2873.27	7451	411	80.46	80.49	79.59	84.82	5.60	4.78	14.73	0.03
1989	2707.27	6859	411	74.79	78.05	75.19	78.30	0.67	0.52	21.43	3.26
1990	2610.91	6751	411	72.72	72.86	72.52	77.07	6.09	4.73	22.42	0.14
1991	2701.86	6983	411	75.33	75.41	75.04	79.71	11.29	9.60	14.99	0.08
1992	2133.04	5871	411	61.85	61.85	59.09	66.85	16.94	12.61	25.54	0.00
1993	2138.83	6377	411	60.68	65.73	59.41	72.80	7.71	5.49	28.77	5.05
1994	398.60	1466	411	16.68	16.68	11.07	16.74	18.79	3.86	79.46	0.00
1995	2205.78	6846	411	93.58	93.58	61.27	78.15	2.08	1.99	4.43	0.00
1996	1946.17	6243	411	65.47	66.30	53.91	71.07	3.53	2.43	31.27	0.84
1997	1157.94	3955	411	40.64	53.44	32.16	45.15	3.35	1.85	44.70	12.80
1998	2655.63	8029	411	74.46	83.64	73.76	91.66	8.88	8.15	8.22	9.18
1999	1272.59	4423	411	36.30	48.99	35.35	50.49	17.19	10.17	40.84	12.69
2000	2430.51	7626	411	68.16	83.38	67.32	86.82	2.56	2.19	14.43	15.22
2001	1722.31	6574	411	49.08	84.74	47.84	75.05	1.21	1.03	14.22	35.67
2002	1738.75	5564	411	48.66	83.24	48.29	63.52	0.30	0.25	16.51	34.58
2003	1866.10	5459	411	52.04	66.40	51.83	62.32	0.54	0.36	33.24	14.37
2004	1787.07	5731	411	49.92	73.84	49.50	65.24	0.04	0.03	26.12	23.93
2005	2889.18	7379	411	78.59	84.24	80.25	84.24	0.00	0.00	15.76	5.65
2006	2640.13	7597	411	71.98	85.73	73.33	86.72	0.00	0.00	14.27	13.75
2007	2508.92	7474	411	70.10	85.69	69.69	85.32	0.19	0.16	14.14	15.59
2008	2554.70	7762	411	89.13	89.92	70.76	88.37	1.32	1.20	8.88	0.79
2009	2384.55	6872	411	79.44	80.28	66.23	78.45	0.00	0.00	19.72	0.84
2010	2531.18	7619	411	90.18	90.41	70.30	86.97	0.00	0.00	9.59	0.24
2011	2501.98	7752	411	83.07	83.63	69.50	88.50	0.00	0.00	16.37	0.56

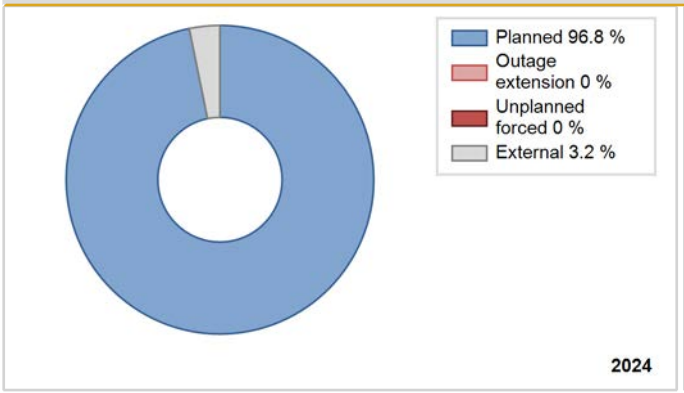
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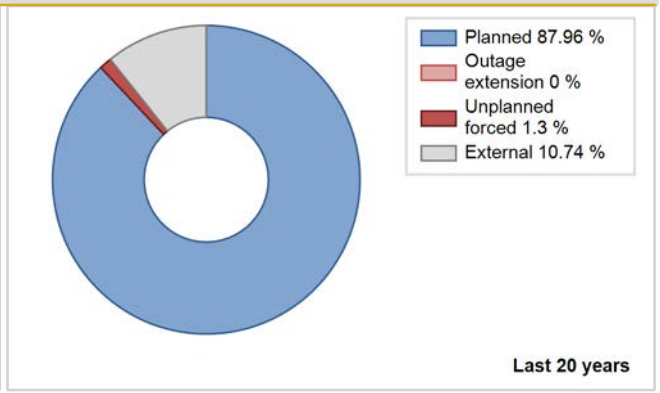
2012	2192.07	7775	411	81.85	81.85	60.72	88.51	0.00	0.00	18.14	0.00
2013	2412.70	7233	411	82.80	82.80	67.01	82.57	1.51	1.27	15.93	0.00
2014	2596.45	7823	411	89.32	90.15	72.11	89.29	0.03	0.03	9.82	0.83
2015	1463.78	5450	411	85.32	85.32	40.66	62.21	0.00	0.00	14.68	0.00
2016	2053.14	6416	411	79.35	79.79	56.87	73.04	0.00	0.00	20.21	0.43
2017	1787.16	5615	411	83.48	83.48	49.64	64.10	0.08	0.07	16.45	0.00
2018	2765.53	7437	411	84.10	84.42	76.81	84.90	0.00	0.00	15.58	0.32
2019	670.53	1904	411	20.38	21.54	18.62	21.74	8.76	2.07	76.39	1.17
2020	1890.68	7188	411	86.71	86.71	52.37	81.83	0.00	0.00	13.29	0.01
2021	1752.15	6931	411	80.43	81.40	48.67	79.12	0.00	0.00	18.60	0.97
2022	2190.58	6498	411	85.85	85.85	60.84	74.18	0.00	0.00	14.15	0.00
2023	2488.57	7555	411	85.42	87.27	69.12	86.24	0.50	0.44	12.29	1.84
2024	2435.67	7585	411	88.94	89.29	67.47	86.35	0.00	0.00	10.71	0.35

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1975 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					63	
C.	Inspection, maintenance or repair combined with refuelling	928			1458		
D.	Inspection, maintenance or repair without refuelling				50		
E.	Testing of plant systems or components				6		
F.	Major backfitting, refurbishment or upgrading activities with refuelling				99		
H.	Nuclear regulatory requirements					3	
J.	Grid limitation, failure or grid unavailability						27
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			271			259
L.	Human factor related					1	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
Z.	Other					0	
Subtotal		928		271	1613	67	288
Total		**1199**			**1968**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		36
12. Reactor I&C Systems		1
13. Reactor Auxiliary Systems		2
14. Safety Systems		2
15. Reactor Cooling Systems		15
16. Steam generation systems		3
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		0
32. Feedwater and Main Steam System		0
35. All other I&C Systems		1
41. Main Generator Systems		0
42. Electrical Power Supply Systems		2
Total		**63**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the intermediate maintenance outage. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-32 KOLA-3 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KALUGA (JSC "Kaluga turbine plant" 32, Glagoleva Street, Kaluga, 248021, Russia)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1375 MWth
Gross electrical power	:	440 MWe
Reference unit power (net)	:	411 MWe

Key Dates

Construction Date	:	1977-04-01
Grid Date	:	1981-03-24
Commercial Date	:	1982-12-03
Age at end of year	:	43 years

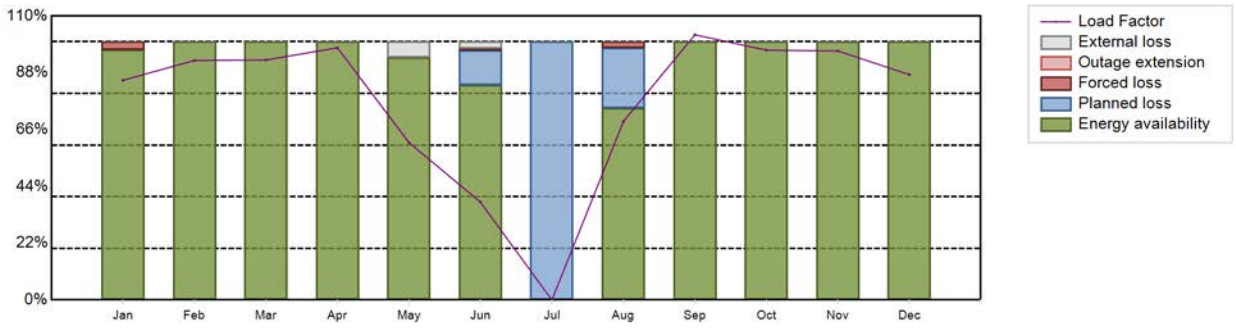
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	28600
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.1
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.5
Reactor outlet temperature [°C]	:	300
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	4.4
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	2760.69 GW(e).h
Energy Availability Factor (EAF)	:	87.22 %
Unit Capability Factor (UCF)	:	87.95 %
Load Factor (LF)	:	76.47 %
Operating Factor (OF)	:	88.5 %
Equivalent non-electrical energy generated (NEG)	:	0 GW(e).h
Forced Loss Rate (FLR)	:	0.6 %
Unplanned Capability Loss Factor (UCL)	:	0.53 %
Planned Unavailability Factor (PUF)	:	11.53 %
Externally cause unavailability (XUF)	:	0.73 %
Total off-line time	:	1010 hours

Annual Summary



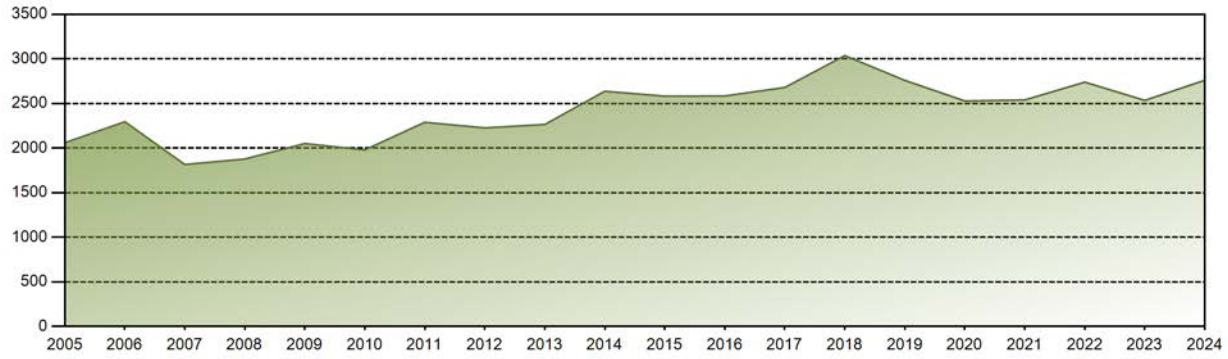
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	260.19	265.33	284.25	288.98	186.44	112.12	0.00	211.33	303.90	295.90	285.39	266.86	2760.69
EAF [%]	96.97	100.00	100.00	100.00	93.93	83.23	0.01	74.43	100.00	100.00	100.00	100.00	87.22
UCF [%]	96.97	100.00	100.00	100.00	100.00	85.84	0.01	74.43	100.00	100.00	100.00	100.00	87.95
LF [%]	85.09	92.76	92.96	97.66	60.97	37.89	0.00	69.11	102.70	96.77	96.44	87.27	76.47
OF [%]	98.25	100.00	100.00	100.00	100.00	83.47	0.00	81.99	100.00	100.00	100.00	100.00	88.50
FLR [%]	3.03	0.00	0.00	0.00	0.00	0.96	0.00	3.11	0.00	0.00	0.00	0.00	0.60
UCL [%]	3.03	0.00	0.00	0.00	0.00	0.83	0.00	2.39	0.00	0.00	0.00	0.00	0.53
PUF [%]	0.00	0.00	0.00	0.00	0.00	13.33	99.99	23.19	0.00	0.00	0.00	0.00	11.53
XUF [%]	0.00	0.00	0.00	0.00	6.07	2.61	0.00	0.00	0.00	0.00	0.00	0.00	0.73

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Historical Summary

Lifetime energy generation	:	109066.71 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.22 %
Cumulative Energy Availability Factor (EAF)	:	77.05 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.89 %
Cumulative Unit Capability Factor (UCF)	:	82.46 %	Cumulative Planned Unavailability Factor (PUF)	:	15.65 %
Cumulative Load Factor (LF)	:	70.33 %	Cumulative Externally cause unavailability (XUF)	:	5.41 %
Cumulative Operating Factor (OF)	:	82.32 %			

Electricity Production (net) [GWh]

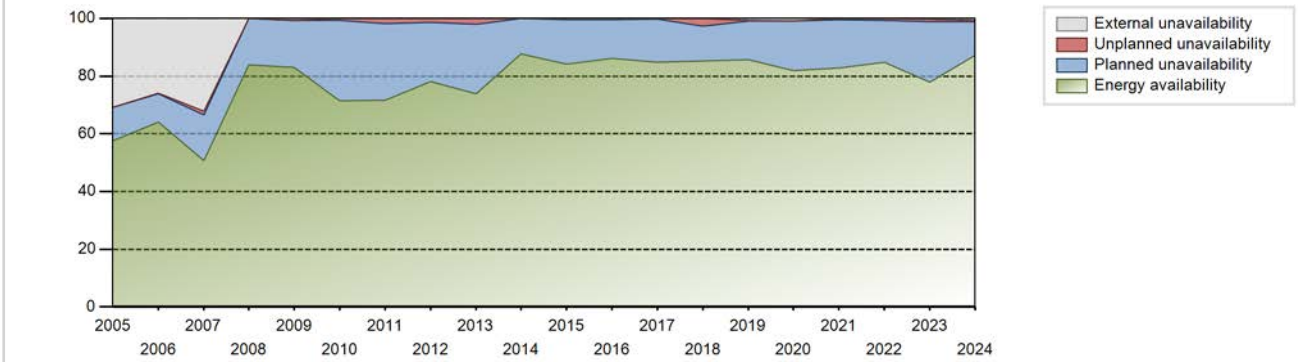


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1982	1891.17	7252	411	99.35	99.38	98.74	100.00	0.08	0.08	0.54	0.03
1983	2459.86	6818	411	71.98	71.99	68.32	77.83	3.90	2.92	25.09	0.01
1984	2830.67	7610	411	82.71	82.71	78.41	86.63	1.76	1.48	15.80	0.01
1985	2972.56	7814	411	86.68	86.77	82.56	89.20	2.25	2.00	11.23	0.09
1986	2627.25	7244	411	74.11	74.11	72.97	82.69	16.48	14.62	11.27	0.00
1987	2837.81	7024	440	74.79	74.79	73.63	80.18	6.83	5.49	19.73	0.00
1988	2933.19	7913	411	81.43	81.52	81.25	90.08	4.73	4.05	14.44	0.08
1989	3186.68	8047	411	87.85	90.50	88.51	91.86	0.81	0.74	8.76	2.65
1990	3256.91	8022	411	89.72	89.77	90.46	91.58	0.95	0.87	9.37	0.05
1991	2935.21	7188	411	79.78	79.78	81.53	82.05	2.74	2.25	17.97	0.00
1992	2806.37	7396	411	87.75	87.95	77.74	84.21	2.36	2.13	9.93	0.20
1993	2548.00	6833	411	70.46	81.91	70.77	78.00	1.41	1.17	16.93	11.45
1994	2466.01	6373	411	70.82	70.90	68.49	72.75	10.76	8.55	20.55	0.08
1995	2526.12	7083	411	80.64	81.00	70.16	80.86	0.82	0.67	18.33	0.36
1996	2327.31	6928	411	79.77	79.77	64.46	78.87	5.33	4.49	15.74	0.00
1997	2340.50	7114	411	74.96	78.46	65.01	81.21	0.56	0.44	21.11	3.49
1998	2006.34	6705	411	56.35	86.29	55.73	76.54	4.27	3.85	9.86	29.94
1999	2140.57	7040	411	59.90	72.59	59.45	80.37	9.77	7.86	19.55	12.69
2000	2244.74	7731	411	62.46	87.91	62.18	88.01	0.08	0.07	12.02	25.46
2001	2543.29	7057	411	70.64	85.28	70.64	80.56	1.10	0.95	13.77	14.64
2002	2742.35	7909	411	75.89	91.39	76.17	90.29	0.43	0.40	8.21	15.51
2003	2740.72	7335	411	75.61	83.69	76.12	83.73	0.06	0.05	16.26	8.08
2004	2816.85	7688	411	77.37	88.10	78.02	87.52	0.57	0.51	11.39	10.73
2005	2059.39	7672	411	57.64	88.49	57.19	87.57	0.00	0.00	11.51	30.85
2006	2294.60	7436	411	64.00	89.99	63.73	84.89	0.05	0.04	9.97	25.99
2007	1815.27	6506	411	50.72	82.86	50.42	74.27	1.49	1.25	15.89	32.14
2008	1876.73	7405	411	83.82	83.82	51.98	84.30	0.04	0.03	16.15	0.00
2009	2050.45	7340	411	83.13	83.85	56.95	83.79	0.10	0.08	16.07	0.71
2010	1979.23	6009	411	71.48	71.48	54.97	68.60	1.03	0.75	27.78	0.00
2011	2288.62	6405	411	71.67	71.67	63.57	73.12	2.56	1.89	26.45	0.00
2012	2226.17	6701	411	78.13	78.13	61.66	76.29	1.74	1.38	20.49	0.00
2013	2264.33	6396	411	73.80	73.80	62.89	73.01	2.75	2.09	24.11	0.00
2014	2636.67	7712	411	87.60	87.60	73.23	88.03	0.02	0.02	12.38	0.00
2015	2581.99	7364	411	84.12	84.12	71.71	84.06	0.45	0.38	15.50	0.00
2016	2583.96	6573	411	86.16	86.29	71.57	74.83	0.41	0.36	13.36	0.13
2017	2679.44	7494	411	84.70	84.70	74.42	85.55	0.31	0.27	15.03	0.00
2018	3036.60	7433	411	85.34	85.34	84.34	84.85	2.24	2.62	12.04	0.00

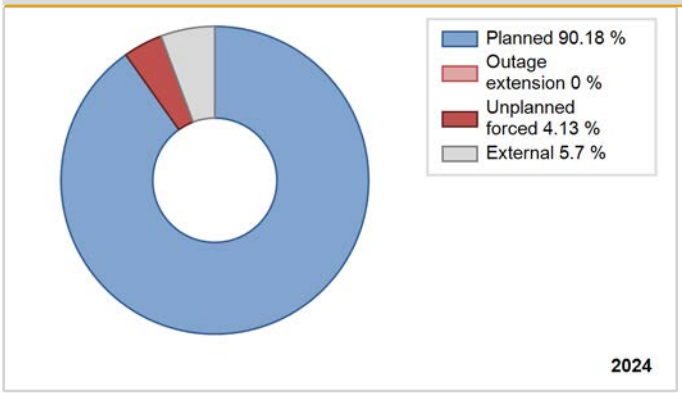
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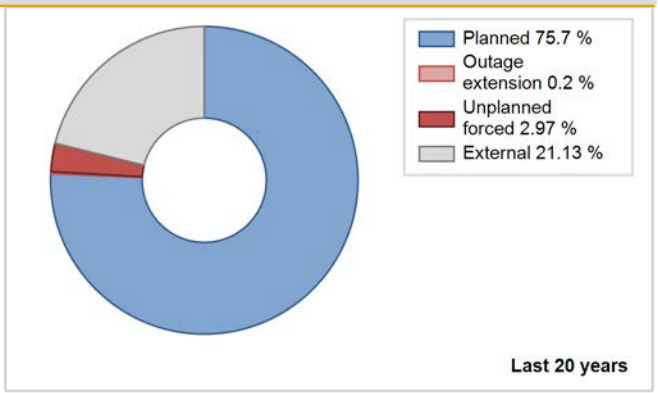
2019	2759.12	7606	411	85.71	86.49	76.63	86.83	0.04	0.04	13.47	0.78
2020	2527.89	7116	411	81.99	82.81	70.02	81.01	0.00	0.00	17.19	0.82
2021	2539.74	7038	411	82.91	82.91	70.54	80.34	0.53	0.44	16.65	0.00
2022	2739.16	7514	411	84.71	84.71	76.08	85.78	0.68	0.79	14.50	0.00
2023	2534.41	6604	411	77.88	78.16	70.39	75.39	1.16	0.92	20.92	0.28
2024	2760.69	7774	411	87.22	87.95	76.47	88.50	0.60	0.53	11.53	0.73

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1982 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		13			65	
C.	Inspection, maintenance or repair combined with refuelling	974			1263		
D.	Inspection, maintenance or repair without refuelling				58		
E.	Testing of plant systems or components				9	1	
J.	Grid limitation, failure or grid unavailability						46
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						111
L.	Human factor related					2	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z.	Other					3	
Subtotal		974	13		1330	71	158
Total			**987**			**1559**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1982 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		6
12. Reactor I&C Systems		21
15. Reactor Cooling Systems		10
16. Steam generation systems		8
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		4
32. Feedwater and Main Steam System		8
34. Miscellaneous Systems		0
41. Main Generator Systems	13	1
42. Electrical Power Supply Systems		8
Total	**13**	**66**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the intermediate maintenance outage. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-33 KOLA-4 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KALUGA (JSC "Kaluga turbine plant" 32, Glagoleva Street, Kaluga, 248021, Russia)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1375 MWth
Gross electrical power	:	440 MWe
Reference unit power (net)	:	411 MWe

Key Dates

Construction Date	:	1976-08-01
Grid Date	:	1984-10-11
Commercial Date	:	1984-12-06
Age at end of year	:	40 years

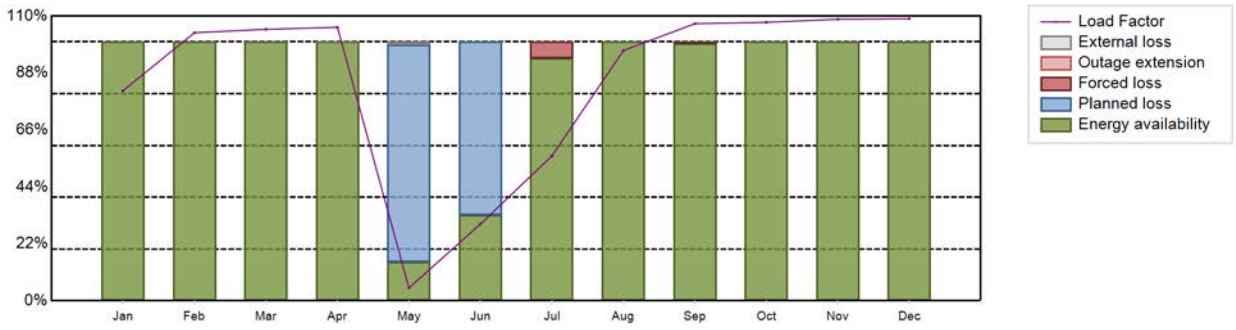
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	28600
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.1
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.5
Reactor outlet temperature [°C]	:	300
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	4.4
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	3048.02 GW(e).h	Forced Loss Rate (FLR)	:	0.67 %
Energy Availability Factor (EAF)	:	86.72 %	Unplanned Capability Loss Factor (UCL)	:	0.59 %
Unit Capability Factor (UCF)	:	86.82 %	Planned Unavailability Factor (PUF)	:	12.59 %
Load Factor (LF)	:	84.43 %	Externally cause unavailability (XUF)	:	0.1 %
Operating Factor (OF)	:	89.15 %	Total off-line time	:	953 hours
Equivalent non-electrical energy generated (NEG)	:	0 GW(e).h			

Annual Summary



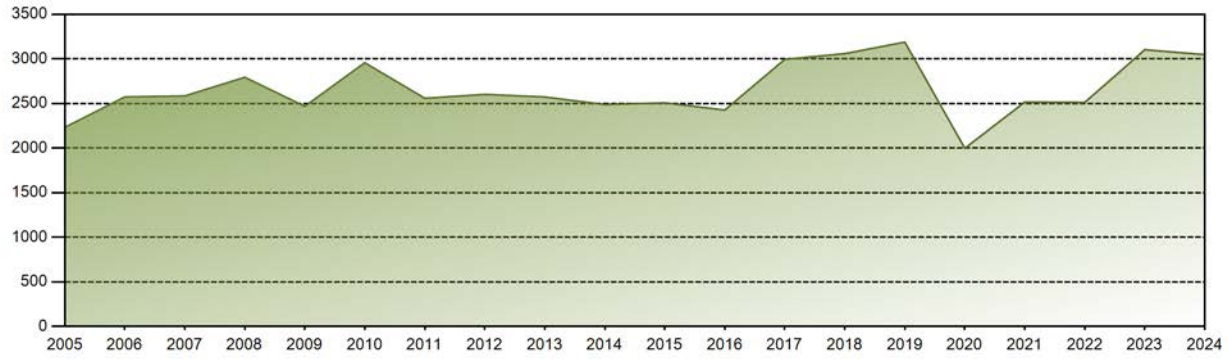
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	248.17	296.19	320.66	312.68	15.27	87.73	171.20	295.55	316.77	328.93	321.79	333.08	3048.02
EAF [%]	100.00	100.00	100.00	99.99	14.94	33.07	93.69	100.00	99.32	100.00	100.00	100.00	86.72
UCF [%]	100.00	100.00	100.00	100.00	16.14	33.07	93.69	100.00	99.32	100.00	100.00	100.00	86.82
LF [%]	81.16	103.54	104.86	105.66	4.99	29.65	55.99	96.65	107.05	107.57	108.74	108.93	84.43
OF [%]	100.00	100.00	100.00	100.00	11.16	59.44	100.00	100.00	100.00	100.00	100.00	100.00	89.15
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	6.31	0.00	0.68	0.00	0.00	0.00	0.67
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	6.31	0.00	0.68	0.00	0.00	0.00	0.59
PUF [%]	0.00	0.00	0.00	0.00	83.86	66.93	0.00	0.00	0.00	0.00	0.00	0.00	12.59
XUF [%]	0.00	0.00	0.00	0.01	1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10

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Historical Summary

Lifetime energy generation	:	104938.36 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.43 %
Cumulative Energy Availability Factor (EAF)	:	77.18 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.06 %
Cumulative Unit Capability Factor (UCF)	:	82.43 %	Cumulative Planned Unavailability Factor (PUF)	:	15.51 %
Cumulative Load Factor (LF)	:	72.68 %	Cumulative Externally cause unavailability (XUF)	:	5.25 %
Cumulative Operating Factor (OF)	:	82.56 %			

Electricity Production (net) [GWh]

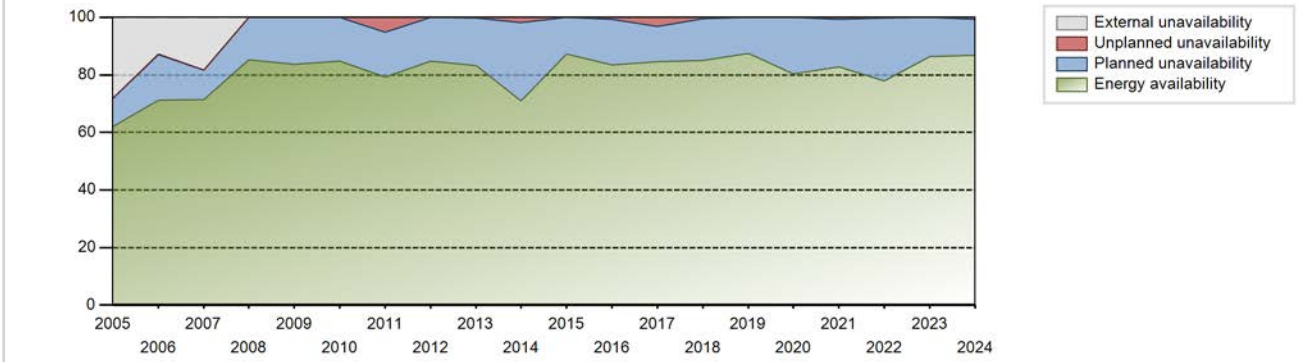


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	249.38	1605	411	100.00	100.00	55.09	98.12	0.00	0.00	0.00	0.00
1985	2585.77	7751	411	78.18	78.19	71.82	88.48	3.31	2.68	19.14	0.01
1986	2690.18	7230	411	72.36	72.36	74.72	82.53	6.11	4.71	22.93	0.00
1987	3341.17	7861	440	85.50	85.50	86.68	89.74	0.91	0.79	13.72	0.00
1988	3124.21	7762	411	84.95	84.96	86.54	88.37	4.04	3.58	11.47	0.01
1989	3111.51	7793	411	85.77	87.57	86.42	88.96	1.33	1.18	11.25	1.80
1990	2930.40	7142	411	80.24	80.28	81.39	81.53	0.76	0.62	19.10	0.05
1991	2790.49	7429	411	76.70	76.70	77.51	84.81	8.47	7.09	16.21	0.00
1992	2764.94	7253	411	79.99	80.51	76.60	82.58	2.77	2.29	17.19	0.52
1993	2826.99	8247	411	79.00	92.43	78.52	94.14	5.98	5.88	1.69	13.43
1994	1939.77	5915	411	55.77	62.72	53.88	67.52	20.29	15.97	21.31	6.95
1995	2288.81	7022	411	73.83	73.83	63.57	80.16	7.04	5.59	20.57	0.00
1996	2537.72	7792	411	84.09	84.09	70.29	88.71	4.39	3.86	12.05	0.00
1997	2271.67	6848	411	74.56	76.16	63.10	78.17	6.93	5.67	18.18	1.59
1998	1927.55	6336	411	49.19	69.38	53.54	72.33	8.64	6.56	24.05	20.20
1999	2567.48	7193	411	71.16	82.00	71.31	82.11	1.51	1.26	16.75	10.84
2000	2177.50	7096	411	60.44	86.31	60.31	80.78	0.07	0.06	13.63	25.86
2001	2447.14	7149	411	67.98	87.38	67.97	81.61	0.00	0.00	12.62	19.40
2002	2601.71	7281	411	71.52	79.71	72.26	83.12	0.00	0.00	20.29	8.19
2003	2480.80	6663	411	68.69	90.88	68.90	76.06	1.45	1.34	7.78	22.20
2004	2391.59	7863	411	66.38	86.78	66.24	89.52	0.00	0.00	13.22	20.40
2005	2231.75	7879	411	62.10	90.21	61.98	89.93	0.00	0.00	9.79	28.11
2006	2573.11	7217	411	71.26	84.11	71.47	82.39	0.13	0.11	15.79	12.85
2007	2584.08	7640	411	71.52	89.77	71.77	87.21	0.00	0.00	10.23	18.25
2008	2793.49	7794	411	85.15	85.20	77.38	88.73	0.05	0.04	14.76	0.04
2009	2468.01	7538	411	83.73	83.74	68.55	86.05	0.01	0.01	16.25	0.02
2010	2956.73	7332	411	84.73	84.73	82.12	83.70	0.00	0.00	15.27	0.00
2011	2558.01	6803	411	79.30	79.33	71.06	77.67	5.98	5.05	15.62	0.03
2012	2601.69	7459	411	84.75	84.75	72.06	84.92	0.11	0.09	15.16	0.00
2013	2572.70	7084	411	83.22	83.22	71.46	80.87	0.26	0.22	16.56	0.00
2014	2488.19	6241	411	70.91	70.91	69.10	71.24	2.61	1.90	27.18	0.00
2015	2506.63	6870	411	87.25	87.25	69.62	78.42	0.00	0.00	12.75	0.00
2016	2425.95	6422	411	83.44	83.44	67.20	73.11	0.86	0.73	15.83	0.00
2017	2994.93	7633	411	84.56	84.56	83.18	87.13	3.60	3.16	12.28	0.00
2018	3058.96	7464	411	84.97	84.97	84.96	85.21	0.57	0.49	14.54	0.00
2019	3188.15	7831	411	87.41	87.48	88.55	89.39	0.00	0.00	12.52	0.07
2020	1996.91	5992	411	80.37	80.37	55.31	68.21	0.00	0.00	19.63	0.00

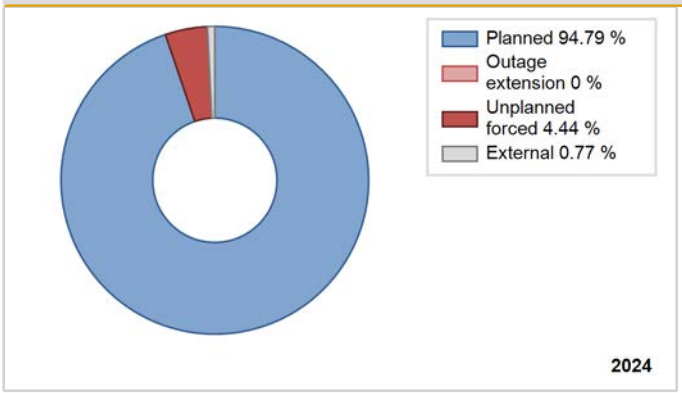
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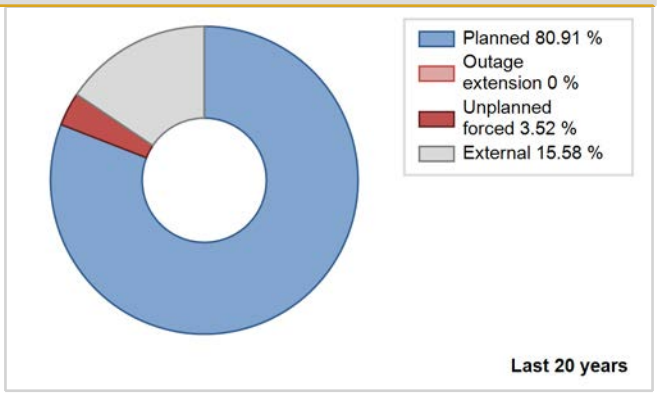
2021	2516.21	6801	411	82.77	82.77	69.89	77.64	0.85	0.71	16.52	0.00
2022	2512.64	6357	411	77.84	77.84	69.79	72.57	0.41	0.32	21.84	0.00
2023	3102.73	7566	411	86.39	86.39	86.18	86.37	0.00	0.00	13.61	0.00
2024	3048.01	7831	411	86.72	86.82	84.43	89.15	0.67	0.59	12.59	0.10

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					48	
C. Inspection, maintenance or repair combined with refuelling	916			1165	15	
D. Inspection, maintenance or repair without refuelling				65		
E. Testing of plant systems or components				4		
J. Grid limitation, failure or grid unavailability						38
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)			37			174
L. Human factor related					3	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
Z. Other					0	
Subtotal	916		37	1234	66	212
Total	**953**			**1512**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		12
14. Safety Systems		5
15. Reactor Cooling Systems		4
16. Steam generation systems		9
17. Safety I&C Systems (excluding reactor I&C)		1
32. Feedwater and Main Steam System		5
41. Main Generator Systems		2
42. Electrical Power Supply Systems		12
Total		**52**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the intermediate maintenance outage. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-22 KURSK-2 RUSSIA

Status at end of year	:	**Permanent Shutdown**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	LWGR / RBMK-1000
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	925 MWe

Key Dates

Construction Date	:	1973-01-01
Grid Date	:	1979-01-28
Commercial Date	:	1979-08-17
Age at end of year	:	45 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	10000
Active core diameter [m]	:	11.8
Active core height/length [m]	:	7
Number of fissile fuel assemblies/bundles	:	1693
Fuel linear heat generation rate [kW/m]	:	11.2
Number of control rod assemblies	:	150
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

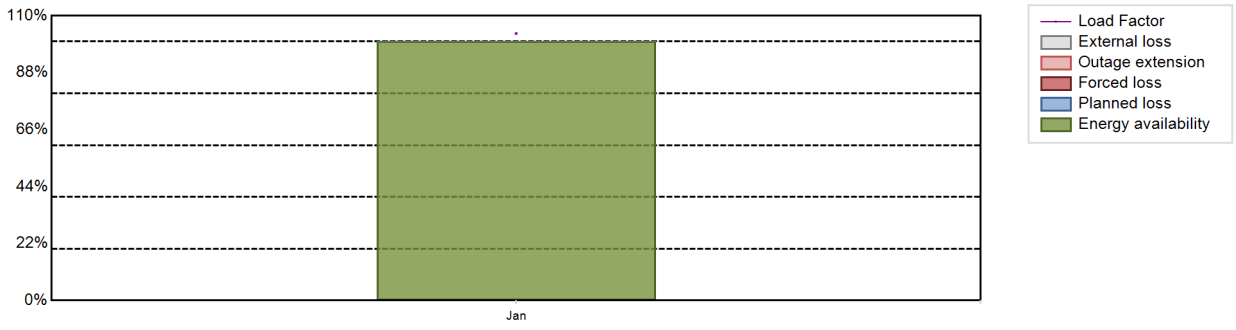
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	284
Number of SG	:	NA
Containment type	:	NA
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.59
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	709.6 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	103.11 %
Operating Factor (OF)	:	97.31 %
Equivalent non-electrical energy generated (NEG)	:	6.96 GW(e).h

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	20 hours

Annual Summary



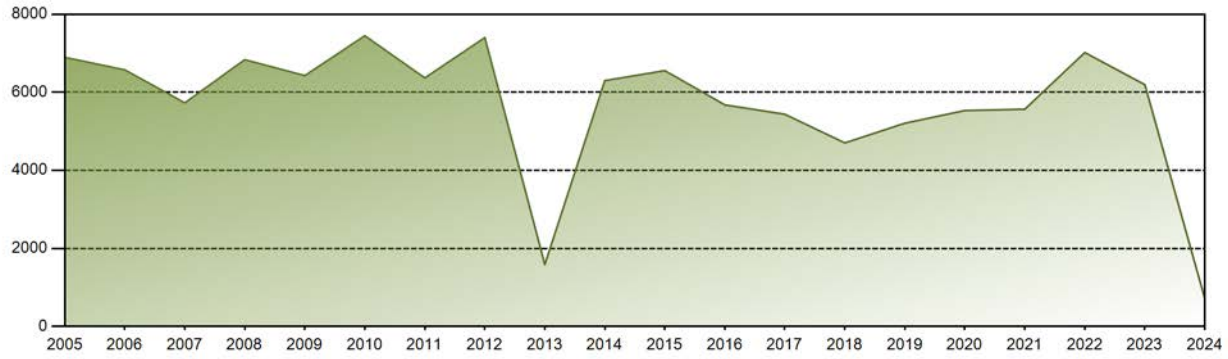
	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Jan	Annual
GW(e)-h												709.60	709.60
EAF [%]												100.00	100.00
UCF [%]												100.00	100.00
LF [%]												103.11	103.11
OF [%]												97.31	97.31
FLR [%]												0.00	0.00
UCL [%]												0.00	0.00
PUF [%]												0.00	0.00
XUF [%]												0.00	0.00

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Historical Summary

Lifetime energy generation	:	236847.18 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.81 %
Cumulative Energy Availability Factor (EAF)	:	64.88 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.32 %
Cumulative Unit Capability Factor (UCF)	:	66.71 %	Cumulative Planned Unavailability Factor (PUF)	:	28.97 %
Cumulative Load Factor (LF)	:	65.21 %	Cumulative Externally cause unavailability (XUF)	:	1.83 %
Cumulative Operating Factor (OF)	:	74.69 %			

Electricity Production (net) [GWh]

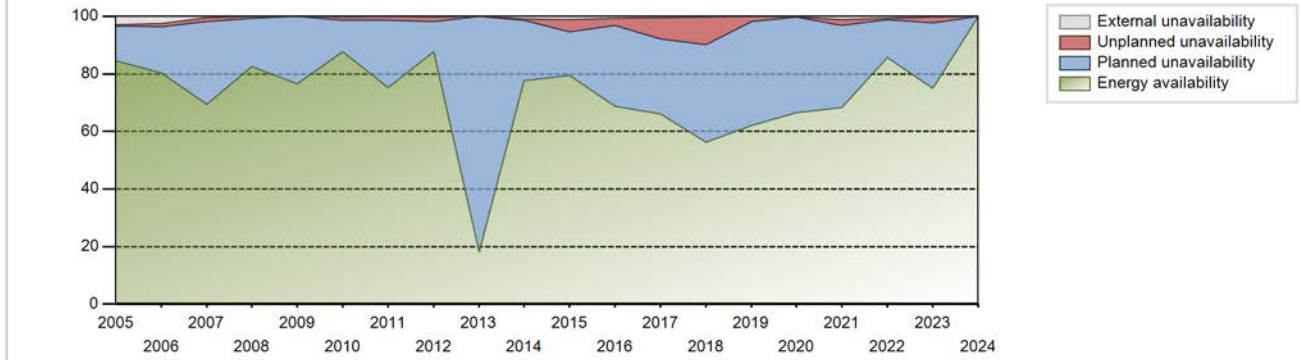


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1979	3613.90	6734	925	62.36	62.36	62.31	80.40	27.83	24.04	13.59	0.00
1980	6404.32	7658	925	78.45	79.02	78.82	87.18	10.04	8.82	12.15	0.58
1981	6385.88	7874	925	78.71	78.71	78.81	89.89	8.73	7.53	13.77	0.00
1982	5875.79	6443	925	71.11	71.11	72.51	73.55	6.25	4.74	24.14	0.00
1983	5707.64	7104	925	70.07	70.07	70.44	81.10	10.00	7.78	22.15	0.00
1984	6326.50	7219	925	77.06	77.10	77.86	82.18	5.31	4.33	18.57	0.05
1985	6459.94	7598	925	79.41	79.41	79.72	86.74	6.09	5.15	15.43	0.00
1986	5617.31	6575	925	69.08	69.08	69.32	75.06	15.66	12.82	18.10	0.00
1987	7196.69	7539	1000	83.29	83.29	82.15	86.06	3.73	3.23	13.48	0.00
1988	5725.66	6609	925	73.88	73.88	70.47	75.24	3.50	2.68	23.44	0.00
1989	6164.20	6797	925	74.90	74.91	76.07	77.59	14.58	12.79	12.30	0.02
1990	4789.70	6874	925	62.20	62.20	59.11	78.47	26.17	22.05	15.75	0.00
1991	4375.96	7361	925	55.26	56.28	54.00	84.03	0.70	0.40	43.32	1.02
1992	2158.37	3552	925	27.24	27.24	26.57	40.44	3.87	1.10	71.67	0.00
1993	4438.15	7432	925	57.09	85.00	54.77	84.84	2.25	1.95	13.04	27.91
1994	4212.17	7385	925	53.46	55.29	51.98	84.30	37.66	33.40	11.31	1.82
1995	4745.36	7708	925	59.79	90.79	58.56	87.99	0.91	0.83	8.38	31.00
1996	4196.12	7099	925	52.69	52.84	51.64	80.82	7.80	4.47	42.69	0.15
1997	4354.28	7076	925	54.94	55.26	53.74	80.78	7.36	4.39	40.36	0.32
1998	1685.05	2805	925	21.30	21.71	20.80	32.02	5.62	1.29	77.00	0.41
1999	3708.09	6066	925	46.84	48.03	45.76	69.25	4.72	2.38	49.59	1.19
2000	3668.06	6211	925	46.19	48.87	45.14	70.71	3.97	2.02	49.11	2.68
2001	4768.15	7667	925	60.09	61.11	58.84	87.52	0.33	0.20	38.69	1.02
2002	3027.77	4770	925	38.07	38.25	37.37	54.45	0.00	0.00	61.75	0.19
2003	3756.24	5834	925	46.36	47.10	46.36	66.60	0.00	0.00	52.90	0.74
2004	3692.07	4318	925	44.97	45.06	45.44	49.16	3.87	1.82	53.13	0.09
2005	6896.62	7782	925	84.68	87.51	85.10	88.83	0.58	0.51	11.98	2.83
2006	6574.42	7320	925	80.34	82.92	81.14	83.56	1.28	1.07	16.01	2.58
2007	5728.65	6207	925	69.48	69.99	70.70	70.86	1.70	1.21	28.80	0.51
2008	6835.74	7351	925	82.61	82.63	84.13	83.69	0.80	0.66	16.70	0.03
2009	6428.15	6778	925	76.64	76.67	79.33	77.37	0.00	0.00	23.33	0.03
2010	7448.67	8076	925	87.81	88.09	91.92	92.19	1.15	1.03	10.88	0.28
2011	6368.67	6539	925	75.31	75.39	78.61	74.65	1.56	1.20	23.41	0.09
2012	7401.98	7802	925	87.76	88.01	91.10	88.82	1.85	1.66	10.33	0.25
2013	1584.36	1606	925	18.25	18.25	19.55	18.33	0.44	0.08	81.67	0.00
2014	6299.77	7011	925	77.67	78.52	77.74	80.03	0.54	0.43	21.05	0.86
2015	6556.20	7160	925	79.38	80.44	80.91	81.74	2.96	4.25	15.31	1.06

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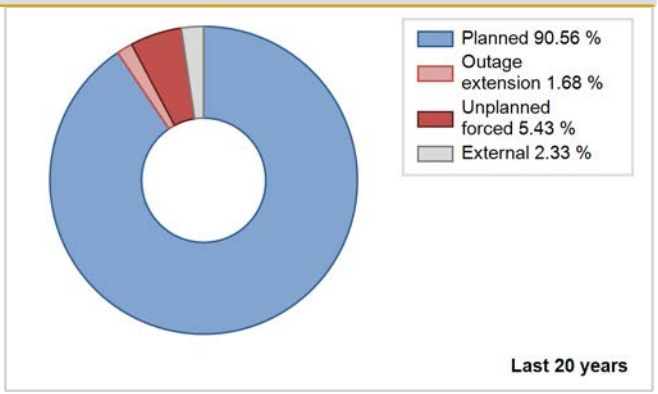
2016	5678.19	6425	925	68.85	69.57	69.88	73.14	3.29	2.37	28.06	0.72
2017	5437.61	6209	925	66.14	66.59	67.11	70.88	3.75	7.38	26.03	0.45
2018	4702.96	5689	925	56.25	56.48	58.04	64.94	11.38	9.58	33.94	0.22
2019	5207.62	5656	925	62.03	62.17	64.27	64.57	2.74	1.75	36.08	0.13
2020	5532.83	5945	925	66.59	66.89	68.09	67.68	0.00	0.00	33.10	0.30
2021	5567.70	6162	925	68.28	69.35	68.71	70.34	2.85	2.04	28.61	1.07
2022	7019.38	7651	925	85.77	86.45	86.63	87.34	0.65	0.56	12.99	0.68
2023	6196.09	6818	925	74.92	75.23	76.47	77.83	2.54	1.96	22.81	0.31
2024	709.60	724	925	100.00	100.00	103.11	97.31	0.00	0.00	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1979 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					107	
C. Inspection, maintenance or repair combined with refuelling				1394		
D. Inspection, maintenance or repair without refuelling				581		
E. Testing of plant systems or components				12		
F. Major backfitting, refurbishment or upgrading activities with refuelling				93		
H. Nuclear regulatory requirements					4	
J. Grid limitation, failure or grid unavailability						5
L. Human factor related					3	
Z. Other					27	
Subtotal				2080	141	5
Total		**0**			**2226**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1979 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		41
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		4
14. Safety Systems		2
15. Reactor Cooling Systems		16
16. Steam generation systems		3
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		6
32. Feedwater and Main Steam System		7
34. Miscellaneous Systems		13
41. Main Generator Systems		3
42. Electrical Power Supply Systems		2
Total		**106**

Highlights (2024)

Unit would have been permanently shut down 2024-01-31. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-38 KURSK-3 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	LWGR / RBMK-1000
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	925 MWe

Key Dates

Construction Date	:	1978-04-01
Grid Date	:	1983-10-17
Commercial Date	:	1984-03-30
Age at end of year	:	41 years

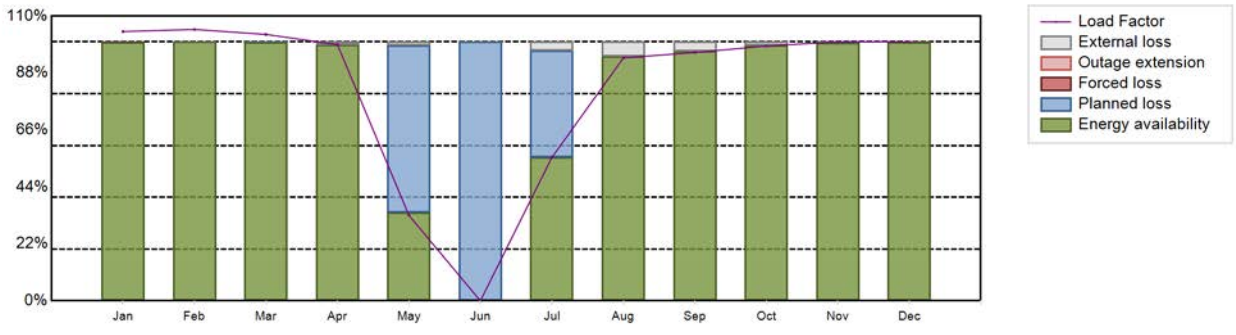
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	10000
Active core diameter [m]	:	11.8
Active core height/length [m]	:	7
Number of fissile fuel assemblies/bundles	:	1661
Fuel linear heat generation rate [kW/m]	:	16
Number of control rod assemblies	:	170
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	284
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.59
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	6682.36 GW(e).h
Energy Availability Factor (EAF)	:	81.42 %
Unit Capability Factor (UCF)	:	82.85 %
Load Factor (LF)	:	82.24 %
Operating Factor (OF)	:	85.26 %
Equivalent non-electrical energy generated (NEG)	:	47.62 GW(e).h
Forced Loss Rate (FLR)	:	0.01 %
Unplanned Capability Loss Factor (UCL)	:	0.01 %
Planned Unavailability Factor (PUF)	:	17.14 %
Externally cause unavailability (XUF)	:	1.43 %
Total off-line time	:	1295 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	715.75	674.81	708.16	658.96	227.19	0.00	381.19	645.75	638.74	677.23	666.34	688.25	6682.37
EAF [%]	99.94	100.00	99.94	98.77	34.20	0.00	55.39	94.35	96.31	98.68	99.70	99.92	81.42
UCF [%]	99.94	100.00	99.94	100.00	35.69	0.00	58.81	100.00	100.00	100.00	99.95	99.92	82.85
LF [%]	104.00	104.82	102.90	98.94	33.01	0.00	55.39	93.83	95.91	98.41	100.05	100.01	82.24
OF [%]	100.00	100.00	100.00	100.00	38.98	0.00	83.74	100.00	100.00	100.00	100.00	100.00	85.26
FLR [%]	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01
UCL [%]	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01
PUF [%]	0.00	0.00	0.06	0.00	64.31	100.00	41.19	0.00	0.00	0.00	0.05	0.00	17.14
XUF [%]	0.00	0.00	0.00	1.23	1.49	0.00	3.42	5.65	3.69	1.32	0.25	0.00	1.43

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Historical Summary

Lifetime energy generation	:	247558.53 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.59 %
Cumulative Energy Availability Factor (EAF)	:	74.17 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.17 %
Cumulative Unit Capability Factor (UCF)	:	75.42 %	Cumulative Planned Unavailability Factor (PUF)	:	21.42 %
Cumulative Load Factor (LF)	:	74.29 %	Cumulative Externally cause unavailability (XUF)	:	1.24 %
Cumulative Operating Factor (OF)	:	77.95 %			

Electricity Production (net) [GWh]

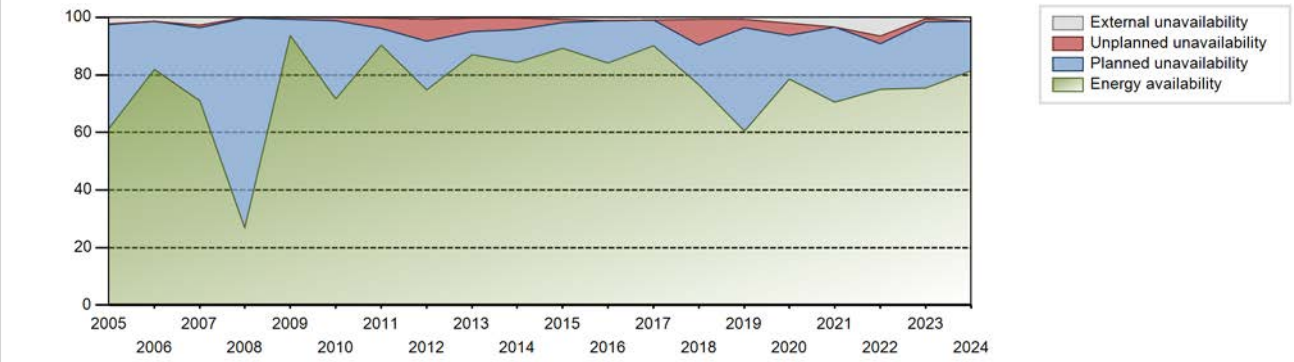


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	5479.24	6830	925	72.49	72.49	72.15	76.71	9.02	7.18	20.33	0.00
1985	6260.75	7250	925	77.59	77.93	77.26	82.76	7.60	6.41	15.66	0.34
1986	4810.84	6269	925	60.00	60.42	59.37	71.56	15.08	10.73	28.85	0.42
1987	5458.95	6185	1000	66.40	69.01	62.32	70.61	5.11	3.71	27.28	2.61
1988	6693.64	7471	925	83.64	83.64	82.38	85.05	3.44	2.98	13.38	0.00
1989	5900.50	7200	925	74.29	74.32	72.82	82.19	8.84	7.21	18.48	0.03
1990	6889.42	8096	925	86.52	86.52	85.02	92.42	7.78	7.30	6.18	0.00
1991	5138.96	5704	925	63.17	63.42	63.42	65.11	1.30	0.83	35.74	0.25
1992	6630.50	8126	925	82.13	82.13	81.61	92.52	5.97	5.22	12.66	0.00
1993	5562.30	6438	925	70.34	71.22	68.64	73.49	8.24	6.39	22.39	0.88
1994	5077.86	6495	925	66.69	73.60	62.67	74.14	0.74	0.55	25.84	6.92
1995	5318.13	5974	925	65.40	65.70	65.63	68.20	2.80	1.90	32.41	0.30
1996	6739.27	7383	925	82.67	82.89	82.94	84.05	2.36	2.00	15.11	0.22
1997	6548.72	7325	925	81.56	82.46	80.82	83.62	0.21	0.17	17.37	0.89
1998	4528.32	5405	925	56.53	60.26	55.88	61.70	17.21	12.53	27.20	3.74
1999	6006.85	6749	925	74.33	75.32	74.13	77.04	4.80	3.80	20.87	0.99
2000	6382.33	7415	925	78.26	78.85	78.55	84.41	7.98	6.83	14.32	0.59
2001	3535.20	3948	925	43.53	44.65	43.63	45.07	0.15	0.07	55.28	1.12
2002	6699.77	7788	925	85.07	88.23	82.68	88.90	0.29	0.26	11.51	3.16
2003	5100.59	5469	925	61.84	62.23	62.95	62.43	0.00	0.00	37.77	0.39
2004	6894.20	7660	925	84.35	86.33	84.85	87.20	0.82	0.71	12.96	1.98
2005	4987.10	5598	925	61.31	63.49	61.55	63.90	0.59	0.37	36.14	2.17
2006	6711.22	7353	925	81.93	83.37	82.82	83.94	0.00	0.00	16.63	1.44
2007	5765.28	6535	925	71.07	73.75	71.15	74.60	1.12	0.84	25.41	2.68
2008	2117.39	2374	925	26.82	26.82	26.06	27.03	1.30	0.35	72.83	0.00
2009	7620.95	8216	925	93.77	93.87	94.05	93.79	0.58	0.55	5.58	0.10
2010	6048.61	6352	925	71.67	71.78	74.65	72.51	1.44	1.05	27.17	0.11
2011	7574.35	8228	925	90.44	90.80	93.49	93.94	3.77	3.56	5.64	0.36
2012	6207.22	6900	925	74.78	75.44	76.39	78.55	5.35	7.58	16.98	0.66
2013	7264.06	8022	925	87.02	87.23	89.65	91.58	5.04	4.63	8.14	0.21
2014	6969.97	7506	925	84.29	84.49	86.01	85.68	0.85	4.03	11.48	0.21
2015	7338.33	8075	925	89.24	89.93	90.56	92.18	1.22	1.11	8.97	0.68
2016	7001.08	7556	925	84.05	85.12	86.17	86.02	0.00	0.00	14.88	1.07
2017	7405.52	8018	925	90.09	90.92	91.39	91.53	0.10	0.09	9.00	0.83
2018	6346.60	7060	925	76.64	77.41	78.32	80.59	4.10	8.89	13.70	0.77
2019	4990.43	5623	925	60.49	61.19	61.59	64.19	2.25	2.92	35.90	0.70
2020	6473.17	7464	925	78.62	80.58	79.67	84.97	4.13	4.32	15.11	1.96

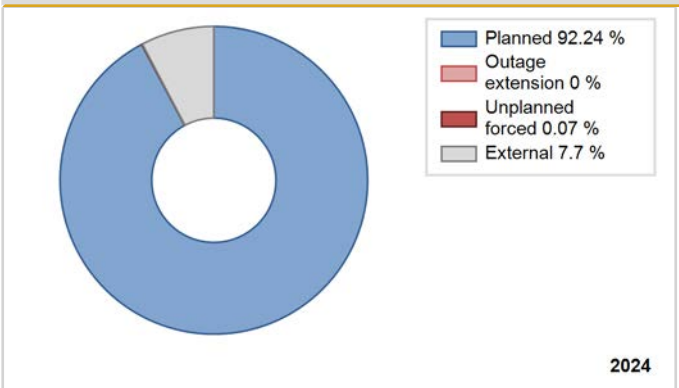
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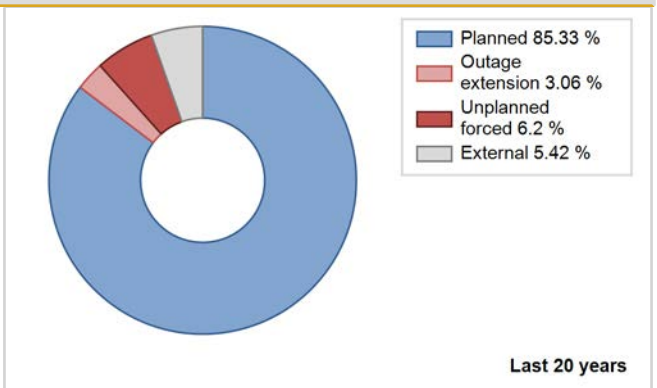
2021	5674.03	6517	925	70.44	73.85	70.02	74.39	0.03	0.02	26.12	3.41
2022	6036.60	7369	925	74.89	81.43	74.50	84.12	3.05	2.57	16.01	6.53
2023	6186.94	6813	925	75.52	75.96	76.35	77.77	1.48	1.14	22.90	0.44
2024	6682.36	7489	925	81.42	82.85	82.24	85.26	0.01	0.01	17.14	1.43

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					129	
C. Inspection, maintenance or repair combined with refuelling	1295			1169		
D. Inspection, maintenance or repair without refuelling				627		
E. Testing of plant systems or components				1		
J. Grid limitation, failure or grid unavailability						7
L. Human factor related					1	
Subtotal	1295			1797	130	7
Total	**1295**			**1934**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		21
12. Reactor I&C Systems		15
13. Reactor Auxiliary Systems		3
14. Safety Systems		10
15. Reactor Cooling Systems		47
16. Steam generation systems		2
17. Safety I&C Systems (excluding reactor I&C)		2
21. Fuel Handling and Storage Facilities		4
31. Turbine and auxiliaries		4
32. Feedwater and Main Steam System		9
41. Main Generator Systems		9
42. Electrical Power Supply Systems		4
Total		**130**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the overhaul outages. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-39 KURSK-4 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	LWGR / RBMK-1000
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	925 MWe

Key Dates

Construction Date	:	1981-05-01
Grid Date	:	1985-12-02
Commercial Date	:	1986-02-05
Age at end of year	:	39 years

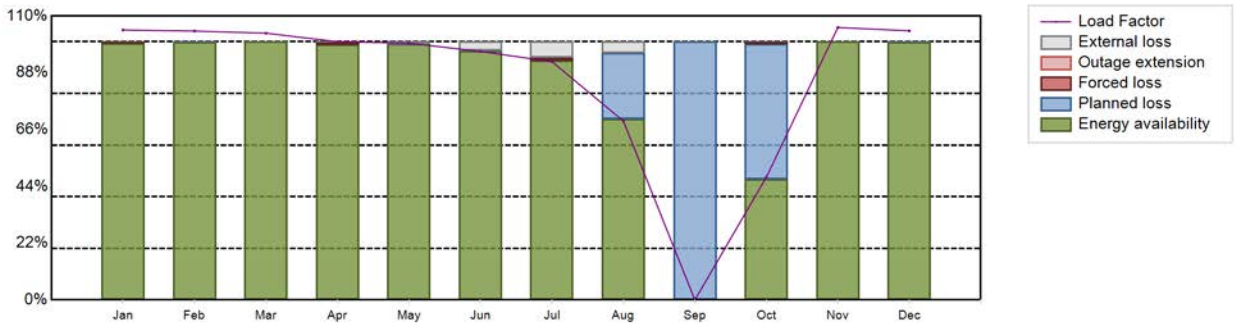
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	10000
Active core diameter [m]	:	11.8
Active core height/length [m]	:	7
Number of fissile fuel assemblies/bundles	:	1661
Fuel linear heat generation rate [kW/m]	:	16
Number of control rod assemblies	:	167
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	284
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.59
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	6952.74 GW(e).h
Energy Availability Factor (EAF)	:	83.61 %
Unit Capability Factor (UCF)	:	84.85 %
Load Factor (LF)	:	85.57 %
Operating Factor (OF)	:	85.84 %
Equivalent non-electrical energy generated (NEG)	:	78.54 GW(e).h
Forced Loss Rate (FLR)	:	0.38 %
Unplanned Capability Loss Factor (UCL)	:	0.32 %
Planned Unavailability Factor (PUF)	:	14.83 %
Externally cause unavailability (XUF)	:	1.24 %
Total off-line time	:	1244 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	719.66	670.54	711.08	666.19	684.56	641.03	635.20	476.92	0.00	327.31	702.74	717.51	6952.74
EAF [%]	99.25	99.95	100.00	98.83	99.12	96.50	92.68	70.10	0.00	46.74	100.00	99.94	83.61
UCF [%]	99.25	99.95	100.00	98.85	99.93	99.85	98.88	74.43	0.00	46.74	100.00	99.94	84.85
LF [%]	104.57	104.15	103.33	100.03	99.47	96.25	92.30	69.30	0.00	47.56	105.52	104.26	85.57
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	77.55	0.00	52.02	100.00	100.00	85.84
FLR [%]	0.75	0.00	0.00	1.15	0.00	0.00	1.12	0.00	0.00	1.68	0.00	0.00	0.38
UCL [%]	0.75	0.00	0.00	1.15	0.00	0.00	1.12	0.00	0.00	0.80	0.00	0.00	0.32
PUF [%]	0.00	0.05	0.00	0.00	0.07	0.15	0.00	25.57	100.00	52.46	0.00	0.06	14.83
XUF [%]	0.00	0.00	0.00	0.02	0.82	3.35	6.20	4.32	0.00	0.00	0.00	0.00	1.24

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Historical Summary

Lifetime energy generation	:	247871.5 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.4 %
Cumulative Energy Availability Factor (EAF)	:	77.5 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2 %
Cumulative Unit Capability Factor (UCF)	:	78.51 %	Cumulative Planned Unavailability Factor (PUF)	:	19.49 %
Cumulative Load Factor (LF)	:	78.35 %	Cumulative Externally cause unavailability (XUF)	:	1.01 %
Cumulative Operating Factor (OF)	:	80.67 %			

Electricity Production (net) [GWh]

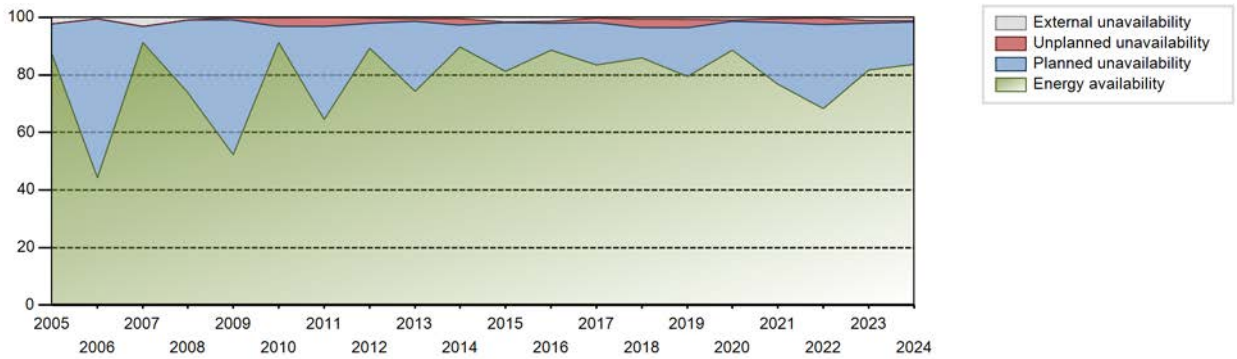


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	6328.54	7574	925	80.35	80.81	80.28	88.06	12.66	11.71	7.47	0.46
1987	6167.68	6704	1000	72.29	72.43	70.41	76.53	6.80	5.28	22.29	0.14
1988	6653.03	7390	925	81.73	81.73	81.88	84.13	5.02	4.32	13.95	0.01
1989	6131.81	6954	925	75.98	76.02	75.67	79.38	4.04	3.20	20.78	0.05
1990	6050.02	6922	925	73.62	73.71	74.66	79.02	7.62	6.08	20.21	0.09
1991	7356.07	8469	925	90.30	92.54	90.78	96.68	4.21	4.06	3.40	2.24
1992	6117.37	7324	925	75.44	75.44	75.30	83.39	2.41	1.87	22.69	0.00
1993	5638.27	6439	925	70.98	71.72	69.58	73.50	4.54	3.41	24.87	0.74
1994	5369.44	6255	925	66.98	71.55	66.26	71.40	1.27	0.92	27.53	4.57
1995	6207.48	7001	925	77.02	78.61	76.61	79.92	3.36	2.74	18.66	1.58
1996	6590.19	7373	925	80.16	81.40	81.11	83.94	3.23	2.71	15.89	1.23
1997	5971.68	6664	925	73.05	73.87	73.70	76.07	2.70	2.05	24.08	0.82
1998	6641.43	7751	925	82.33	86.66	81.96	88.48	1.46	1.29	12.05	4.34
1999	5895.38	6595	925	72.77	74.17	72.76	75.29	1.02	0.77	25.06	1.40
2000	6778.77	7423	925	82.81	83.47	83.43	84.51	0.59	0.50	16.03	0.66
2001	6671.63	7281	925	81.52	82.20	82.34	83.12	0.81	0.67	17.13	0.68
2002	5530.98	6094	925	67.61	68.31	68.26	69.57	1.54	1.07	30.62	0.71
2003	6233.39	6802	925	75.84	77.26	76.93	77.65	0.27	0.21	22.54	1.42
2004	5422.93	6005	925	66.70	68.02	66.74	68.36	0.27	0.18	31.80	1.32
2005	7081.14	7858	925	87.15	89.43	87.38	89.69	0.00	0.00	10.57	2.28
2006	3636.44	4115	925	44.24	44.77	44.88	46.97	0.00	0.00	55.23	0.53
2007	7426.50	8298	925	91.23	94.27	91.65	94.73	0.19	0.18	5.54	3.04
2008	6052.40	6580	925	73.94	74.87	74.49	74.91	0.00	0.00	25.13	0.93
2009	4184.28	4786	925	52.34	52.46	51.64	54.63	1.38	0.73	46.81	0.12
2010	7557.08	8109	925	91.31	91.65	93.26	92.57	2.88	2.72	5.62	0.35
2011	5500.69	5729	925	64.46	64.51	67.89	65.41	4.61	3.12	32.37	0.05
2012	7470.41	8144	925	89.18	89.36	91.94	92.71	2.11	1.93	8.72	0.18
2013	6213.89	6807	925	74.33	74.78	76.69	77.71	1.12	0.85	24.37	0.46
2014	7517.80	8201	925	89.67	90.11	92.78	93.62	2.44	2.26	7.64	0.44
2015	6745.34	7348	925	81.17	82.83	83.24	83.88	0.07	0.06	17.11	1.67
2016	7420.59	8055	925	88.67	90.08	91.33	91.70	0.76	0.69	9.23	1.40
2017	6940.86	7471	925	83.55	83.71	85.66	85.29	2.08	1.78	14.52	0.15
2018	7117.30	7645	925	85.95	86.70	87.84	87.27	3.14	2.81	10.49	0.75
2019	6538.38	7095	925	79.38	80.03	80.69	80.99	2.71	2.99	16.98	0.65
2020	7277.83	7991	925	88.64	89.46	89.57	90.97	0.62	0.56	9.98	0.81
2021	6292.87	6865	925	76.86	77.33	77.66	78.37	1.79	1.41	21.26	0.47
2022	5672.23	6628	925	68.23	68.49	70.00	75.66	0.11	2.17	29.34	0.26

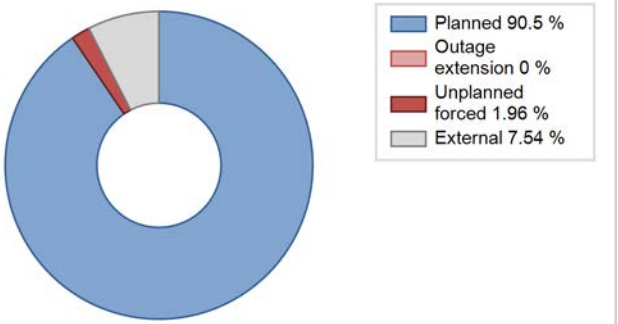
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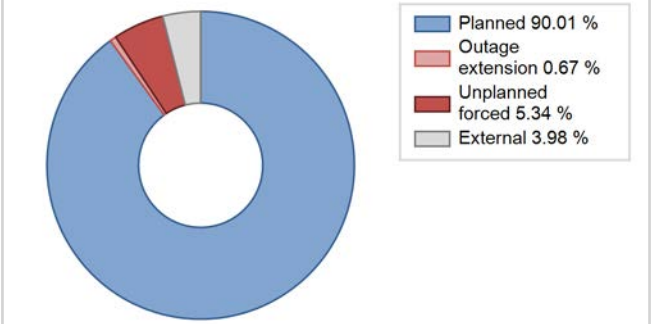
2023	6760.71	7417	925	81.64	82.74	83.43	84.67	1.14	0.95	16.30	1.10
2024	6952.74	7540	925	83.61	84.85	85.57	85.84	0.38	0.32	14.83	1.24

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					67	
C. Inspection, maintenance or repair combined with refuelling	1245			1184		
D. Inspection, maintenance or repair without refuelling				362		
F. Major backfitting, refurbishment or upgrading activities with refuelling				70		
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					5	
Z. Other					5	
Subtotal	1245			1616	77	1
Total	**1245**			**1694**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1986 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		8
12. Reactor I&C Systems		13
15. Reactor Cooling Systems		12
16. Steam generation systems		0
31. Turbine and auxiliaries		3
32. Feedwater and Main Steam System		7
33. Circulating Water System		3
42. Electrical Power Supply Systems		21
Total		**67**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. In the reporting period, the unit underwent routine maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-163 LENINGRAD 2-1 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	AEM (Atomenergomash)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-491
Thermal power	:	3200 MWth
Gross electrical power	:	1188 MWe
Reference unit power (net)	:	1101 MWe

Key Dates

Construction Date	:	2008-10-25
Grid Date	:	2018-03-09
Commercial Date	:	2018-10-29
Age at end of year	:	6 years

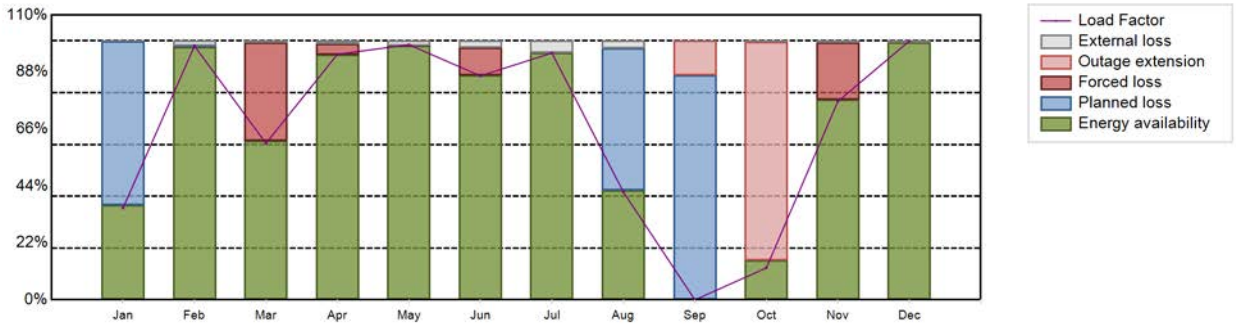
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6430.66 GW(e).h	Forced Loss Rate (FLR)	:	8.33 %
Energy Availability Factor (EAF)	:	66.92 %	Unplanned Capability Loss Factor (UCL)	:	14.47 %
Unit Capability Factor (UCF)	:	68.39 %	Planned Unavailability Factor (PUF)	:	17.14 %
Load Factor (LF)	:	66.49 %	Externally cause unavailability (XUF)	:	1.47 %
Operating Factor (OF)	:	69.08 %	Total off-line time	:	2716 hours

Annual Summary



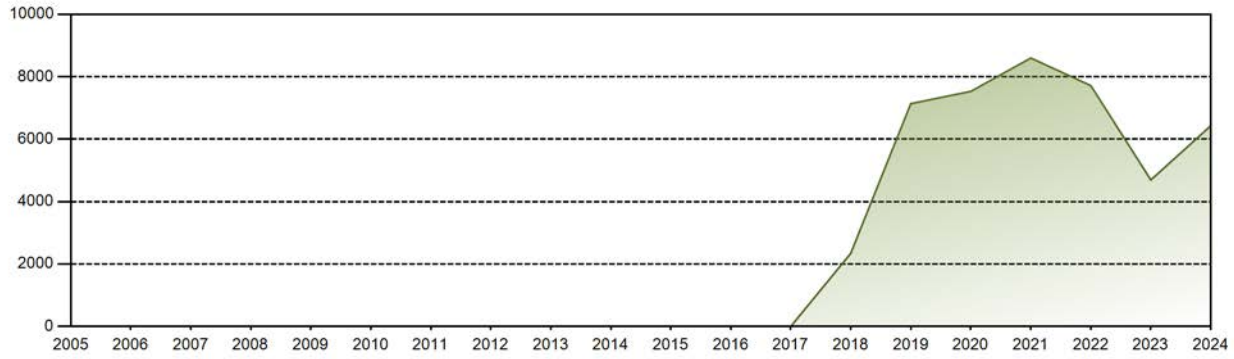
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	290.16	751.35	495.17	752.01	807.03	685.73	780.84	341.08	0.00	101.04	607.49	818.76	6430.66
EAF [%]	36.66	97.58	61.41	94.59	98.12	86.79	95.29	42.25	0.01	15.19	77.35	99.46	66.92
UCF [%]	36.77	99.47	62.15	95.80	99.99	89.46	100.00	45.18	0.01	15.47	78.02	100.00	68.39
LF [%]	35.42	98.05	60.45	94.86	98.52	86.50	95.32	41.64	0.00	12.33	76.63	99.95	66.49
OF [%]	39.25	100.00	62.10	96.39	100.00	91.39	100.00	45.30	0.00	17.07	79.17	100.00	69.08
FLR [%]	0.00	0.00	37.85	4.20	0.01	10.54	0.00	0.00	0.00	0.00	21.98	0.00	8.33
UCL [%]	0.00	0.00	37.85	4.20	0.01	10.54	0.00	0.00	13.33	84.53	21.98	0.00	14.47
PUF [%]	63.23	0.53	0.00	0.00	0.00	0.00	0.00	54.82	86.66	0.00	0.00	0.00	17.14
XUF [%]	0.11	1.89	0.74	1.21	1.87	2.67	4.71	2.93	0.00	0.28	0.67	0.54	1.47

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Historical Summary

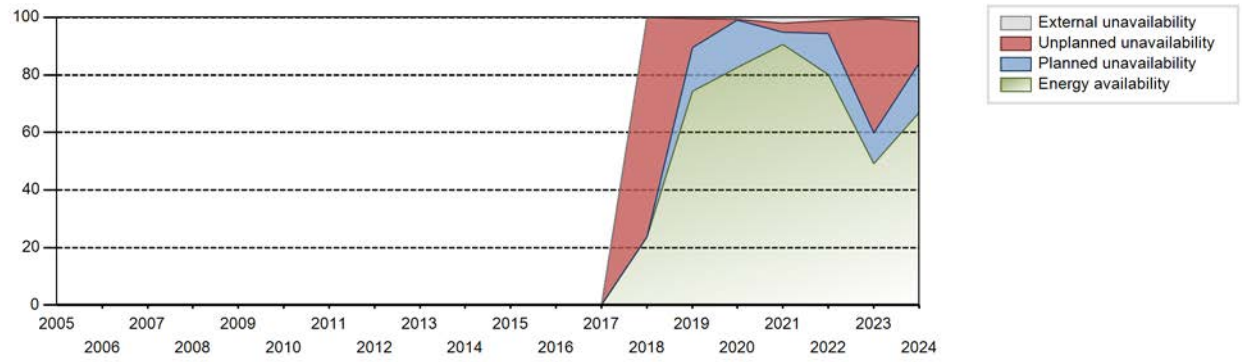
Lifetime energy generation	:	44447.38 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	13.86 %
Cumulative Energy Availability Factor (EAF)	:	72.63 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	13.67 %
Cumulative Unit Capability Factor (UCF)	:	73.72 %	Cumulative Planned Unavailability Factor (PUF)	:	12.62 %
Cumulative Load Factor (LF)	:	71.29 %	Cumulative Externally cause unavailability (XUF)	:	1.08 %
Cumulative Operating Factor (OF)	:	74.16 %			

Electricity Production (net) [GWh]

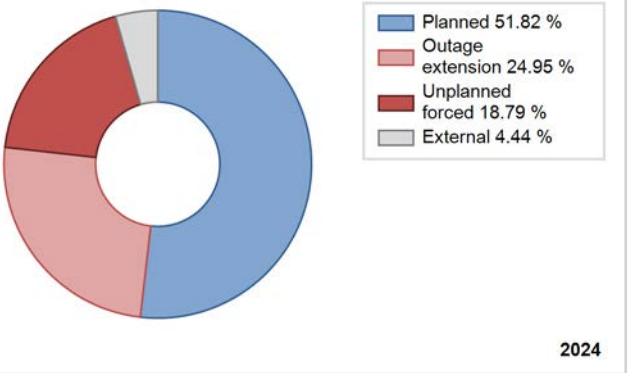


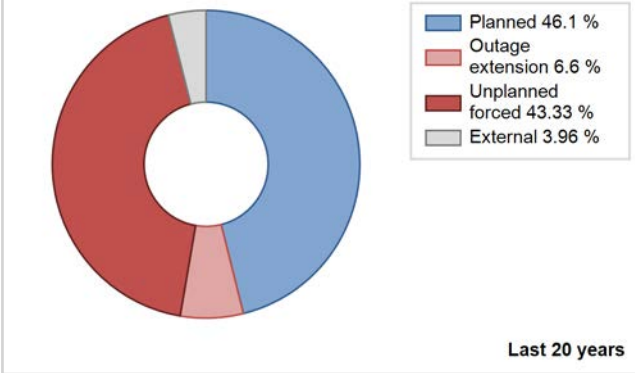
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2018	2344.91	3078	1085	23.75	23.75	20.26	25.14	76.25	76.25	0.00	0.00
2019	7137.13	6666	1101	74.35	74.93	74.00	76.10	8.67	9.99	15.09	0.57
2020	7530.82	7037	1101	82.64	83.44	77.87	80.11	0.18	0.15	16.41	0.80
2021	8598.45	8324	1101	90.52	92.65	89.15	95.02	3.11	2.98	4.38	2.12
2022	7714.52	7241	1101	80.22	81.40	79.99	82.66	5.16	4.42	14.17	1.18
2023	4690.90	4397	1101	49.18	49.71	48.64	50.19	44.41	39.72	10.57	0.53
2024	6430.66	6068	1101	66.92	68.39	66.49	69.08	8.33	14.47	17.14	1.47

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2018 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		553			1097	
C. Inspection, maintenance or repair combined with refuelling	1484			1035		
D. Inspection, maintenance or repair without refuelling				39		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						52
Z. Other		726			118	
Subtotal	1484	1279		1074	1215	52
Total		**2763**			**2341**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2018 to 2024 Average hours lost per reactor-year
16. Steam generation systems		62
31. Turbine and auxiliaries	50	343
32. Feedwater and Main Steam System	111	98
33. Circulating Water System		4
35. All other I&C Systems	307	45
41. Main Generator Systems	85	437
42. Electrical Power Supply Systems		1
Total	**553**	**990**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the routine maintenance and in the overhaul. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-164 LENINGRAD 2-2 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	AEM (Atomenergomash)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-491
Thermal power	:	3200 MWth
Gross electrical power	:	1188 MWe
Reference unit power (net)	:	1101 MWe

Key Dates

Construction Date	:	2010-04-15
Grid Date	:	2020-10-22
Commercial Date	:	2021-03-18
Age at end of year	:	4 years

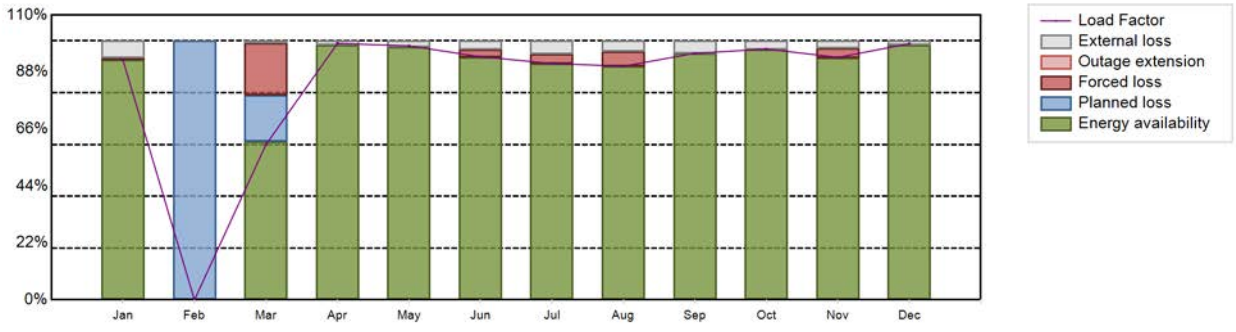
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8169.97 GW(e).h	Forced Loss Rate (FLR)	:	3.46 %
Energy Availability Factor (EAF)	:	84.37 %	Unplanned Capability Loss Factor (UCL)	:	3.13 %
Unit Capability Factor (UCF)	:	87.45 %	Planned Unavailability Factor (PUF)	:	9.42 %
Load Factor (LF)	:	84.48 %	Externally cause unavailability (XUF)	:	3.08 %
Operating Factor (OF)	:	88.65 %	Total off-line time	:	997 hours

Annual Summary



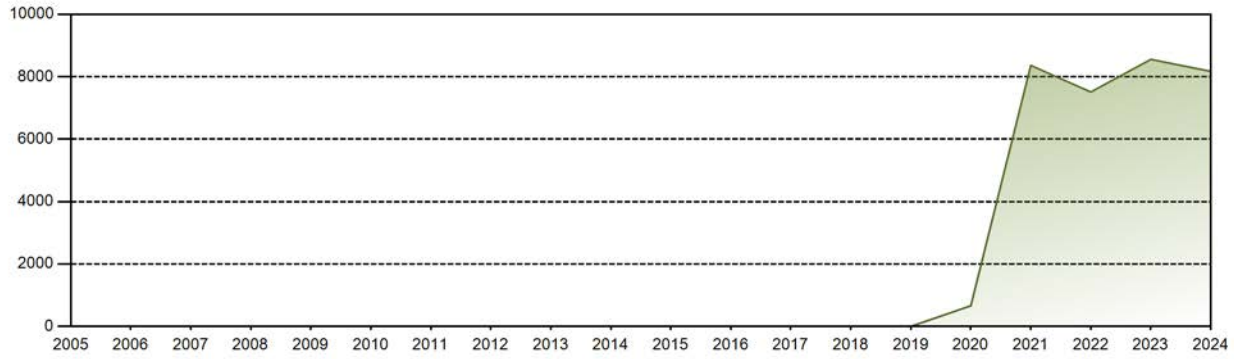
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	758.27	0.00	491.23	784.90	803.50	744.37	747.70	739.20	754.74	793.49	742.37	810.21	8169.97
EAF [%]	92.55	0.00	61.27	98.35	97.53	93.68	91.24	90.22	95.24	96.55	93.36	98.35	84.37
UCF [%]	99.02	0.00	62.25	100.00	100.00	96.97	96.26	94.40	100.00	100.00	96.23	100.00	87.45
LF [%]	92.57	0.00	59.97	99.01	98.09	93.90	91.28	90.24	95.21	96.87	93.65	98.91	84.48
OF [%]	100.00	0.14	63.98	100.00	100.00	100.00	100.00	95.43	100.00	100.00	100.00	100.00	88.65
FLR [%]	0.98	0.00	24.42	0.00	0.00	3.03	3.74	5.60	0.00	0.00	3.77	0.00	3.46
UCL [%]	0.98	0.00	20.12	0.00	0.00	3.03	3.74	5.60	0.00	0.00	3.77	0.00	3.13
PUF [%]	0.00	100.00	17.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.42
XUF [%]	6.47	0.00	0.98	1.65	2.47	3.28	5.02	4.18	4.76	3.45	2.87	1.65	3.08

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Historical Summary

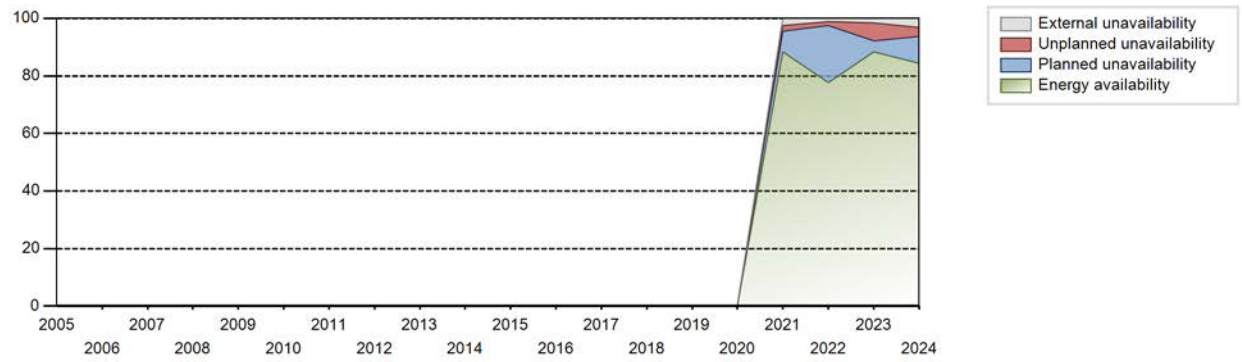
Lifetime energy generation	:	33257.24 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.51 %
Cumulative Energy Availability Factor (EAF)	:	84.43 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.24 %
Cumulative Unit Capability Factor (UCF)	:	86.46 %	Cumulative Planned Unavailability Factor (PUF)	:	10.3 %
Cumulative Load Factor (LF)	:	84.73 %	Cumulative Externally cause unavailability (XUF)	:	2.03 %
Cumulative Operating Factor (OF)	:	87.1 %			

Electricity Production (net) [GWh]

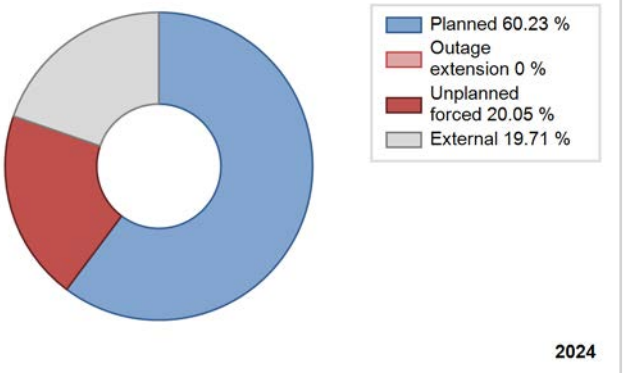


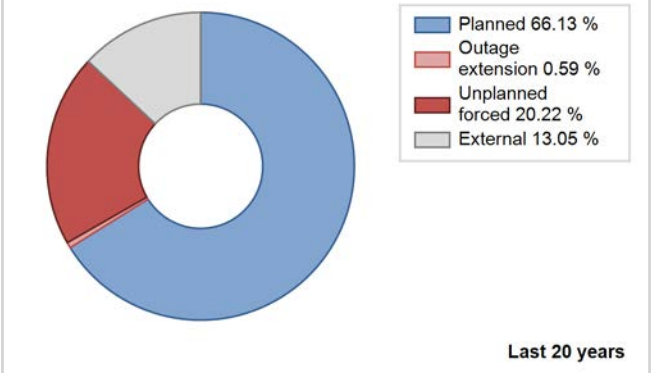
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2021	8361.90	7935	1101	88.43	90.96	88.87	91.67	2.03	1.88	7.16	2.53
2022	7510.31	6919	1101	77.62	78.66	77.87	78.98	1.74	1.39	19.95	1.04
2023	8555.51	7905	1101	88.29	89.89	88.71	90.24	6.13	6.22	3.89	1.59
2024	8169.97	7787	1101	84.37	87.45	84.48	88.65	3.46	3.13	9.42	3.08

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2021 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		178			243	
C. Inspection, maintenance or repair combined with refuelling	819			817		
D. Inspection, maintenance or repair without refuelling				77		
Z. Other					8	
Subtotal	819	178		894	251	
Total		**997**			**1145**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2021 to 2024
	Hours Lost	Average hours lost per reactor-year
13. Reactor Auxiliary Systems		32
15. Reactor Cooling Systems		30
16. Steam generation systems	144	45
31. Turbine and auxiliaries		20
41. Main Generator Systems		91
42. Electrical Power Supply Systems	34	10
Total	**178**	**228**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in intermediate repair. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-34 LENINGRAD-3 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	LWGR / RBMK-1000
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	925 MWe

Key Dates

Construction Date	:	1973-12-01
Grid Date	:	1979-12-07
Commercial Date	:	1980-06-29
Age at end of year	:	45 years

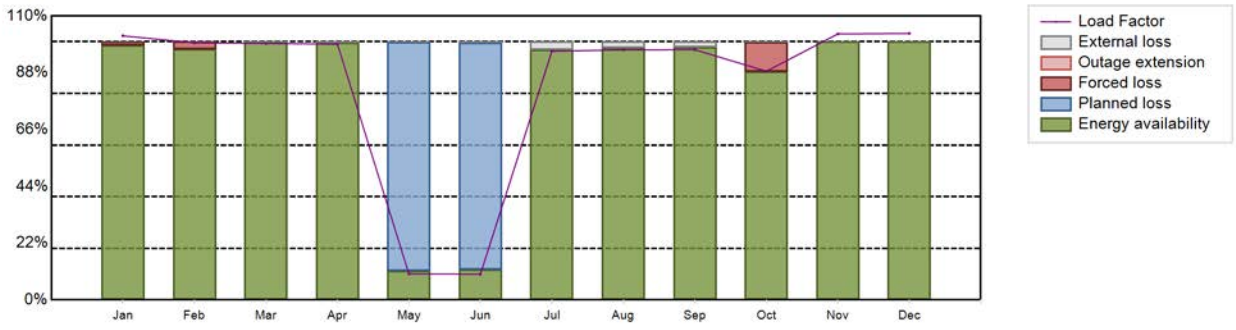
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	22000
Active core diameter [m]	:	11.8
Active core height/length [m]	:	7
Number of fissile fuel assemblies/bundles	:	1661
Fuel linear heat generation rate [kW/m]	:	14.5
Number of control rod assemblies	:	211
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	284
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.59
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	6805.97 GW(e).h
Energy Availability Factor (EAF)	:	83.25 %
Unit Capability Factor (UCF)	:	83.98 %
Load Factor (LF)	:	83.76 %
Operating Factor (OF)	:	85.45 %
Equivalent non-electrical energy generated (NEG)	:	64.46 GW(e).h
Forced Loss Rate (FLR)	:	1.55 %
Unplanned Capability Loss Factor (UCL)	:	1.32 %
Planned Unavailability Factor (PUF)	:	14.7 %
Externally cause unavailability (XUF)	:	0.73 %
Total off-line time	:	1278 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	703.95	641.17	683.77	659.74	69.24	66.77	663.18	666.50	645.48	609.66	686.16	710.34	6805.97
EAF [%]	98.70	97.07	99.79	99.69	11.32	11.77	96.95	97.52	97.84	88.42	100.00	100.00	83.25
UCF [%]	98.70	97.07	100.00	100.00	11.39	12.20	100.00	100.00	100.00	88.44	100.00	100.00	83.98
LF [%]	102.29	99.59	99.36	99.06	10.06	10.03	96.36	96.85	96.92	88.59	103.03	103.22	83.76
OF [%]	100.00	100.00	100.00	100.00	18.28	14.17	100.00	100.00	100.00	93.01	100.00	100.00	85.45
FLR [%]	1.30	2.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.56	0.00	0.00	1.55
UCL [%]	1.30	2.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.56	0.00	0.00	1.32
PUF [%]	0.00	0.00	0.00	0.00	88.61	87.80	0.00	0.00	0.00	0.00	0.00	0.00	14.70
XUF [%]	0.00	0.00	0.21	0.31	0.07	0.43	3.05	2.48	2.16	0.01	0.00	0.00	0.73

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Historical Summary

Lifetime energy generation	:	266569.92 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.56 %
Cumulative Energy Availability Factor (EAF)	:	73.99 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.73 %
Cumulative Unit Capability Factor (UCF)	:	74.81 %	Cumulative Planned Unavailability Factor (PUF)	:	22.46 %
Cumulative Load Factor (LF)	:	73.07 %	Cumulative Externally cause unavailability (XUF)	:	0.82 %
Cumulative Operating Factor (OF)	:	76.71 %			

Electricity Production (net) [GWh]

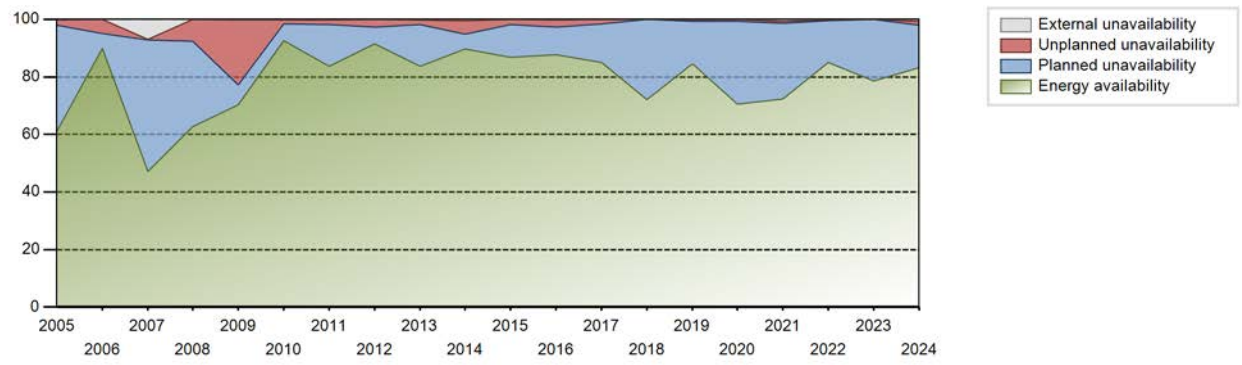


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	5345.39	7504	925	81.59	81.61	80.55	90.94	10.86	9.95	8.45	0.02
1981	6553.56	7528	925	81.35	81.66	80.88	85.94	9.31	8.38	9.96	0.32
1982	6413.26	7448	925	80.27	80.80	79.15	85.02	7.18	6.25	12.95	0.53
1983	5708.44	6809	925	70.90	71.30	70.45	77.73	7.88	6.10	22.61	0.39
1984	7214.95	8060	925	89.22	89.76	88.80	91.76	1.88	1.72	8.52	0.55
1985	6831.90	7835	925	84.94	85.42	84.31	89.44	5.45	4.92	9.67	0.47
1986	6890.93	7935	925	85.89	86.44	85.04	90.58	3.36	3.01	10.55	0.55
1987	6010.31	6362	1000	69.36	70.37	68.61	72.63	1.12	0.79	28.83	1.01
1988	6951.74	7885	925	86.53	86.53	85.56	89.77	1.44	1.26	12.21	0.00
1989	6938.14	7455	925	85.86	86.23	85.62	85.10	0.97	0.84	12.93	0.37
1990	7531.93	8280	925	92.35	92.96	92.95	94.52	1.36	1.28	5.76	0.61
1991	6506.60	7197	925	80.59	80.59	80.30	82.16	1.25	1.02	18.39	0.00
1992	5516.63	6122	925	68.39	68.49	67.90	69.70	2.92	2.06	29.45	0.09
1993	7143.82	7966	925	88.90	90.14	88.16	90.94	0.56	0.51	9.35	1.24
1994	6631.82	8135	925	91.04	92.42	81.84	92.87	0.26	0.24	7.34	1.39
1995	3585.96	4332	925	46.53	49.40	44.25	49.45	0.44	0.22	50.38	2.87
1996	0.00	0	925	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1997	0.00	0	925	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1998	1386.50	1610	925	17.41	17.49	17.11	18.38	4.00	0.73	81.78	0.08
1999	7853.14	8701	925	97.08	99.66	96.92	99.33	0.34	0.34	0.00	2.58
2000	6352.80	7169	925	78.25	79.64	78.19	81.61	1.83	1.49	18.87	1.39
2001	6173.49	7007	925	76.58	78.92	76.19	79.99	0.19	0.15	20.93	2.34
2002	2514.75	3332	925	31.88	33.60	31.03	38.04	17.29	7.02	59.38	1.72
2003	6729.17	8100	925	84.54	86.65	83.05	92.47	6.00	5.53	7.82	2.11
2004	6909.08	8426	925	86.47	90.86	85.03	95.92	5.04	4.82	4.31	4.40
2005	4447.28	5397	925	61.10	61.46	54.88	61.60	2.72	1.72	36.83	0.36
2006	7332.11	8274	925	89.86	89.86	90.49	94.45	2.22	4.89	5.25	0.00
2007	3755.96	4820	925	47.04	54.08	46.35	55.02	0.24	0.13	45.78	7.04
2008	5013.64	5632	925	62.68	62.71	61.70	64.12	1.64	7.69	29.60	0.03
2009	5336.12	6209	925	70.38	70.65	65.85	70.88	3.40	22.58	6.78	0.26
2010	7303.22	8261	925	92.58	92.88	90.13	94.30	1.27	1.19	5.93	0.29
2011	6803.29	7548	925	83.65	83.81	83.97	86.17	0.47	1.73	14.46	0.15
2012	7401.44	8115	925	91.56	91.65	91.09	92.38	2.66	2.51	5.84	0.10
2013	6892.27	7446	925	83.65	83.95	85.06	85.00	1.79	1.55	14.50	0.30
2014	7199.40	8229	925	89.69	90.10	88.84	93.93	1.79	4.75	5.15	0.41
2015	6817.12	7628	925	86.76	86.85	84.13	87.08	2.01	1.78	11.37	0.09
2016	7024.91	7879	925	87.77	87.94	86.46	89.70	2.71	2.45	9.62	0.16

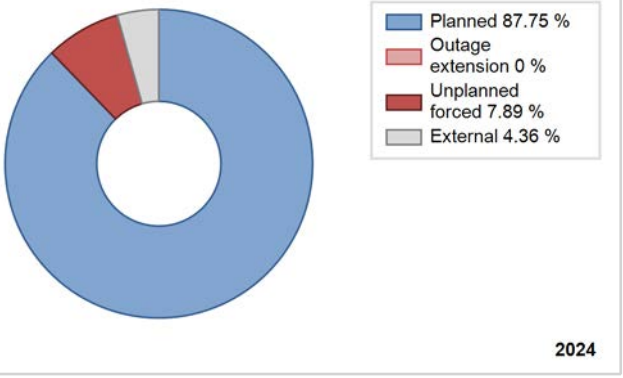
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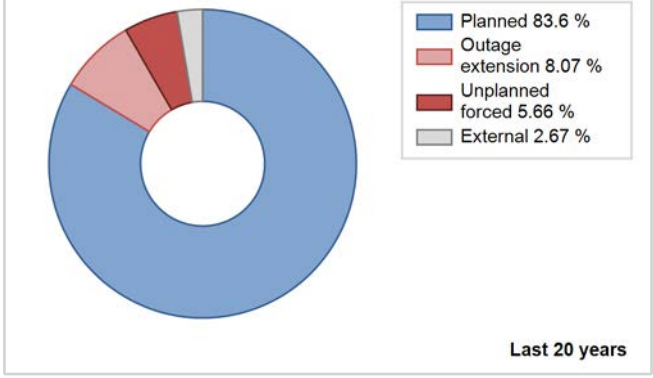
2017	6786.43	7460	925	84.94	84.96	83.75	85.16	1.87	1.62	13.42	0.03
2018	5801.48	6257	925	72.16	72.21	71.60	71.43	0.02	0.02	27.77	0.05
2019	6890.81	7642	925	84.69	84.85	85.04	87.24	0.65	0.56	14.59	0.16
2020	5765.23	6269	925	70.51	70.53	70.95	71.37	1.02	0.72	28.75	0.01
2021	5763.58	6496	925	72.24	72.94	71.13	74.16	0.80	0.59	26.47	0.70
2022	6944.66	7526	925	84.93	85.20	85.70	85.91	0.14	0.12	14.68	0.26
2023	6419.76	6976	925	78.53	78.64	79.23	79.63	0.04	0.03	21.33	0.11
2024	6805.97	7506	925	83.25	83.98	83.76	85.45	1.55	1.32	14.70	0.73

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1980 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		56			96	
C.	Inspection, maintenance or repair combined with refuelling	1226			857		
D.	Inspection, maintenance or repair without refuelling				858		
E.	Testing of plant systems or components				1	15	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				118		
G.	Major backfitting, refurbishment or upgrading activities without refuelling				72		
J.	Grid limitation, failure or grid unavailability						3
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						12
L.	Human factor related					3	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z.	Other					1	
Subtotal		1226	56		1906	115	16
Total		**1282**			**2037**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		9
12. Reactor I&C Systems		3
14. Safety Systems		1
15. Reactor Cooling Systems		6
16. Steam generation systems		2
17. Safety I&C Systems (excluding reactor I&C)		6
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		49
32. Feedwater and Main Steam System		5
33. Circulating Water System		1
35. All other I&C Systems		15
41. Main Generator Systems		2
42. Electrical Power Supply Systems	56	13
Total	**56**	**113**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the routine maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-35 LENINGRAD-4 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	LWGR / RBMK-1000
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	925 MWe

Key Dates

Construction Date	:	1975-02-01
Grid Date	:	1981-02-09
Commercial Date	:	1981-08-29
Age at end of year	:	43 years

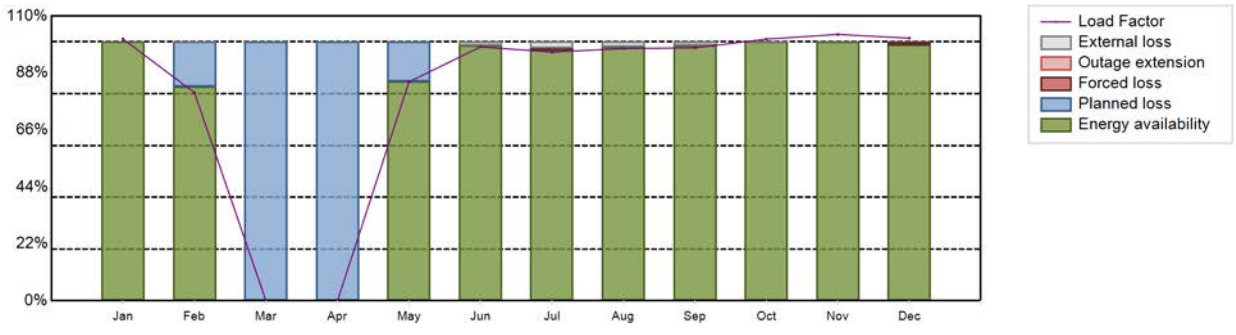
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	22000
Active core diameter [m]	:	11.8
Active core height/length [m]	:	7
Number of fissile fuel assemblies/bundles	:	1661
Fuel linear heat generation rate [kW/m]	:	14.5
Number of control rod assemblies	:	211
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	284
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.59
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	6510.11 GW(e).h
Energy Availability Factor (EAF)	:	79.91 %
Unit Capability Factor (UCF)	:	80.5 %
Load Factor (LF)	:	80.12 %
Operating Factor (OF)	:	81.15 %
Equivalent non-electrical energy generated (NEG)	:	54.04 GW(e).h
Forced Loss Rate (FLR)	:	0.21 %
Unplanned Capability Loss Factor (UCL)	:	0.17 %
Planned Unavailability Factor (PUF)	:	19.33 %
Externally cause unavailability (XUF)	:	0.59 %
Total off-line time	:	1656 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	695.89	517.48	0.00	0.00	581.97	653.12	661.19	670.56	650.72	695.67	685.27	698.22	6510.11
EAF [%]	100.00	82.70	0.00	0.00	84.72	98.59	96.94	98.10	98.54	99.99	100.00	98.79	79.91
UCF [%]	100.00	82.71	0.00	0.00	84.72	100.00	99.25	99.99	100.00	100.00	100.00	98.79	80.50
LF [%]	101.12	80.38	0.00	0.00	84.56	98.07	96.08	97.44	97.71	101.09	102.89	101.46	80.12
OF [%]	100.00	82.76	0.00	0.00	90.32	100.00	100.00	100.00	100.00	100.00	100.00	100.00	81.15
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.00	1.21	0.21
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.00	1.21	0.17
PUF [%]	0.00	17.29	100.00	100.00	15.28	0.00	0.00	0.01	0.00	0.00	0.00	0.00	19.33
XUF [%]	0.00	0.00	0.00	0.00	0.00	1.41	2.31	1.88	1.46	0.01	0.00	0.00	0.59

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Historical Summary

Lifetime energy generation	:	256917.34 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.88 %
Cumulative Energy Availability Factor (EAF)	:	75.13 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.88 %
Cumulative Unit Capability Factor (UCF)	:	76.01 %	Cumulative Planned Unavailability Factor (PUF)	:	21.11 %
Cumulative Load Factor (LF)	:	74.39 %	Cumulative Externally cause unavailability (XUF)	:	0.88 %
Cumulative Operating Factor (OF)	:	77.69 %			

Electricity Production (net) [GWh]

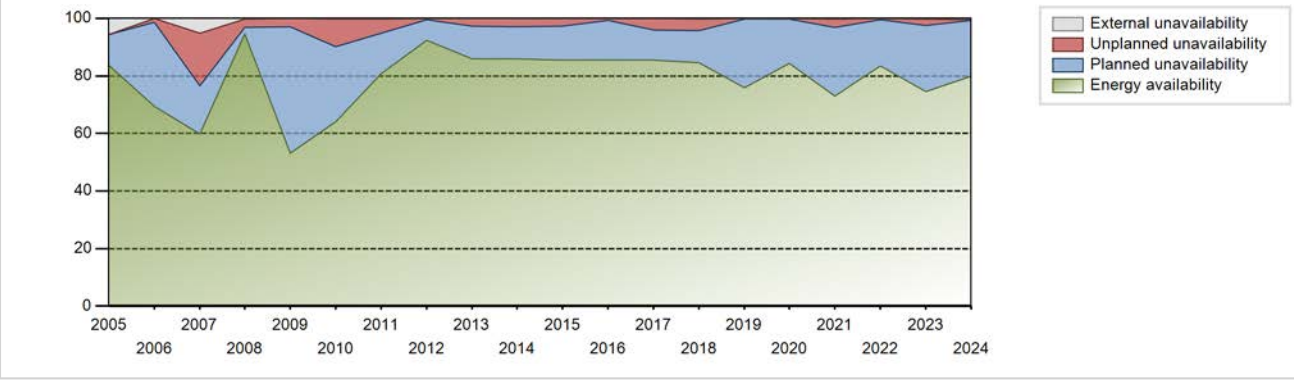


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	3931.27	6151	925	76.82	76.83	76.06	83.41	12.21	10.69	12.48	0.01
1982	6715.19	7609	925	83.59	83.72	82.87	86.86	4.43	3.88	12.40	0.13
1983	6844.23	8159	925	85.33	86.12	84.47	93.14	6.80	6.29	7.59	0.79
1984	6126.32	6803	925	74.43	74.94	75.40	77.45	3.19	2.47	22.59	0.52
1985	7335.31	8309	925	90.92	91.18	90.53	94.85	3.29	3.10	5.72	0.26
1986	7060.95	7826	925	87.65	88.69	87.14	89.34	0.49	0.44	10.87	1.04
1987	7319.23	7530	1000	84.15	85.01	83.55	85.96	2.18	1.90	13.09	0.86
1988	6050.44	6667	925	74.82	74.82	74.47	75.90	0.72	0.54	24.64	0.00
1989	7409.69	8185	925	91.46	91.89	91.44	93.44	2.23	2.10	6.01	0.43
1990	7762.56	8588	925	95.38	96.06	95.80	98.04	2.33	2.29	1.65	0.68
1991	6130.70	6870	925	76.14	76.77	75.66	78.42	1.77	1.38	21.85	0.62
1992	5618.11	6617	925	70.29	70.79	69.15	75.34	4.30	3.18	26.02	0.51
1993	6735.70	7762	925	85.27	87.61	83.13	88.61	1.54	1.37	11.02	2.34
1994	6167.07	7340	925	82.08	83.16	76.11	83.79	1.33	1.12	15.72	1.07
1995	6140.97	7270	925	82.96	86.06	75.79	82.99	0.29	0.25	13.69	3.11
1996	7079.69	8048	925	88.30	88.78	87.13	91.62	4.63	4.31	6.91	0.47
1997	7644.68	8760	925	95.95	98.19	94.34	100.00	1.81	1.81	0.00	2.24
1998	3681.98	4341	925	45.98	47.31	45.44	49.55	2.11	1.02	51.68	1.32
1999	0.00	0	925	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2000	0.00	0	925	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2001	3585.73	4387	925	44.56	45.54	44.25	50.08	23.52	14.00	40.46	0.98
2002	7528.53	8760	925	93.93	97.55	92.91	100.00	2.45	2.45	0.00	3.62
2003	1957.16	2399	925	24.69	26.03	24.15	27.39	2.58	0.69	73.28	1.35
2004	7232.18	8243	925	89.58	92.27	89.01	93.84	3.43	3.28	4.45	2.70
2005	6730.12	7838	925	83.76	89.33	83.05	89.46	0.11	0.10	10.57	5.57
2006	5611.94	6197	925	69.36	69.36	69.26	70.74	0.80	1.36	29.29	0.00
2007	4827.43	5713	925	59.73	64.85	59.58	65.22	3.84	18.24	16.91	5.11
2008	7526.25	8714	925	94.69	94.90	92.63	99.20	2.93	2.86	2.24	0.22
2009	4052.83	4695	925	53.23	53.37	50.02	53.60	4.90	2.75	43.88	0.14
2010	5222.37	5798	925	64.04	64.18	64.45	66.19	3.64	9.60	26.21	0.14
2011	6589.79	7177	925	80.76	81.01	81.33	81.94	3.53	4.93	14.06	0.25
2012	7559.92	8254	925	92.28	92.30	93.04	93.97	0.23	0.52	7.18	0.02
2013	6992.92	7739	925	85.84	85.93	86.30	88.34	2.97	2.63	11.43	0.09
2014	6942.49	7665	925	85.92	86.00	85.67	87.49	2.03	2.77	11.23	0.08
2015	6617.16	7414	925	85.58	85.60	81.66	84.63	2.97	2.62	11.78	0.02
2016	6912.04	7660	925	85.43	85.45	85.07	87.20	0.85	0.73	13.82	0.01
2017	6846.75	7873	925	85.57	85.58	84.50	89.87	4.04	4.04	10.39	0.01

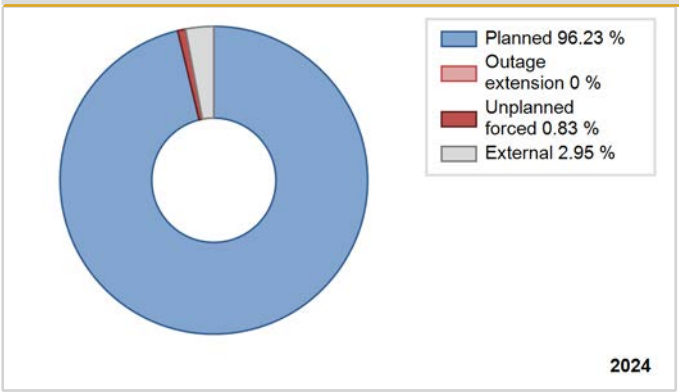
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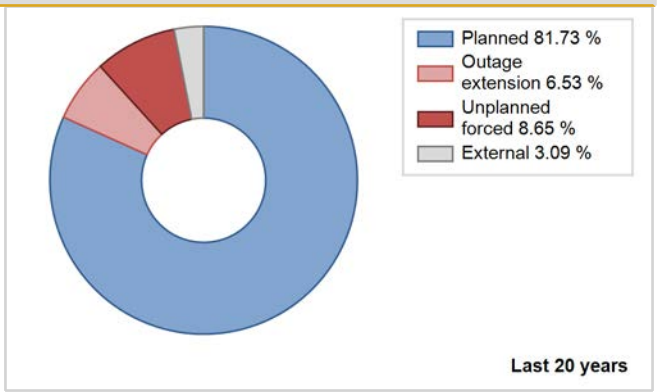
2018	6951.25	7499	925	84.68	84.83	85.79	85.61	4.62	4.11	11.06	0.15
2019	6265.79	6730	925	75.83	75.83	77.33	76.83	0.31	0.24	23.94	0.00
2020	6842.29	7486	925	84.44	84.44	84.21	85.22	0.42	0.35	15.20	0.01
2021	5789.70	6585	925	72.99	73.22	71.45	75.17	3.83	2.91	23.87	0.23
2022	6839.10	7399	925	83.47	83.51	84.40	84.46	0.41	0.34	16.15	0.05
2023	6049.67	6651	925	74.49	74.70	74.66	75.92	2.88	2.22	23.08	0.21
2024	6510.11	7128	925	79.91	80.50	80.12	81.15	0.21	0.17	19.33	0.59

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					85	
C. Inspection, maintenance or repair combined with refuelling	1648			1357		
D. Inspection, maintenance or repair without refuelling				194		
E. Testing of plant systems or components					0	
F. Major backfitting, refurbishment or upgrading activities with refuelling				147		
G. Major backfitting, refurbishment or upgrading activities without refuelling				93	32	
J. Grid limitation, failure or grid unavailability						1
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						10
L. Human factor related					1	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					0	
Z. Other					18	1
Subtotal	1648			1791	136	12
Total	**1648**			**1939**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		24
14. Safety Systems		1
15. Reactor Cooling Systems		18
16. Steam generation systems		10
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		4
33. Circulating Water System		1
41. Main Generator Systems		3
42. Electrical Power Supply Systems		9
Total		**87**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the routine maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-161 NOVOVORONEZH 2-1 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	AEM (Atomenergomash)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-392M
Thermal power	:	3200 MWth
Gross electrical power	:	1180 MWe
Reference unit power (net)	:	1100 MWe

Key Dates

Construction Date	:	2008-06-24
Grid Date	:	2016-08-05
Commercial Date	:	2017-02-27
Age at end of year	:	8 years

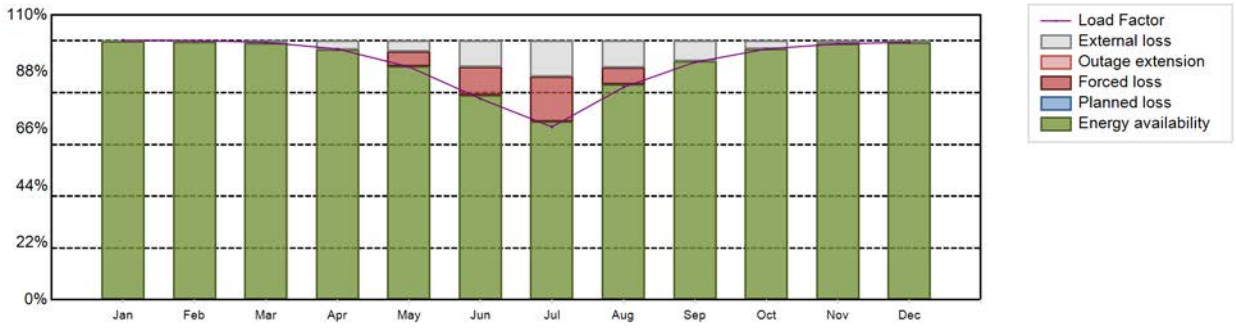
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8855.03 GW(e).h	Forced Loss Rate (FLR)	:	3.39 %
Energy Availability Factor (EAF)	:	91.94 %	Unplanned Capability Loss Factor (UCL)	:	3.39 %
Unit Capability Factor (UCF)	:	96.61 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	91.64 %	Externally cause unavailability (XUF)	:	4.67 %
Operating Factor (OF)	:	99.6 %	Total off-line time	:	35 hours

Annual Summary



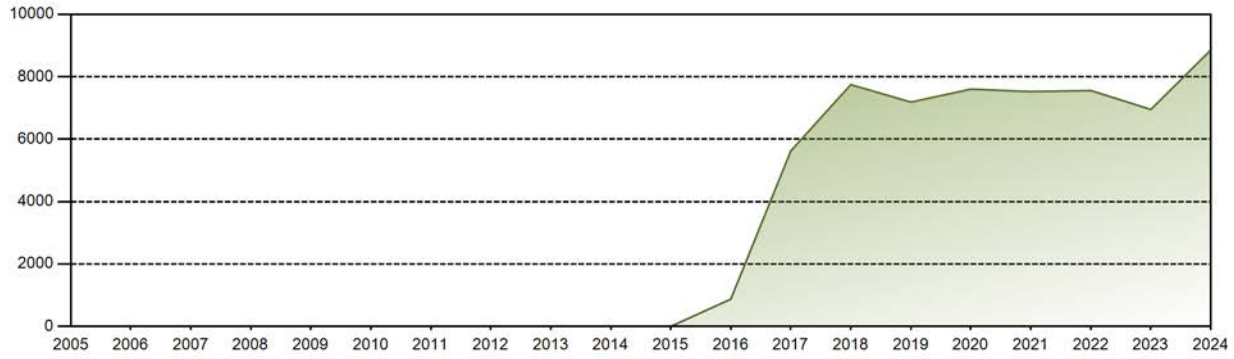
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	820.22	766.25	814.05	767.22	736.66	615.08	546.75	671.77	726.97	792.80	783.12	814.13	8855.03
EAF [%]	99.82	99.71	99.18	96.51	90.19	79.01	68.84	83.24	92.26	96.91	98.76	99.30	91.94
UCF [%]	100.00	100.00	100.00	100.00	94.42	88.98	82.58	93.64	100.00	100.00	100.00	100.00	96.61
LF [%]	100.22	100.08	99.47	96.87	90.01	77.66	66.81	82.08	91.79	96.87	98.88	99.48	91.64
OF [%]	100.00	100.00	100.00	100.00	95.30	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.60
FLR [%]	0.00	0.00	0.00	0.00	5.58	11.02	17.42	6.36	0.00	0.00	0.00	0.00	3.39
UCL [%]	0.00	0.00	0.00	0.00	5.58	11.02	17.42	6.36	0.00	0.00	0.00	0.00	3.39
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.18	0.29	0.82	3.49	4.22	9.97	13.74	10.41	7.74	3.09	1.24	0.70	4.67

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Historical Summary

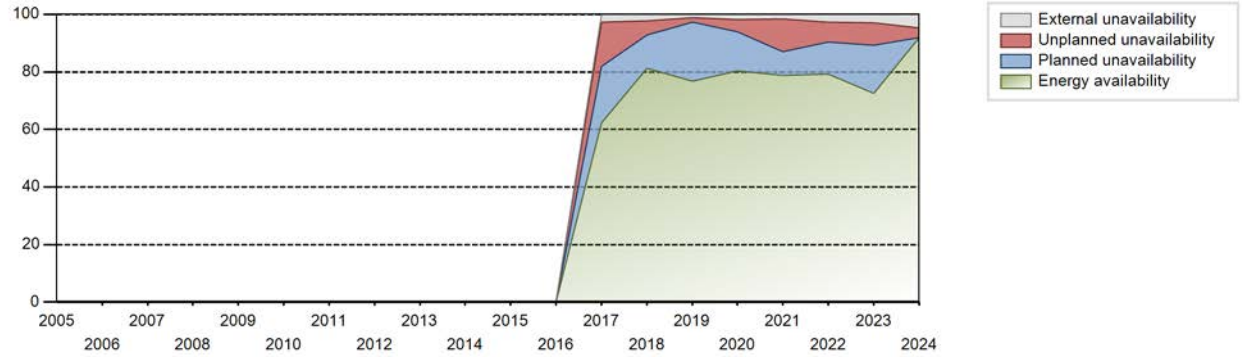
Lifetime energy generation	:	59916.18 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.78 %
Cumulative Energy Availability Factor (EAF)	:	78.22 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.76 %
Cumulative Unit Capability Factor (UCF)	:	80.72 %	Cumulative Planned Unavailability Factor (PUF)	:	12.52 %
Cumulative Load Factor (LF)	:	77.04 %	Cumulative Externally cause unavailability (XUF)	:	2.5 %
Cumulative Operating Factor (OF)	:	82.81 %			

Electricity Production (net) [GWh]

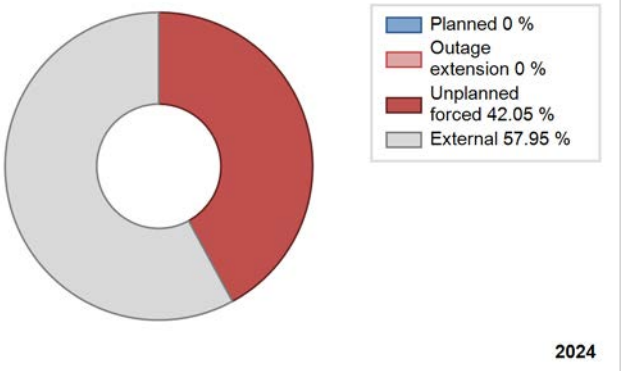


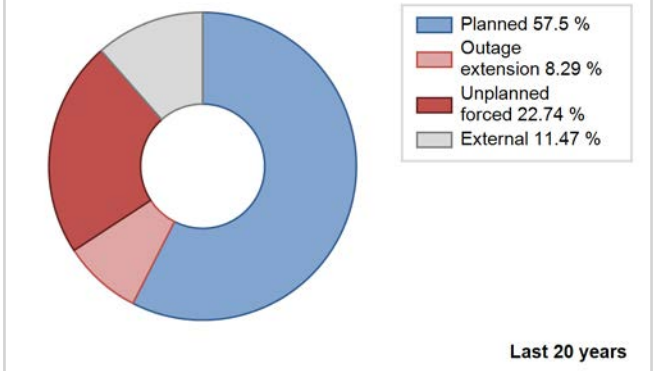
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2017	5620.47	6226	1114	62.35	65.08	60.87	75.08	19.08	15.34	19.58	2.73
2018	7746.87	7378	1114	81.34	83.60	79.38	84.22	5.56	4.92	11.47	2.27
2019	7186.30	6885	1100	76.74	77.97	74.58	78.60	1.81	1.44	20.59	1.22
2020	7602.46	7465	1100	80.29	82.00	78.68	84.98	3.44	4.32	13.67	1.71
2021	7523.13	6953	1100	78.81	80.41	78.07	79.37	4.37	11.39	8.19	1.60
2022	7558.04	7279	1100	79.16	81.98	78.44	83.09	7.76	6.89	11.13	2.81
2023	6950.52	6677	1100	72.63	75.62	72.13	76.22	3.35	7.71	16.66	2.99
2024	8855.03	8749	1100	91.94	96.61	91.64	99.60	3.39	3.39	0.00	4.67

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2017 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		35			283	
C. Inspection, maintenance or repair combined with refuelling				1087		
Z. Other					143	
Subtotal		35		1087	426	
Total		**35**			**1513**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2017 to 2024
	Hours Lost	Average hours lost per reactor-year
14. Safety Systems		15
16. Steam generation systems		2
31. Turbine and auxiliaries		57
32. Feedwater and Main Steam System		49
33. Circulating Water System		27
41. Main Generator Systems		122
42. Electrical Power Supply Systems	35	4
Total	**35**	**276**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-162 NOVOVORONEZH 2-2 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	AEM (Atomenergomash)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-392M
Thermal power	:	3200 MWth
Gross electrical power	:	1181 MWe
Reference unit power (net)	:	1101 MWe

Key Dates

Construction Date	:	2009-07-12
Grid Date	:	2019-05-01
Commercial Date	:	2019-10-31
Age at end of year	:	5 years

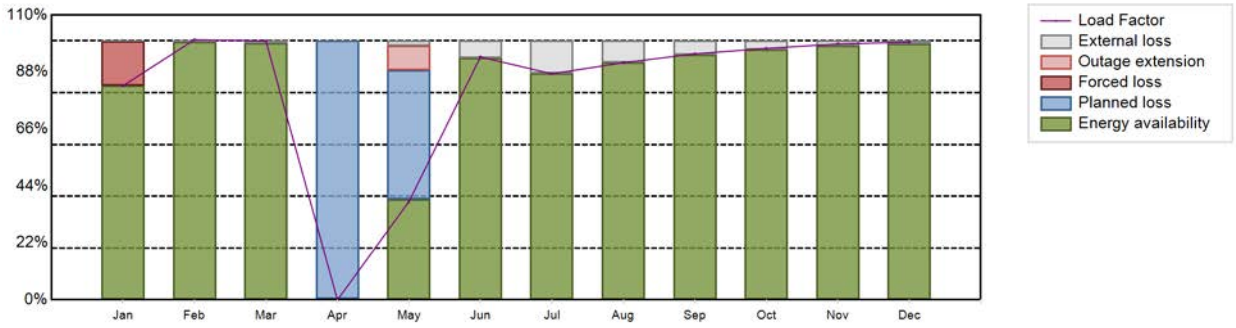
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7932.55 GW(e).h	Forced Loss Rate (FLR)	:	1.67 %
Energy Availability Factor (EAF)	:	81.81 %	Unplanned Capability Loss Factor (UCL)	:	2.25 %
Unit Capability Factor (UCF)	:	85.37 %	Planned Unavailability Factor (PUF)	:	12.39 %
Load Factor (LF)	:	82.02 %	Externally cause unavailability (XUF)	:	3.56 %
Operating Factor (OF)	:	85.54 %	Total off-line time	:	1270 hours

Annual Summary



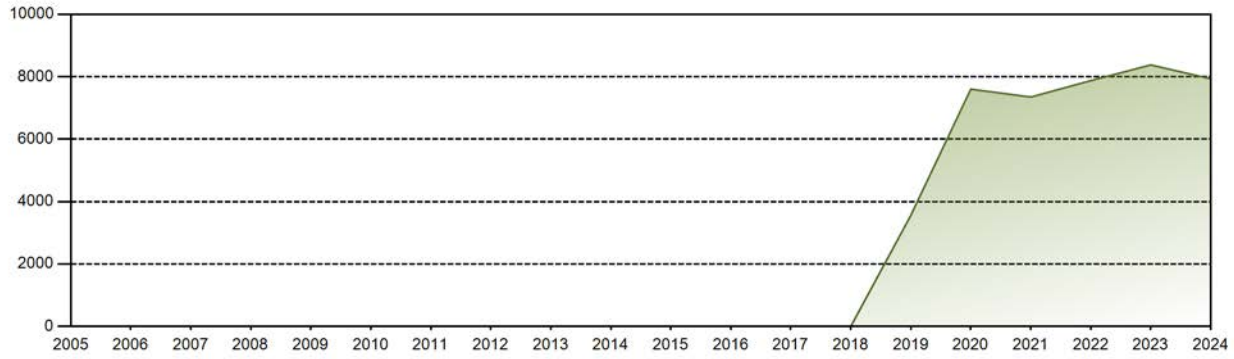
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	677.13	769.83	819.01	0.00	310.66	743.54	715.19	750.12	753.14	795.40	783.30	815.22	7932.55
EAF [%]	82.65	99.62	99.19	0.31	38.89	93.45	87.44	91.56	94.76	96.63	98.18	98.83	81.81
UCF [%]	82.88	100.00	100.00	0.31	40.81	100.00	100.00	100.00	100.00	100.00	100.00	100.00	85.37
LF [%]	82.66	100.46	99.98	0.00	37.93	93.80	87.31	91.57	95.01	97.10	98.81	99.52	82.02
OF [%]	83.33	100.00	100.00	0.56	42.20	100.00	100.00	100.00	100.00	100.00	100.00	100.00	85.54
FLR [%]	17.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67
UCL [%]	17.12	0.00	0.00	0.00	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.25
PUF [%]	0.00	0.00	0.00	99.69	49.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.39
XUF [%]	0.23	0.38	0.81	0.00	1.92	6.55	12.56	8.44	5.24	3.37	1.82	1.17	3.56

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Historical Summary

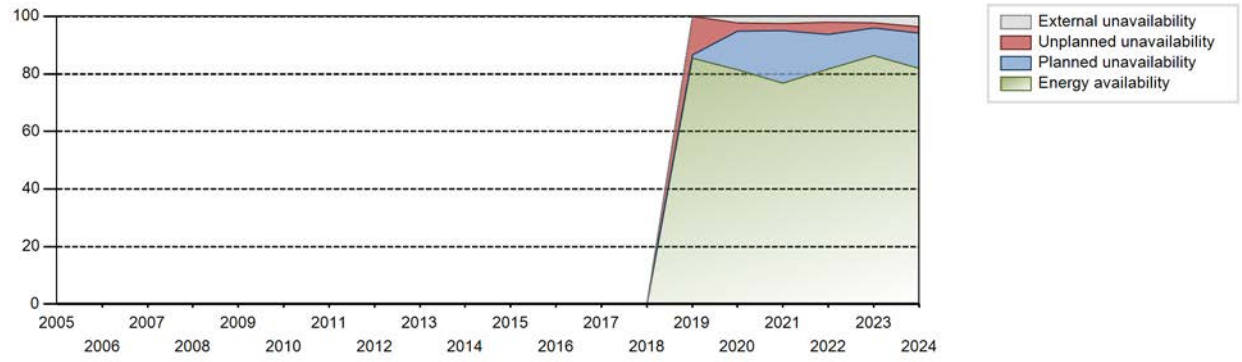
Lifetime energy generation	:	42692.95 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.72 %
Cumulative Energy Availability Factor (EAF)	:	81.75 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.1 %
Cumulative Unit Capability Factor (UCF)	:	84.17 %	Cumulative Planned Unavailability Factor (PUF)	:	12.74 %
Cumulative Load Factor (LF)	:	81.14 %	Cumulative Externally cause unavailability (XUF)	:	2.42 %
Cumulative Operating Factor (OF)	:	84.44 %			

Electricity Production (net) [GWh]

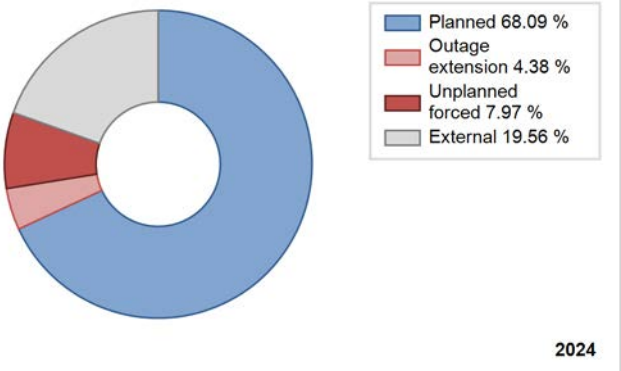


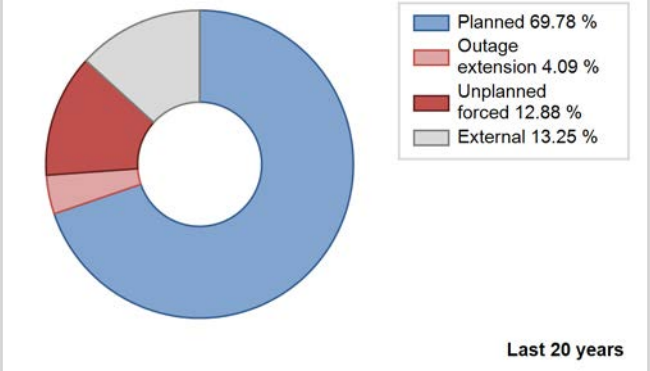
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2019	3557.06	4222	1101	85.48	85.48	83.47	88.25	13.57	13.43	1.09	0.00
2020	7602.61	7367	1101	81.50	83.68	78.61	83.87	3.46	3.00	13.32	2.18
2021	7348.32	6953	1101	76.69	79.28	76.19	79.37	0.15	2.40	18.33	2.59
2022	7875.32	7368	1101	81.69	83.70	81.65	84.11	4.89	4.30	12.00	2.01
2023	8377.15	7767	1101	86.43	88.59	86.86	88.66	1.15	1.82	9.59	2.17
2024	7932.55	7514	1101	81.81	85.37	82.02	85.54	1.67	2.25	12.39	3.56

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2019 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		124			195	
C. Inspection, maintenance or repair combined with refuelling	1077			1106		
L. Human factor related					4	
Z. Other		70			82	
Subtotal	1077	194		1106	281	
Total		**1271**			**1387**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2019 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems	124	28
15. Reactor Cooling Systems		36
31. Turbine and auxiliaries		31
32. Feedwater and Main Steam System		55
33. Circulating Water System		9
35. All other I&C Systems		6
41. Main Generator Systems		15
42. Electrical Power Supply Systems		2
Total	**124**	**182**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the overhaul. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-11 NOVOVORONEZH-4 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-179
Thermal power	:	1375 MWth
Gross electrical power	:	417 MWe
Reference unit power (net)	:	385 MWe

Key Dates

Construction Date	:	1967-07-01
Grid Date	:	1972-12-28
Commercial Date	:	1973-03-24
Age at end of year	:	52 years

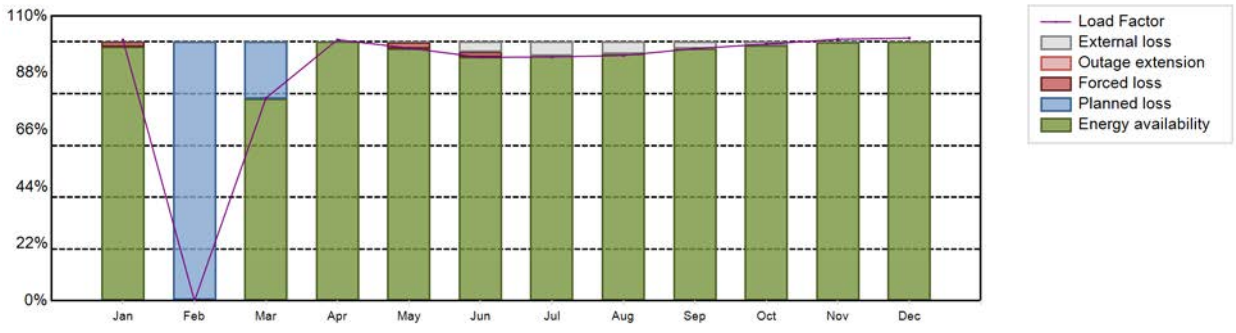
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	28600
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.1
Number of control rod assemblies	:	73
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.5
Reactor outlet temperature [°C]	:	295.8
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	4.4
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	2998.82 GW(e).h
Energy Availability Factor (EAF)	:	88.19 %
Unit Capability Factor (UCF)	:	89.72 %
Load Factor (LF)	:	88.67 %
Operating Factor (OF)	:	90.32 %
Equivalent non-electrical energy generated (NEG)	:	43.97 GW(e).h
Forced Loss Rate (FLR)	:	0.58 %
Unplanned Capability Loss Factor (UCL)	:	0.53 %
Planned Unavailability Factor (PUF)	:	9.75 %
Externally cause unavailability (XUF)	:	1.53 %
Total off-line time	:	850 hours

Annual Summary



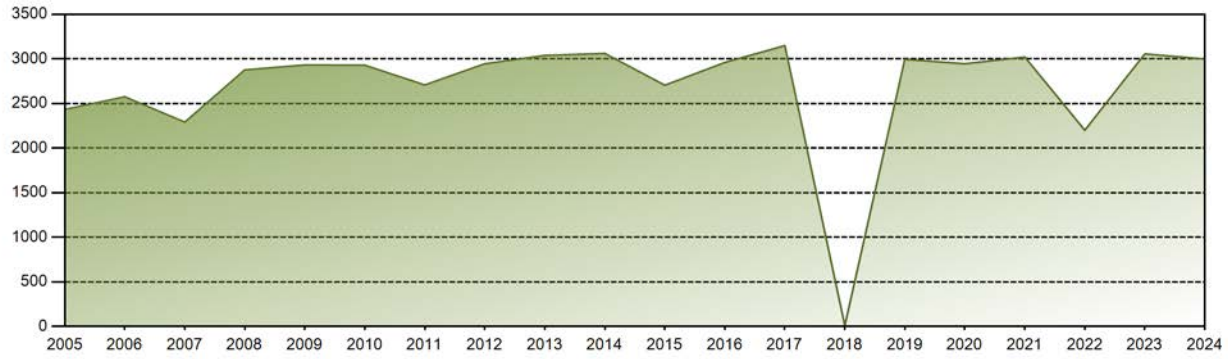
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	288.61	0.00	224.35	279.55	279.61	260.69	269.86	271.44	270.00	284.01	280.04	290.65	2998.82
EAF [%]	98.10	0.31	78.11	100.00	97.30	94.19	94.67	95.31	97.27	98.71	99.92	100.00	88.19
UCF [%]	98.10	0.31	78.11	100.00	97.56	98.05	100.00	100.00	100.00	100.00	100.00	100.00	89.72
LF [%]	100.76	0.00	78.32	100.85	97.62	94.04	94.21	94.76	97.40	99.15	101.03	101.47	88.67
OF [%]	100.00	0.57	78.76	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.32
FLR [%]	1.90	0.00	0.00	0.00	2.44	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.58
UCL [%]	1.90	0.00	0.00	0.00	2.44	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.53
PUF [%]	0.00	99.69	21.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.75
XUF [%]	0.00	0.00	0.00	0.00	0.26	3.86	5.33	4.69	2.73	1.29	0.08	0.00	1.53

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Historical Summary

Lifetime energy generation	:	137399.36 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.27 %
Cumulative Energy Availability Factor (EAF)	:	78.35 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.64 %
Cumulative Unit Capability Factor (UCF)	:	79.66 %	Cumulative Planned Unavailability Factor (PUF)	:	16.71 %
Cumulative Load Factor (LF)	:	78.26 %	Cumulative Externally cause unavailability (XUF)	:	1.3 %
Cumulative Operating Factor (OF)	:	82.84 %			

Electricity Production (net) [GWh]

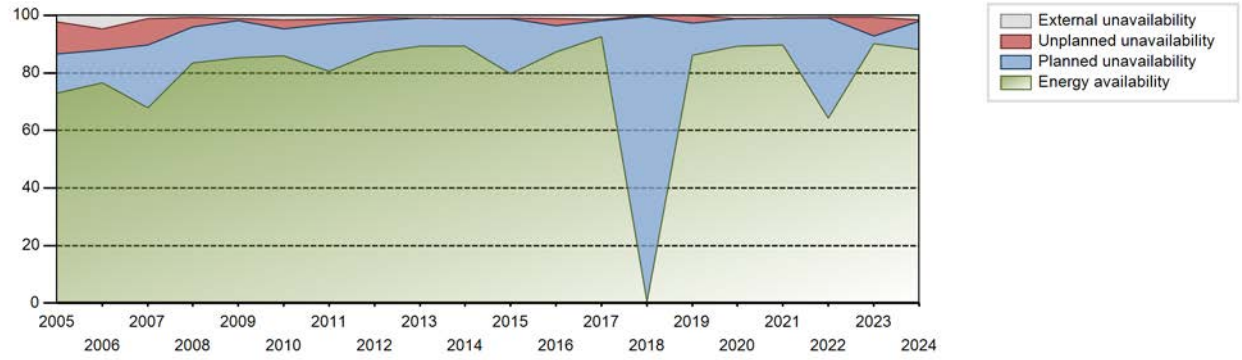


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1973	2570.51	8072	385	84.20	84.20	84.95	93.15	14.82	14.65	1.15	0.00
1974	2411.84	7159	385	71.28	71.28	71.51	81.72	15.90	13.48	15.24	0.00
1975	2644.87	7950	385	75.64	75.64	78.42	90.75	9.17	7.63	16.73	0.00
1976	2924.13	7963	385	84.48	84.48	86.47	90.65	4.63	4.10	11.42	0.00
1977	2822.95	7637	385	81.34	81.34	83.70	87.18	4.88	4.17	14.49	0.00
1978	2658.54	7388	385	78.18	78.18	78.83	84.34	3.70	3.00	18.82	0.00
1979	2442.24	6888	385	72.44	72.44	72.41	78.63	8.70	6.90	20.66	0.00
1980	2842.93	7690	385	84.08	84.08	84.06	87.55	3.15	2.74	13.18	0.00
1981	3019.87	8278	385	90.03	90.03	89.55	94.51	4.32	4.06	5.91	0.00
1982	2797.51	8278	385	83.88	83.88	82.95	94.50	9.47	8.78	7.35	0.00
1983	2950.30	8216	385	89.15	89.15	87.48	93.79	3.80	3.52	7.33	0.00
1984	2974.10	7982	385	87.89	87.89	87.94	90.87	3.16	2.87	9.24	0.00
1985	3097.87	8250	385	91.30	91.30	91.85	94.18	2.71	2.54	6.16	0.00
1986	2792.21	7688	385	82.62	82.62	82.79	87.76	5.57	4.88	12.51	0.00
1987	3262.68	8252	417	91.72	91.72	89.32	94.20	0.15	0.14	8.14	0.00
1988	2529.37	7152	385	79.97	79.97	74.79	81.42	1.21	0.98	19.05	0.00
1989	2710.26	8357	385	90.16	90.19	80.36	95.40	5.71	5.46	4.35	0.04
1990	2244.69	6622	385	69.63	70.55	66.56	75.59	11.28	8.97	20.48	0.92
1991	1827.62	5540	385	57.96	58.24	54.19	63.24	9.28	5.96	35.80	0.28
1992	2853.44	8163	385	82.38	87.35	84.38	92.94	6.01	5.58	7.07	4.97
1993	2613.71	7204	385	76.60	79.73	77.50	82.24	2.64	2.16	18.11	3.13
1994	1954.27	6033	385	56.65	66.91	57.95	68.87	2.79	1.92	31.17	10.26
1995	2119.99	5818	385	62.15	65.50	62.86	66.42	0.64	0.42	34.08	3.35
1996	3080.28	8362	385	90.38	93.78	91.08	95.20	1.08	1.02	5.20	3.40
1997	2235.48	6690	385	66.98	70.29	66.28	76.37	0.76	0.54	29.17	3.30
1998	2714.87	7366	385	80.18	83.16	80.50	84.09	0.98	0.82	16.02	2.98
1999	1791.48	4927	385	53.21	54.93	53.12	56.24	17.55	11.69	33.38	1.72
2000	2474.25	6784	385	73.08	74.64	73.16	77.23	3.12	2.40	22.96	1.56
2001	2655.95	7173	385	79.22	80.72	78.75	81.88	1.24	1.01	18.26	1.51
2002	2184.85	5857	385	64.21	65.37	64.78	66.86	4.51	3.09	31.55	1.15
2003	2583.05	6950	385	76.75	78.78	76.59	79.34	1.32	1.05	20.17	2.02
2004	2714.01	7685	385	80.75	83.75	80.25	87.49	4.90	4.32	11.94	2.99
2005	2433.38	7228	385	73.09	75.27	72.15	82.51	12.96	11.20	13.53	2.18
2006	2575.08	7636	385	76.49	81.29	76.35	87.17	8.30	7.36	11.36	4.79
2007	2290.27	6488	385	67.88	69.12	67.91	74.06	8.19	9.08	21.80	1.24
2008	2876.30	7464	385	83.37	84.02	85.05	84.97	3.95	3.45	12.53	0.65
2009	2931.78	7580	385	85.23	86.31	86.93	86.53	0.01	0.78	12.91	1.08

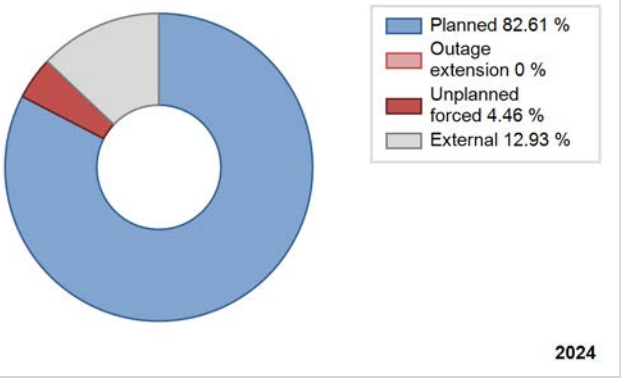
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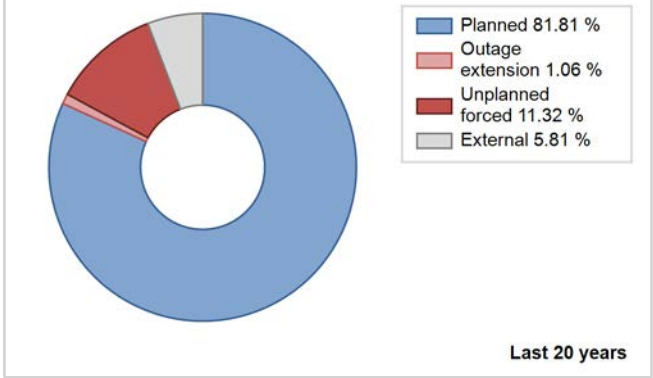
2010	2928.70	7727	385	85.82	87.48	86.84	88.21	3.36	3.04	9.48	1.66
2011	2707.55	7263	385	80.64	82.08	80.29	82.92	1.69	1.41	16.51	1.44
2012	2944.86	7707	385	87.14	87.87	87.08	87.74	1.22	1.09	11.04	0.73
2013	3038.98	7929	385	89.36	90.36	90.11	90.51	0.01	0.01	9.63	1.00
2014	3061.07	7932	385	89.26	90.33	90.75	90.54	0.12	0.11	9.56	1.07
2015	2704.38	7085	385	79.59	80.43	80.19	80.88	0.45	0.36	19.21	0.83
2016	2959.49	7783	385	87.26	88.31	87.51	88.60	2.91	2.65	9.04	1.05
2017	3148.86	8259	385	92.54	93.92	93.37	94.28	0.37	0.35	5.73	1.38
2018	8.92	73	385	0.43	0.43	0.26	0.83	47.79	0.39	99.18	0.00
2019	2994.94	7654	385	86.23	86.33	88.80	87.37	3.00	2.67	11.01	0.09
2020	2945.24	7956	385	89.27	90.40	87.09	90.57	0.00	0.00	9.60	1.13
2021	3020.99	7951	385	89.69	90.51	89.57	90.76	0.03	0.02	9.46	0.82
2022	2199.85	5716	385	64.37	65.15	65.23	65.25	0.13	0.09	34.76	0.78
2023	3055.96	8001	385	90.16	90.76	90.61	91.34	6.18	6.67	2.57	0.59
2024	2998.82	7934	385	88.19	89.72	88.67	90.32	0.58	0.53	9.75	1.53

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1973 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					75	
C.	Inspection, maintenance or repair combined with refuelling	850			1235		
D.	Inspection, maintenance or repair without refuelling				86		
E.	Testing of plant systems or components				11		
F.	Major backfitting, refurbishment or upgrading activities with refuelling				52		
J.	Grid limitation, failure or grid unavailability						8
L.	Human factor related					2	
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					8	
Z.	Other				2	13	
Subtotal		850			1386	98	8
Total		**850**			**1492**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1973 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		13
13. Reactor Auxiliary Systems		2
15. Reactor Cooling Systems		4
16. Steam generation systems		40
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		8
34. Miscellaneous Systems		0
35. All other I&C Systems		1
42. Electrical Power Supply Systems		0
Total		**77**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in intermediate repair. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-20 NOVOVORONEZH-5 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-187
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1974-03-01
Grid Date	:	1980-05-31
Commercial Date	:	1981-02-20
Age at end of year	:	44 years

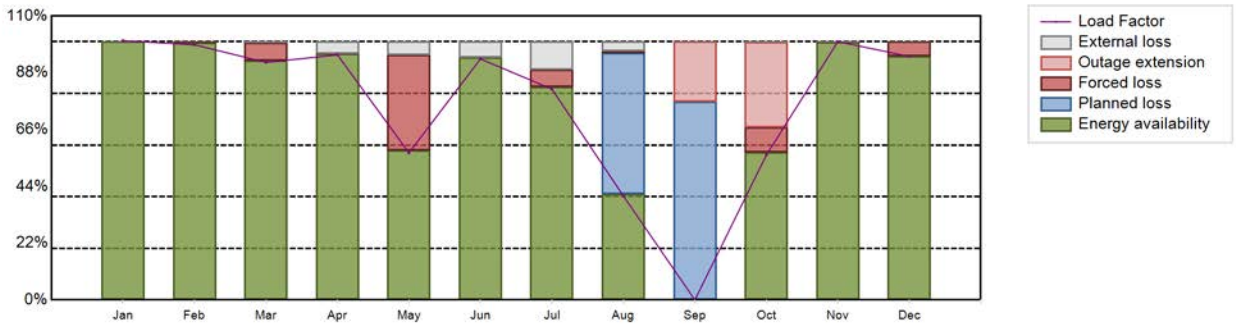
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	109
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	324
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	-
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.5
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	6314.21 GW(e).h
Energy Availability Factor (EAF)	:	76.12 %
Unit Capability Factor (UCF)	:	78.69 %
Load Factor (LF)	:	75.67 %
Operating Factor (OF)	:	80.6 %
Equivalent non-electrical energy generated (NEG)	:	5.15 GW(e).h
Forced Loss Rate (FLR)	:	6.75 %
Unplanned Capability Loss Factor (UCL)	:	10.41 %
Planned Unavailability Factor (PUF)	:	10.89 %
Externally cause unavailability (XUF)	:	2.57 %
Total off-line time	:	1704 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	709.81	653.49	650.33	649.28	402.70	638.55	577.37	284.73	0.00	396.85	684.31	666.78	6314.21
EAF [%]	100.00	99.51	92.77	95.40	57.87	93.86	82.53	41.14	0.00	57.12	99.91	94.37	76.12
UCF [%]	100.00	99.51	93.23	99.91	62.89	100.00	93.28	44.77	0.00	57.28	99.96	94.37	78.69
LF [%]	100.43	98.83	92.01	94.92	56.98	93.36	81.69	40.28	0.00	56.15	100.05	94.34	75.67
OF [%]	100.00	100.00	95.03	100.00	63.84	100.00	100.00	45.97	0.00	67.34	100.00	95.56	80.60
FLR [%]	0.00	0.49	6.77	0.09	37.11	0.00	6.72	1.76	0.00	14.39	0.04	5.63	6.75
UCL [%]	0.00	0.49	6.77	0.09	37.11	0.00	6.72	0.80	23.33	42.72	0.04	5.63	10.41
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.43	76.67	0.00	0.00	0.00	10.89
XUF [%]	0.00	0.00	0.46	4.52	5.02	6.14	10.75	3.63	0.00	0.15	0.05	0.00	2.57

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Historical Summary

Lifetime energy generation	:	242167.86 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	11.07 %
Cumulative Energy Availability Factor (EAF)	:	68 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	10.58 %
Cumulative Unit Capability Factor (UCF)	:	68.86 %	Cumulative Planned Unavailability Factor (PUF)	:	20.56 %
Cumulative Load Factor (LF)	:	67.76 %	Cumulative Externally cause unavailability (XUF)	:	0.86 %
Cumulative Operating Factor (OF)	:	74.59 %			

Electricity Production (net) [GWh]

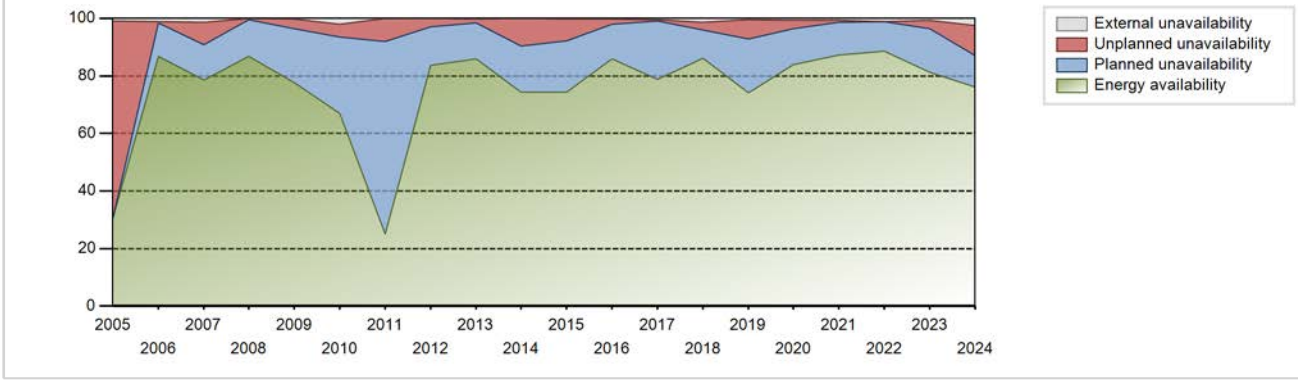


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	4639.79	6929	950	56.62	56.62	56.10	77.77	28.48	22.54	20.83	0.00
1982	5042.84	6631	950	60.89	60.89	60.60	75.70	25.30	20.62	18.49	0.00
1983	6607.53	7716	950	79.53	79.53	79.40	88.08	7.92	6.84	13.64	0.00
1984	6979.64	7742	950	83.42	83.42	83.64	88.14	5.18	4.56	12.02	0.00
1985	6894.29	7979	950	83.12	83.12	82.84	91.08	8.96	8.18	8.69	0.00
1986	5523.75	6806	950	65.91	65.96	66.38	77.69	17.36	13.86	20.18	0.04
1987	7052.70	7399	1000	81.79	81.79	80.51	84.46	2.68	2.26	15.96	0.00
1988	3017.85	3439	950	36.51	36.51	36.16	39.15	59.88	54.50	8.98	0.00
1989	3308.95	3778	950	40.88	40.88	39.76	43.13	25.41	13.93	45.19	0.00
1990	3913.28	4715	950	47.63	47.72	47.02	53.82	15.35	8.66	43.62	0.09
1991	5878.22	6996	950	71.54	71.54	70.63	79.86	19.86	17.72	10.74	0.00
1992	3752.83	5244	950	45.70	45.89	44.98	59.71	8.71	4.38	49.73	0.20
1993	5935.41	7448	950	72.55	73.79	71.32	85.02	10.42	8.59	17.62	1.24
1994	2281.89	4288	950	28.94	33.19	27.42	48.95	50.98	34.51	32.29	4.26
1995	4753.72	6670	950	57.46	63.87	57.12	76.14	14.52	10.85	25.28	6.41
1996	3861.84	4759	950	46.71	46.71	46.28	54.18	15.10	8.31	44.98	0.00
1997	5949.25	6854	950	71.37	71.69	71.49	78.24	7.84	6.10	22.21	0.33
1998	3771.78	4457	950	44.89	45.48	45.32	50.88	28.35	17.99	36.52	0.60
1999	4845.42	6062	950	58.73	61.16	58.22	69.20	17.37	12.86	25.99	2.43
2000	5278.64	6479	950	63.54	65.56	63.26	73.76	7.30	5.17	29.27	2.02
2001	5984.59	7508	950	72.26	73.22	71.91	85.71	6.60	5.17	21.61	0.96
2002	6762.21	7430	950	80.68	83.14	81.26	84.82	1.95	1.65	15.21	2.45
2003	6951.21	7507	950	83.05	84.51	83.53	85.70	0.93	0.79	14.70	1.46
2004	3610.61	4032	950	43.13	43.61	43.27	45.90	44.15	34.48	21.91	0.48
2005	2544.26	2861	950	30.60	31.42	30.57	32.66	0.00	68.58	0.00	0.82
2006	7264.41	7762	950	86.70	87.75	87.29	88.61	0.61	0.54	11.71	1.05
2007	6556.27	7140	950	78.48	79.84	78.78	81.51	7.10	7.85	12.31	1.36
2008	7285.18	7718	950	86.89	87.00	87.30	87.86	0.51	0.44	12.56	0.11
2009	6518.11	6865	950	77.59	77.86	78.32	78.37	4.04	3.28	18.86	0.27
2010	5585.30	6404	950	66.98	69.12	67.11	73.11	5.83	4.28	26.61	2.13
2011	2085.77	2422	950	25.11	25.11	25.07	27.65	7.01	7.99	66.90	0.00
2012	7014.58	7457	950	83.60	83.72	84.06	84.89	1.80	2.89	13.38	0.13
2013	7205.36	7773	950	85.97	86.24	86.58	88.73	1.20	1.23	12.54	0.27
2014	6193.58	7712	950	74.39	74.40	74.42	88.03	11.44	9.61	15.99	0.01
2015	6209.76	7120	950	74.34	74.50	74.62	81.28	8.43	7.73	17.77	0.16
2016	7191.83	7777	950	85.94	86.18	86.18	88.54	1.73	1.85	11.97	0.24
2017	6560.03	7811	950	78.87	79.36	78.83	89.17	0.60	0.48	20.16	0.49

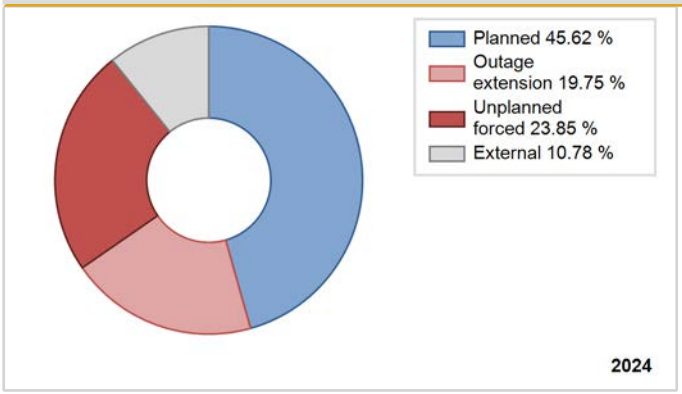
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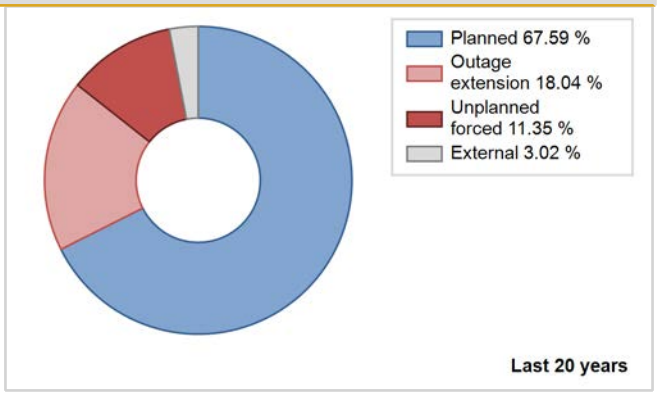
2018	7134.80	7766	950	86.22	87.70	85.73	88.65	0.99	2.46	9.84	1.48
2019	6092.49	6806	950	74.19	74.67	73.21	77.69	8.33	6.79	18.54	0.49
2020	6787.87	7483	950	83.89	84.60	81.34	85.19	2.96	2.84	12.56	0.71
2021	7227.84	7774	950	87.16	87.84	86.85	88.74	0.45	0.77	11.40	0.68
2022	7312.92	7908	950	88.52	89.62	87.87	90.27	0.16	0.14	10.24	1.10
2023	6729.73	7333	950	81.27	81.94	80.87	83.71	1.44	2.99	15.07	0.67
2024	6314.21	7080	950	76.12	78.69	75.67	80.60	6.75	10.41	10.89	2.57

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		335			577	
C. Inspection, maintenance or repair combined with refuelling	954			1409		
D. Inspection, maintenance or repair without refuelling				281		
L. Human factor related					2	
Z. Other		411			21	
Subtotal	954	746		1690	600	
Total	**1700**			**2290**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		219
12. Reactor I&C Systems		18
13. Reactor Auxiliary Systems	37	6
14. Safety Systems		2
15. Reactor Cooling Systems	29	48
16. Steam generation systems	269	205
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		15
32. Feedwater and Main Steam System		6
34. Miscellaneous Systems		6
35. All other I&C Systems		5
41. Main Generator Systems		45
42. Electrical Power Supply Systems		4
Total	**335**	**580**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in intermediate repair. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-59 ROSTOV-1 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3200 MWth
Gross electrical power	:	1041 MWe
Reference unit power (net)	:	989 MWe

Key Dates

Construction Date	:	1981-09-01
Grid Date	:	2001-03-30
Commercial Date	:	2001-12-25
Age at end of year	:	23 years

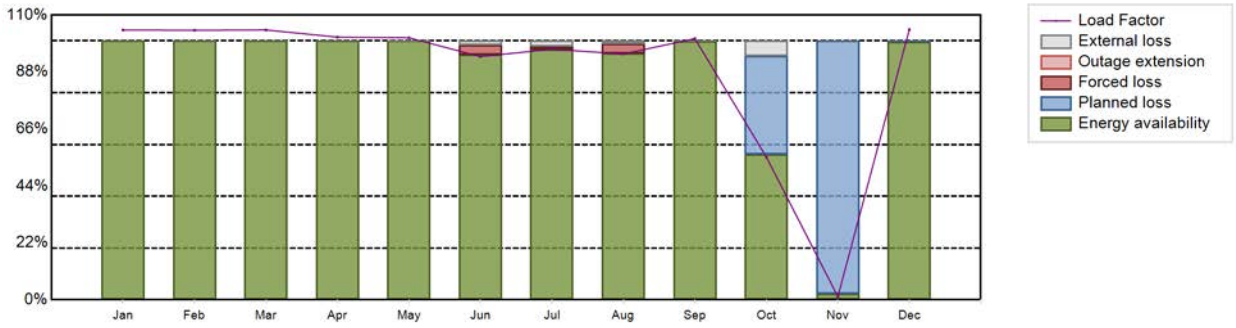
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	16
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	322
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	30	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	40000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6
Active core height/length [m]	:	3.53	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7698.57 GW(e).h	Forced Loss Rate (FLR)	:	0.84 %
Energy Availability Factor (EAF)	:	87.11 %	Unplanned Capability Loss Factor (UCL)	:	0.74 %
Unit Capability Factor (UCF)	:	87.99 %	Planned Unavailability Factor (PUF)	:	11.26 %
Load Factor (LF)	:	88.62 %	Externally cause unavailability (XUF)	:	0.89 %
Operating Factor (OF)	:	88.32 %	Total off-line time	:	1026 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	766.82	716.62	766.91	722.57	744.75	668.93	712.30	698.71	718.32	405.66	8.96	768.03	7698.57
EAF [%]	100.00	100.00	100.00	100.00	100.00	94.63	96.71	95.08	99.90	56.11	2.30	99.73	87.11
UCF [%]	100.00	100.00	100.00	100.00	100.00	96.23	98.77	96.12	100.00	61.84	2.30	99.73	87.99
LF [%]	104.21	104.11	104.23	101.47	101.21	93.94	96.80	94.96	100.88	55.13	1.26	104.38	88.62
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	99.06	96.51	100.00	61.56	1.81	100.00	88.32
FLR [%]	0.00	0.00	0.00	0.00	0.00	3.77	1.23	3.88	0.00	0.00	0.00	0.00	0.84
UCL [%]	0.00	0.00	0.00	0.00	0.00	3.77	1.23	3.88	0.00	0.00	0.00	0.00	0.74
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.16	97.70	0.27	11.26
XUF [%]	0.00	0.00	0.00	0.00	0.00	1.60	2.05	1.04	0.10	5.74	0.00	0.00	0.89

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Historical Summary

Lifetime energy generation	:	179363.52 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.08 %
Cumulative Energy Availability Factor (EAF)	:	88 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.23 %
Cumulative Unit Capability Factor (UCF)	:	88.4 %	Cumulative Planned Unavailability Factor (PUF)	:	10.37 %
Cumulative Load Factor (LF)	:	90.92 %	Cumulative Externally cause unavailability (XUF)	:	0.4 %
Cumulative Operating Factor (OF)	:	88.69 %			

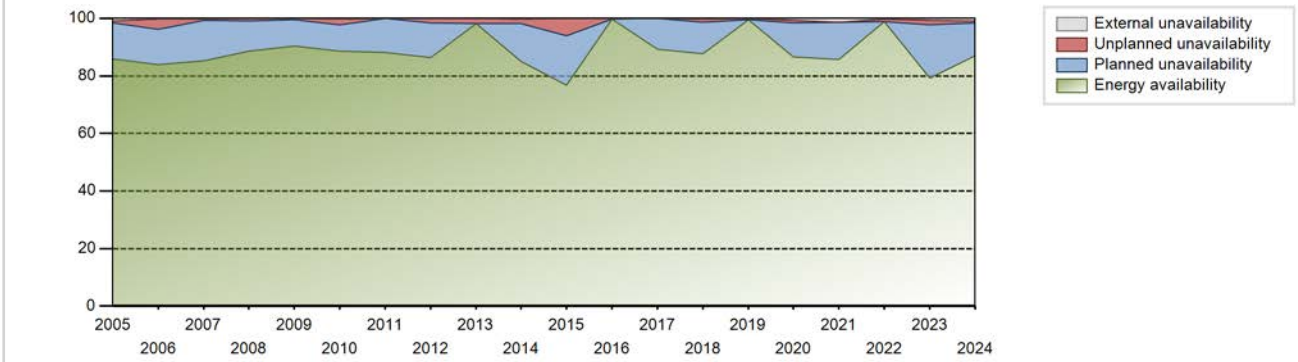
Electricity Production (net) [GWh]



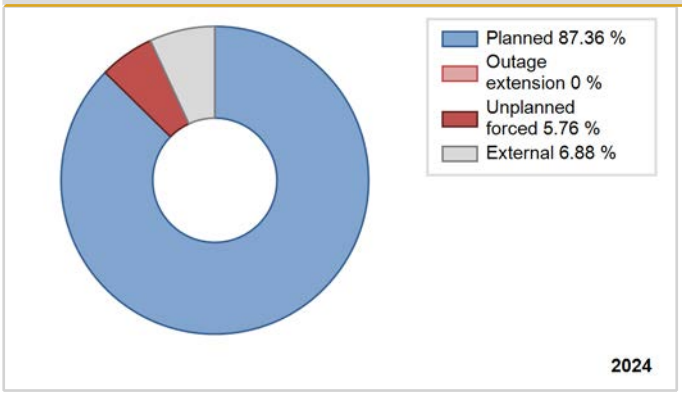
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2001	Data not provided										
2002	7176.18	7543	950	84.06	85.51	86.23	86.11	1.33	1.16	13.33	1.45
2003	6973.93	7154	950	81.33	82.56	83.80	81.67	2.81	2.39	15.05	1.23
2004	7439.31	7766	950	87.75	87.96	89.15	88.41	0.19	0.17	11.87	0.21
2005	7232.86	7628	950	85.85	86.87	86.90	87.07	0.60	0.52	12.60	1.02
2006	7216.42	7386	950	83.82	84.19	86.71	84.32	0.29	3.46	12.35	0.38
2007	7309.44	7536	950	85.28	85.48	87.83	86.03	0.55	0.47	14.04	0.20
2008	7745.73	7799	950	88.53	88.56	92.82	88.79	1.00	0.89	10.54	0.03
2009	7927.02	7916	950	90.27	90.29	95.25	90.37	0.52	0.47	9.25	0.01
2010	7398.47	7828	950	88.60	88.91	88.90	89.36	2.23	2.02	9.06	0.32
2011	7695.35	7736	950	88.24	88.24	92.48	88.32	0.09	0.08	11.68	0.00
2012	7569.03	7614	950	86.42	86.51	90.70	86.68	0.10	1.40	12.09	0.09
2013	8557.12	8618	950	98.15	98.15	102.83	98.38	1.85	1.85	0.00	0.00
2014	7227.67	7498	950	85.13	85.37	86.84	85.58	1.82	1.58	13.05	0.25
2015	6713.50	6980	950	76.83	76.83	80.67	79.68	7.21	5.97	17.21	0.00
2016	8833.60	8753	950	99.63	99.63	105.86	99.65	0.37	0.37	0.00	0.00
2017	7840.38	7825	950	89.24	89.24	94.21	89.33	0.01	0.01	10.76	0.00
2018	7609.90	7719	950	87.71	87.98	91.44	88.12	0.74	1.07	10.95	0.27
2019	8620.25	8723	950	99.49	99.52	103.58	99.58	0.48	0.48	0.00	0.03
2020	7443.25	7689	950	86.60	87.29	89.20	87.53	0.96	0.85	11.86	0.68
2021	7416.99	7622	989	85.73	87.04	85.61	87.01	0.00	0.00	12.96	1.31
2022	8753.70	8728	989	98.87	99.02	101.04	99.63	0.98	0.98	0.00	0.14
2023	6993.42	7011	989	79.28	79.95	80.72	80.03	0.39	1.52	18.53	0.67
2024	7698.57	7758	989	87.11	87.99	88.62	88.32	0.84	0.74	11.26	0.89

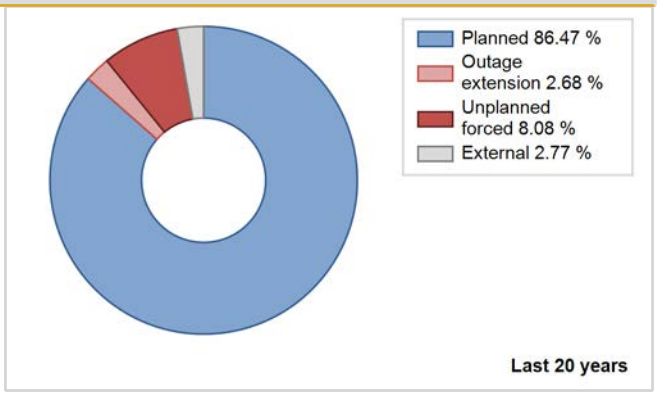
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2001 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		33			83	
C. Inspection, maintenance or repair combined with refuelling	993			894		
D. Inspection, maintenance or repair without refuelling				6		
E. Testing of plant systems or components					1	
L. Human factor related					3	
Subtotal	993	33		900	87	
Total		**1026**			**987**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2001 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		3
14. Safety Systems		1
16. Steam generation systems		30
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries	26	2
33. Circulating Water System		3
35. All other I&C Systems		0
41. Main Generator Systems	7	27
42. Electrical Power Supply Systems		18
Total	**33**	**85**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in intermediate repair. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-62 ROSTOV-2 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	FAEA (Federal Atomic Energy Agency)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1983-05-01
Grid Date	:	2010-03-18
Commercial Date	:	2010-12-10
Age at end of year	:	14 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	30
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	-
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

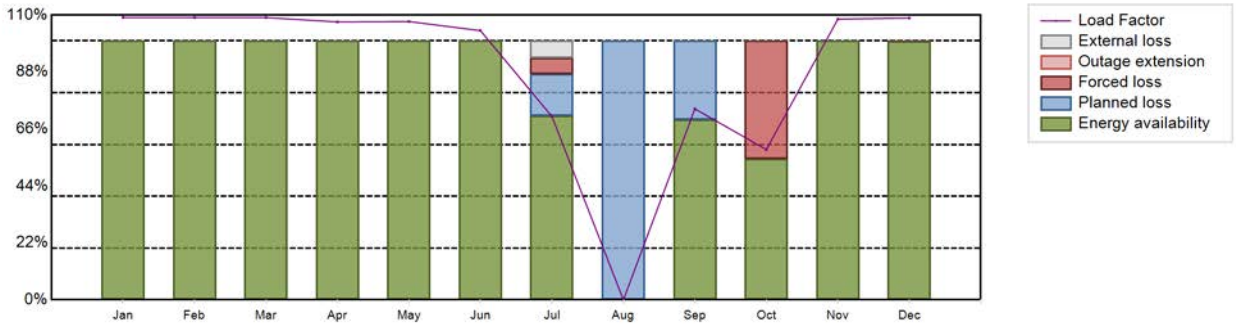
Operating coolant pressure [MPa]	:	0.7
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7393.31 GW(e).h
Energy Availability Factor (EAF)	:	82.74 %
Unit Capability Factor (UCF)	:	83.3 %
Load Factor (LF)	:	88.6 %
Operating Factor (OF)	:	83.33 %

Forced Loss Rate (FLR)	:	4.99 %
Unplanned Capability Loss Factor (UCL)	:	4.38 %
Planned Unavailability Factor (PUF)	:	12.33 %
Externally cause unavailability (XUF)	:	0.56 %
Total off-line time	:	1464 hours

Annual Summary



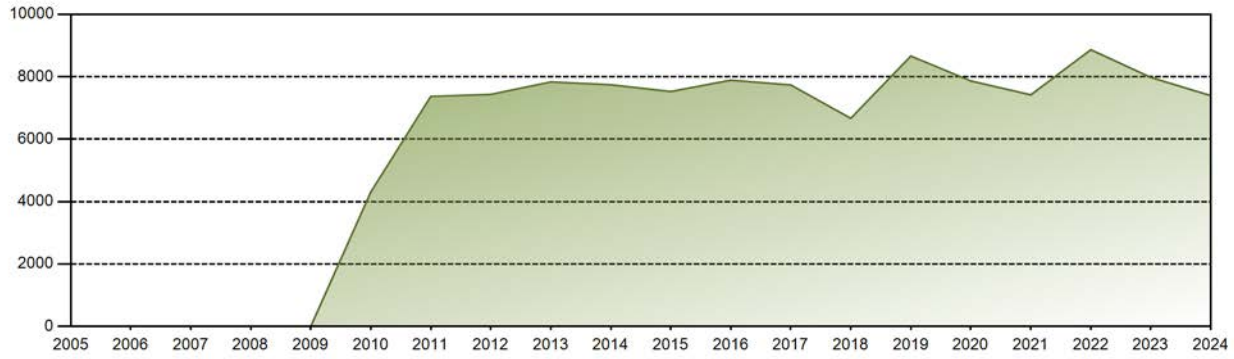
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	770.77	720.90	770.42	734.14	759.70	711.25	500.69	0.00	504.48	410.06	741.60	769.29	7393.31
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	71.04	0.00	69.63	54.54	100.00	99.98	82.74
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	77.68	0.00	69.63	54.54	100.00	99.98	83.30
LF [%]	109.05	109.03	109.00	107.33	107.48	103.98	70.84	0.00	73.75	58.02	108.42	108.84	88.60
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	76.75	0.00	70.69	54.84	100.00	100.00	83.33
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	7.39	0.00	0.00	45.46	0.00	0.02	4.99
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	6.20	0.00	0.00	45.46	0.00	0.02	4.38
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	16.13	100.00	30.37	0.00	0.00	0.00	12.33
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	6.64	0.00	0.00	0.00	0.00	0.00	0.56

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Historical Summary

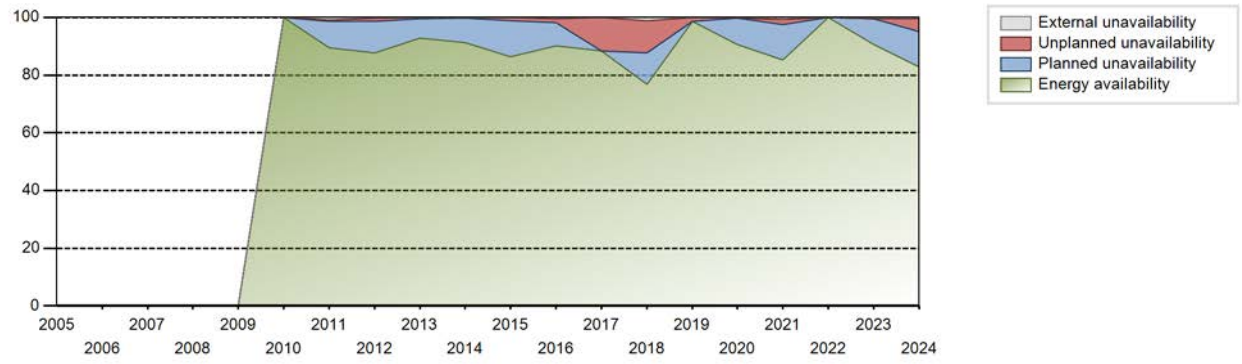
Lifetime energy generation	:	112677.58 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.66 %
Cumulative Energy Availability Factor (EAF)	:	89.38 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.5 %
Cumulative Unit Capability Factor (UCF)	:	89.71 %	Cumulative Planned Unavailability Factor (PUF)	:	7.79 %
Cumulative Load Factor (LF)	:	92.98 %	Cumulative Externally cause unavailability (XUF)	:	0.34 %
Cumulative Operating Factor (OF)	:	89.93 %			

Electricity Production (net) [GWh]



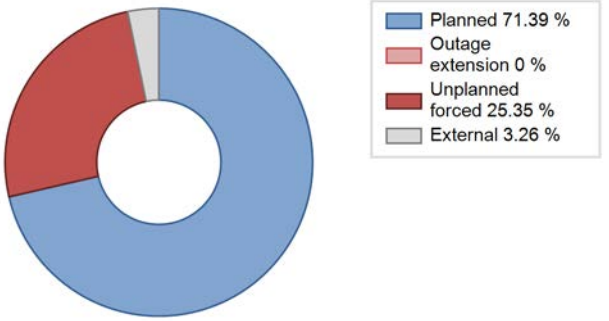
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2010	4303.76	6133	950	100.00	100.00	97.93	100.00	0.00	0.00	0.00	0.00
2011	7368.43	7944	950	89.41	90.23	88.55	90.70	0.63	0.58	9.19	0.82
2012	7433.18	7781	950	87.61	87.79	89.08	88.58	1.30	1.16	11.05	0.18
2013	7832.67	8151	950	92.80	92.80	94.12	93.05	0.55	0.51	6.69	0.00
2014	7741.45	8018	950	91.20	91.29	93.01	91.52	0.26	0.24	8.47	0.09
2015	7525.83	7610	950	86.39	86.41	90.43	86.87	1.26	1.11	12.48	0.03
2016	7890.03	7974	950	90.15	90.69	94.55	90.78	1.44	1.33	7.98	0.54
2017	7734.15	7755	950	88.29	88.31	92.94	88.53	11.64	11.63	0.06	0.01
2018	6666.68	6845	950	76.80	77.90	80.11	78.14	12.50	11.13	10.98	1.09
2019	8662.06	8650	950	98.71	98.72	104.09	98.74	1.28	1.28	0.00	0.01
2020	7864.15	7982	950	90.61	90.79	94.24	90.87	0.01	0.01	9.21	0.18
2021	7418.56	7532	950	85.14	85.85	89.14	85.98	1.31	1.79	12.36	0.71
2022	8865.36	8760	950	99.97	99.97	106.53	100.00	0.03	0.03	0.00	0.00
2023	7978.31	7985	950	90.55	91.06	95.87	91.15	0.02	0.02	8.93	0.51
2024	7393.31	7320	950	82.74	83.30	88.60	83.33	4.99	4.38	12.33	0.56

Key Factors in Last 20 Years [%]

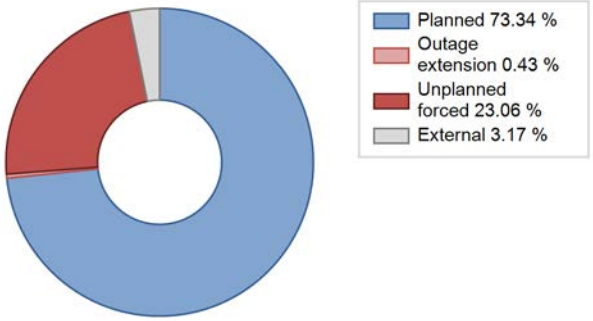


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Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2010 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		389			203	
C. Inspection, maintenance or repair combined with refuelling	1075			632		
D. Inspection, maintenance or repair without refuelling				41		
J. Grid limitation, failure or grid unavailability						1
Z. Other					4	
Subtotal	1075	389		673	207	1
Total	**1464**			**881**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2010 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		6
13. Reactor Auxiliary Systems	336	23
15. Reactor Cooling Systems		4
16. Steam generation systems		10
31. Turbine and auxiliaries		33
33. Circulating Water System	53	4
41. Main Generator Systems		74
42. Electrical Power Supply Systems		39
Total	**389**	**193**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the overhaul outages. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-63 ROSTOV-3 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	AEM (Atomenergomash)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	2009-09-15
Grid Date	:	2014-12-27
Commercial Date	:	2015-09-17
Age at end of year	:	10 years

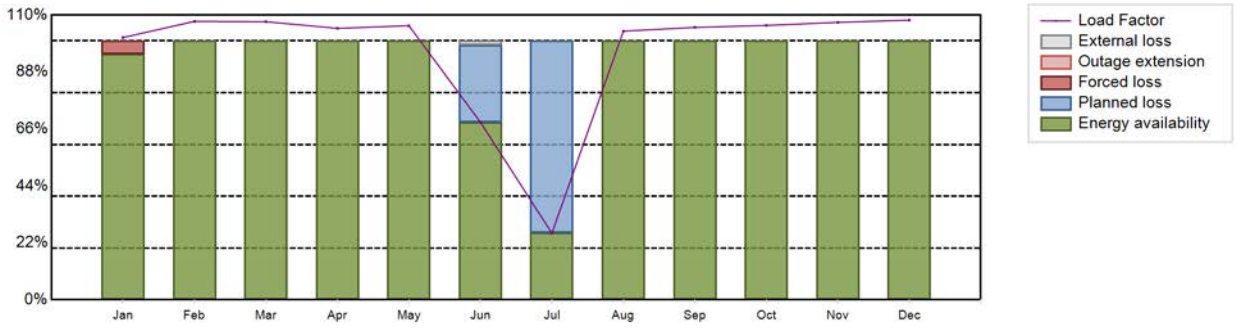
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8001.65 GW(e).h	Forced Loss Rate (FLR)	:	0.47 %
Energy Availability Factor (EAF)	:	90.74 %	Unplanned Capability Loss Factor (UCL)	:	0.42 %
Unit Capability Factor (UCF)	:	90.87 %	Planned Unavailability Factor (PUF)	:	8.71 %
Load Factor (LF)	:	95.89 %	Externally cause unavailability (XUF)	:	0.12 %
Operating Factor (OF)	:	91.38 %	Total off-line time	:	757 hours

Annual Summary



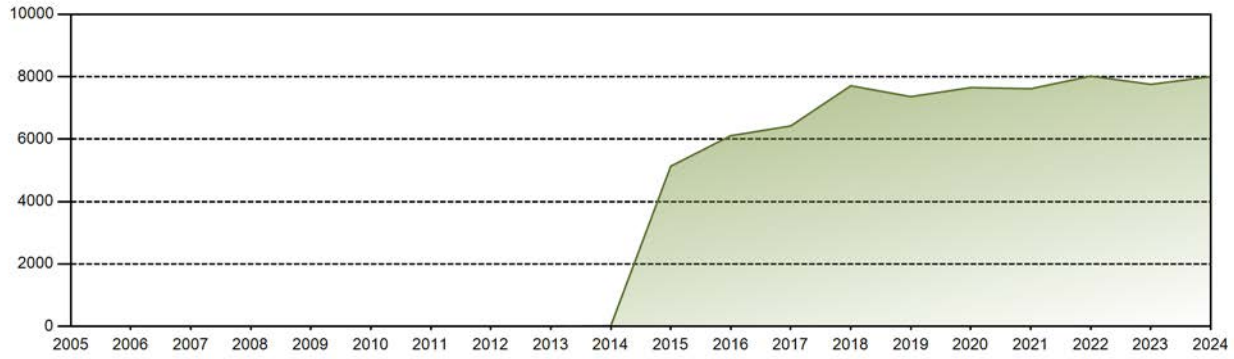
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	715.97	711.10	759.15	717.21	748.25	469.32	182.00	733.43	719.71	749.13	732.96	763.45	8001.65
EAF [%]	94.99	100.00	100.00	100.00	100.00	68.70	25.98	100.00	100.00	100.00	100.00	100.00	90.74
UCF [%]	94.99	100.00	100.00	100.00	100.00	70.22	25.98	100.00	100.00	100.00	100.00	100.00	90.87
LF [%]	101.30	107.55	107.41	104.85	105.86	68.61	25.75	103.77	105.22	105.99	107.16	108.01	95.89
OF [%]	100.00	100.00	100.00	100.00	100.00	70.56	26.75	100.00	100.00	100.00	100.00	100.00	91.38
FLR [%]	5.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47
UCL [%]	5.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42
PUF [%]	0.00	0.00	0.00	0.00	0.00	29.78	74.02	0.00	0.00	0.00	0.00	0.00	8.71
XUF [%]	0.00	0.00	0.00	0.00	0.00	1.52	0.00	0.00	0.00	0.00	0.00	0.00	0.12

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Historical Summary

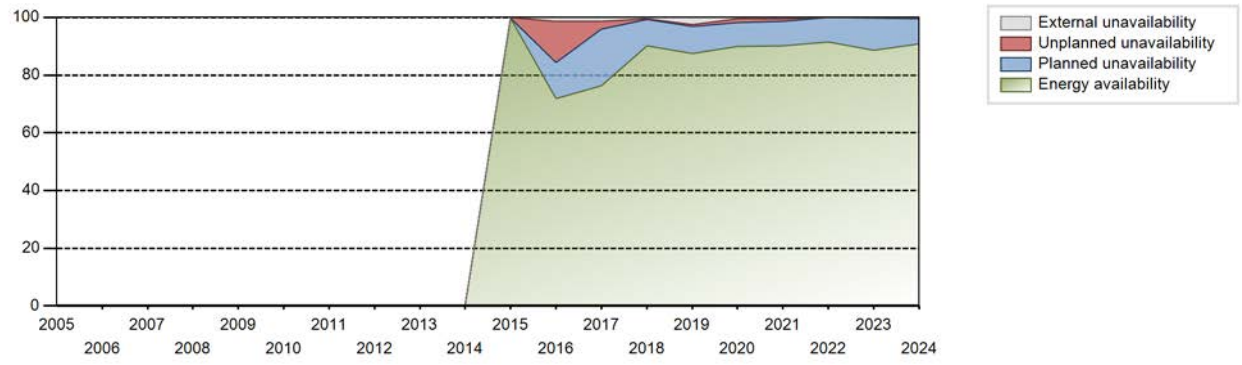
Lifetime energy generation	:	71777.88 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.31 %
Cumulative Energy Availability Factor (EAF)	:	86.7 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.25 %
Cumulative Unit Capability Factor (UCF)	:	87.46 %	Cumulative Planned Unavailability Factor (PUF)	:	10.29 %
Cumulative Load Factor (LF)	:	89.33 %	Cumulative Externally cause unavailability (XUF)	:	0.75 %
Cumulative Operating Factor (OF)	:	88.2 %			

Electricity Production (net) [GWh]



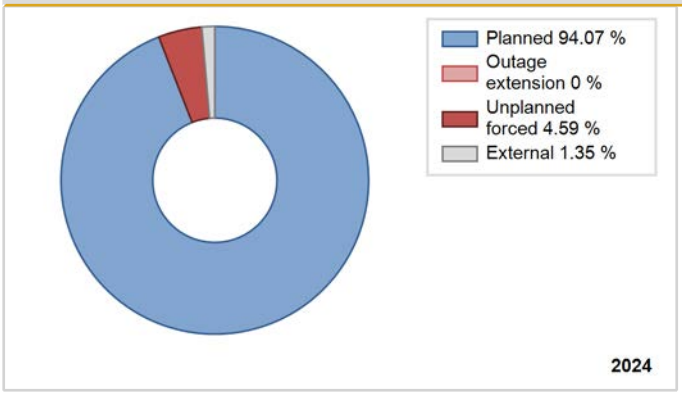
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2015	5132.22	7040	950	99.65	99.65	104.56	100.00	0.35	0.35	0.00	0.00
2016	6110.00	6728	950	71.98	73.43	73.22	76.59	5.40	14.24	12.33	1.45
2017	6422.53	6888	950	76.35	77.80	77.18	78.63	3.24	2.60	19.60	1.45
2018	7709.57	7962	950	90.24	90.77	92.64	90.89	0.30	0.27	8.95	0.53
2019	7360.63	7848	950	87.53	89.97	88.45	89.59	0.71	0.64	9.39	2.44
2020	7651.88	8081	950	89.89	90.36	91.70	92.00	1.38	1.26	8.38	0.47
2021	7615.55	8010	950	90.16	90.67	91.51	91.44	0.97	0.89	8.45	0.51
2022	8018.57	8016	950	91.52	91.52	96.35	91.51	0.00	0.00	8.48	0.00
2023	7755.53	7783	950	88.69	88.69	93.19	88.85	0.38	0.34	10.97	0.00
2024	8001.65	8027	950	90.74	90.87	95.89	91.38	0.47	0.42	8.71	0.12

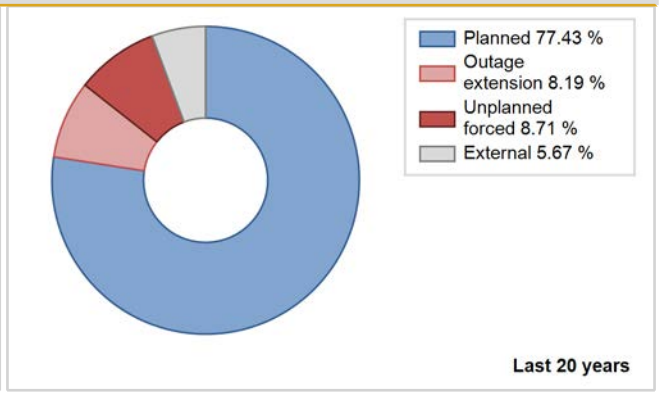
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2015 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					139	
C. Inspection, maintenance or repair combined with refuelling	758			702		
D. Inspection, maintenance or repair without refuelling				11		
G. Major backfitting, refurbishment or upgrading activities without refuelling				181		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						7
Subtotal	758			894	139	7
Total	**758**			**1040**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2015 to 2024 Average hours lost per reactor-year
15. Reactor Cooling Systems		20
16. Steam generation systems		2
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		2
33. Circulating Water System		1
41. Main Generator Systems		2
42. Electrical Power Supply Systems		90
Total		**128**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the intermediate repair. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-64 ROSTOV-4 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	AEM (Atomenergomash)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1030 MWe
Reference unit power (net)	:	979 MWe

Key Dates

Construction Date	:	2010-06-16
Grid Date	:	2018-02-02
Commercial Date	:	2018-09-28
Age at end of year	:	6 years

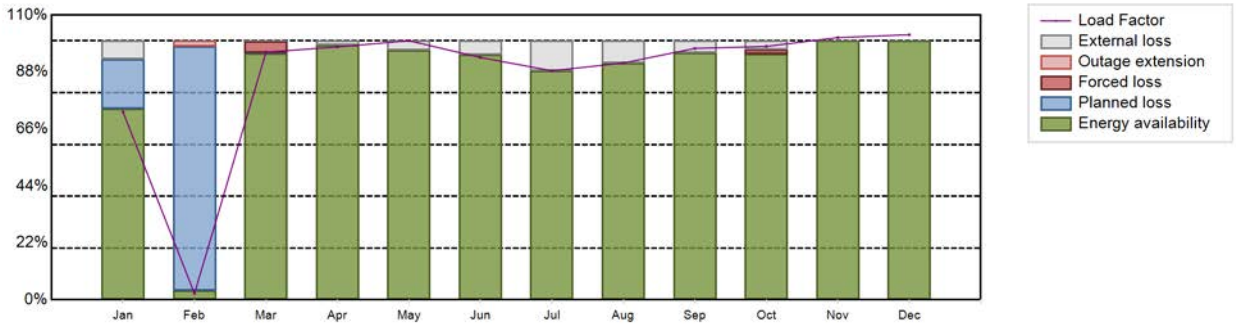
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7486.94 GW(e).h	Forced Loss Rate (FLR)	:	0.59 %
Energy Availability Factor (EAF)	:	86.35 %	Unplanned Capability Loss Factor (UCL)	:	0.71 %
Unit Capability Factor (UCF)	:	90.2 %	Planned Unavailability Factor (PUF)	:	9.09 %
Load Factor (LF)	:	87.06 %	Externally cause unavailability (XUF)	:	3.85 %
Operating Factor (OF)	:	90.49 %	Total off-line time	:	835 hours

Annual Summary



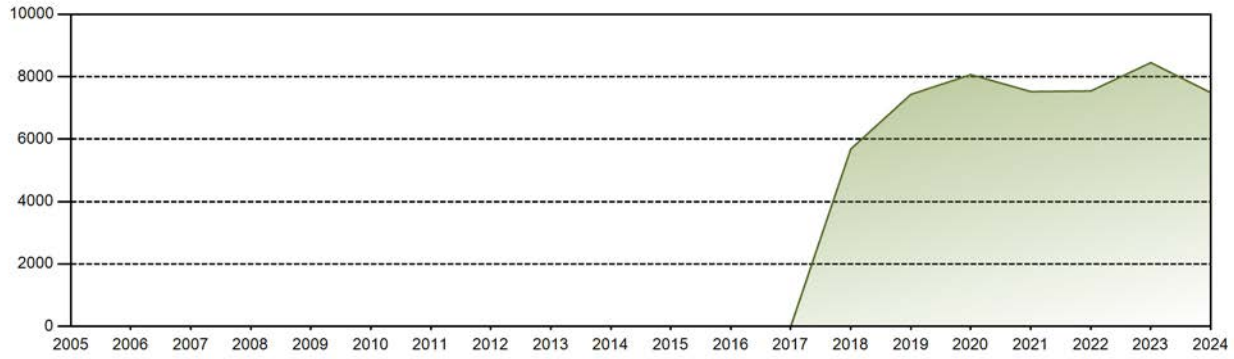
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	528.68	16.57	696.66	688.38	728.95	659.73	644.36	666.26	684.54	713.00	713.92	745.89	7486.94
EAF [%]	73.74	3.58	95.26	98.38	96.34	94.67	88.48	91.50	95.33	94.93	100.00	100.00	86.35
UCF [%]	80.86	3.58	95.39	100.00	100.00	100.00	100.00	100.00	100.00	98.24	100.00	100.00	90.20
LF [%]	72.58	2.43	95.65	97.66	100.08	93.59	88.47	91.47	97.11	97.89	101.28	102.40	87.06
OF [%]	81.18	4.74	95.70	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.49
FLR [%]	0.00	0.00	4.60	0.00	0.00	0.00	0.00	0.00	0.00	1.76	0.00	0.00	0.59
UCL [%]	0.00	2.13	4.60	0.00	0.00	0.00	0.00	0.00	0.00	1.76	0.00	0.00	0.71
PUF [%]	19.14	94.29	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09
XUF [%]	7.11	0.00	0.13	1.62	3.66	5.33	11.52	8.50	4.67	3.31	0.00	0.00	3.85

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Historical Summary

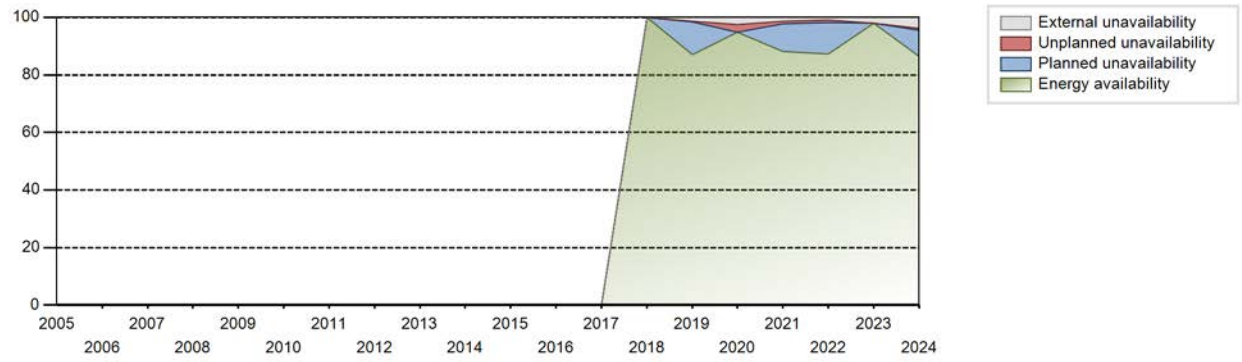
Lifetime energy generation	:	52113.84 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.87 %
Cumulative Energy Availability Factor (EAF)	:	90.63 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.84 %
Cumulative Unit Capability Factor (UCF)	:	92.58 %	Cumulative Planned Unavailability Factor (PUF)	:	6.58 %
Cumulative Load Factor (LF)	:	90.81 %	Cumulative Externally cause unavailability (XUF)	:	1.95 %
Cumulative Operating Factor (OF)	:	92.79 %			

Electricity Production (net) [GWh]

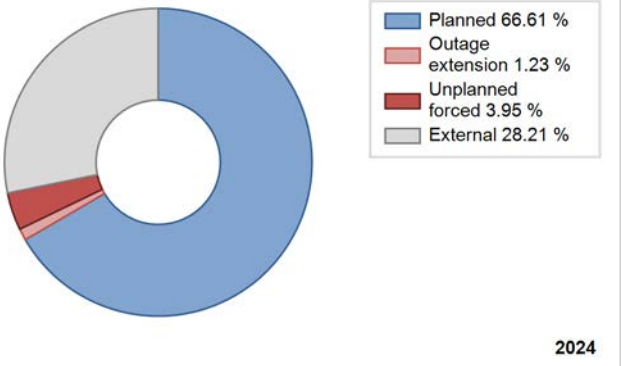


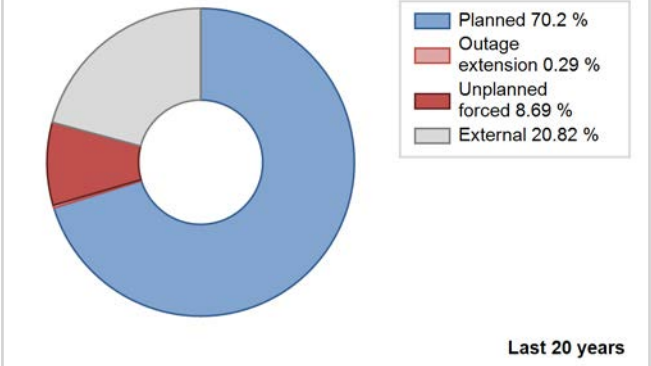
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2018	5681.92	6556	950	99.97	99.99	103.76	100.00	0.01	0.01	0.00	0.01
2019	7430.57	7751	979	87.01	88.29	86.64	88.48	0.40	0.35	11.36	1.28
2020	8066.50	8573	979	94.86	97.45	93.80	97.60	2.50	2.50	0.05	2.58
2021	7521.96	7862	979	88.05	89.52	87.71	89.75	0.91	0.82	9.66	1.47
2022	7542.06	7761	979	87.28	88.19	87.94	88.60	0.98	0.87	10.94	0.91
2023	8450.68	8760	979	97.92	100.00	98.54	100.00	0.00	0.00	0.00	2.08
2024	7486.94	7949	979	86.35	90.20	87.06	90.49	0.59	0.71	9.09	3.85

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2018 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		32			61	
C. Inspection, maintenance or repair combined with refuelling	788			593		
L. Human factor related					1	
Z. Other		15			2	
Subtotal	788	47		593	64	
Total	**835**			**657**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2018 to 2024
	Hours Lost	Average hours lost per reactor-year
16. Steam generation systems		15
31. Turbine and auxiliaries		9
32. Feedwater and Main Steam System		31
33. Circulating Water System		1
41. Main Generator Systems	32	5
Total	**32**	**61**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the intermediate repair. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-23 SMOLENSK-1 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	LWGR / RBMK-1000
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	925 MWe

Key Dates

Construction Date	:	1975-10-01
Grid Date	:	1982-12-09
Commercial Date	:	1983-09-30
Age at end of year	:	42 years

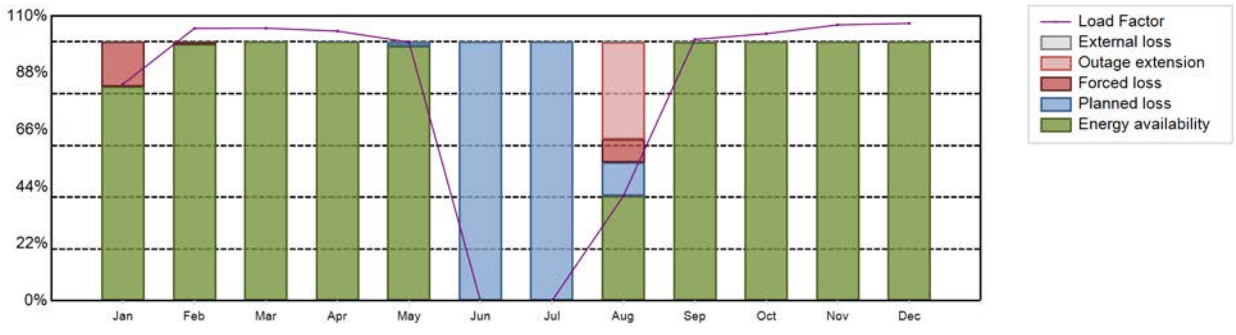
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	22200
Active core diameter [m]	:	11.8
Active core height/length [m]	:	7
Number of fissile fuel assemblies/bundles	:	1661
Fuel linear heat generation rate [kW/m]	:	14.5
Number of control rod assemblies	:	175
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	284
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.59
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	PH / DH

Annual Production Results (2024)

Net Energy Production	:	6467.88 GW(e).h
Energy Availability Factor (EAF)	:	76.66 %
Unit Capability Factor (UCF)	:	76.69 %
Load Factor (LF)	:	79.6 %
Operating Factor (OF)	:	77.76 %
Equivalent non-electrical energy generated (NEG)	:	84.03 GW(e).h
Forced Loss Rate (FLR)	:	2.9 %
Unplanned Capability Loss Factor (UCL)	:	5.46 %
Planned Unavailability Factor (PUF)	:	17.85 %
Externally cause unavailability (XUF)	:	0.03 %
Total off-line time	:	1954 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	575.88	677.40	724.80	693.72	687.70	0.00	0.00	278.83	672.22	710.12	709.78	737.44	6467.88
EAF [%]	82.78	99.21	100.00	99.99	98.47	0.16	0.00	40.59	99.94	100.00	100.00	100.00	76.66
UCF [%]	82.78	99.21	100.00	99.99	98.67	0.16	0.00	40.73	100.00	100.00	100.00	100.00	76.69
LF [%]	83.68	105.22	105.32	104.16	99.93	0.00	0.00	40.52	100.93	103.18	106.57	107.15	79.60
OF [%]	84.01	100.00	100.00	100.00	100.00	0.42	0.00	49.73	100.00	100.00	100.00	100.00	77.76
FLR [%]	17.22	0.79	0.00	0.00	0.00	0.00	0.00	18.30	0.00	0.00	0.00	0.00	2.90
UCL [%]	17.22	0.79	0.00	0.00	0.00	0.00	0.00	46.49	0.00	0.00	0.00	0.00	5.46
PUF [%]	0.00	0.00	0.00	0.01	1.33	99.84	100.00	12.79	0.00	0.00	0.00	0.00	17.85
XUF [%]	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.13	0.06	0.00	0.00	0.00	0.03

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Historical Summary

Lifetime energy generation	:	253590.94 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.45 %
Cumulative Energy Availability Factor (EAF)	:	74.21 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.1 %
Cumulative Unit Capability Factor (UCF)	:	75.82 %	Cumulative Planned Unavailability Factor (PUF)	:	22.08 %
Cumulative Load Factor (LF)	:	74.99 %	Cumulative Externally cause unavailability (XUF)	:	1.62 %
Cumulative Operating Factor (OF)	:	77.32 %			

Electricity Production (net) [GWh]

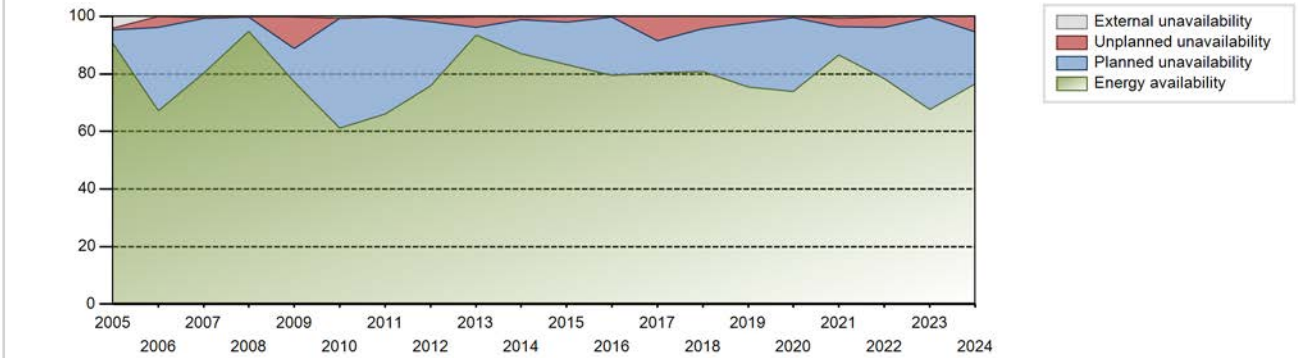


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	4744.20	7223	925	99.64	99.64	100.76	99.86	0.36	0.36	0.00	0.00
1984	6921.35	7830	925	84.23	84.23	85.18	89.14	2.64	2.28	13.49	0.00
1985	5850.24	6806	925	72.40	74.87	72.20	77.69	1.52	1.15	23.97	2.47
1986	3039.75	3472	925	37.79	37.79	37.51	39.63	0.05	0.02	62.20	0.00
1987	7445.76	7620	1000	86.72	86.72	85.00	86.99	2.08	1.84	11.44	0.00
1988	6695.59	7288	925	81.89	81.89	82.41	82.97	0.44	0.36	17.75	0.00
1989	6506.46	7177	925	79.32	79.70	80.30	81.93	6.44	5.49	14.82	0.38
1990	6227.84	6851	925	76.14	76.59	76.86	78.21	3.90	3.11	20.30	0.45
1991	6693.92	7252	925	81.29	81.29	82.61	82.79	3.68	3.11	15.60	0.00
1992	6849.38	7563	925	83.69	83.69	84.31	86.11	2.55	2.19	14.12	0.00
1993	6290.56	6993	925	78.01	78.41	77.63	79.83	0.38	0.30	21.29	0.40
1994	4217.84	6286	925	57.81	71.04	52.05	71.76	0.20	0.14	28.82	13.23
1995	5002.47	6390	925	62.97	77.35	61.74	72.95	1.91	1.50	21.15	14.38
1996	5666.43	6604	925	71.56	71.73	69.74	75.18	1.05	0.76	27.51	0.17
1997	4674.51	5366	925	57.82	59.14	57.69	61.26	2.88	1.75	39.11	1.32
1998	3554.08	5411	925	45.04	58.85	43.86	61.77	3.49	2.13	39.02	13.81
1999	6478.89	7417	925	80.06	83.51	79.96	84.67	3.29	2.84	13.65	3.45
2000	5228.48	5738	925	63.83	64.36	64.35	65.32	0.06	0.04	35.60	0.53
2001	5165.12	5940	925	63.24	67.43	63.74	67.81	2.61	1.81	30.76	4.19
2002	6866.73	7587	925	83.69	85.10	84.74	86.61	2.59	2.26	12.64	1.41
2003	6711.76	7533	925	82.90	84.38	82.83	85.99	3.18	2.77	12.85	1.48
2004	2337.12	2592	925	28.50	29.09	28.76	29.51	0.00	0.00	70.91	0.59
2005	7354.10	8414	925	90.63	94.66	90.75	96.04	0.80	0.76	4.58	4.03
2006	5417.08	6021	925	67.09	67.09	66.85	68.73	1.33	3.79	29.12	0.00
2007	6569.65	7138	925	80.25	80.82	81.08	81.48	0.20	0.16	19.02	0.57
2008	7794.93	8430	925	94.94	95.19	95.94	95.97	0.01	0.01	4.79	0.25
2009	6122.29	6974	925	77.32	77.60	75.56	79.61	12.28	10.86	11.54	0.28
2010	4896.26	5424	925	61.10	61.75	60.43	61.92	0.02	0.01	38.24	0.65
2011	5444.54	5899	925	65.97	66.24	67.20	67.35	0.05	0.03	33.73	0.27
2012	6306.76	6741	925	75.88	76.32	77.62	76.74	1.76	1.37	22.31	0.45
2013	7775.27	8267	925	93.47	93.80	95.96	94.37	3.63	3.53	2.67	0.34
2014	7330.99	7691	925	87.06	87.27	90.46	87.79	0.92	0.83	11.89	0.21
2015	7050.99	7394	925	83.24	83.37	87.02	84.41	2.18	1.86	14.77	0.14
2016	6746.07	7003	925	79.38	79.45	83.03	79.72	0.15	0.12	20.42	0.07
2017	6710.68	7720	925	80.35	80.44	82.82	88.13	9.47	8.41	11.15	0.08
2018	6788.06	7256	925	80.82	80.92	83.77	82.83	4.80	4.08	15.00	0.10
2019	6373.86	6673	925	75.51	75.51	78.66	76.18	0.54	2.32	22.17	0.00

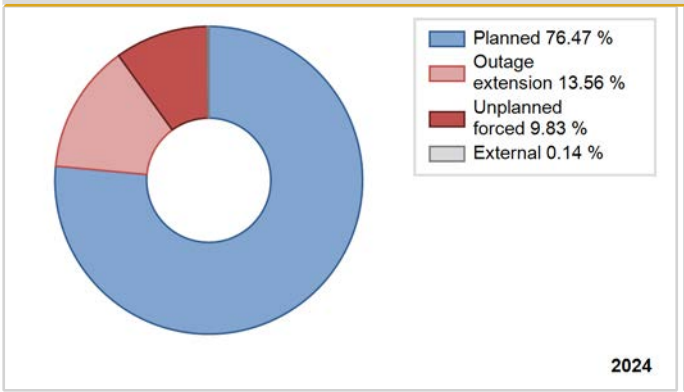
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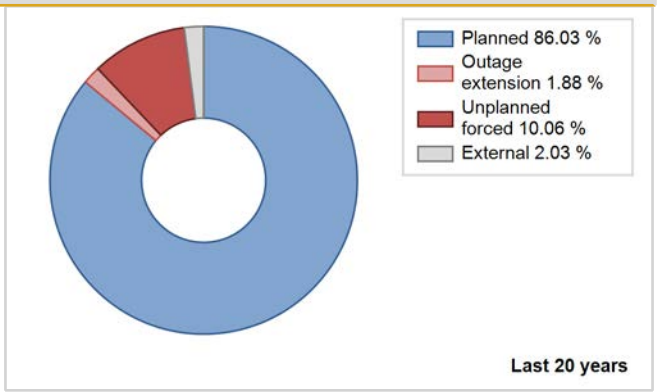
2020	6155.00	6930	925	73.88	73.96	75.75	78.89	0.51	0.38	25.66	0.08
2021	7267.29	7736	925	86.52	87.17	89.69	88.31	3.27	2.94	9.89	0.66
2022	6594.48	7001	925	78.31	78.56	81.38	79.92	4.46	3.67	17.78	0.24
2023	5689.02	6153	925	67.72	67.85	70.21	70.24	0.03	0.02	32.13	0.13
2024	6467.88	6830	925	76.66	76.69	79.60	77.76	2.90	5.46	17.85	0.03

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1983 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		418			110	
C. Inspection, maintenance or repair combined with refuelling	1558			1226		
D. Inspection, maintenance or repair without refuelling				258		
E. Testing of plant systems or components				18		
G. Major backfitting, refurbishment or upgrading activities without refuelling				249		
J. Grid limitation, failure or grid unavailability						4
L. Human factor related					1	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						11
Subtotal	1558	418		1751	111	15
Total	**1976**			**1877**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		19
12. Reactor I&C Systems		12
13. Reactor Auxiliary Systems		12
14. Safety Systems		12
15. Reactor Cooling Systems		21
16. Steam generation systems	140	4
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		2
31. Turbine and auxiliaries	278	7
32. Feedwater and Main Steam System		8
34. Miscellaneous Systems		5
42. Electrical Power Supply Systems		7
Total	**418**	**110**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the routine maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-24 SMOLENSK-2 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	LWGR / RBMK-1000
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	925 MWe

Key Dates

Construction Date	:	1976-06-01
Grid Date	:	1985-05-31
Commercial Date	:	1985-07-02
Age at end of year	:	39 years

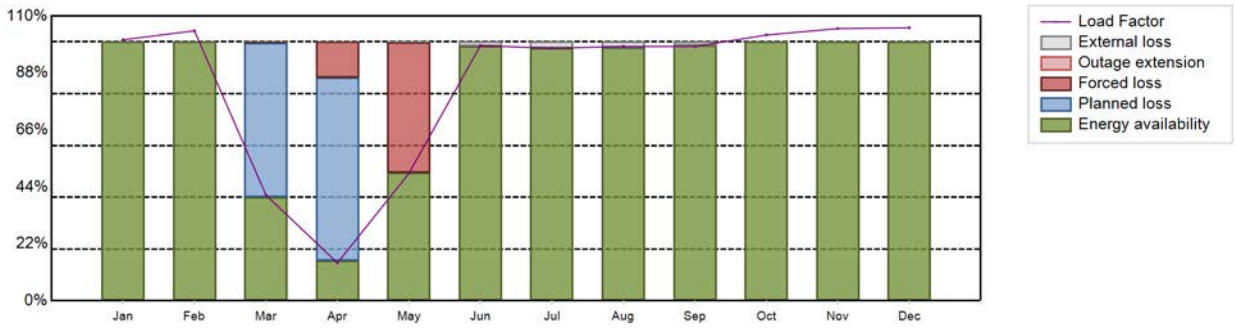
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	22200
Active core diameter [m]	:	11.8
Active core height/length [m]	:	7
Number of fissile fuel assemblies/bundles	:	1661
Fuel linear heat generation rate [kW/m]	:	14.5
Number of control rod assemblies	:	175
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	284
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.59
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	PH / DH

Annual Production Results (2024)

Net Energy Production	:	6873.48 GW(e).h
Energy Availability Factor (EAF)	:	83.07 %
Unit Capability Factor (UCF)	:	83.73 %
Load Factor (LF)	:	84.59 %
Operating Factor (OF)	:	89.73 %
Equivalent non-electrical energy generated (NEG)	:	50.65 GW(e).h
Forced Loss Rate (FLR)	:	6.09 %
Unplanned Capability Loss Factor (UCL)	:	5.43 %
Planned Unavailability Factor (PUF)	:	10.83 %
Externally cause unavailability (XUF)	:	0.66 %
Total off-line time	:	902 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	693.88	671.38	281.11	97.55	338.97	656.53	671.14	676.16	654.21	706.48	700.20	725.86	6873.48
EAF [%]	100.00	100.00	40.10	15.56	49.45	98.28	97.52	97.87	98.53	100.00	100.00	100.00	83.07
UCF [%]	100.00	100.00	40.10	15.56	49.68	99.92	100.00	99.94	100.00	100.00	100.00	100.00	83.73
LF [%]	100.83	104.28	40.85	14.65	49.25	98.58	97.52	98.25	98.23	102.66	105.14	105.47	84.59
OF [%]	100.00	100.00	42.34	34.31	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.73
FLR [%]	0.00	0.00	1.16	46.89	50.32	0.08	0.00	0.00	0.00	0.00	0.00	0.00	6.09
UCL [%]	0.00	0.00	0.47	13.74	50.32	0.08	0.00	0.00	0.00	0.00	0.00	0.00	5.43
PUF [%]	0.00	0.00	59.43	70.70	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	10.83
XUF [%]	0.00	0.00	0.00	0.00	0.23	1.64	2.48	2.07	1.47	0.00	0.00	0.00	0.66

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Historical Summary

Lifetime energy generation	:	247615.62 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.82 %
Cumulative Energy Availability Factor (EAF)	:	76.47 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.43 %
Cumulative Unit Capability Factor (UCF)	:	78.2 %	Cumulative Planned Unavailability Factor (PUF)	:	19.37 %
Cumulative Load Factor (LF)	:	77.13 %	Cumulative Externally cause unavailability (XUF)	:	1.72 %
Cumulative Operating Factor (OF)	:	80.32 %			

Electricity Production (net) [GWh]

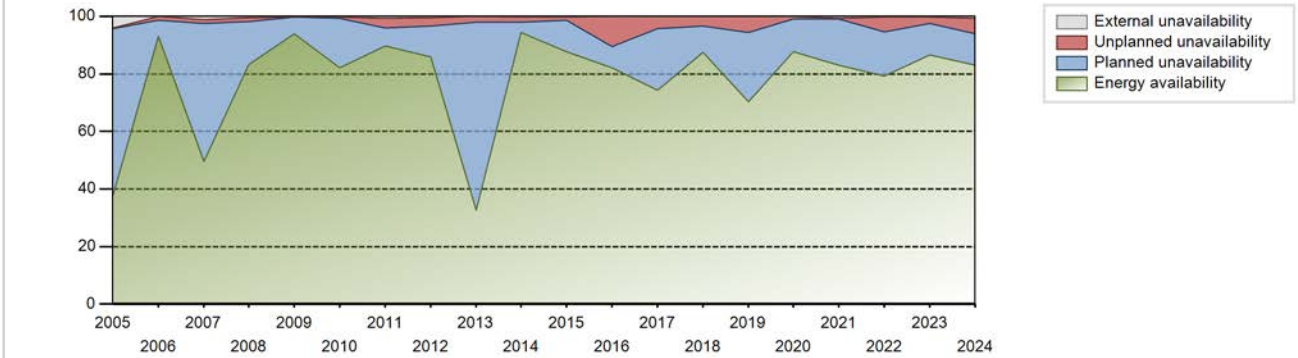


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	3623.94	4593	925	81.32	90.61	80.97	91.89	6.31	6.10	3.29	9.28
1986	6667.30	7442	925	82.57	82.57	82.28	84.95	1.56	1.31	16.12	0.00
1987	6364.93	6707	1000	74.52	74.52	72.66	76.56	4.46	3.48	22.01	0.00
1988	6757.16	7594	925	83.49	83.55	83.16	86.45	1.83	1.56	14.89	0.06
1989	6627.33	7336	925	81.50	81.85	81.79	83.74	2.69	2.26	15.88	0.36
1990	6710.59	7453	925	82.52	82.97	82.82	85.08	5.48	4.81	12.22	0.45
1991	5796.72	6495	925	71.36	71.36	71.54	74.14	3.36	2.48	26.16	0.00
1992	6731.61	7472	925	82.63	83.90	82.86	85.07	1.14	0.96	15.13	1.28
1993	6634.11	7492	925	82.69	84.90	81.87	85.53	0.29	0.25	14.86	2.21
1994	5259.83	7044	925	66.56	80.25	64.91	80.41	0.03	0.02	19.73	13.69
1995	5337.40	6738	925	66.84	80.32	65.87	76.92	0.26	0.21	19.47	13.49
1996	6127.71	7010	925	77.82	79.09	75.42	79.80	0.89	0.71	20.20	1.27
1997	4991.02	5642	925	61.57	61.70	61.59	64.41	4.41	2.84	35.46	0.13
1998	5297.02	6576	925	65.58	73.88	65.37	75.07	1.37	1.03	25.09	8.30
1999	5362.50	6090	925	66.03	69.14	66.18	69.52	0.12	0.09	30.78	3.11
2000	6566.15	7108	925	80.10	80.54	80.81	80.92	3.91	3.28	16.19	0.44
2001	6457.64	7537	925	78.96	81.02	79.69	86.04	6.08	5.25	13.73	2.06
2002	3431.09	3890	925	41.69	43.60	42.34	44.41	1.66	0.74	55.66	1.91
2003	6438.59	7734	925	79.13	81.42	79.46	88.29	8.45	7.52	11.06	2.29
2004	7480.14	8312	925	90.85	93.66	92.06	94.63	0.62	0.59	5.75	2.80
2005	3053.40	3734	925	37.72	41.71	37.68	42.63	0.42	0.17	58.11	4.00
2006	7623.87	8306	925	93.15	93.15	94.09	94.82	0.16	1.27	5.58	0.00
2007	4096.43	4878	925	49.68	50.76	50.55	55.68	2.50	1.30	47.94	1.08
2008	6718.76	7823	925	83.20	83.66	82.69	89.06	1.71	1.46	14.89	0.46
2009	7668.41	8279	925	93.84	94.10	94.64	94.51	0.09	0.08	5.82	0.26
2010	6651.23	7626	925	82.04	82.31	82.08	87.05	0.56	0.46	17.23	0.27
2011	7328.17	8314	925	89.65	90.28	90.45	94.92	3.58	3.36	6.36	0.63
2012	6802.21	7767	925	85.94	86.34	83.72	88.42	3.24	2.89	10.76	0.41
2013	2630.28	3045	925	32.61	32.62	32.46	34.76	5.82	2.02	65.36	0.01
2014	7821.17	8524	925	94.28	94.57	96.51	97.29	1.89	1.82	3.61	0.29
2015	7404.36	7809	925	87.61	87.79	91.38	89.14	1.26	1.12	11.09	0.17
2016	6910.57	7360	925	82.20	82.32	85.05	83.79	11.12	10.30	7.39	0.12
2017	6307.00	6734	925	74.22	74.29	77.84	76.87	5.42	4.26	21.45	0.07
2018	7352.87	7772	925	87.37	87.42	90.74	88.72	3.77	3.43	9.16	0.05
2019	5918.57	6573	925	70.29	70.31	73.04	75.03	7.33	5.56	24.13	0.03
2020	7313.92	7838	925	87.74	87.86	90.02	89.23	0.86	0.76	11.38	0.11
2021	6939.32	7444	925	83.12	83.80	85.64	84.98	0.39	0.33	15.87	0.68

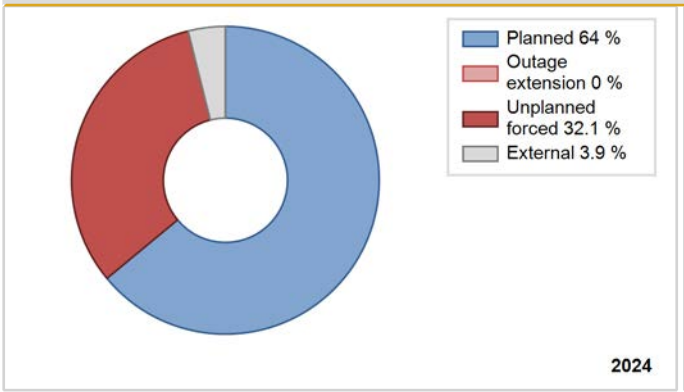
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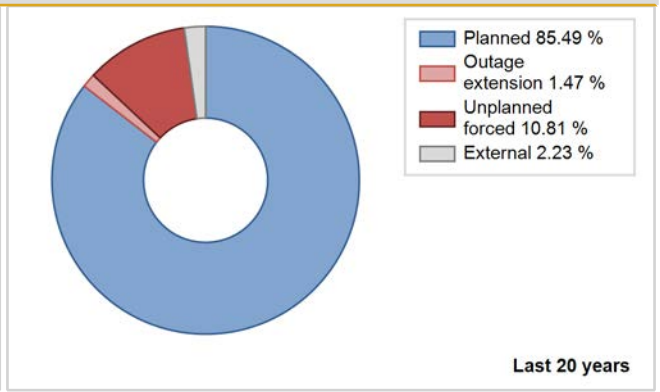
2022	6641.85	7002	925	79.30	79.46	81.97	79.93	0.06	5.34	15.21	0.16
2023	7182.68	7709	925	86.63	86.91	88.64	88.00	2.43	2.17	10.92	0.29
2024	6873.48	7882	925	83.07	83.73	84.59	89.73	6.09	5.43	10.83	0.66

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		19			93	
C. Inspection, maintenance or repair combined with refuelling	883			1021		
D. Inspection, maintenance or repair without refuelling				244		
F. Major backfitting, refurbishment or upgrading activities with refuelling				122		
G. Major backfitting, refurbishment or upgrading activities without refuelling				223		
J. Grid limitation, failure or grid unavailability						10
L. Human factor related					2	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						9
Z. Other					2	
Subtotal	883	19		1610	97	19
Total	**902**			**1726**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		16
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		5
14. Safety Systems		0
15. Reactor Cooling Systems		36
16. Steam generation systems		1
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		5
32. Feedwater and Main Steam System		8
34. Miscellaneous Systems		3
41. Main Generator Systems	19	0
42. Electrical Power Supply Systems		13
Total	**19**	**96**

Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the routine maintenance from Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

RU-67 SMOLENSK-3 RUSSIA

Status at end of year	:	**Operational**
Operator	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Owner	:	REA (Joint Stock Company 'Concern Rosenergoatom')
Reactor Supplier	:	AEM (Atomenergomash)
Turbine Supplier	:	KTF (Kharkiv Turbine Factory)

Reactor Unit Details

Reactor type and model	:	LWGR / RBMK-1000
Thermal power	:	3200 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	925 MWe

Key Dates

Construction Date	:	1984-05-01
Grid Date	:	1990-01-17
Commercial Date	:	1990-10-12
Age at end of year	:	34 years

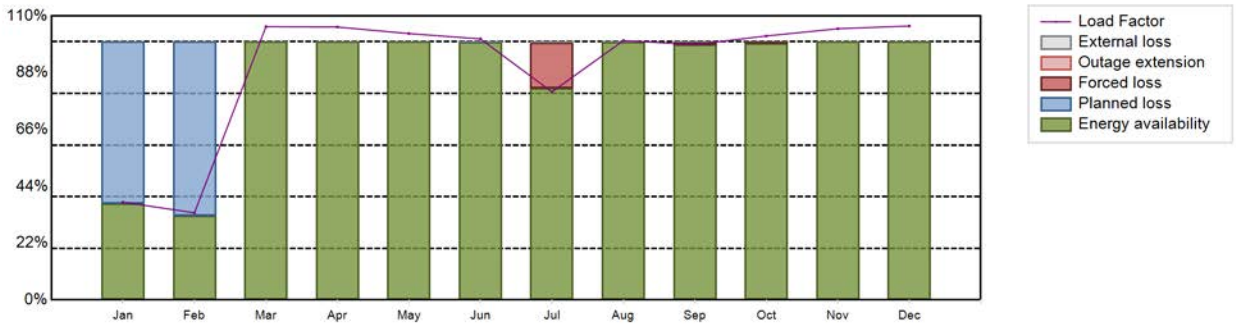
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	22200
Active core diameter [m]	:	11.8
Active core height/length [m]	:	7
Number of fissile fuel assemblies/bundles	:	1661
Fuel linear heat generation rate [kW/m]	:	14.5
Number of control rod assemblies	:	175
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	284
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.59
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	PH / DH

Annual Production Results (2024)

Net Energy Production	:	7332.45 GW(e).h
Energy Availability Factor (EAF)	:	87.67 %
Unit Capability Factor (UCF)	:	87.71 %
Load Factor (LF)	:	90.24 %
Operating Factor (OF)	:	88.55 %
Equivalent non-electrical energy generated (NEG)	:	59.24 GW(e).h
Forced Loss Rate (FLR)	:	1.83 %
Unplanned Capability Loss Factor (UCL)	:	1.63 %
Planned Unavailability Factor (PUF)	:	10.65 %
Externally cause unavailability (XUF)	:	0.04 %
Total off-line time	:	1006 hours

Annual Summary



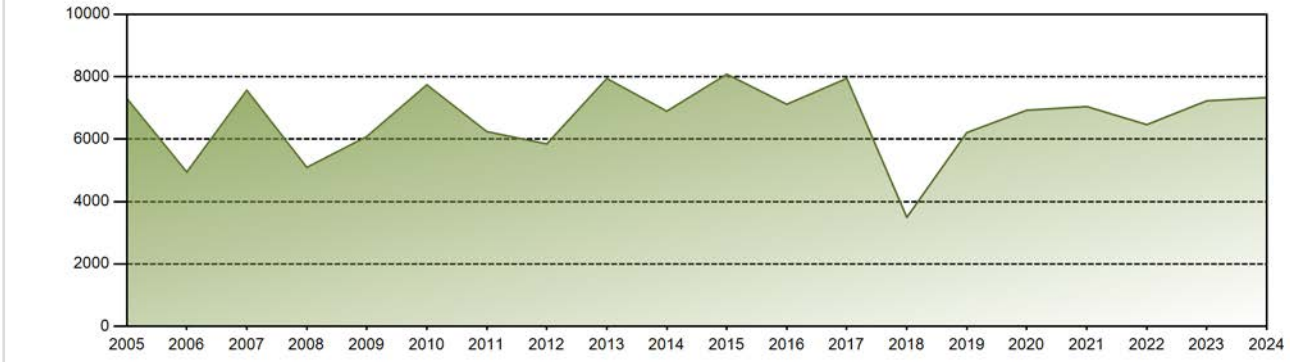
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	260.67	217.29	728.55	703.97	710.02	673.42	554.68	691.25	658.98	703.69	699.65	730.29	7332.45
EAF [%]	37.42	32.55	100.00	100.00	100.00	99.89	82.06	99.92	98.79	99.42	100.00	100.00	87.67
UCF [%]	37.42	32.55	100.00	100.00	100.00	99.92	82.43	100.00	98.82	99.42	100.00	100.00	87.71
LF [%]	37.88	33.75	105.86	105.70	103.17	101.11	80.60	100.44	98.95	102.25	105.05	106.12	90.24
OF [%]	39.11	37.21	100.00	100.00	100.00	100.00	84.41	100.00	100.00	100.00	100.00	100.00	88.55
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	17.57	0.00	1.18	0.58	0.00	0.00	1.83
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	17.57	0.00	1.18	0.58	0.00	0.00	1.63
PUF [%]	62.58	67.45	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	10.65
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.03	0.37	0.08	0.03	0.00	0.00	0.00	0.04

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Historical Summary

Lifetime energy generation	:	227246.66 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.23 %
Cumulative Energy Availability Factor (EAF)	:	79.53 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.92 %
Cumulative Unit Capability Factor (UCF)	:	80.96 %	Cumulative Planned Unavailability Factor (PUF)	:	17.12 %
Cumulative Load Factor (LF)	:	80.82 %	Cumulative Externally cause unavailability (XUF)	:	1.43 %
Cumulative Operating Factor (OF)	:	81.76 %			

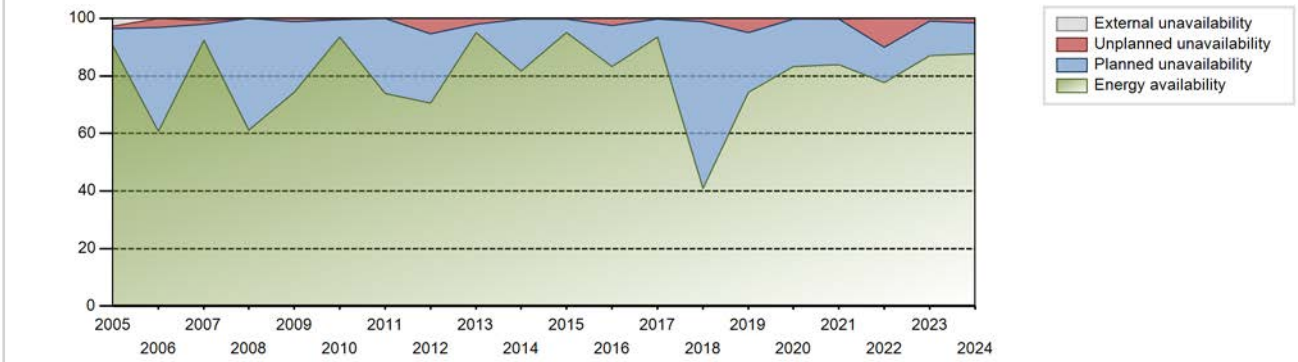
Electricity Production (net) [GWh]



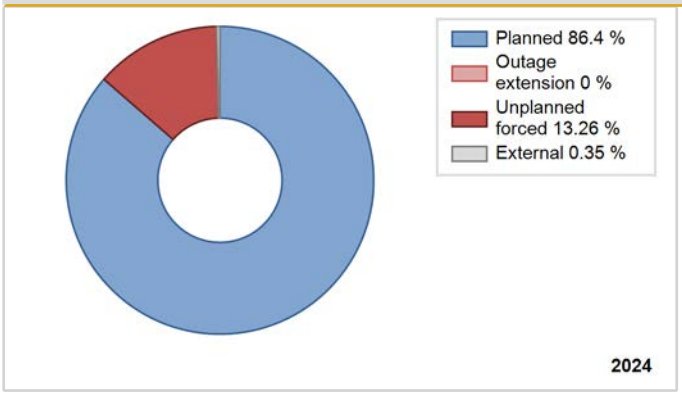
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1990	4570.76	6767	925	99.06	99.06	101.20	100.00	0.62	0.62	0.32	0.00
1991	6561.74	7338	925	80.87	80.87	80.98	83.77	3.91	3.29	15.84	0.00
1992	6866.56	7515	925	83.90	83.92	84.52	85.56	6.83	6.15	9.93	0.03
1993	6595.99	7419	925	81.42	82.61	81.40	84.69	1.76	1.48	15.91	1.19
1994	5513.66	6701	925	72.50	82.28	68.04	76.50	0.43	0.35	17.37	9.78
1995	5090.97	5844	925	63.17	78.19	62.83	66.71	1.13	0.89	20.92	15.02
1996	6496.64	7268	925	80.83	82.16	79.96	82.74	7.42	6.58	11.25	1.34
1997	5559.27	6469	925	69.32	69.32	68.61	73.85	6.03	4.45	26.23	0.00
1998	4575.89	6162	925	57.53	68.95	56.47	70.34	3.48	2.49	28.56	11.42
1999	6410.98	7063	925	78.19	79.31	79.12	80.63	0.39	0.31	20.38	1.12
2000	6970.48	7542	925	84.58	84.70	85.79	85.86	2.37	2.06	13.24	0.12
2001	6951.72	7823	925	85.39	87.30	85.79	89.30	0.15	0.13	12.57	1.91
2002	7204.90	7831	925	87.67	88.71	88.92	89.39	0.30	0.27	11.02	1.03
2003	7038.23	7697	925	86.26	87.09	86.86	87.87	0.20	0.18	12.73	0.82
2004	7085.74	7765	925	86.88	87.86	87.21	88.40	0.00	0.08	12.05	0.99
2005	7303.68	8192	925	90.36	93.06	90.14	93.52	1.07	1.01	5.93	2.70
2006	4942.96	5631	925	60.71	60.71	61.00	64.28	4.39	3.15	36.14	0.00
2007	7566.25	8247	925	92.46	93.15	93.38	94.14	1.48	1.40	5.44	0.70
2008	5093.44	5396	925	61.23	61.29	62.69	61.43	0.07	0.04	38.67	0.06
2009	6082.98	6706	925	74.30	74.31	75.07	76.55	1.66	1.26	24.44	0.00
2010	7738.82	8233	925	93.55	93.71	95.51	93.98	0.12	0.38	5.91	0.16
2011	6241.79	6579	925	73.98	74.01	77.04	75.11	0.15	0.11	25.88	0.03
2012	5845.23	6279	925	70.62	70.62	71.94	71.48	7.04	5.35	24.03	0.00
2013	7942.17	8471	925	95.12	95.19	98.02	96.70	2.12	2.06	2.75	0.07
2014	6894.49	7219	925	81.72	81.82	85.08	82.40	0.30	0.24	17.94	0.10
2015	8079.91	8364	925	95.01	95.01	99.71	95.48	0.33	0.31	4.67	0.00
2016	7116.59	7352	925	83.34	83.35	87.59	83.70	2.89	2.48	14.17	0.02
2017	7946.26	8266	925	93.42	93.49	98.07	94.36	0.12	0.11	6.40	0.06
2018	3494.62	3601	925	40.84	40.84	43.13	41.11	0.66	1.09	58.07	0.00
2019	6207.98	6723	925	74.43	74.46	76.61	76.75	5.25	4.90	20.64	0.03
2020	6927.47	7624	925	83.21	83.22	85.26	86.79	0.35	0.29	16.49	0.00
2021	7044.34	7418	925	83.94	84.13	86.93	84.68	0.02	0.01	15.85	0.19
2022	6464.67	6991	925	77.70	77.76	79.78	79.81	11.48	10.09	12.15	0.06
2023	7227.81	7776	925	87.06	87.10	89.20	88.77	0.89	0.78	12.12	0.03
2024	7332.45	7778	925	87.67	87.71	90.24	88.55	1.83	1.63	10.65	0.04

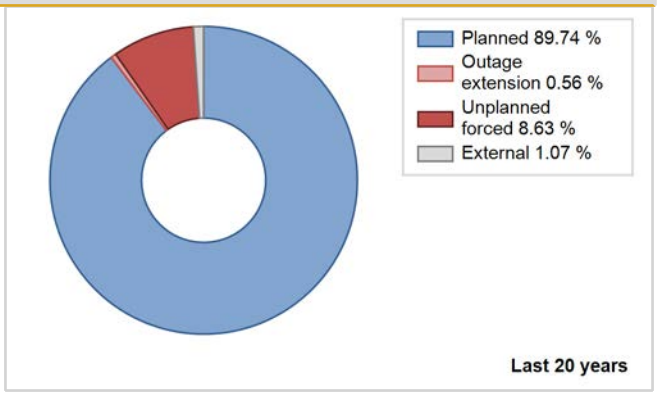
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1990 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		116			93	
C. Inspection, maintenance or repair combined with refuelling	891			1008		
D. Inspection, maintenance or repair without refuelling				231		
F. Major backfitting, refurbishment or upgrading activities with refuelling				157		
G. Major backfitting, refurbishment or upgrading activities without refuelling				91		
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					2	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						47
Z. Other					16	
Subtotal	891	116		1487	111	48
Total	**1007**			**1646**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1990 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		12
12. Reactor I&C Systems		12
13. Reactor Auxiliary Systems		3
15. Reactor Cooling Systems		8
16. Steam generation systems		26
31. Turbine and auxiliaries		7
32. Feedwater and Main Steam System		3
34. Miscellaneous Systems		4
35. All other I&C Systems		3
41. Main Generator Systems		2
42. Electrical Power Supply Systems	116	11
Total	**116**	**91**

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Highlights (2024)

The Russian NPPs are operating in the baseload mode agreed with the Russia's Federal Energy Commission. The unit was in the current maintenance. Radionuclides content in the monitored environmental objects in the plant vicinity was on the level of average background values typical for the European part of the Russian Federation.

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2024 Operating Experience

SK-13 BOHUNICE-3 SLOVAKIA



Status at end of year	:	**Operational**
Operator	:	SE (SLOVENSKÉ ELEKTRÁRNE, A.S.)
Owner	:	SE (SLOVENSKÉ ELEKTRÁRNE, A.S.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1471 MWth
Gross electrical power	:	500 MWe
Reference unit power (net)	:	466 MWe

Key Dates

Construction Date	:	1976-12-01
Grid Date	:	1984-08-20
Commercial Date	:	1985-02-14
Age at end of year	:	40 years

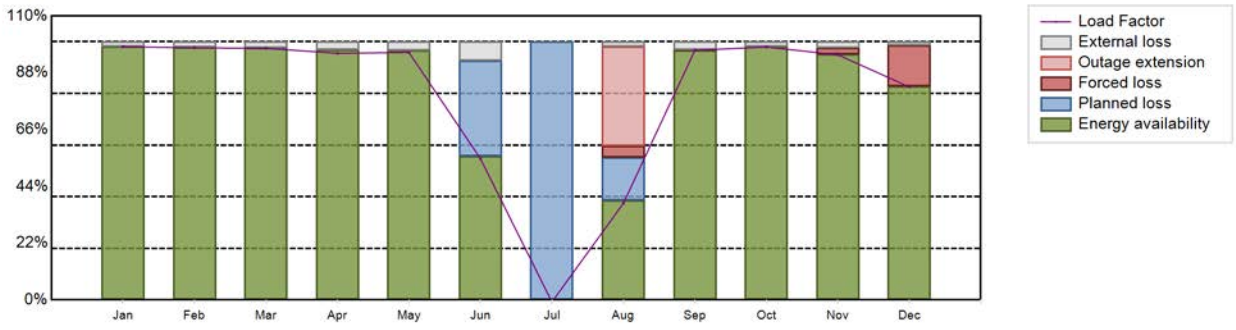
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.25
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	23
Average discharge burnup [MWd/t]	:	55000
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.49
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.3
Reactor outlet temperature [°C]	:	297
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.245
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.32
Output voltage [kV]	:	15.75
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	6
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	3227.2 GW(e).h	Forced Loss Rate (FLR)	:	2.3 %
Energy Availability Factor (EAF)	:	79.35 %	Unplanned Capability Loss Factor (UCL)	:	5.2 %
Unit Capability Factor (UCF)	:	81.9 %	Planned Unavailability Factor (PUF)	:	12.9 %
Load Factor (LF)	:	78.84 %	Externally cause unavailability (XUF)	:	2.55 %
Operating Factor (OF)	:	82.76 %	Total off-line time	:	1514 hours
Equivalent non-electrical energy generated (NEG)	:	43.04 GW(e).h			

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	340.07	316.74	337.93	320.52	332.37	183.71	-2.68	129.78	324.46	339.64	318.60	286.06	3227.20
EAF [%]	98.13	97.78	97.64	96.79	96.74	55.67	0.00	38.63	96.72	98.11	95.15	82.86	79.35
UCF [%]	100.00	100.00	99.99	100.00	100.00	63.07	0.00	40.40	99.81	100.00	97.49	84.24	81.90
LF [%]	98.09	97.66	97.47	95.53	95.87	54.75	-0.77	37.43	96.70	97.96	94.96	82.51	78.84
OF [%]	100.00	100.00	100.00	100.00	100.00	63.19	0.00	46.91	100.00	100.00	100.00	85.22	82.76
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.76	0.19	0.00	2.51	15.76	2.30
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.04	0.19	0.00	2.51	15.76	5.20
PUF [%]	0.00	0.00	0.01	0.00	0.00	36.93	100.00	16.56	0.00	0.00	0.00	0.00	12.90
XUF [%]	1.87	2.22	2.36	3.21	3.26	7.40	0.00	1.77	3.09	1.89	2.34	1.38	2.55

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Historical Summary

Lifetime energy generation	:	123377.89 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.14 %
Cumulative Energy Availability Factor (EAF)	:	82.07 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.21 %
Cumulative Unit Capability Factor (UCF)	:	85.26 %	Cumulative Planned Unavailability Factor (PUF)	:	13.53 %
Cumulative Load Factor (LF)	:	80.7 %	Cumulative Externally cause unavailability (XUF)	:	3.19 %
Cumulative Operating Factor (OF)	:	86.11 %			

Electricity Production (net) [GWh]

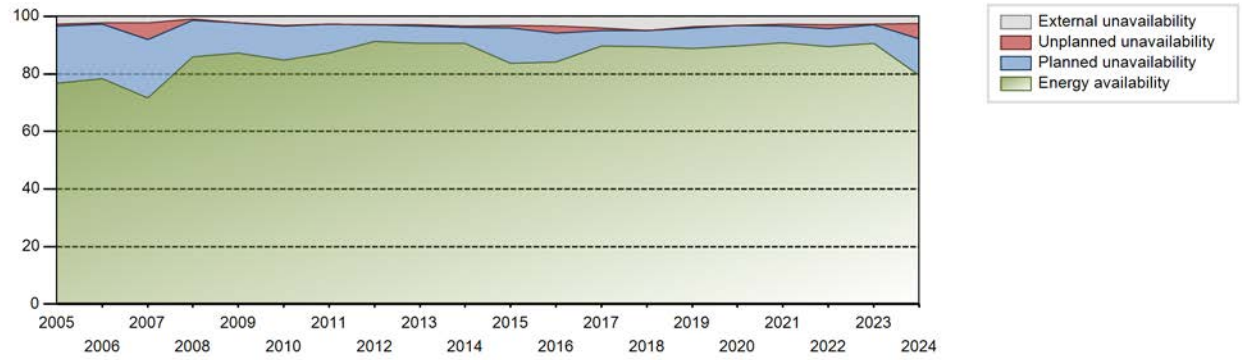


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	2721.56	7057	408	76.82	76.82	74.45	78.87	1.66	1.30	21.89	0.00
1986	2674.14	7089	408	75.40	75.43	74.82	80.92	7.77	6.35	18.22	0.03
1987	1997.38	5181	408	53.70	55.54	55.89	59.14	2.29	1.30	43.16	1.83
1988	2866.88	7329	408	79.89	80.24	79.99	83.44	0.42	0.34	19.43	0.35
1989	2992.32	7633	408	84.14	85.01	83.72	87.13	0.57	0.49	14.50	0.88
1990	2829.10	7376	408	79.25	80.49	79.16	84.20	5.39	4.59	14.93	1.24
1991	2585.64	6717	408	71.95	74.16	72.34	76.68	1.36	1.03	24.81	2.21
1992	3140.69	7528	408	82.77	83.89	87.63	85.70	0.75	0.63	15.48	1.12
1993	2973.14	7721	408	83.19	86.52	83.19	88.14	1.24	1.09	12.39	3.34
1994	2806.83	7423	405	79.05	84.03	79.11	84.74	0.73	0.62	15.36	4.97
1995	2536.71	6440	408	70.14	78.13	70.98	73.52	1.74	1.39	20.48	8.00
1996	3045.91	7504	436	82.50	85.56	79.53	85.43	1.45	1.26	13.18	3.06
1997	3096.42	7711	440	84.04	87.73	80.33	88.03	0.49	0.43	11.84	3.69
1998	2804.63	7571	408	81.80	85.32	78.47	86.43	2.30	2.00	12.68	3.52
1999	2468.54	6620	408	69.65	76.46	69.07	75.57	3.81	3.03	20.51	6.81
2000	2806.72	7776	408	79.82	87.92	78.32	88.52	1.07	0.95	11.13	8.10
2001	2686.99	7680	408	76.48	86.60	75.18	87.67	1.03	0.90	12.50	10.12
2002	2690.74	7711	408	83.86	87.38	75.28	88.03	0.22	0.19	12.43	3.52
2003	2484.97	6908	408	75.46	78.28	69.53	78.86	0.16	0.13	21.59	2.82
2004	2564.55	7228	408	79.03	81.97	71.56	82.29	0.39	0.32	17.72	2.93
2005	2587.73	7034	408	76.69	79.44	72.40	80.30	0.91	0.73	19.83	2.74
2006	2582.58	7106	408	78.36	80.73	72.26	81.12	0.29	0.24	19.03	2.37
2007	2432.56	6687	408	71.57	73.84	68.06	76.34	7.18	5.71	20.45	2.27
2008	3038.40	7680	429	85.82	86.69	83.70	87.43	0.56	0.49	12.82	0.87
2009	3309.67	8176	442	87.18	89.33	87.40	93.33	0.12	0.10	10.56	2.15
2010	3385.92	8194	472	84.80	87.97	85.98	93.54	0.26	0.23	11.80	3.17
2011	3586.04	7890	472	87.25	89.94	86.73	90.07	0.04	0.04	10.03	2.69
2012	3761.71	8295	472	91.28	94.17	90.73	94.43	0.02	0.02	5.81	2.90
2013	3726.97	8245	472	90.67	93.71	90.14	94.12	0.38	0.36	5.93	3.04
2014	3730.20	8235	471	90.60	93.90	90.41	94.01	0.01	0.58	5.53	3.30
2015	3388.98	7635	471	83.58	86.81	82.14	87.16	0.40	0.73	12.46	3.23
2016	3425.51	7738	471	84.12	87.53	82.80	88.09	0.45	2.46	10.00	3.42
2017	3615.51	8231	471	89.61	93.73	87.63	93.96	0.05	0.89	5.38	4.12
2018	3609.99	8288	471	89.51	94.39	87.49	94.61	0.00	0.12	5.49	4.88
2019	3625.03	8135	471	88.72	92.26	87.86	92.87	0.33	0.59	7.14	3.55
2020	3683.59	8236	466	89.64	92.78	89.11	93.76	0.09	0.08	7.14	3.14
2021	3699.61	8307	466	90.90	93.67	90.63	94.83	0.32	0.54	5.79	2.76

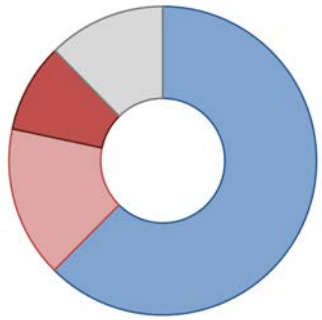
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2022	3637.81	8248	466	89.43	92.26	89.11	94.16	1.11	1.53	6.20	2.83
2023	3685.70	8197	466	90.55	93.37	90.29	93.57	0.10	0.09	6.54	2.83
2024	3227.20	7270	466	79.35	81.90	78.84	82.76	2.30	5.20	12.90	2.55

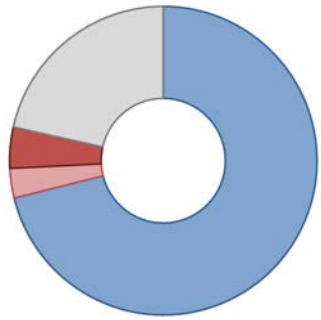
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		398			83	
C. Inspection, maintenance or repair combined with refuelling	1116			1042		
D. Inspection, maintenance or repair without refuelling				83		
J. Grid limitation, failure or grid unavailability						5
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L. Human factor related					0	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z. Other					1	
Subtotal	1116	398		1125	84	7
Total	**1514**			**1216**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	110	9
12. Reactor I&C Systems		4
13. Reactor Auxiliary Systems		3
14. Safety Systems		1
15. Reactor Cooling Systems	288	17
16. Steam generation systems		22
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		0
32. Feedwater and Main Steam System		7
33. Circulating Water System		1
35. All other I&C Systems		0
41. Main Generator Systems		1
42. Electrical Power Supply Systems		17
Total	**398**	**83**

Highlights (2024)

01. - 05. 2024 operation without any planned or unplanned power decreasing. Steam extraction for district heating exchanger.

29.05. - 19.06.2024 coast-down operation,
19.06. - 17.08.2024 annual maintenance and refuelling, annual maintenance unplanned extension (+12 days). Unit start-up, scheduled measuring and testing.
19.08.24 TG31 shutdown (during unit start-up) due to high pressure part of TG31 thermal insulation oil pollution.
30.09.2024 reactor power decreasing to 72,5 %, RCP35 shutdown due to electromagnet failure.
10.11.2024 reactor power decreasing to 52 %, TG31 trip due to electrical protection actuation.
20.12. - 26.12.2024 forced unit outage (approved power reduction – unplanned), upper block bolts rewiev and cleaning, RCP 1YD15S01 flange sealing ring repair.

From 09.2024 steam extraction for district heating exchanger.

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2024 Operating Experience

SK-14 BOHUNICE-4 SLOVAKIA



Status at end of year	:	**Operational**
Operator	:	SE (SLOVENSKÉ ELEKTRÁRNE, A.S.)
Owner	:	SE (SLOVENSKÉ ELEKTRÁRNE, A.S.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1471 MWth
Gross electrical power	:	500 MWe
Reference unit power (net)	:	466 MWe

Key Dates

Construction Date	:	1976-12-01
Grid Date	:	1985-08-09
Commercial Date	:	1985-12-18
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.25
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	22
Average discharge burnup [MWd/t]	:	54000
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.49
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O

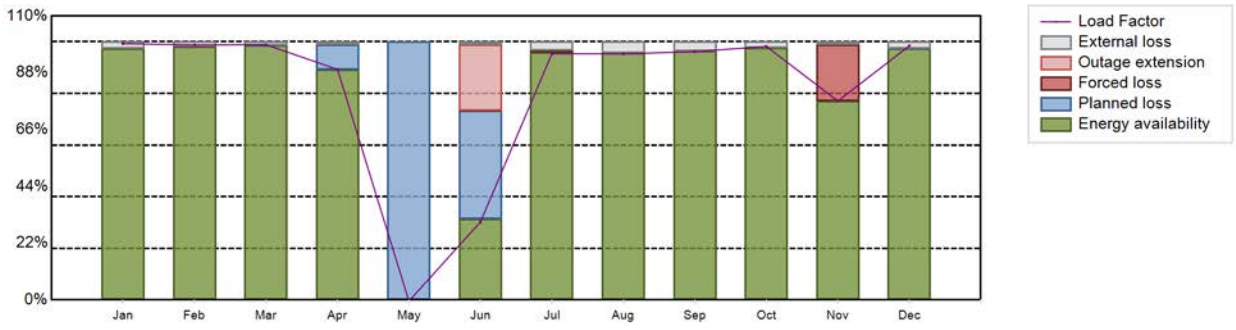
Operating coolant pressure [MPa]	:	12.3
Reactor outlet temperature [°C]	:	297
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.245
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.32
Output voltage [kV]	:	15.75
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	6
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH / PH

Annual Production Results (2024)

Net Energy Production	:	3330.88 GW(e).h
Energy Availability Factor (EAF)	:	81.21 %
Unit Capability Factor (UCF)	:	83.33 %
Load Factor (LF)	:	81.37 %
Operating Factor (OF)	:	83.71 %
Equivalent non-electrical energy generated (NEG)	:	45.24 GW(e).h

Forced Loss Rate (FLR)	:	2.2 %
Unplanned Capability Loss Factor (UCL)	:	3.96 %
Planned Unavailability Factor (PUF)	:	12.71 %
Externally cause unavailability (XUF)	:	2.12 %
Total off-line time	:	1431 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	344.13	320.39	342.70	299.65	-1.48	101.29	330.69	330.52	322.71	340.45	258.52	341.31	3330.88
EAF [%]	97.45	98.10	98.53	89.09	0.00	31.37	95.78	95.70	96.43	97.69	77.03	97.44	81.21
UCF [%]	100.00	99.86	99.99	90.11	0.00	32.58	99.24	100.00	100.00	100.00	78.19	100.00	83.33
LF [%]	99.26	98.78	98.84	89.31	-0.43	30.19	95.38	95.33	96.18	98.20	77.05	98.44	81.37
OF [%]	100.00	100.00	100.00	90.42	0.00	34.17	99.73	100.00	100.00	100.00	80.28	100.00	83.71
FLR [%]	0.00	0.14	0.00	0.00	0.00	0.50	0.76	0.00	0.00	0.00	21.81	0.00	2.20
UCL [%]	0.00	0.14	0.00	0.00	0.00	25.56	0.76	0.00	0.00	0.00	21.81	0.00	3.96
PUF [%]	0.00	0.00	0.01	9.89	100.00	41.86	0.00	0.00	0.00	0.00	0.00	0.00	12.71
XUF [%]	2.55	1.76	1.47	1.02	0.00	1.21	3.46	4.30	3.57	2.31	1.15	2.56	2.12

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Historical Summary

Lifetime energy generation	:	122597.34 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.15 %
Cumulative Energy Availability Factor (EAF)	:	83.09 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.32 %
Cumulative Unit Capability Factor (UCF)	:	86.08 %	Cumulative Planned Unavailability Factor (PUF)	:	12.6 %
Cumulative Load Factor (LF)	:	81.91 %	Cumulative Externally cause unavailability (XUF)	:	2.98 %
Cumulative Operating Factor (OF)	:	86.9 %			

Electricity Production (net) [GWh]

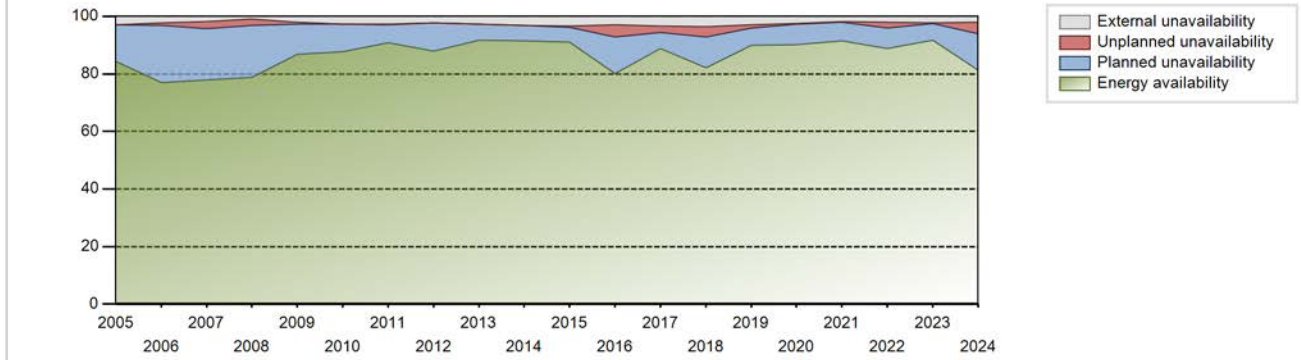


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	1083.50	3177	408	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1986	2887.85	7294	408	80.98	80.98	80.80	83.26	3.11	2.60	16.42	0.00
1987	3084.68	7783	408	86.11	86.60	86.31	88.85	0.89	0.78	12.63	0.49
1988	2786.46	7248	408	77.76	78.01	77.75	82.51	1.22	0.96	21.02	0.25
1989	2827.66	7548	408	79.20	79.98	79.12	86.16	5.84	4.96	15.06	0.78
1990	2873.81	7427	408	80.71	81.99	80.41	84.78	1.42	1.18	16.83	1.29
1991	2850.52	7438	408	80.36	82.88	79.76	84.91	0.54	0.45	16.66	2.52
1992	2711.90	6714	408	70.43	73.33	75.67	76.43	2.61	1.96	24.71	2.89
1993	2847.62	7341	408	79.68	82.63	79.67	83.80	5.40	4.72	12.65	2.95
1994	2791.41	7389	405	78.68	83.87	78.68	84.35	0.30	0.25	15.88	5.19
1995	2823.67	7211	408	79.29	88.47	79.00	82.32	0.96	0.86	10.67	9.18
1996	2834.89	6953	436	76.13	79.21	74.02	79.16	0.18	0.14	20.65	3.08
1997	2953.49	7469	440	80.22	84.66	76.63	85.26	2.41	2.09	13.25	4.43
1998	2822.41	7525	408	82.45	85.68	78.97	85.90	1.62	1.41	12.92	3.23
1999	2656.54	7283	408	75.13	81.68	74.33	83.14	2.00	1.66	16.66	6.54
2000	2431.85	6791	408	68.88	76.32	67.86	77.31	1.40	1.08	22.60	7.44
2001	2793.27	7721	408	79.25	86.73	78.15	88.14	1.29	1.13	12.14	7.48
2002	2823.23	7742	408	84.99	87.88	78.99	88.38	0.36	0.32	11.81	2.89
2003	2814.89	7737	408	84.35	87.76	78.76	88.32	0.42	0.37	11.87	3.41
2004	2390.94	6786	408	74.44	76.95	66.71	77.25	0.24	0.18	22.86	2.51
2005	2840.98	7671	408	84.31	87.29	79.49	87.57	0.06	0.05	12.66	2.98
2006	2489.28	7035	408	77.03	79.27	69.65	80.31	1.06	0.85	19.89	2.24
2007	2648.45	7053	408	77.97	79.87	74.10	80.51	2.90	2.39	17.74	1.90
2008	2739.03	7254	410	78.82	79.65	76.27	82.58	2.90	2.38	17.98	0.83
2009	3239.57	8118	448	86.87	88.92	87.05	92.67	0.67	0.60	10.48	2.06
2010	3513.14	8214	472	87.73	90.33	87.55	93.77	0.05	0.05	9.62	2.60
2011	3732.88	8225	472	90.80	93.43	90.28	93.89	0.27	0.25	6.32	2.62
2012	3640.36	7952	472	87.88	90.12	87.80	90.53	0.00	0.00	9.88	2.23
2013	3788.68	8313	471	91.81	94.54	91.83	94.90	0.07	0.07	5.40	2.72
2014	3767.52	8314	471	91.44	94.56	91.31	94.91	0.00	0.00	5.44	3.12
2015	3697.16	8285	471	91.11	94.40	89.61	94.58	0.05	0.54	5.06	3.28
2016	3293.87	7371	471	80.22	83.23	79.61	83.91	0.63	4.05	12.72	3.01
2017	3648.54	8115	471	88.85	92.33	88.43	92.64	0.12	2.03	5.64	3.49
2018	3367.93	7553	471	82.13	85.75	81.63	86.22	3.42	3.57	10.68	3.62
2019	3711.18	8157	471	90.02	92.85	89.95	93.12	0.01	1.28	5.87	2.82
2020	3730.79	8163	466	90.19	92.71	90.26	92.93	0.00	0.23	7.06	2.52
2021	3760.12	8227	466	91.51	93.37	92.11	93.92	0.14	0.13	6.50	1.87

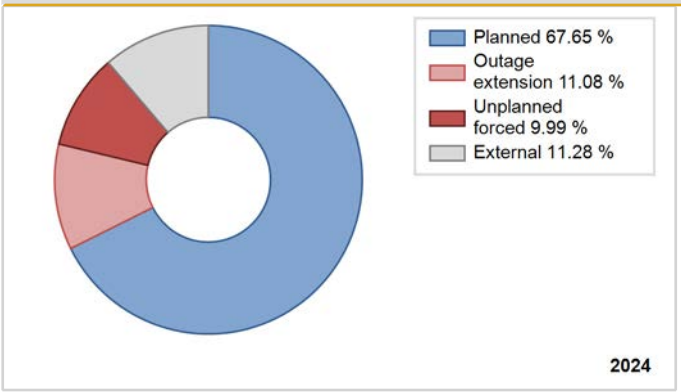
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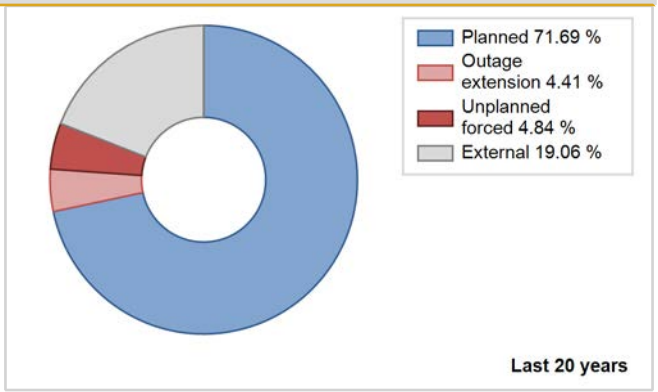
2022	3638.00	8061	466	88.79	90.84	89.12	92.02	0.95	2.06	7.11	2.04
2023	3761.34	8244	466	91.75	93.99	92.14	94.11	0.00	0.13	5.87	2.25
2024	3330.88	7353	466	81.21	83.33	81.37	83.71	2.20	3.96	12.71	2.12

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		327			60	
C.	Inspection, maintenance or repair combined with refuelling	1104			1006		
D.	Inspection, maintenance or repair without refuelling				42		
E.	Testing of plant systems or components				1	0	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				14		
J.	Grid limitation, failure or grid unavailability						0
L.	Human factor related					8	
Subtotal		1104	327		1063	68	0
Total		**1431**			**1131**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		15
12. Reactor I&C Systems		4
15. Reactor Cooling Systems	142	9
16. Steam generation systems		25
17. Safety I&C Systems (excluding reactor I&C)		3
21. Fuel Handling and Storage Facilities	183	5
31. Turbine and auxiliaries	2	0
32. Feedwater and Main Steam System		5
33. Circulating Water System		0
34. Miscellaneous Systems		1
35. All other I&C Systems		0
42. Electrical Power Supply Systems		1
Total	**327**	**68**

Highlights (2024)

01.-04. 2024, operation with 1 unplanned power decreasing - fast acting live steam isolation valve closing (TG42) due to signal pmax („hydrogen pressure „MAX) in generator stator cooling water. Reactor power decreasing to 54 %. Steam extraction for district heating exchanger.
27.04. - 13.06.2024 planned unit shutdown, annual maintenance and refuelling. 13.06. - 20.06.2024 outage unplanned extension, 20.06. - 23.06.2024 unit start-up, scheduled measuring and testing.
21.06.2024 failure - fast acting live steam isolation valve closing (TG41) due to signal pmax („hydrogen pressure „MAX) in generator stator cooling water. Reactor power decreasing to 54 %.
From 20.06.2024 steam extraction for district heating exchanger.
07.07.2024 failure - TG41,42 fast acting live steam isolation valve closing, reactor power decreasing to 18 %.

14.11. - 21.11.2024 reactor scram – AO1 (4 RCP trip), reactor cold shutdown due to RCP44 sealing ring repair, TG42 generator tightnes test -hydrogen leakness.
05.12.2024 ancillary services certification (mFRR-).

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2024 Operating Experience

SK-6 MOCHOVCE-1 SLOVAKIA



Status at end of year	:	**Operational**
Operator	:	SE (SLOVENSKÉ ELEKTRÁRNE, A.S.)
Owner	:	SE (SLOVENSKÉ ELEKTRÁRNE, A.S.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1471 MWth
Gross electrical power	:	500 MWe
Reference unit power (net)	:	467 MWe

Key Dates

Construction Date	:	1983-10-13
Grid Date	:	1998-07-04
Commercial Date	:	1998-10-29
Age at end of year	:	26 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.415
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	22
Average discharge burnup [MWd/t]	:	54000
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.49
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O

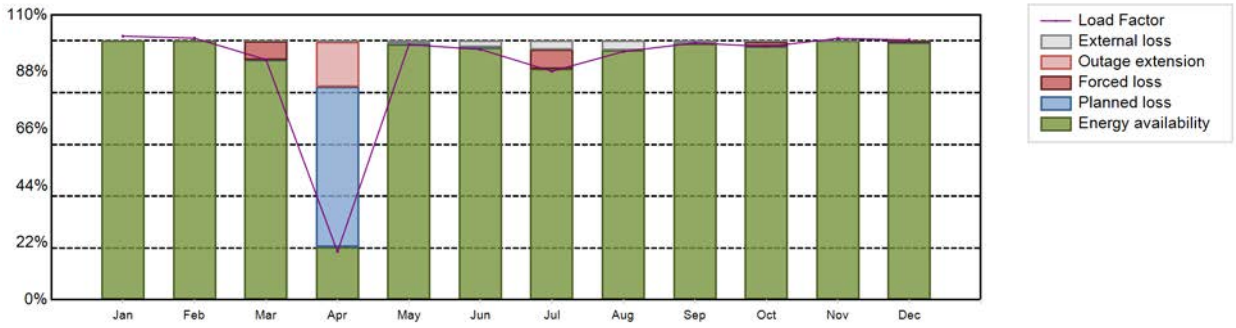
Operating coolant pressure [MPa]	:	12.0
Reactor outlet temperature [°C]	:	295
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.245
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.3
Output voltage [kV]	:	15.75
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	6
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3736.39 GW(e).h
Energy Availability Factor (EAF)	:	90.97 %
Unit Capability Factor (UCF)	:	92.01 %
Load Factor (LF)	:	91.08 %
Operating Factor (OF)	:	92.77 %

Forced Loss Rate (FLR)	:	1.55 %
Unplanned Capability Loss Factor (UCL)	:	2.87 %
Planned Unavailability Factor (PUF)	:	5.12 %
Externally cause unavailability (XUF)	:	1.04 %
Total off-line time	:	635 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	353.84	328.47	322.36	62.54	342.54	325.24	306.68	333.10	333.61	339.80	339.46	348.76	3736.39
EAF [%]	100.00	100.00	92.60	20.38	98.55	97.48	89.19	96.39	98.88	97.79	100.00	99.43	90.97
UCF [%]	100.00	100.00	92.68	20.69	99.66	99.84	92.52	100.00	100.00	98.27	100.00	99.43	92.01
LF [%]	101.84	101.06	92.78	18.60	98.59	96.73	88.27	95.87	99.22	97.80	100.96	100.38	91.08
OF [%]	100.00	100.00	94.35	24.31	100.00	100.00	93.55	100.00	100.00	100.00	100.00	100.00	92.77
FLR [%]	0.00	0.00	7.32	0.00	0.00	0.00	7.48	0.00	0.00	1.72	0.00	0.55	1.55
UCL [%]	0.00	0.00	7.32	17.43	0.00	0.00	7.48	0.00	0.00	1.72	0.00	0.55	2.87
PUF [%]	0.00	0.00	0.00	61.88	0.34	0.16	0.00	0.00	0.00	0.00	0.00	0.01	5.12
XUF [%]	0.00	0.00	0.08	0.31	1.11	2.36	3.33	3.61	1.12	0.48	0.00	0.00	1.04

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Historical Summary

Lifetime energy generation	:	85635.3 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.88 %
Cumulative Energy Availability Factor (EAF)	:	87.46 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.01 %
Cumulative Unit Capability Factor (UCF)	:	89.04 %	Cumulative Planned Unavailability Factor (PUF)	:	9.95 %
Cumulative Load Factor (LF)	:	86.77 %	Cumulative Externally cause unavailability (XUF)	:	1.58 %
Cumulative Operating Factor (OF)	:	90.01 %			

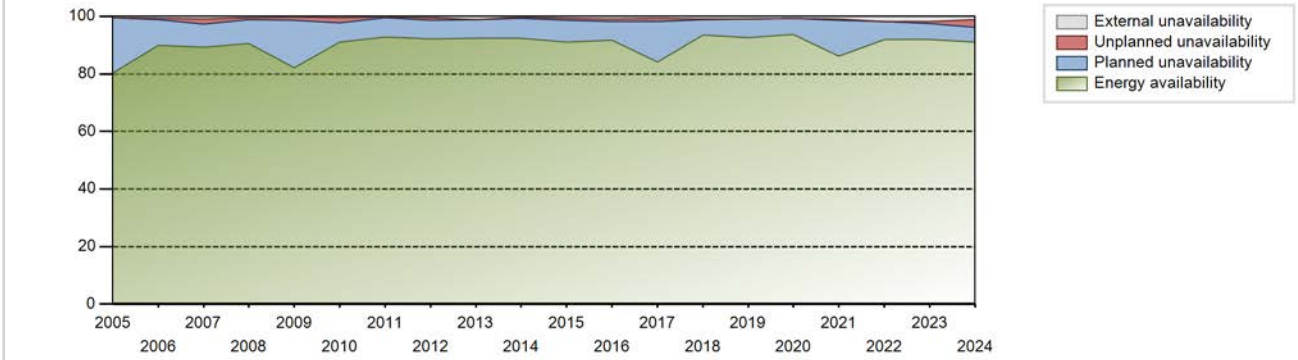
Electricity Production (net) [GWh]



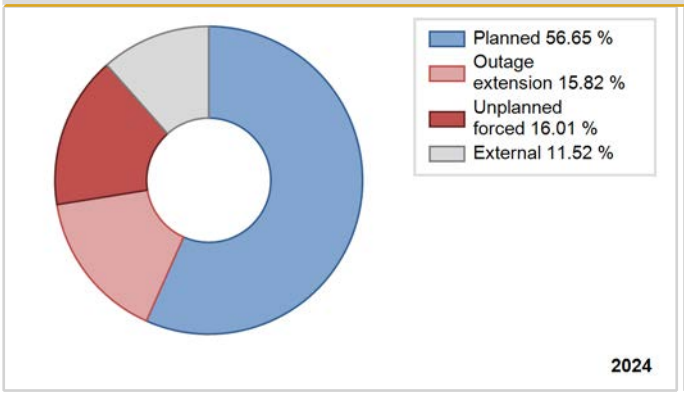
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1998	936.28	3343	408	94.96	96.83	93.54	98.98	3.17	3.17	0.00	1.87
1999	2376.14	6397	404	65.82	70.37	67.14	73.03	3.19	2.32	27.30	4.55
2000	2816.90	8311	404	79.38	89.96	79.38	94.62	2.46	2.27	7.77	10.58
2001	2423.59	6648	404	68.15	74.98	68.48	75.89	2.49	1.92	23.10	6.83
2002	2914.76	7628	405	83.31	86.32	82.16	87.08	0.24	0.21	13.47	3.02
2003	2796.62	7324	405	82.28	82.97	78.83	83.61	5.91	5.21	11.82	0.69
2004	2995.97	7801	405	88.10	88.58	84.22	88.81	0.15	0.13	11.28	0.48
2005	2712.57	7128	405	80.33	80.76	76.46	81.37	0.10	0.08	19.16	0.43
2006	3059.75	7977	405	90.01	90.72	86.23	91.05	0.43	0.39	8.88	0.71
2007	3142.72	7954	405	89.21	90.03	88.58	90.80	0.28	1.79	8.18	0.82
2008	3329.40	8064	436	90.62	91.05	89.58	91.80	0.21	0.76	8.19	0.43
2009	3111.64	7466	436	82.05	82.37	81.47	85.23	1.27	1.06	16.57	0.32
2010	3446.79	8074	436	91.02	91.51	90.25	92.17	1.92	1.79	6.70	0.49
2011	3542.88	8235	436	92.92	93.27	92.76	94.01	0.05	0.04	6.69	0.35
2012	3532.61	8188	436	92.14	92.63	92.24	93.21	0.81	0.82	6.55	0.49
2013	3526.15	8195	436	92.29	93.33	92.32	93.55	0.00	0.00	6.67	1.04
2014	3530.12	8259	436	92.38	92.55	92.43	94.28	0.13	0.55	6.90	0.18
2015	3436.31	8067	436	90.98	91.59	89.97	92.09	0.76	0.71	7.71	0.61
2016	3478.22	8185	436	91.64	92.67	90.82	93.18	0.42	0.73	6.60	1.03
2017	3208.45	7542	436	84.20	84.97	84.00	86.10	1.05	1.07	13.96	0.77
2018	3539.85	8299	436	93.39	94.37	92.68	94.74	0.27	0.25	5.38	0.98
2019	3547.11	8225	436	92.50	93.44	92.87	93.89	0.09	0.09	6.47	0.94
2020	3610.01	8322	436	93.82	94.52	94.27	94.75	0.02	0.07	5.42	0.69
2021	3438.55	8083	467	86.07	87.05	86.91	92.27	0.06	0.37	12.57	0.99
2022	3753.95	8253	467	91.89	93.65	91.76	94.21	0.11	0.10	6.25	1.76
2023	3764.66	8256	467	92.04	93.87	92.02	94.25	0.07	0.76	5.37	1.83
2024	3736.39	8149	467	90.97	92.01	91.08	92.77	1.55	2.87	5.12	1.04

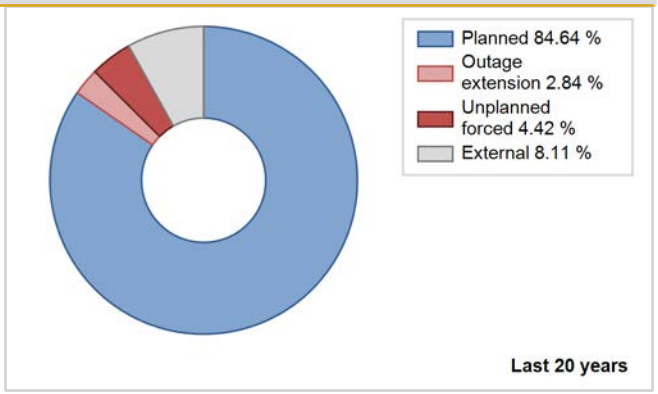
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1998 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		217			53	
C. Inspection, maintenance or repair combined with refuelling	420			782		
D. Inspection, maintenance or repair without refuelling				27		
J. Grid limitation, failure or grid unavailability						2
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L. Human factor related					7	
Z. Other					3	
Subtotal	420	217		809	63	3
Total		**637**			**875**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1998 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		14
12. Reactor I&C Systems	48	7
13. Reactor Auxiliary Systems	125	5
14. Safety Systems		9
15. Reactor Cooling Systems		1
16. Steam generation systems		1
17. Safety I&C Systems (excluding reactor I&C)		2
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries	43	2
32. Feedwater and Main Steam System		2
35. All other I&C Systems		0
41. Main Generator Systems		1
42. Electrical Power Supply Systems		13
Total	**216**	**58**

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Highlights (2024)

MOCHOVCE 1 unit was operated at full power in base load mode in 2024. Throughout the year there were two unplanned full outage. The first of them occured in March, when the Unit was shut down by automatic reactor scram. In July the Unit was shut down due to control fuel rod 09-34 drop on. In October the Unit regulated to self-consumption at turbine TG11 after 400kV circuit breaker tripping. The value of total unplanned losses (117.9 GWh) was also affected by losses from general overhaul extension. Planned production losses of 209.8 GWh included general overhaul with fuel replacement in April and the certification of the supporting services for grid adjustment. Other factors affecting energy generation were limitations due to environmental conditions and site heating. During the year the unit provided supporting services for grid adjustment.

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2024 Operating Experience

SK-7 MOCHOVCE-2 SLOVAKIA



Status at end of year	:	**Operational**
Operator	:	SE (SLOVENSKÉ ELEKTRÁRNE, A.S.)
Owner	:	SE (SLOVENSKÉ ELEKTRÁRNE, A.S.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1471 MWth
Gross electrical power	:	500 MWe
Reference unit power (net)	:	469 MWe

Key Dates

Construction Date	:	1983-10-13
Grid Date	:	1999-12-20
Commercial Date	:	2000-04-11
Age at end of year	:	25 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.415
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	22
Average discharge burnup [MWd/t]	:	54000
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	13.49
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O

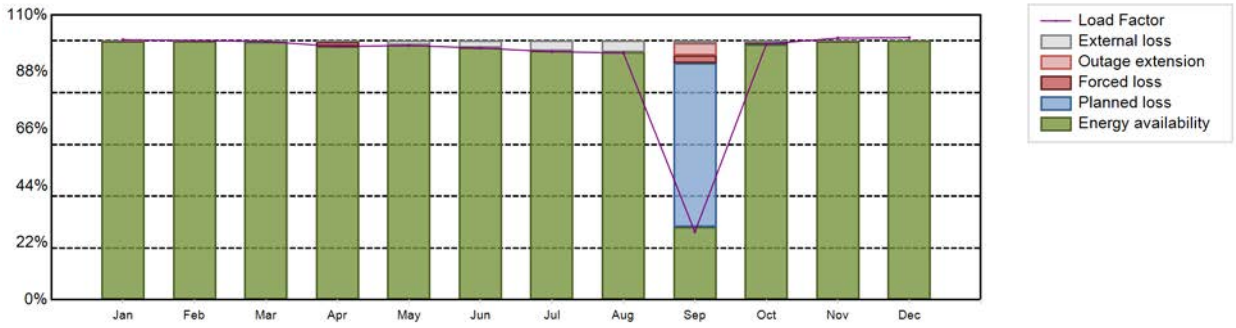
Operating coolant pressure [MPa]	:	12.0
Reactor outlet temperature [°C]	:	295
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.245
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.3
Output voltage [kV]	:	15.75
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	6
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3822.24 GW(e).h
Energy Availability Factor (EAF)	:	92.71 %
Unit Capability Factor (UCF)	:	93.98 %
Load Factor (LF)	:	92.78 %
Operating Factor (OF)	:	94.57 %

Forced Loss Rate (FLR)	:	0.45 %
Unplanned Capability Loss Factor (UCL)	:	0.81 %
Planned Unavailability Factor (PUF)	:	5.21 %
Externally cause unavailability (XUF)	:	1.26 %
Total off-line time	:	477 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	350.53	326.78	348.28	330.25	342.82	328.36	334.37	332.80	88.63	344.70	341.42	353.32	3822.24
EAF [%]	99.89	99.87	99.72	97.77	98.39	97.33	96.12	95.73	28.05	98.68	99.95	100.00	92.71
UCF [%]	99.97	100.00	99.99	98.25	99.99	100.00	100.00	100.00	29.01	99.39	99.97	100.00	93.98
LF [%]	100.46	100.11	99.81	97.80	98.25	97.24	95.83	95.37	26.25	98.79	101.11	101.26	92.78
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	33.75	100.00	100.00	100.00	94.57
FLR [%]	0.03	0.00	0.00	1.75	0.01	0.00	0.00	0.00	9.06	0.49	0.03	0.00	0.45
UCL [%]	0.03	0.00	0.00	1.75	0.01	0.00	0.00	0.00	7.55	0.49	0.03	0.00	0.81
PUF [%]	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	63.44	0.12	0.00	0.00	5.21
XUF [%]	0.08	0.13	0.27	0.48	1.59	2.67	3.88	4.27	0.97	0.72	0.02	0.00	1.26

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Historical Summary

Lifetime energy generation	:	81163.66 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.69 %
Cumulative Energy Availability Factor (EAF)	:	88 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.08 %
Cumulative Unit Capability Factor (UCF)	:	89.34 %	Cumulative Planned Unavailability Factor (PUF)	:	9.58 %
Cumulative Load Factor (LF)	:	86.43 %	Cumulative Externally cause unavailability (XUF)	:	1.34 %
Cumulative Operating Factor (OF)	:	90.05 %			

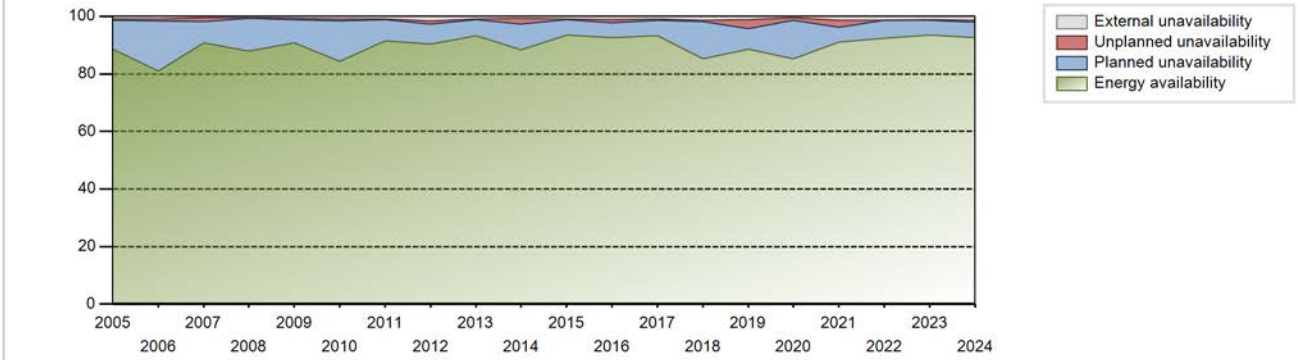
Electricity Production (net) [GWh]



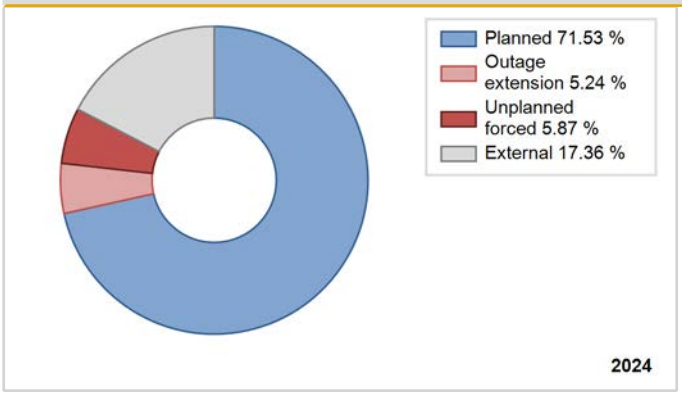
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2000	2641.42	7513	404	87.87	91.55	83.34	89.56	1.67	1.56	6.89	3.68
2001	2540.88	6967	404	72.10	78.17	71.80	79.53	6.46	5.40	16.43	6.07
2002	2498.36	6862	405	71.67	76.02	70.42	78.33	2.28	1.78	22.20	4.36
2003	2964.87	7729	405	87.37	87.81	83.57	88.23	0.52	0.46	11.73	0.43
2004	2034.50	7210	405	81.41	81.61	57.19	82.08	0.43	1.11	17.28	0.20
2005	3050.88	7900	405	88.52	89.45	85.99	90.18	0.51	0.45	10.09	0.93
2006	2787.17	7254	405	81.05	82.07	78.56	82.81	0.59	0.60	17.33	1.02
2007	3191.35	8082	405	90.85	91.26	89.95	92.26	1.11	1.39	7.36	0.41
2008	3070.50	7797	436	87.85	88.31	85.22	88.76	0.31	0.28	11.41	0.46
2009	3414.88	8128	436	90.86	91.54	89.41	92.79	0.50	0.56	7.90	0.68
2010	3189.95	7574	436	84.38	85.22	83.52	86.46	0.83	0.72	14.07	0.84
2011	3480.32	8195	436	91.55	92.49	91.12	93.55	0.33	0.31	7.21	0.93
2012	3476.42	8121	436	90.40	91.96	90.77	92.45	0.35	1.10	6.94	1.56
2013	3581.83	8274	436	93.27	94.22	93.78	94.45	0.11	0.10	5.68	0.95
2014	3392.49	7842	436	88.41	89.18	88.82	89.52	0.16	1.86	8.96	0.76
2015	3561.23	8296	436	93.39	94.40	93.24	94.70	0.01	0.10	5.50	1.02
2016	3535.75	8268	436	92.59	93.67	92.32	94.13	0.50	1.15	5.18	1.08
2017	3543.32	8280	436	93.20	94.16	92.77	94.52	0.15	0.41	5.43	0.95
2018	3271.12	7642	436	85.31	86.66	85.65	87.24	0.38	0.48	12.86	1.35
2019	3398.93	7922	436	88.65	89.77	88.99	90.43	0.18	3.26	6.97	1.12
2020	3332.80	8112	469	85.26	85.77	86.47	92.35	0.11	0.79	13.44	0.50
2021	3747.56	8155	469	91.05	92.35	91.22	93.09	0.73	2.44	5.20	1.30
2022	3800.50	8249	469	92.41	93.74	92.50	94.17	0.03	0.03	6.23	1.33
2023	3848.01	8327	469	93.46	94.63	93.66	95.06	0.09	0.23	5.13	1.18
2024	3822.24	8307	469	92.71	93.98	92.78	94.57	0.45	0.81	5.21	1.26

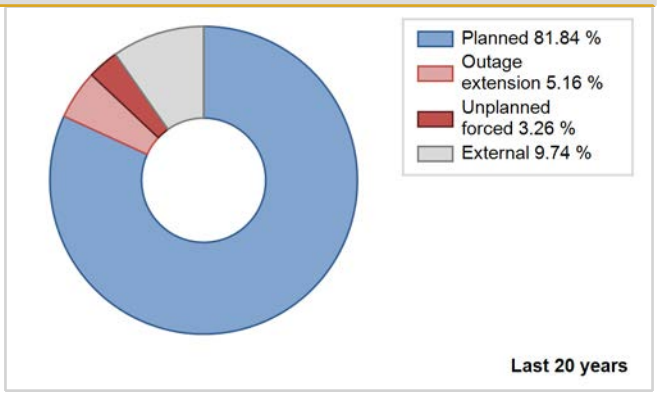
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2000 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		34			61	
C. Inspection, maintenance or repair combined with refuelling	443			734		
D. Inspection, maintenance or repair without refuelling				64		
L. Human factor related					4	
Z. Other					1	
Subtotal	443	34		798	66	
Total		**477**			**864**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2000 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories	34	4
12. Reactor I&C Systems		8
13. Reactor Auxiliary Systems		3
14. Safety Systems		6
15. Reactor Cooling Systems		24
16. Steam generation systems		7
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		1
33. Circulating Water System		0
41. Main Generator Systems		3
42. Electrical Power Supply Systems		3
Total	**34**	**60**

Highlights (2024)

MOCHOVCE 2 unit was operated at full power in base load mode in 2024. Throughout the year there were no reactor scram and no unplanned full outage. Annual value of the unplanned energy loses of 33.4 GWh was affected by TG22 shut down in April and in September due to leak repair and by TG21 shut down in October. Planned energy loses of 214.7 GWh included the the losses by general overhaul with refueling in September. Other factors affecting energy generation were limitations due to environmental conditions and site heating. During the year the unit provided supporting services for grid adjustment.

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2024 Operating Experience

SK-10 MOCHOVCE-3 SLOVAKIA

Status at end of year	:	**Operational**
Operator	:	SE (SLOVENSKÉ ELEKTRÁRNE, A.S.)
Owner	:	SE (SLOVENSKÉ ELEKTRÁRNE, A.S.)
Reactor Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)
Turbine Supplier	:	ŠKODA (ŠKODA CONCERN NUCLEAR POWER PLANT WORKS)

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1375 MWth
Gross electrical power	:	471 MWe
Reference unit power (net)	:	434 MWe

Key Dates

Construction Date	:	1987-01-27
Grid Date	:	2023-01-31
Commercial Date	:	
Age at end of year	:	1 years

Design Characteristics

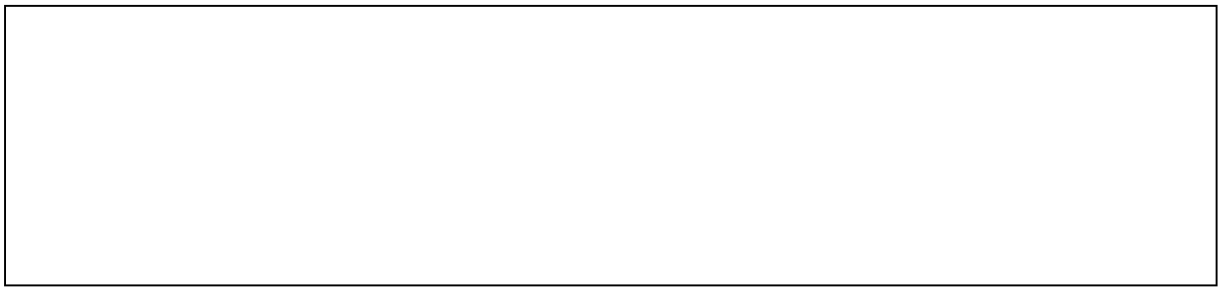
Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	31000
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	349
Fuel linear heat generation rate [kW/m]	:	-
Number of control rod assemblies	:	-
Number of external reactor coolant loops	:	6
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	12.23
Reactor outlet temperature [°C]	:	267.8
Number of SG	:	6
Containment type	:	-
Containment design pressure [MPa]	:	-
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	4.4
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2841.27 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1894 hours

Annual Summary

No data found



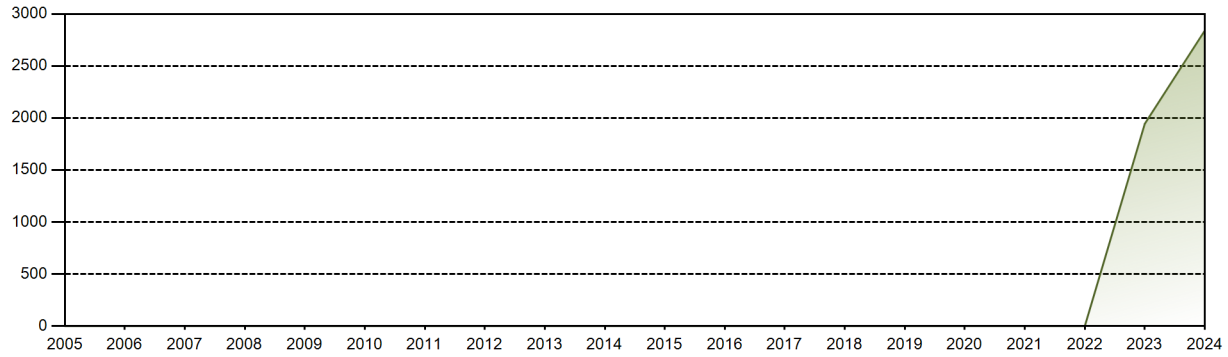
	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

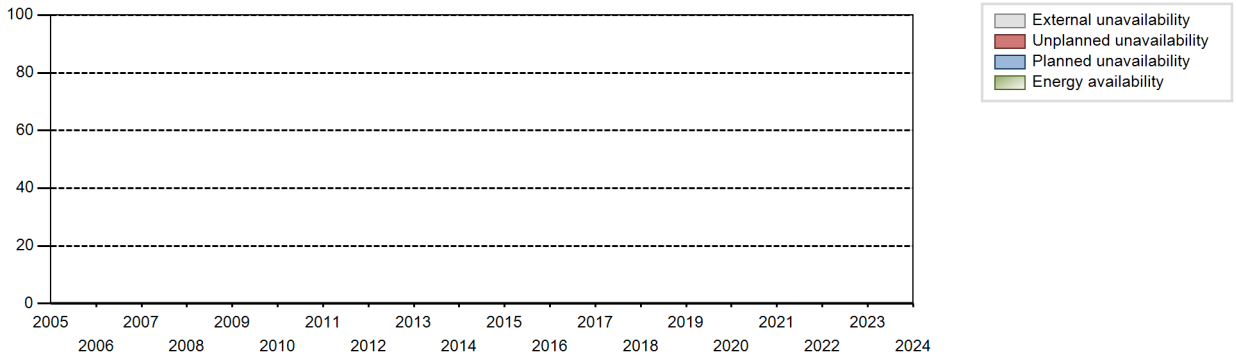
Lifetime energy generation	:	4786.54 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0 %
Cumulative Energy Availability Factor (EAF)	:	0 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0 %
Cumulative Unit Capability Factor (UCF)	:	0 %	Cumulative Planned Unavailability Factor (PUF)	:	0 %
Cumulative Load Factor (LF)	:	0 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	0 %			

Electricity Production (net) [GWh]

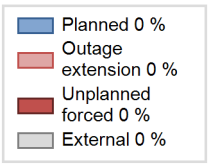


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]

Key Factors in Last 20 Years [%]



Energy Losses by Type



2024

No Data Available

Last 20 years

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Full Outages, Analysis by Cause

Outage Cause	2024			1 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		642				
C. Inspection, maintenance or repair combined with refuelling	1242					
E. Testing of plant systems or components	2					
J. Grid limitation, failure or grid unavailability			8			
Subtotal	1244	642	8			
Total	**1894**			**0**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	216	216
33. Circulating Water System	46	46
42. Electrical Power Supply Systems	380	380
Total	**642**	**642**

Highlights (2024)

MOCHOVCE 3 unit was operated at full power in base load mode in 2024. In the period from May 17th to July 8th the unit was shut down as a part of the first planned refuelling outage. Replacement of the high pressure section of the turbogenerator's timing wheels contributed to the increase of the unit's achievable power output value. The total planned energy losses in the reporting period was 559.3 GWh. Throughout the year there were several full outage of the unit. The first of them occurred in January as a result of the external grid failure. Unplanned full outages occurred in August, in October and in November. The total unplanned energy losses in the reporting period was 307.9 GWh. Other factors affecting energy generation were limitations due to environmental conditions.

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2024 Operating Experience

SI-1 KRSKO SLOVENIA



Status at end of year	:	**Operational**
Operator	:	NEK (Nuklearna elektrarna Krško)
Owner	:	GEN (GEN Energija, d.o.o)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP
Thermal power	:	1994 MWth
Gross electrical power	:	736 MWe
Reference unit power (net)	:	696 MWe

Key Dates

Construction Date	:	1975-03-30
Grid Date	:	1981-10-02
Commercial Date	:	1983-01-01
Age at end of year	:	43 years

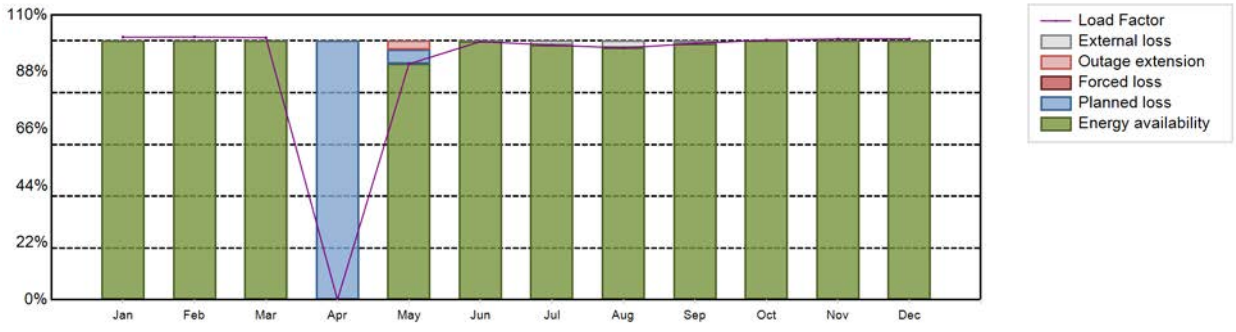
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	325.2
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.309
Average fuel enrichment [% of U235]	:	4.8	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	46	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	44029	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	2.46	HP cylinder inlet steam pressure [MPa]	:	6.13
Active core height/length [m]	:	3.66	Output voltage [kV]	:	21
Number of fissile fuel assemblies/bundles	:	121	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	17.62	Number of main condensate pumps	:	3
Number of control rod assemblies	:	33	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5551.25 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	90.64 %	Unplanned Capability Loss Factor (UCL)	:	0.28 %
Unit Capability Factor (UCF)	:	91.12 %	Planned Unavailability Factor (PUF)	:	8.6 %
Load Factor (LF)	:	91.15 %	Externally cause unavailability (XUF)	:	0.48 %
Operating Factor (OF)	:	91.52 %	Total off-line time	:	745 hours

Annual Summary



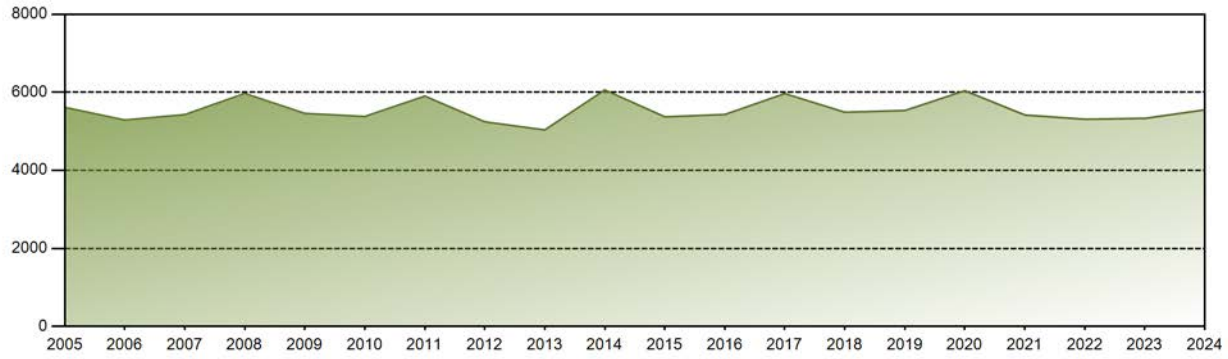
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	519.38	486.01	517.65	0.36	471.74	499.82	509.32	503.75	496.01	520.45	504.84	521.92	5551.25
EAF [%]	100.00	100.00	100.00	0.07	91.09	99.74	98.36	97.28	98.98	100.00	100.00	100.00	90.64
UCF [%]	100.00	100.00	100.00	0.07	91.09	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.12
LF [%]	101.47	101.49	101.27	0.07	91.10	99.74	98.36	97.28	98.98	100.37	100.74	100.79	91.15
OF [%]	100.00	100.00	100.00	0.28	96.37	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.52
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	3.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28
PUF [%]	0.00	0.00	0.00	99.93	5.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.60
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.26	1.64	2.72	1.02	0.00	0.00	0.00	0.48

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Historical Summary

Lifetime energy generation	:	210909.9 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.49 %
Cumulative Energy Availability Factor (EAF)	:	86.63 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.64 %
Cumulative Unit Capability Factor (UCF)	:	87.64 %	Cumulative Planned Unavailability Factor (PUF)	:	10.73 %
Cumulative Load Factor (LF)	:	86.22 %	Cumulative Externally cause unavailability (XUF)	:	1.01 %
Cumulative Operating Factor (OF)	:	87.98 %			

Electricity Production (net) [GWh]

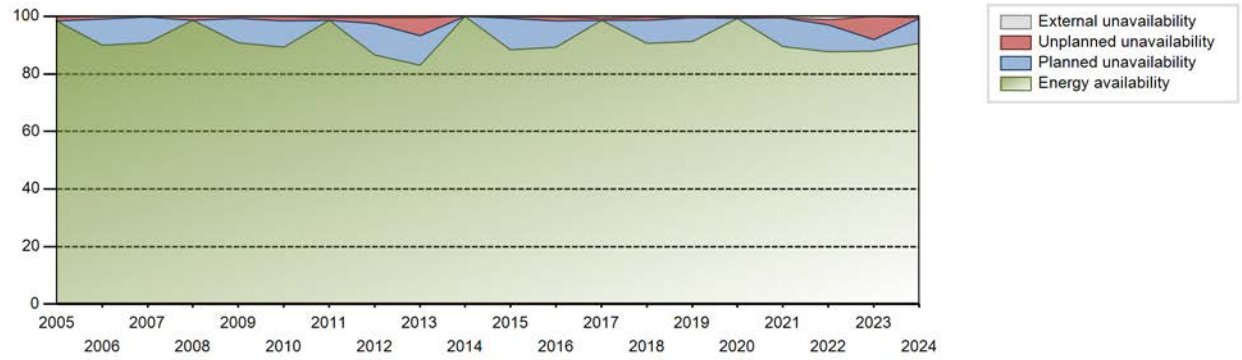


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	3724.10	6255	632	69.63	69.63	67.27	71.40	5.54	4.08	26.29	0.00
1984	4207.60	7073	632	79.80	79.80	75.79	80.52	5.16	4.34	15.86	0.00
1985	3845.27	6421	632	72.06	72.06	69.46	73.30	8.22	6.46	21.48	0.00
1986	3821.99	6561	620	73.74	74.83	70.37	74.90	2.64	2.03	23.14	1.10
1987	4278.82	7287	620	83.54	83.54	78.78	83.18	1.90	1.62	14.84	0.00
1988	3935.75	6866	620	76.94	77.03	72.27	78.16	6.58	5.43	17.54	0.09
1989	4453.95	7500	620	85.18	85.46	82.01	85.62	1.38	1.20	13.34	0.27
1990	4386.77	7592	620	85.38	87.10	80.77	86.67	0.17	0.15	12.75	1.72
1991	4718.22	8133	632	88.67	94.63	85.22	92.84	0.09	0.09	5.28	5.96
1992	3767.25	6699	632	68.60	73.98	67.86	76.26	2.41	1.83	24.19	5.38
1993	3762.77	6493	620	69.28	72.53	69.28	74.12	6.46	5.01	22.46	3.26
1994	4403.53	7402	620	81.08	82.10	81.08	84.50	0.80	0.66	17.25	1.02
1995	4568.50	7606	620	84.07	85.09	84.12	86.83	2.21	1.92	12.99	1.02
1996	4361.62	7143	620	79.64	79.64	80.09	81.32	0.27	0.22	20.14	0.00
1997	4793.98	7824	620	87.76	88.27	88.27	89.32	2.28	2.06	9.66	0.51
1998	4793.60	7913	620	88.01	89.54	88.26	90.33	0.05	0.05	10.42	1.53
1999	4492.38	7480	620	82.45	84.73	82.71	85.39	1.17	1.00	14.27	2.28
2000	4548.79	7295	676	80.49	82.56	80.10	83.05	0.00	0.00	17.43	2.08
2001	5036.28	7790	656	86.22	88.45	87.64	88.93	0.00	0.00	11.55	2.23
2002	5308.75	8111	676	91.09	91.99	89.65	92.59	0.86	0.80	7.20	0.91
2003	4963.34	8084	676	86.19	91.60	83.82	92.28	0.87	0.81	7.59	5.42
2004	5212.18	8081	676	89.88	91.41	87.78	92.00	0.40	0.88	7.71	1.53
2005	5613.65	8664	656	98.32	98.55	97.69	98.90	1.45	1.45	0.00	0.22
2006	5289.47	7883	666	89.92	90.06	91.34	89.99	0.00	0.83	9.11	0.14
2007	5428.19	7989	666	90.90	91.01	93.04	91.20	0.12	0.11	8.89	0.11
2008	5972.03	8660	666	98.59	98.59	102.08	98.59	1.41	1.41	0.00	0.00
2009	5459.72	7992	666	90.75	90.75	93.58	91.23	0.03	0.60	8.65	0.00
2010	5380.71	7876	666	89.33	89.33	92.23	89.91	0.00	1.52	9.15	0.00
2011	5902.24	8600	688	98.64	99.20	97.93	98.17	0.77	0.77	0.03	0.55
2012	5243.68	7697	688	86.48	87.00	86.77	87.63	0.72	1.96	11.04	0.52
2013	5036.47	7391	688	83.04	83.47	83.57	84.37	2.79	6.28	10.25	0.43
2014	6060.82	8760	688	99.95	100.00	100.56	100.00	0.00	0.00	0.00	0.05
2015	5371.66	7826	688	88.47	88.78	89.13	89.34	0.00	0.31	10.91	0.31
2016	5431.27	7923	688	89.25	89.62	89.87	90.20	0.00	1.15	9.23	0.36
2017	5967.83	8708	688	98.52	99.19	99.01	99.40	0.81	0.81	0.00	0.67
2018	5489.91	8010	688	90.57	90.92	91.09	91.44	0.20	0.98	8.09	0.35
2019	5532.98	8081	688	91.28	91.72	91.81	92.25	0.00	0.00	8.28	0.44

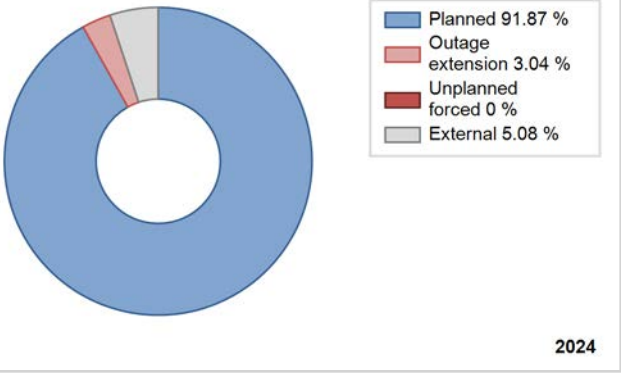
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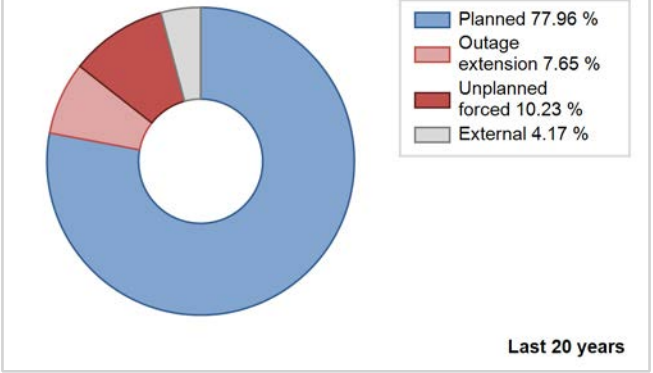
2020	6040.85	8748	688	99.34	99.51	99.96	99.59	0.49	0.49	0.00	0.17
2021	5418.64	7940	688	89.57	90.15	89.91	90.64	0.00	0.00	9.85	0.58
2022	5310.70	7849	688	87.80	89.06	88.12	89.60	0.00	1.62	9.32	1.27
2023	5332.49	7693	688	87.83	87.83	88.48	87.82	8.49	8.14	4.02	0.00
2024	5551.25	8039	696	90.64	91.12	91.15	91.52	0.00	0.28	8.60	0.48

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1983 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		25			140	
C.	Inspection, maintenance or repair combined with refuelling				755		
D.	Inspection, maintenance or repair without refuelling				125		
E.	Testing of plant systems or components				36	1	
F.	Major backfitting, refurbishment or upgrading activities with refuelling	720			71		
J.	Grid limitation, failure or grid unavailability						3
L.	Human factor related					1	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z.	Other					1	
Subtotal		720	25		987	143	4
Total		**745**			**1134**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	25	14
12. Reactor I&C Systems		3
13. Reactor Auxiliary Systems		2
14. Safety Systems		2
15. Reactor Cooling Systems		27
16. Steam generation systems		10
21. Fuel Handling and Storage Facilities		2
31. Turbine and auxiliaries		26
32. Feedwater and Main Steam System		32
33. Circulating Water System		3
35. All other I&C Systems		0
41. Main Generator Systems		6
42. Electrical Power Supply Systems		13
Total	**25**	**140**

RUP revision during the year (2024) due to power uprate

RUP at the end of previous year : 688 [MWe]

Month	Capacity [MWe]	Power Uprate	Main modifications	Description
May	696	Stretch power uprate (2-7%)	Balance of plant	Final results of the plant performance test conducted following the modification of high-pressure (HP) turbine during the 2024 outage. The HP turbine was replaced during the 2022 outage per modification 1098-TU-L. In 2024 outage, further modification

Highlights (2024)

There were no automatic or manual reactor scrams during the year 2024. The planned outage with refuelling was successfully completed from April 1, 2024 to May 2, 2024.

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2024 Operating Experience

ZA-1 KOEBERG-1 SOUTH AFRICA

Status at end of year	:	**Operational**
Operator	:	ESKOM (ESKOM)
Owner	:	ESKOM (ESKOM)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	AA (ALSTHOM ATLANTIQUE)



Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2775 MWth
Gross electrical power	:	964 MWe
Reference unit power (net)	:	924 MWe

Key Dates

Construction Date	:	1976-07-01
Grid Date	:	1984-04-04
Commercial Date	:	1984-07-21
Age at end of year	:	40 years

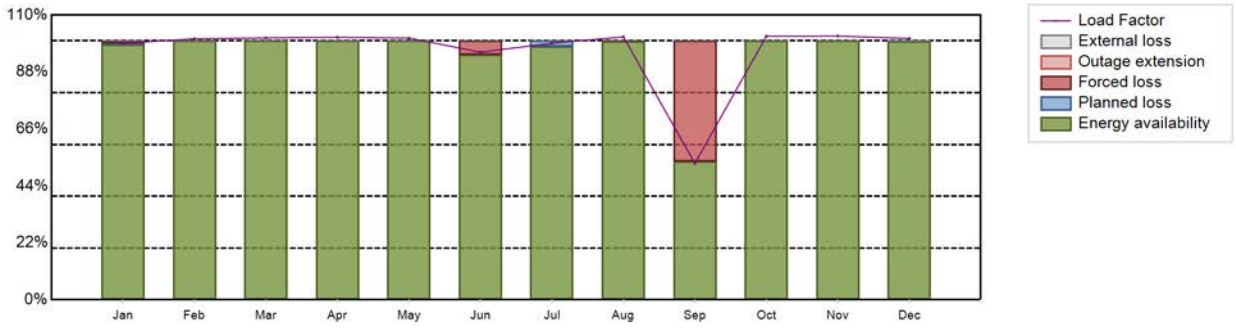
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	314.9
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.5
Average fuel enrichment [% of U235]	:	3.9	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	46000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.5
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.6	Number of main condensate pumps	:	-
Number of control rod assemblies	:	32	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7832.56 GW(e).h	Forced Loss Rate (FLR)	:	4.33 %
Energy Availability Factor (EAF)	:	95.44 %	Unplanned Capability Loss Factor (UCL)	:	4.34 %
Unit Capability Factor (UCF)	:	95.44 %	Planned Unavailability Factor (PUF)	:	0.22 %
Load Factor (LF)	:	96.5 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	97.58 %	Total off-line time	:	213 hours

Annual Summary



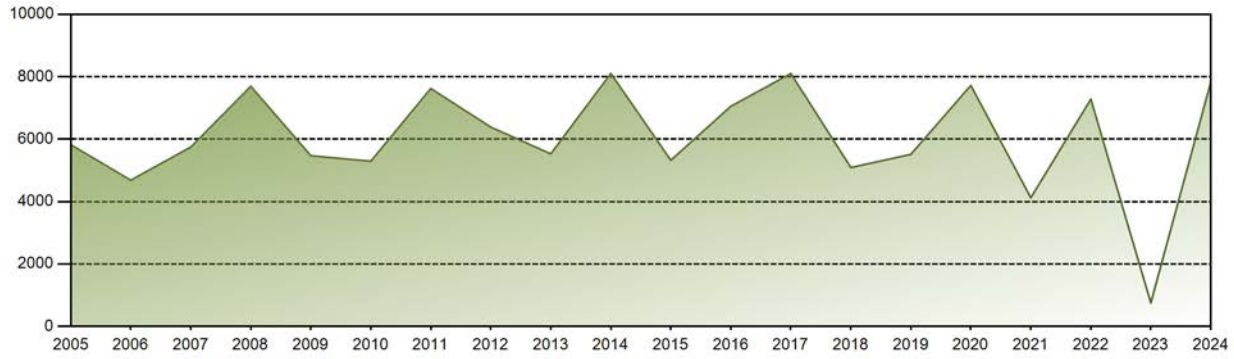
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	681.27	648.36	695.36	674.61	695.01	636.38	681.39	698.15	350.65	699.79	677.68	693.90	7832.56
EAF [%]	98.57	100.00	100.00	100.00	100.00	94.61	97.92	99.95	53.50	100.00	100.00	99.97	95.44
UCF [%]	98.57	100.00	100.00	100.00	100.00	94.61	97.92	99.95	53.50	100.00	100.00	100.00	95.44
LF [%]	99.10	100.82	101.15	101.40	101.10	95.66	99.12	101.56	52.71	101.79	101.86	100.94	96.50
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	70.42	100.00	100.00	100.00	97.58
FLR [%]	0.75	0.00	0.00	0.00	0.00	5.39	0.00	0.05	46.50	0.00	0.00	0.00	4.33
UCL [%]	0.92	0.00	0.00	0.00	0.00	5.39	0.00	0.05	46.50	0.00	0.00	0.00	4.34
PUF [%]	0.51	0.00	0.00	0.00	0.00	0.00	2.08	0.00	0.00	0.00	0.00	0.00	0.22
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00

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Historical Summary

Lifetime energy generation	:	231925.26 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.56 %
Cumulative Energy Availability Factor (EAF)	:	72.79 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.33 %
Cumulative Unit Capability Factor (UCF)	:	75.81 %	Cumulative Planned Unavailability Factor (PUF)	:	16.86 %
Cumulative Load Factor (LF)	:	71.16 %	Cumulative Externally cause unavailability (XUF)	:	3.02 %
Cumulative Operating Factor (OF)	:	76.89 %			

Electricity Production (net) [GWh]

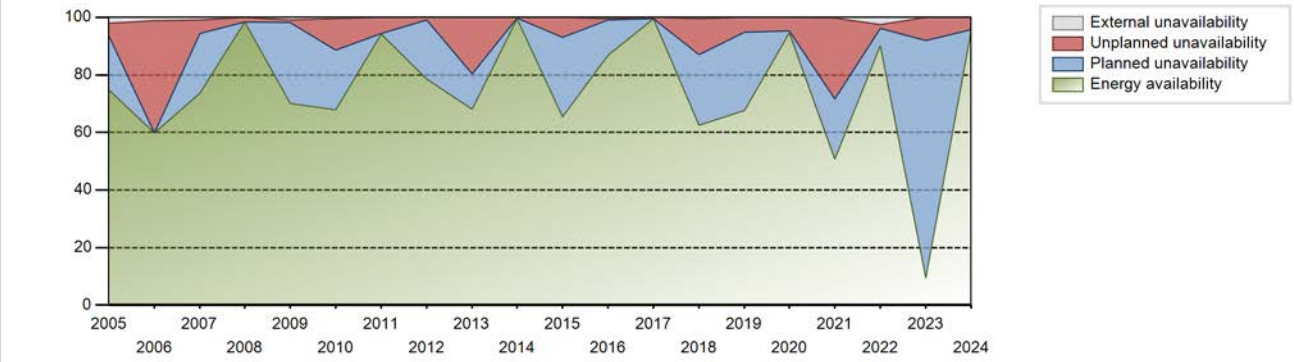


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	3949.53	5063	920	91.26	91.46	86.35	95.26	8.50	8.50	0.03	0.20
1985	4004.30	4986	920	53.49	53.49	49.69	56.92	45.38	44.45	2.06	0.00
1986	3418.99	4575	922	53.58	53.58	42.33	52.23	14.53	9.11	37.31	0.00
1987	2864.54	4337	920	61.60	61.60	35.54	49.51	1.96	1.23	37.17	0.00
1988	5964.44	6791	920	76.03	76.03	73.81	77.31	5.42	4.36	19.61	0.00
1989	4498.08	5655	922	63.21	63.21	55.24	64.03	8.46	5.84	30.95	0.00
1990	3852.07	5360	920	52.72	61.72	47.80	61.19	2.85	1.81	36.47	8.99
1991	5976.84	6886	920	74.56	76.34	74.16	78.61	6.48	5.29	18.37	1.78
1992	3992.53	5697	920	50.32	63.62	49.40	64.86	8.83	6.16	30.22	13.29
1993	4097.94	6010	920	50.52	66.41	50.85	68.61	9.43	6.92	26.68	15.88
1994	5933.92	8422	920	74.86	95.64	73.63	96.14	3.87	3.85	0.51	20.79
1995	4576.86	5853	920	56.81	65.70	56.75	66.82	13.12	9.92	24.38	8.88
1996	5672.79	7260	920	70.37	81.82	70.20	82.65	1.73	1.44	16.74	11.46
1997	6610.69	7676	920	82.31	87.37	82.03	87.63	3.07	2.77	9.86	5.06
1998	7248.29	8552	920	90.11	97.63	89.94	97.63	2.37	2.37	0.00	7.52
1999	7051.70	7848	920	83.28	88.07	87.50	89.59	3.96	3.64	8.29	4.79
2000	5629.15	7250	920	70.21	73.36	69.79	82.70	15.82	13.79	12.85	3.16
2001	6042.50	7303	920	77.13	83.02	74.98	83.37	1.64	1.38	15.60	5.89
2002	7328.60	8417	900	93.07	95.19	92.96	96.08	3.67	3.62	1.19	2.12
2003	6413.36	7398	900	81.94	84.12	81.35	84.45	2.88	2.50	13.39	2.18
2004	6388.00	7358	900	81.13	81.65	80.80	83.77	2.53	3.07	15.28	0.51
2005	5821.02	6726	900	74.69	76.76	73.83	76.78	3.84	4.33	18.90	2.07
2006	4682.78	5435	900	59.76	60.99	59.40	62.04	39.01	39.01	0.00	1.23
2007	5747.01	6609	900	73.57	74.40	72.89	75.45	2.13	4.74	20.85	0.83
2008	7691.88	8689	900	98.33	98.33	97.30	98.92	1.67	1.67	0.00	0.00
2009	5467.97	6307	900	70.10	71.12	69.36	72.00	0.05	0.71	28.17	1.02
2010	5291.74	6085	900	67.83	68.37	67.12	69.46	12.55	10.81	20.82	0.55
2011	7622.37	8315	930	94.27	94.28	94.05	94.92	5.67	5.67	0.05	0.02
2012	6384.83	6975	930	78.47	78.58	78.16	79.41	1.12	0.89	20.53	0.11
2013	5527.64	6084	930	68.15	68.15	67.85	69.45	20.99	19.60	12.25	0.00
2014	8102.87	8760	930	99.60	99.62	99.46	100.00	0.23	0.23	0.15	0.02
2015	5321.75	5860	930	65.47	65.50	65.32	66.89	3.61	6.89	27.61	0.03
2016	7051.38	7759	930	86.77	87.20	86.32	88.33	0.39	0.40	12.40	0.43
2017	8103.47	8760	930	99.49	99.49	99.47	100.00	0.50	0.50	0.01	0.00
2018	5090.34	5838	930	62.50	62.99	62.48	66.64	7.46	12.40	24.61	0.48
2019	5510.90	6049	930	67.74	67.83	67.64	69.05	5.53	5.05	27.12	0.09
2020	7719.38	8572	930	94.52	94.60	94.49	97.59	3.28	4.65	0.76	0.08

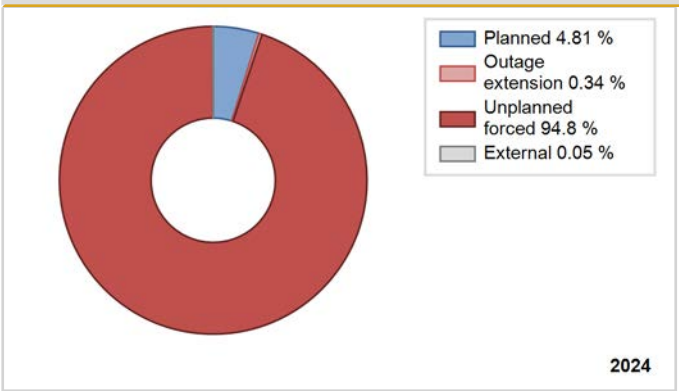
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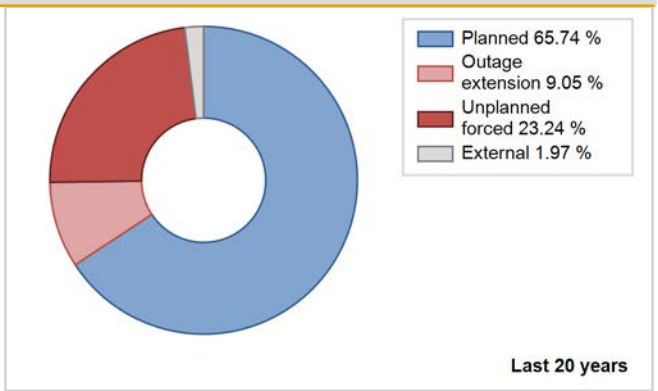
2021	4120.92	4664	924	50.74	51.06	50.69	53.24	20.81	28.10	20.84	0.33
2022	7280.79	8236	924	90.11	92.63	89.95	94.02	1.47	1.38	5.98	2.52
2023	752.77	1041	924	9.44	9.44	9.30	11.88	3.38	8.10	82.46	0.00
2024	7832.56	8571	924	95.44	95.44	96.50	97.58	4.33	4.34	0.22	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		213			368	
C. Inspection, maintenance or repair combined with refuelling				1314	11	
D. Inspection, maintenance or repair without refuelling				122		
E. Testing of plant systems or components				3	10	
J. Grid limitation, failure or grid unavailability						0
L. Human factor related					42	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				40		
Z. Other					51	
Subtotal		213		1479	482	0
Total		**213**			**1961**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		48
12. Reactor I&C Systems	213	25
13. Reactor Auxiliary Systems		1
14. Safety Systems		2
15. Reactor Cooling Systems		66
16. Steam generation systems		21
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		46
32. Feedwater and Main Steam System		35
33. Circulating Water System		5
35. All other I&C Systems		0
41. Main Generator Systems		107
42. Electrical Power Supply Systems		38
Total	**213**	**395**

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2024 Operating Experience

ZA-2 KOEBERG-2 SOUTH AFRICA

Status at end of year	:	**Operational**
Operator	:	ESKOM (ESKOM)
Owner	:	ESKOM (ESKOM)
Reactor Supplier	:	FRAM (FRAMATOME)
Turbine Supplier	:	AA (ALSTHOM ATLANTIQUE)



Reactor Unit Details

Reactor type and model	:	PWR / CP1
Thermal power	:	2775 MWth
Gross electrical power	:	970 MWe
Reference unit power (net)	:	930 MWe

Key Dates

Construction Date	:	1976-07-01
Grid Date	:	1985-07-25
Commercial Date	:	1985-11-09
Age at end of year	:	39 years

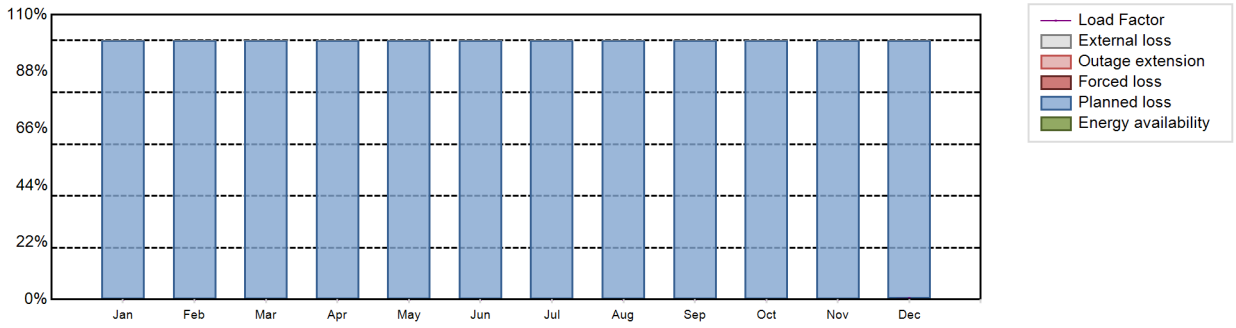
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	314.9
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.5
Average fuel enrichment [% of U235]	:	3.9	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	46000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.5
Active core height/length [m]	:	3.66	Output voltage [kV]	:	24
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.6	Number of main condensate pumps	:	3
Number of control rod assemblies	:	32	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	2.44 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0.03 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0.03 %	Planned Unavailability Factor (PUF)	:	99.97 %
Load Factor (LF)	:	0.03 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0.38 %	Total off-line time	:	8751 hours

Annual Summary



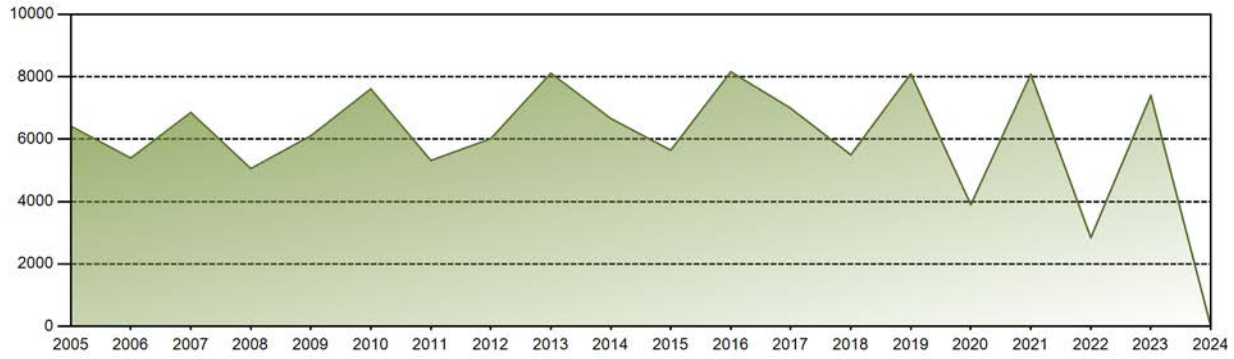
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.44	2.44
EAF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.03
UCF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.03
LF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.03
OF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.44	0.38
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.62	99.97
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	223890.53 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.62 %
Cumulative Energy Availability Factor (EAF)	:	71.69 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.73 %
Cumulative Unit Capability Factor (UCF)	:	77.13 %	Cumulative Planned Unavailability Factor (PUF)	:	17.14 %
Cumulative Load Factor (LF)	:	70.78 %	Cumulative Externally cause unavailability (XUF)	:	5.44 %
Cumulative Operating Factor (OF)	:	77.07 %			

Electricity Production (net) [GWh]

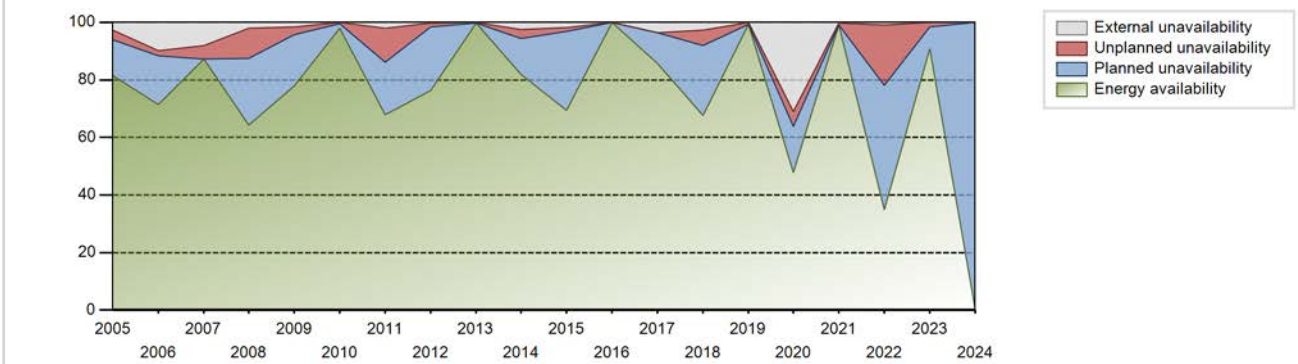


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	1389.80	2006	920	37.18	37.18	35.91	37.91	0.05	0.02	62.80	0.00
1986	5408.99	5969	922	67.32	67.38	66.97	68.14	32.00	31.70	0.91	0.06
1987	3352.78	4193	920	48.63	48.63	41.60	47.87	15.41	8.86	42.51	0.00
1988	4552.69	5626	920	63.07	63.07	56.34	64.05	14.74	10.91	26.02	0.00
1989	6620.21	8115	922	89.24	89.24	81.30	91.88	4.13	3.84	6.92	0.00
1990	4614.34	5933	920	58.39	64.80	57.26	67.73	2.46	1.63	33.57	6.41
1991	3191.94	5067	920	40.27	56.29	39.61	57.84	1.63	0.93	42.78	16.02
1992	5308.06	8439	920	66.26	94.89	65.68	96.07	4.87	4.86	0.25	28.63
1993	3212.30	4654	920	40.36	52.62	39.86	53.13	18.51	11.95	35.43	12.26
1994	3755.92	5944	920	49.45	69.19	46.60	67.85	9.80	7.52	23.30	19.73
1995	6710.53	8640	920	83.21	98.60	83.27	98.63	1.40	1.40	0.00	15.39
1996	6084.93	7177	920	75.78	81.46	75.30	81.71	3.71	3.13	15.41	5.68
1997	6016.36	7409	920	75.20	83.77	74.65	84.58	5.73	5.09	11.14	8.57
1998	6333.04	7194	920	78.97	81.31	78.58	82.12	8.14	7.21	11.48	2.35
1999	6413.89	7509	920	75.71	86.19	79.58	85.72	3.45	3.08	10.74	10.48
2000	7365.91	8687	920	91.23	98.06	91.15	98.90	1.23	1.22	0.72	6.83
2001	4662.84	5461	920	60.08	66.55	57.86	62.34	23.64	20.61	12.84	6.47
2002	4688.80	5439	900	59.59	60.58	59.47	62.09	9.17	21.90	17.52	0.99
2003	6255.50	7150	900	79.41	82.92	79.34	81.62	3.33	2.98	14.10	3.51
2004	7896.70	8784	900	99.78	99.81	99.89	100.00	0.19	0.19	0.00	0.02
2005	6416.81	7330	900	81.55	84.17	81.39	83.68	1.63	3.50	12.33	2.62
2006	5391.37	7003	900	71.44	81.26	68.38	79.94	0.73	1.78	16.96	9.82
2007	6853.86	8422	900	87.29	95.31	86.93	96.14	4.69	4.69	0.00	8.02
2008	5055.87	5960	900	64.20	66.24	63.95	67.85	12.77	10.38	23.38	2.04
2009	6105.80	7079	900	77.86	79.40	77.45	80.81	3.41	2.81	17.79	1.54
2010	7608.20	8565	900	98.03	98.06	96.50	97.77	0.35	0.35	1.59	0.03
2011	5316.17	6254	900	67.96	70.12	67.43	71.39	13.51	11.78	18.11	2.16
2012	6012.70	6911	930	76.28	76.43	75.84	78.68	1.84	1.47	22.10	0.15
2013	8112.97	8760	930	99.81	99.81	99.58	100.00	0.19	0.19	0.00	0.00
2014	6659.83	7462	930	82.01	84.47	81.75	85.18	0.11	3.13	12.40	2.46
2015	5643.39	6328	930	69.35	71.08	69.27	72.24	1.10	1.38	27.54	1.73
2016	8158.09	8784	930	99.99	100.00	99.86	100.00	0.00	0.00	0.00	0.01
2017	6983.82	7878	930	85.65	89.18	85.72	89.93	0.16	0.14	10.67	3.54
2018	5496.77	6320	930	67.54	70.28	67.47	72.15	2.60	5.20	24.51	2.74
2019	8091.67	8760	930	99.35	99.40	99.32	100.00	0.59	0.59	0.01	0.05
2020	3896.22	4667	930	47.72	78.86	47.69	53.13	1.25	5.10	16.05	31.14
2021	8077.98	8760	930	99.15	99.47	99.16	100.00	0.53	0.53	0.00	0.32

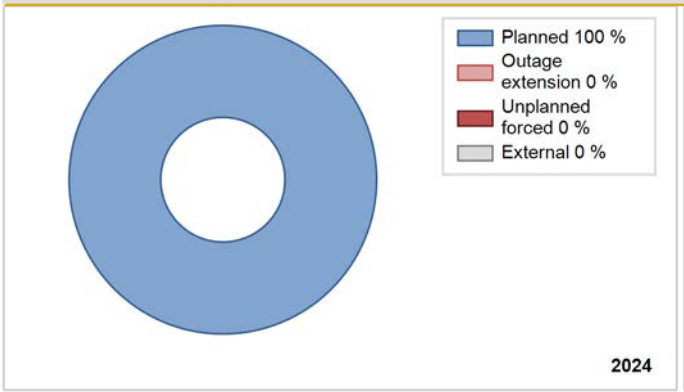
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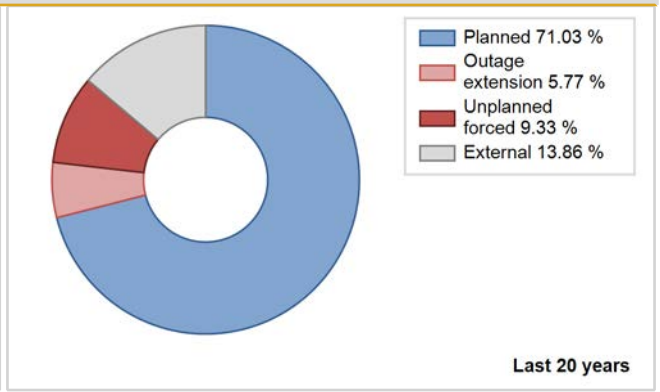
2022	2842.90	3239	930	34.90	35.73	34.90	36.97	18.89	21.12	43.15	0.83
2023	7401.06	8203	930	90.92	90.95	90.85	93.64	1.75	1.62	7.42	0.03
2024	2.44	33	930	0.03	0.03	0.03	0.38	0.00	0.00	99.97	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					394	
C. Inspection, maintenance or repair combined with refuelling				1149	25	
D. Inspection, maintenance or repair without refuelling				37		
E. Testing of plant systems or components				34	1	
F. Major backfitting, refurbishment or upgrading activities with refuelling	8751			236		
H. Nuclear regulatory requirements					1	
J. Grid limitation, failure or grid unavailability						23
L. Human factor related					37	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						0
Z. Other					32	62
Subtotal	8751			1456	490	85
Total	**8751**			**2031**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		24
12. Reactor I&C Systems		27
13. Reactor Auxiliary Systems		1
14. Safety Systems		48
15. Reactor Cooling Systems		11
16. Steam generation systems		36
31. Turbine and auxiliaries		25
32. Feedwater and Main Steam System		22
33. Circulating Water System		3
34. Miscellaneous Systems		33
35. All other I&C Systems		1
41. Main Generator Systems		60
42. Electrical Power Supply Systems		123
Total		**414**

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2024 Operating Experience

ES-6 ALMARAZ-1 SPAIN



Status at end of year	:	**Operational**
Operator	:	CNAT (CENTRALES NUCLEARES ALMARAZ-TRILLO (ID/UFG/ENDESA/HC/NUCLENOR))
Owner	:	ID/EN/GN (Iberdrola, Endesa, Gas Natural)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP
Thermal power	:	2947 MWth
Gross electrical power	:	1049 MWe
Reference unit power (net)	:	1011 MWe

Key Dates

Construction Date	:	1973-07-03
Grid Date	:	1981-05-01
Commercial Date	:	1983-09-01
Age at end of year	:	43 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.60
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	58000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.65
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.3
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

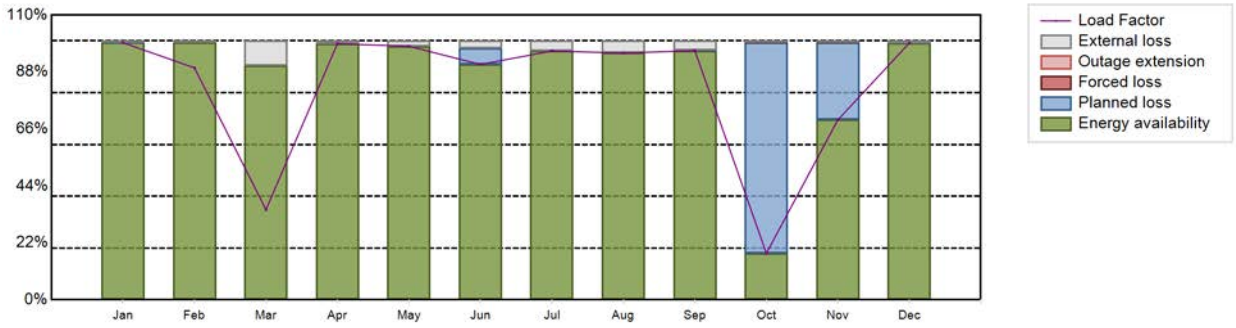
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	325
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	3.5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.9
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	NA
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7285.28 GW(e).h
Energy Availability Factor (EAF)	:	87.53 %
Unit Capability Factor (UCF)	:	90.14 %
Load Factor (LF)	:	82.04 %
Operating Factor (OF)	:	86.68 %

Forced Loss Rate (FLR)	:	0.01 %
Unplanned Capability Loss Factor (UCL)	:	0.01 %
Planned Unavailability Factor (PUF)	:	9.85 %
Externally cause unavailability (XUF)	:	2.62 %
Total off-line time	:	1170 hours

Annual Summary



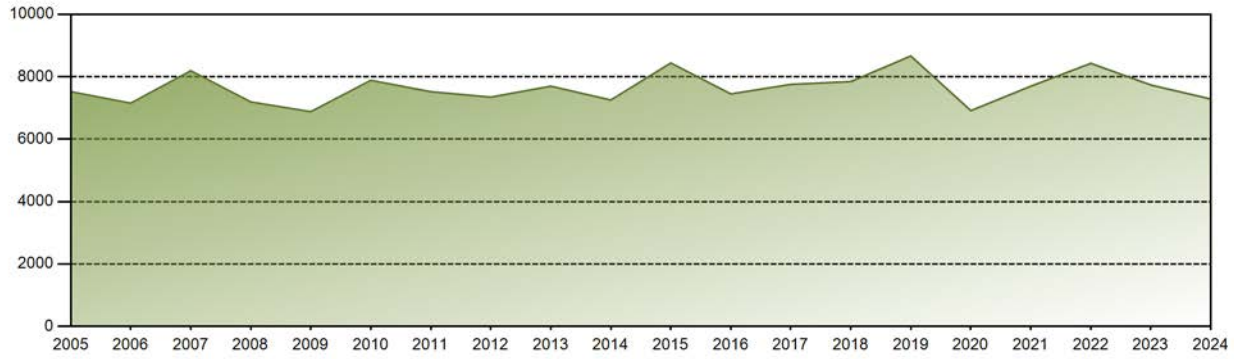
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	746.91	630.51	261.68	720.11	736.51	661.77	722.80	717.07	700.60	135.39	506.05	745.88	7285.28
EAF [%]	99.30	99.45	90.52	98.93	97.92	90.91	96.09	95.33	96.25	17.98	69.52	99.16	87.53
UCF [%]	99.97	100.00	100.00	100.00	100.00	93.82	100.00	100.00	99.96	18.58	70.25	100.00	90.14
LF [%]	99.30	89.60	34.84	98.93	97.92	90.91	96.09	95.33	96.25	17.98	69.52	99.16	82.04
OF [%]	100.00	100.00	49.26	100.00	100.00	98.06	100.00	100.00	100.00	19.33	75.28	100.00	86.68
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.01
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.01
PUF [%]	0.03	0.00	0.00	0.00	0.00	6.18	0.00	0.00	0.04	81.33	29.75	0.00	9.85
XUF [%]	0.67	0.55	9.48	1.07	2.08	2.91	3.91	4.67	3.71	0.60	0.73	0.84	2.62

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Historical Summary

Lifetime energy generation	:	302656.11 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.16 %
Cumulative Energy Availability Factor (EAF)	:	86.33 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.05 %
Cumulative Unit Capability Factor (UCF)	:	87.48 %	Cumulative Planned Unavailability Factor (PUF)	:	10.47 %
Cumulative Load Factor (LF)	:	86.2 %	Cumulative Externally cause unavailability (XUF)	:	1.15 %
Cumulative Operating Factor (OF)	:	88.76 %			

Electricity Production (net) [GWh]

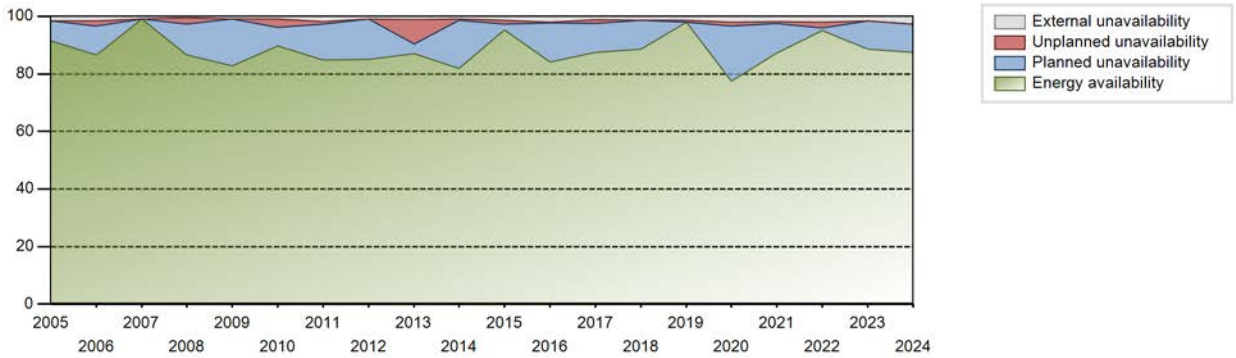


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	3713.90	5925	930	78.42	78.42	78.40	88.67	1.07	0.85	20.73	0.00
1984	4820.50	6062	893	65.03	65.03	61.45	69.01	6.16	4.27	30.71	0.00
1985	4825.17	5705	900	61.63	61.63	61.20	65.13	7.22	4.80	33.57	0.00
1986	5425.02	6418	900	69.29	69.29	68.81	73.26	10.45	8.08	22.63	0.00
1987	7193.69	8346	900	92.54	92.54	91.24	95.27	2.97	2.83	4.63	0.00
1988	5879.59	6899	900	74.60	74.60	74.37	78.54	15.76	13.96	11.45	0.00
1989	6562.18	7640	895	83.20	83.20	83.70	87.21	1.90	1.61	15.19	0.00
1990	6460.66	7451	895	82.22	82.22	82.40	85.06	1.63	1.36	16.42	0.00
1991	7481.71	8589	895	96.20	96.20	95.43	98.05	2.72	2.69	1.11	0.00
1992	6379.06	7387	895	80.76	80.76	81.14	84.10	1.88	1.55	17.68	0.00
1993	6530.85	7663	895	83.19	85.05	83.30	87.48	4.26	3.78	11.17	1.86
1994	7448.60	8495	895	95.05	95.92	95.01	96.97	3.38	3.36	0.73	0.86
1995	6588.46	7709	895	83.74	86.23	84.03	88.00	3.41	3.05	10.73	2.49
1996	5904.30	6789	895	72.53	73.77	75.10	77.29	2.81	2.13	24.09	1.24
1997	6642.83	7371	895	79.57	82.95	84.73	84.14	3.20	2.75	14.30	3.38
1998	8032.46	8760	944	97.12	98.81	97.13	100.00	1.19	1.19	0.00	1.69
1999	6988.63	7613	927	84.68	85.40	86.06	86.91	2.93	2.58	12.01	0.73
2000	7471.57	8014	927	90.32	91.08	91.76	91.23	1.08	0.99	7.93	0.76
2001	8151.39	8749	927	99.02	99.59	100.38	99.87	0.41	0.41	0.00	0.56
2002	7427.99	8100	944	90.38	92.21	89.82	92.47	0.66	0.61	7.17	1.83
2003	7499.11	8233	944	91.59	93.76	90.68	93.98	0.00	0.00	6.24	2.17
2004	8185.69	8784	944	99.23	99.90	98.72	100.00	0.10	0.10	0.01	0.67
2005	7519.43	8180	944	91.45	93.06	90.93	93.38	0.03	0.03	6.92	1.61
2006	7152.42	7831	944	86.54	88.07	86.49	89.39	1.96	1.76	10.17	1.54
2007	8189.80	8760	944	98.98	99.93	99.04	100.00	0.07	0.07	0.00	0.95
2008	7190.76	7725	944	86.61	87.16	86.72	87.94	0.10	2.08	10.77	0.55
2009	6880.10	7336	944	82.85	83.73	83.20	83.74	0.00	0.00	16.27	0.88
2010	7884.25	8147	1008	89.67	90.50	89.70	93.00	3.31	3.10	6.40	0.82
2011	7519.49	7814	1011	84.91	86.77	84.90	89.20	0.94	0.82	12.41	1.86
2012	7346.07	7405	1004	85.00	85.90	83.30	84.30	0.00	0.00	14.10	0.90
2013	7695.84	7882	1011	87.08	88.34	86.90	89.98	8.65	8.36	3.30	1.26
2014	7252.45	7351	1011	81.86	82.70	81.89	83.92	0.56	0.47	16.83	0.84
2015	8438.61	8613	1011	95.28	96.61	95.28	98.32	1.43	1.41	1.98	1.33
2016	7447.79	7622	1011	84.08	86.06	83.87	86.77	0.43	0.37	13.57	1.98
2017	7753.93	7885	1011	87.55	88.77	87.55	90.01	1.44	1.29	9.94	1.22
2018	7844.02	7934	1011	88.69	89.96	88.57	90.57	0.04	0.03	10.01	1.27
2019	8662.82	8760	1011	98.05	99.42	97.81	100.00	0.57	0.57	0.01	1.37

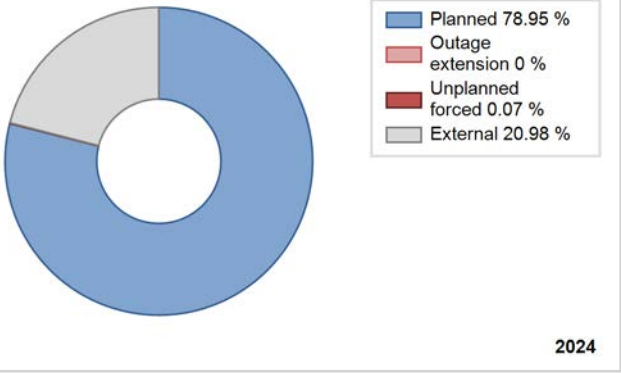
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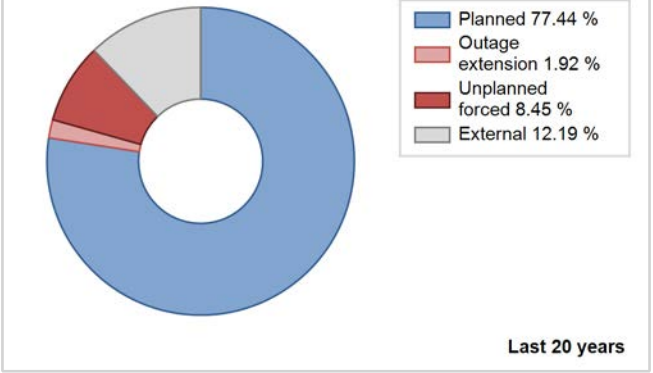
2020	6913.13	7065	1011	77.54	79.58	77.85	80.43	1.66	1.34	19.08	2.04
2021	7695.62	7800	1011	87.16	89.02	86.89	89.04	0.00	0.68	10.30	1.86
2022	8427.99	8564	1011	95.16	97.30	95.16	97.76	0.02	1.94	0.77	2.13
2023	7735.09	7948	1011	88.58	90.18	87.34	90.73	0.00	0.00	9.82	1.61
2024	7285.28	7614	1011	87.53	90.14	82.04	86.68	0.01	0.01	9.85	2.62

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1983 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					119	
C. Inspection, maintenance or repair combined with refuelling	779			792		
D. Inspection, maintenance or repair without refuelling	14			144		
E. Testing of plant systems or components				42	0	
J. Grid limitation, failure or grid unavailability						4
L. Human factor related					3	
O. Load dispatching, prioritization			377			9
Z. Other					1	
Subtotal	793		377	978	123	13
Total	**1170**			**1114**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		12
13. Reactor Auxiliary Systems		26
15. Reactor Cooling Systems		15
16. Steam generation systems		4
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		4
32. Feedwater and Main Steam System		16
33. Circulating Water System		1
41. Main Generator Systems		22
42. Electrical Power Supply Systems		18
Total		**118**

Highlights (2024)

22/02/2024 - Decrease power due to load dispatching.
08/03/2024 - Unit disconnected from the grid due to load dispatching.
24/03/2024 - Unit connected to the grid.
02/06/2024 - Decrease power due to turbine valve failure.
07/10/2024 - Start outage number 30.
08/11/2024 - Unit connected to the grid after outage number 30.

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2024 Operating Experience

ES-7 ALMARAZ-2 SPAIN



Status at end of year	:	**Operational**
Operator	:	CNAT (CENTRALES NUCLEARES ALMARAZ-TRILLO (ID/UFG/ENDESA/HC/NUCLENOR))
Owner	:	ID/EN/GN (Iberdrola, Endesa, Gas Natural)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP
Thermal power	:	2947 MWth
Gross electrical power	:	1044 MWe
Reference unit power (net)	:	1006 MWe

Key Dates

Construction Date	:	1973-07-03
Grid Date	:	1983-10-08
Commercial Date	:	1984-07-01
Age at end of year	:	41 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.60
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	58000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.65
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.3
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

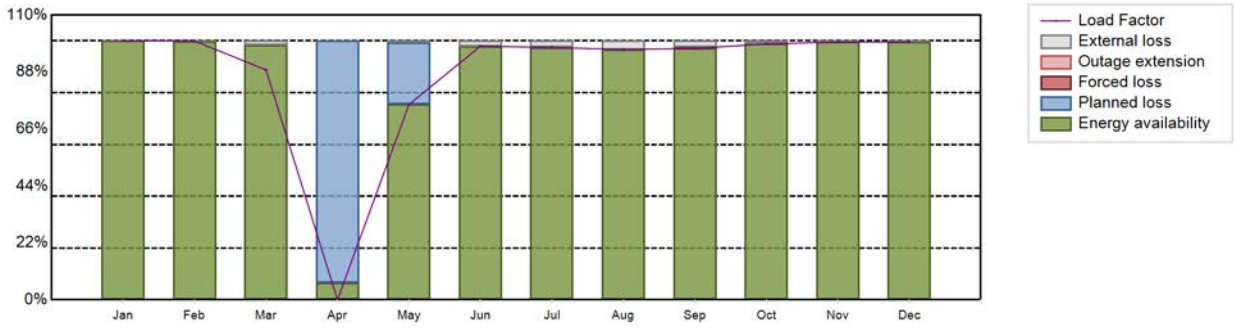
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	325
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	3.5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.9
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	NA
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7750.63 GW(e).h
Energy Availability Factor (EAF)	:	89.06 %
Unit Capability Factor (UCF)	:	90.26 %
Load Factor (LF)	:	87.71 %
Operating Factor (OF)	:	89.91 %

Forced Loss Rate (FLR)	:	0.06 %
Unplanned Capability Loss Factor (UCL)	:	0.05 %
Planned Unavailability Factor (PUF)	:	9.69 %
Externally cause unavailability (XUF)	:	1.2 %
Total off-line time	:	886 hours

Annual Summary



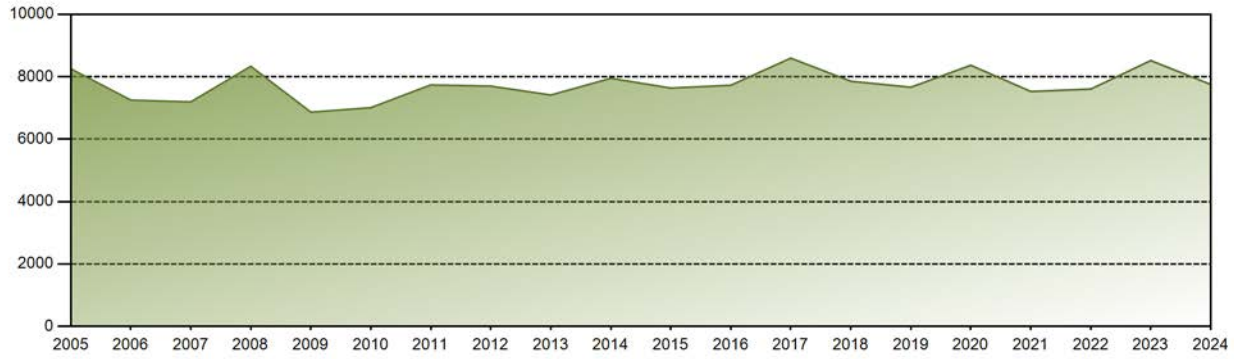
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	748.89	700.05	664.06	0.00	564.49	709.62	729.53	723.54	703.28	740.56	721.09	745.51	7750.63
EAF [%]	100.06	99.98	98.37	6.67	75.42	97.97	97.47	96.67	97.09	98.81	99.55	99.61	89.06
UCF [%]	99.98	100.00	100.00	6.67	76.05	100.00	99.95	100.00	99.47	99.87	100.00	100.00	90.26
LF [%]	100.06	99.98	88.84	0.00	75.42	97.97	97.47	96.67	97.09	98.81	99.55	99.61	87.71
OF [%]	100.00	100.00	96.77	0.00	81.05	100.00	100.00	100.00	100.00	99.87	100.00	100.00	89.91
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.11	0.00	0.00	0.06
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.11	0.00	0.00	0.05
PUF [%]	0.02	0.00	0.00	93.33	23.95	0.00	0.05	0.00	0.00	0.02	0.00	0.00	9.69
XUF [%]	-0.07	0.02	1.63	0.00	0.63	2.03	2.48	3.33	2.38	1.06	0.45	0.39	1.20

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Historical Summary

Lifetime energy generation	:	300375.44 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.09 %
Cumulative Energy Availability Factor (EAF)	:	87.89 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.24 %
Cumulative Unit Capability Factor (UCF)	:	89.03 %	Cumulative Planned Unavailability Factor (PUF)	:	8.72 %
Cumulative Load Factor (LF)	:	87.88 %	Cumulative Externally cause unavailability (XUF)	:	1.14 %
Cumulative Operating Factor (OF)	:	90.41 %			

Electricity Production (net) [GWh]

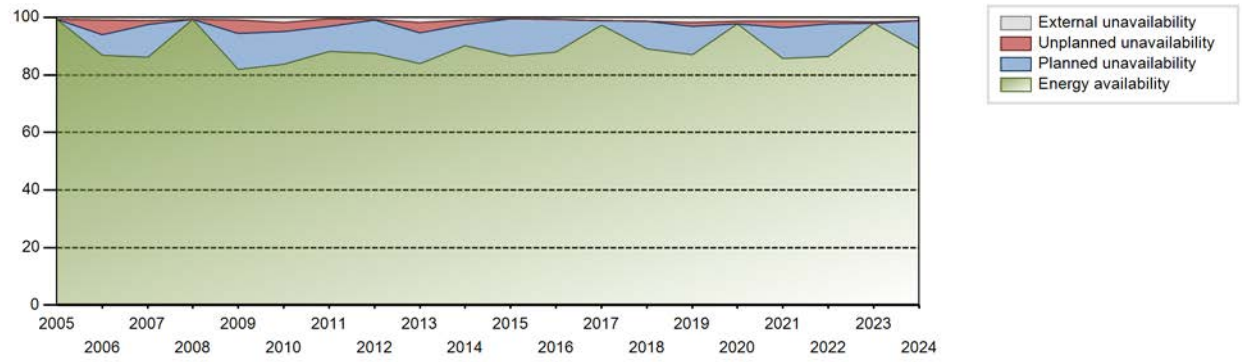


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	6012.94	7502	893	86.01	86.01	81.25	90.31	6.46	5.94	8.05	0.00
1985	6236.07	7297	900	79.84	79.84	79.10	83.30	2.74	2.25	17.91	0.00
1986	5825.18	7136	900	75.23	75.23	73.89	81.46	4.46	3.51	21.26	0.00
1987	6402.53	7351	900	81.78	81.78	81.21	83.92	2.13	1.78	16.45	0.00
1988	6809.37	7838	900	86.26	86.26	86.13	89.23	2.06	1.81	11.93	0.00
1989	6545.67	7638	895	82.83	82.83	83.49	87.19	5.23	4.57	12.60	0.00
1990	7649.30	8652	895	97.39	97.39	97.57	98.77	1.08	1.06	1.54	0.00
1991	6812.87	7712	895	85.35	85.35	86.90	88.04	2.01	1.75	12.90	0.00
1992	6892.72	7997	895	87.33	87.33	87.67	91.04	0.66	0.58	12.09	0.00
1993	7710.14	8760	895	98.54	98.99	98.34	100.00	0.94	0.94	0.07	0.45
1994	6384.58	7562	895	80.89	84.25	81.43	86.32	1.56	1.34	14.42	3.35
1995	6814.74	7952	895	86.18	89.05	86.92	90.78	1.22	1.10	9.85	2.87
1996	7273.32	8108	895	91.50	91.64	92.52	92.30	8.16	8.15	0.22	0.13
1997	6042.50	6811	895	72.56	76.60	77.07	77.75	3.68	2.93	20.47	4.04
1998	5892.43	6810	953	70.16	75.90	70.58	77.74	13.09	11.43	12.67	5.75
1999	8126.64	8743	936	97.41	98.04	99.11	99.81	1.96	1.96	0.00	0.63
2000	7401.83	8160	936	88.45	90.58	90.03	92.90	1.69	1.56	7.86	2.13
2001	7601.46	8189	936	91.33	92.08	92.71	93.48	1.56	1.46	6.45	0.75
2002	8154.94	8760	953	98.10	98.84	97.68	100.00	1.14	1.14	0.01	0.75
2003	6627.94	7391	953	79.90	81.88	79.39	84.37	4.75	10.80	7.32	1.97
2004	7563.17	8083	953	90.93	91.63	90.35	92.02	1.00	0.92	7.45	0.69
2005	8253.32	8760	956	99.24	99.96	98.55	100.00	0.03	0.03	0.00	0.73
2006	7250.11	7747	956	86.78	87.71	86.56	88.43	5.41	5.02	7.27	0.93
2007	7191.67	7668	956	86.04	87.11	85.88	87.53	0.00	1.38	11.51	1.07
2008	8331.69	8784	956	99.22	99.98	99.22	100.00	0.02	0.02	0.00	0.76
2009	6864.58	7367	956	82.01	82.91	81.97	84.10	2.19	4.60	12.49	0.90
2010	7007.03	7572	956	83.79	85.50	83.67	86.44	3.74	3.32	11.18	1.71
2011	7737.28	7991	1006	88.07	88.58	88.17	91.22	2.84	2.59	8.83	0.51
2012	7698.78	7730	1006	87.55	88.16	87.12	88.00	0.00	0.22	11.63	0.61
2013	7412.90	7557	1006	84.00	85.90	84.12	86.27	3.94	3.52	10.58	1.90
2014	7949.00	8054	1006	90.18	91.06	90.20	91.94	1.78	1.65	7.29	0.88
2015	7635.93	7709	1006	86.58	87.06	86.65	88.00	0.00	0.00	12.94	0.47
2016	7726.48	7827	1006	87.88	88.56	87.44	89.11	0.00	0.00	11.44	0.68
2017	8593.49	8656	1006	97.36	98.47	97.51	98.81	0.00	0.00	1.53	1.11
2018	7854.88	7969	1006	88.97	90.40	89.13	90.97	0.00	0.00	9.60	1.43
2019	7662.81	7824	1006	86.95	88.66	86.95	89.32	0.00	1.36	9.98	1.70
2020	8366.41	8741	1006	97.82	99.22	94.68	99.51	0.77	0.77	0.01	1.40

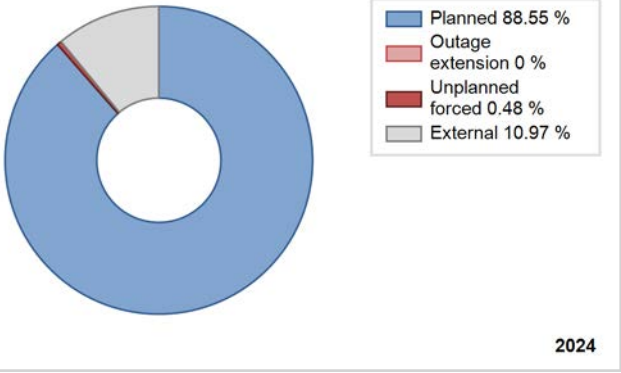
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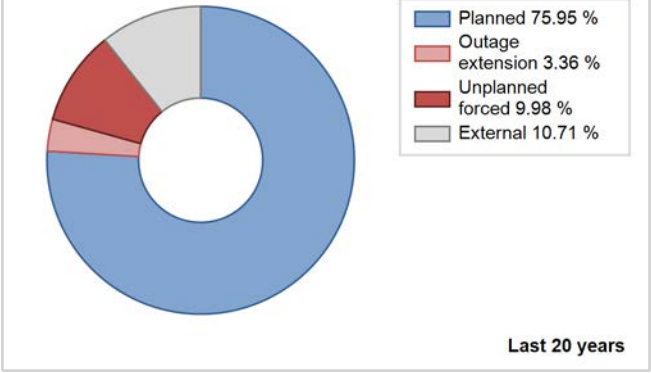
2021	7527.14	7722	1006	85.65	86.92	85.41	88.15	1.22	2.33	10.75	1.27
2022	7604.97	7764	1006	86.31	87.77	86.30	88.63	0.71	0.79	11.44	1.46
2023	8517.29	8740	1006	97.91	99.51	96.65	99.77	0.48	0.48	0.01	1.60
2024	7750.63	7898	1006	89.06	90.26	87.71	89.91	0.06	0.05	9.69	1.20

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					118	
C. Inspection, maintenance or repair combined with refuelling	813			687	5	
D. Inspection, maintenance or repair without refuelling				16		
E. Testing of plant systems or components				26		
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					6	
O. Load dispatching, prioritization			72			2
Z. Other					11	
Subtotal	813		72	729	140	4
Total	**885**			**873**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		11
13. Reactor Auxiliary Systems		2
14. Safety Systems		2
15. Reactor Cooling Systems		14
16. Steam generation systems		20
21. Fuel Handling and Storage Facilities		0
31. Turbine and auxiliaries		21
32. Feedwater and Main Steam System		20
35. All other I&C Systems		0
41. Main Generator Systems		14
42. Electrical Power Supply Systems		23
Total		**129**

Highlights (2024)

14/3/2024 - Coastdown.
25/3/2024 - Decrease power due load dispatching.
30/3/2024 - Unit disconected from the grid due load dispatching.
03/4/2024 - Start outage number 28.
06/5/2024 - Unit connected to the grid.
30/9/2024 - Decrease power due to feed water turbopump trip.

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2024 Operating Experience

ES-8 ASCO-1 SPAIN



Status at end of year	:	**Operational**
Operator	:	ANAV (ASOCIACIÓN NUCLEAR ASCÓ-VANDELLÓS A.I.E. (ENDESA/ID))
Owner	:	ENDESA (ENDESA, S.A.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP
Thermal power	:	2941 MWth
Gross electrical power	:	1033 MWe
Reference unit power (net)	:	995 MWe

Key Dates

Construction Date	:	1974-05-16
Grid Date	:	1983-08-13
Commercial Date	:	1984-12-10
Age at end of year	:	41 years

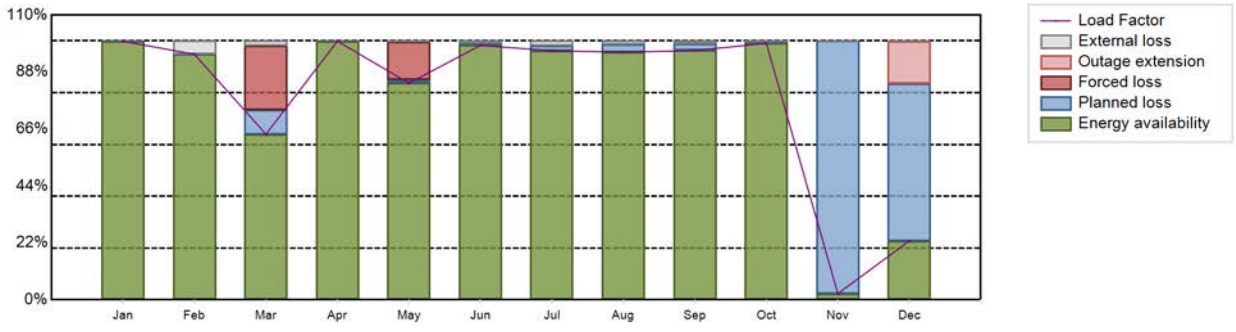
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.72
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	326.7
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	3.86
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	28	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	50500	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	6.6
Active core height/length [m]	:	3.65	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	18.92	Number of main condensate pumps	:	4
Number of control rod assemblies	:	48	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6937.81 GW(e).h	Forced Loss Rate (FLR)	:	3.99 %
Energy Availability Factor (EAF)	:	79.38 %	Unplanned Capability Loss Factor (UCL)	:	4.73 %
Unit Capability Factor (UCF)	:	80.43 %	Planned Unavailability Factor (PUF)	:	14.84 %
Load Factor (LF)	:	79.38 %	Externally cause unavailability (XUF)	:	1.05 %
Operating Factor (OF)	:	82.41 %	Total off-line time	:	1545 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	739.31	656.58	472.91	715.46	619.64	703.86	712.20	707.99	689.83	734.18	17.37	168.47	6937.81
EAF [%]	99.87	94.81	63.97	99.87	83.70	98.25	96.21	95.64	96.29	99.04	2.42	22.76	79.38
UCF [%]	99.87	99.99	65.85	99.87	84.15	99.04	98.03	96.90	97.36	99.31	2.43	22.83	80.43
LF [%]	99.87	94.81	63.97	99.87	83.70	98.25	96.21	95.64	96.29	99.04	2.42	22.76	79.38
OF [%]	100.00	100.00	68.91	100.00	87.90	100.00	100.00	100.00	100.00	100.00	3.47	28.90	82.41
FLR [%]	0.00	0.00	27.38	0.00	14.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.99
UCL [%]	0.00	0.00	24.83	0.00	14.69	0.00	0.00	0.00	0.00	0.00	0.00	16.40	4.73
PUF [%]	0.13	0.01	9.32	0.13	1.16	0.96	1.97	3.10	2.64	0.69	97.57	60.77	14.84
XUF [%]	0.00	5.17	1.88	0.00	0.45	0.79	1.82	1.26	1.07	0.27	0.01	0.07	1.05

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Historical Summary

Lifetime energy generation	:	291911.06 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.7 %
Cumulative Energy Availability Factor (EAF)	:	85.38 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.45 %
Cumulative Unit Capability Factor (UCF)	:	86.11 %	Cumulative Planned Unavailability Factor (PUF)	:	10.43 %
Cumulative Load Factor (LF)	:	84.83 %	Cumulative Externally cause unavailability (XUF)	:	0.73 %
Cumulative Operating Factor (OF)	:	87.72 %			

Electricity Production (net) [GWh]

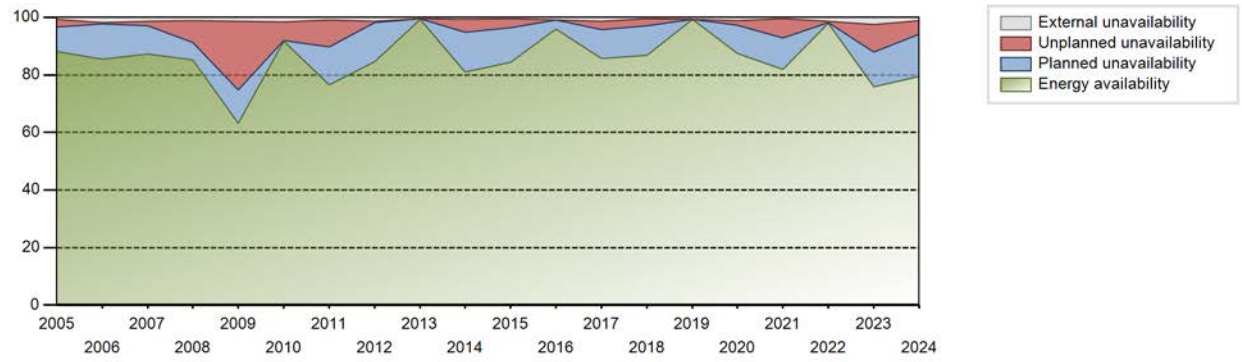


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	4038.42	5771	887	20.02	20.02	15.76	21.64	67.19	41.00	38.98	0.00
1985	4429.40	5342	898	60.32	60.32	56.31	60.98	6.75	4.37	35.31	0.00
1986	5129.00	6208	898	68.16	68.16	65.20	70.87	2.29	1.60	30.24	0.00
1987	6392.00	7569	898	83.70	84.27	81.26	86.40	2.22	1.91	13.82	0.57
1988	6669.00	7599	898	84.11	84.11	84.55	86.51	6.85	6.19	9.70	0.00
1989	6750.00	7771	930	86.03	86.05	82.85	88.71	2.79	2.47	11.48	0.03
1990	6642.00	7699	930	84.54	84.54	81.53	87.89	2.21	1.91	13.55	0.00
1991	6836.00	7810	930	87.03	87.16	83.91	89.16	1.58	1.40	11.44	0.13
1992	6875.00	7898	887	86.51	86.51	88.24	89.91	1.66	1.46	12.03	0.00
1993	6599.00	7401	930	83.19	83.33	81.00	84.49	5.59	4.94	11.73	0.14
1994	6868.00	7758	930	86.85	87.13	84.30	88.56	1.43	1.26	11.60	0.29
1995	5708.00	6387	900	70.37	70.75	72.40	72.91	1.90	1.37	27.88	0.38
1996	7972.00	8755	947	99.04	99.04	95.84	99.67	0.86	0.85	0.10	0.00
1997	6411.00	7198	915	77.58	80.50	79.98	82.17	9.99	8.93	10.57	2.92
1998	7349.00	7943	949	89.13	89.28	88.40	90.67	3.21	2.96	7.75	0.16
1999	8147.00	8741	945	98.74	98.96	98.42	99.78	1.00	1.00	0.03	0.23
2000	7681.00	8008	991	89.50	89.81	89.27	91.17	1.23	1.12	9.07	0.31
2001	7798.00	8056	991	89.81	90.30	89.83	91.96	0.58	0.52	9.18	0.48
2002	8397.00	8737	998	97.60	98.24	96.05	99.74	0.43	0.43	1.33	0.64
2003	7581.11	7900	995	87.32	88.04	86.89	90.18	0.12	0.10	11.85	0.73
2004	7734.27	7949	995	88.62	89.16	88.49	90.49	0.36	0.78	10.05	0.55
2005	7640.50	8548	995	88.24	88.99	87.66	97.58	2.98	2.73	8.28	0.76
2006	7418.37	7971	995	85.38	87.09	85.10	90.98	0.32	0.52	12.39	1.71
2007	7574.76	7876	995	87.36	88.63	86.90	89.91	0.73	1.72	9.65	1.27
2008	7436.29	7768	995	85.23	86.34	85.08	88.43	0.61	7.65	6.00	1.12
2009	5499.76	5758	995	63.10	64.43	63.10	65.73	22.82	23.92	11.65	1.33
2010	7996.12	8231	995	91.74	93.31	91.74	93.96	6.45	6.43	0.25	1.58
2011	6674.51	6946	995	76.58	77.45	76.58	79.29	0.43	9.31	13.24	0.88
2012	7388.22	7666	995	84.51	85.97	84.53	87.27	0.41	0.35	13.67	1.46
2013	8687.39	8760	995	99.33	99.87	99.67	100.00	0.00	0.00	0.13	0.54
2014	7096.39	7226	995	80.98	81.69	81.42	82.49	0.00	4.48	13.82	0.72
2015	7397.93	7725	995	84.36	84.82	84.88	88.18	2.13	3.24	11.93	0.46
2016	8439.80	8560	995	95.91	96.83	96.56	97.45	0.05	0.05	3.12	0.91
2017	7522.94	7689	995	85.67	86.95	86.31	87.77	1.05	2.92	10.13	1.27
2018	7592.83	7718	995	86.76	87.18	87.11	88.11	0.00	2.44	10.38	0.42
2019	8630.08	8760	995	99.25	99.87	99.01	100.00	0.00	0.00	0.13	0.62
2020	7654.10	7848	995	87.57	88.75	87.57	89.34	1.03	1.64	9.61	1.18

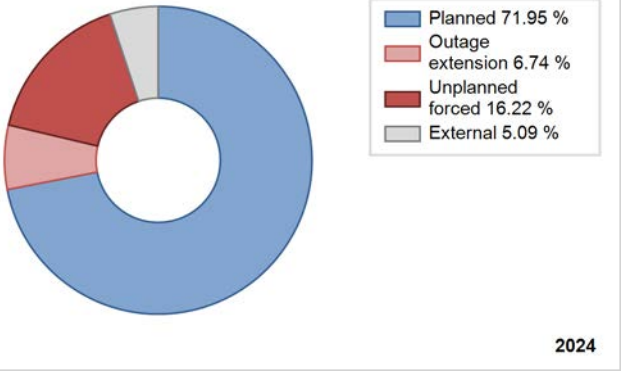
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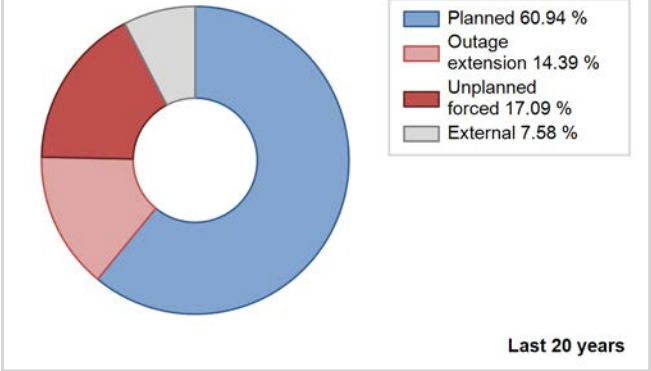
2021	7085.78	7324	995	81.94	82.35	81.29	83.61	3.18	6.81	10.84	0.41
2022	8532.56	8715	995	98.05	99.34	97.89	99.49	0.53	0.53	0.13	1.29
2023	6634.81	7025	995	75.78	78.26	76.12	80.19	8.94	9.59	12.15	2.48
2024	6937.81	7239	995	79.38	80.43	79.38	82.41	3.99	4.73	14.84	1.05

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		266			265	
C.	Inspection, maintenance or repair combined with refuelling	1103			785	35	
D.	Inspection, maintenance or repair without refuelling	43			31		
E.	Testing of plant systems or components		122		42	7	
J.	Grid limitation, failure or grid unavailability						3
L.	Human factor related					4	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						6
Z.	Other			14		10	0
Subtotal		1146	388	14	858	321	10
Total		**1548**			**1189**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		5
12. Reactor I&C Systems		3
13. Reactor Auxiliary Systems		2
14. Safety Systems		1
15. Reactor Cooling Systems		10
16. Steam generation systems	266	19
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities	122	50
31. Turbine and auxiliaries	14	56
32. Feedwater and Main Steam System		17
33. Circulating Water System		4
34. Miscellaneous Systems		3
35. All other I&C Systems		1
41. Main Generator Systems		74
42. Electrical Power Supply Systems		70
Total	**402**	**315**

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2024 Operating Experience

ES-9 ASCO-2 SPAIN



Status at end of year	:	**Operational**
Operator	:	ANAV (ASOCIACIÓN NUCLEAR ASCÓ-VANDELLÓS A.I.E. (ENDESA/ID))
Owner	:	EN/ID (ENDESA, IBERDROLA)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP
Thermal power	:	2941 MWth
Gross electrical power	:	1027 MWe
Reference unit power (net)	:	997 MWe

Key Dates

Construction Date	:	1975-03-07
Grid Date	:	1985-10-23
Commercial Date	:	1986-03-31
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	50500
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.65
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.92
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

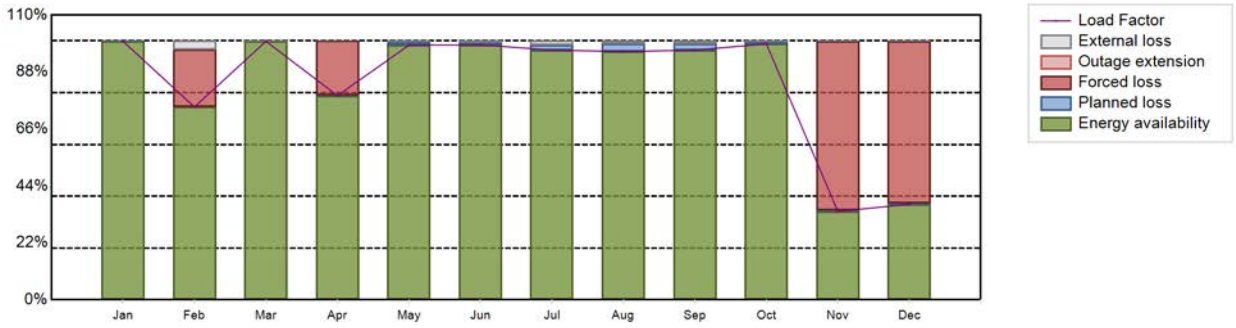
Operating coolant pressure [MPa]	:	15.72
Reactor outlet temperature [°C]	:	327
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	3.86
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7372.32 GW(e).h
Energy Availability Factor (EAF)	:	84.18 %
Unit Capability Factor (UCF)	:	84.93 %
Load Factor (LF)	:	84.18 %
Operating Factor (OF)	:	86.21 %

Forced Loss Rate (FLR)	:	14.27 %
Unplanned Capability Loss Factor (UCL)	:	14.14 %
Planned Unavailability Factor (PUF)	:	0.93 %
Externally cause unavailability (XUF)	:	0.75 %
Total off-line time	:	1211 hours

Annual Summary



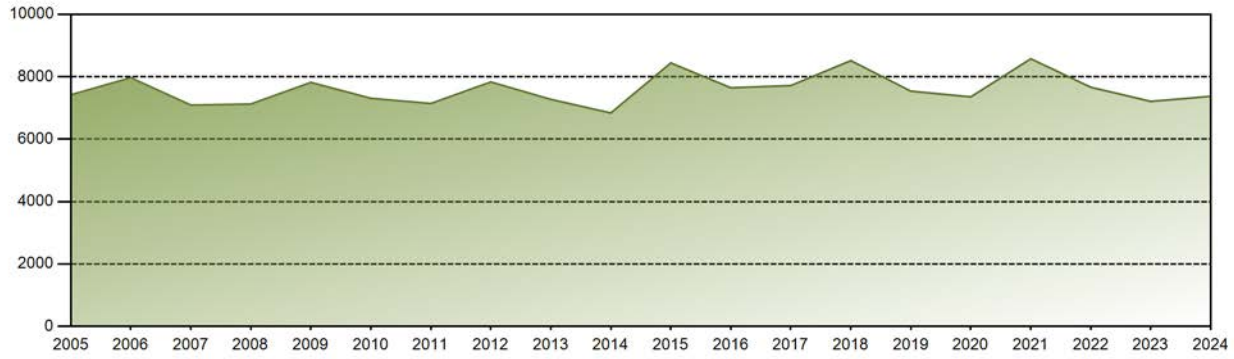
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	740.82	516.78	739.72	566.19	729.36	706.99	715.36	711.39	692.35	734.21	245.28	273.87	7372.32
EAF [%]	99.87	74.47	99.86	78.87	98.33	98.49	96.44	95.90	96.45	98.85	34.17	36.92	84.18
UCF [%]	99.87	77.94	99.87	78.87	98.76	99.07	98.13	97.08	97.61	99.24	34.29	37.03	84.93
LF [%]	99.87	74.47	99.86	78.87	98.33	98.49	96.44	95.90	96.45	98.85	34.17	36.92	84.18
OF [%]	100.00	78.74	100.00	80.69	100.00	100.00	100.00	100.00	100.00	100.00	34.58	39.11	86.21
FLR [%]	0.00	22.06	0.00	21.04	0.00	0.00	0.00	0.00	0.00	0.00	65.60	62.86	14.27
UCL [%]	0.00	22.06	0.00	21.02	0.00	0.00	0.00	0.00	0.00	0.00	65.40	62.66	14.14
PUF [%]	0.13	0.00	0.13	0.10	1.24	0.93	1.87	2.92	2.39	0.76	0.32	0.30	0.93
XUF [%]	0.00	3.47	0.01	0.00	0.43	0.58	1.69	1.18	1.16	0.40	0.12	0.11	0.75

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Historical Summary

Lifetime energy generation	:	286614.69 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.87 %
Cumulative Energy Availability Factor (EAF)	:	87.37 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.29 %
Cumulative Unit Capability Factor (UCF)	:	88.36 %	Cumulative Planned Unavailability Factor (PUF)	:	8.35 %
Cumulative Load Factor (LF)	:	86.63 %	Cumulative Externally cause unavailability (XUF)	:	0.99 %
Cumulative Operating Factor (OF)	:	89.68 %			

Electricity Production (net) [GWh]

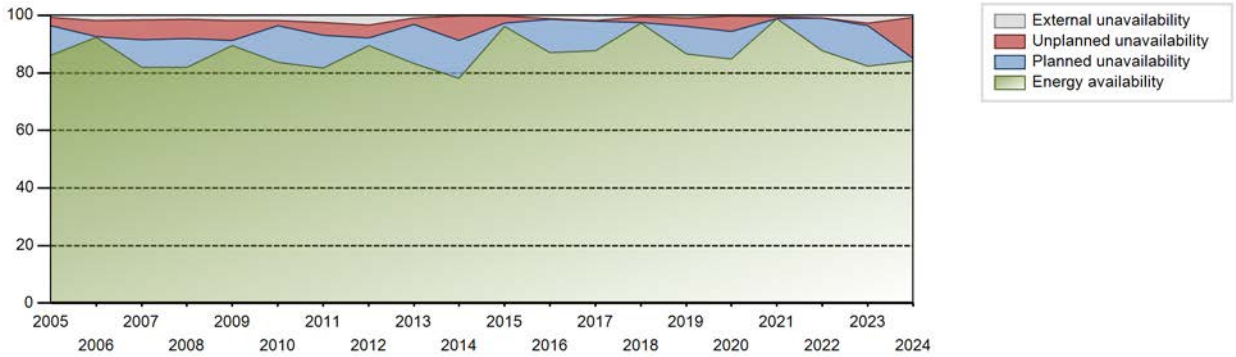


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	5368.00	6639	898	77.72	77.72	74.11	78.65	21.50	21.28	1.00	0.00
1987	5954.00	7035	898	77.27	78.13	75.69	80.31	3.63	2.94	18.93	0.86
1988	6865.00	7874	898	86.76	88.23	87.03	89.64	1.86	1.67	10.10	1.47
1989	6732.00	7729	930	85.70	86.30	82.63	88.23	1.79	1.57	12.13	0.60
1990	6933.00	7916	930	90.42	90.42	85.10	90.37	0.73	0.66	8.92	0.00
1991	6820.00	7799	930	86.49	86.69	83.71	89.03	0.76	0.67	12.64	0.20
1992	7077.00	8042	953	89.92	89.92	84.54	91.55	0.99	0.90	9.17	0.00
1993	7052.00	7897	930	88.61	90.02	86.56	90.15	1.20	1.09	8.89	1.41
1994	7085.00	7962	930	89.47	89.77	86.97	90.89	1.56	1.43	8.81	0.29
1995	6977.00	7674	900	86.25	86.39	88.50	87.60	1.04	0.91	12.70	0.13
1996	6011.00	6825	963	75.14	75.61	71.06	77.70	3.95	3.11	21.28	0.47
1997	7916.00	8725	900	96.18	98.17	100.42	99.61	1.24	1.23	0.60	1.99
1998	7399.00	8050	946	89.88	90.57	89.28	91.89	1.27	1.16	8.26	0.69
1999	7215.00	7854	946	86.42	87.17	87.06	89.66	3.04	2.73	10.10	0.75
2000	8451.00	8734	983	98.63	98.63	97.87	99.43	0.59	0.59	0.78	0.00
2001	7829.00	8102	983	90.55	90.97	90.92	92.49	0.48	0.44	8.59	0.42
2002	7780.00	8127	997	89.40	90.78	89.08	92.77	0.50	0.45	8.77	1.38
2003	8521.20	8738	997	98.73	99.59	97.57	99.75	0.27	0.27	0.14	0.86
2004	6909.28	7287	997	79.62	80.24	78.89	82.96	10.36	9.83	9.93	0.62
2005	7418.88	7779	997	86.10	86.75	84.95	88.80	2.29	3.03	10.22	0.65
2006	7968.75	8335	997	92.42	94.34	91.24	95.15	5.52	5.51	0.16	1.92
2007	7091.43	7532	997	81.94	83.58	81.20	85.98	5.19	6.77	9.64	1.65
2008	7123.62	7413	997	81.98	83.28	81.34	84.39	0.03	6.84	9.88	1.30
2009	7818.32	8082	997	89.52	91.34	89.52	92.26	6.95	6.82	1.84	1.82
2010	7309.13	7583	997	83.69	85.62	83.69	86.56	0.03	1.68	12.70	1.93
2011	7142.24	7560	997	81.78	84.19	81.78	86.30	1.55	4.57	11.25	2.41
2012	7831.53	8327	997	89.43	92.80	89.43	94.80	1.14	4.47	2.73	3.37
2013	7274.22	7499	997	83.27	84.30	83.29	85.61	2.16	2.16	13.55	1.02
2014	6837.37	7010	997	78.03	78.37	78.29	80.02	9.18	8.43	13.20	0.33
2015	8442.11	8656	997	96.27	96.47	96.66	98.81	2.62	2.59	0.94	0.20
2016	7646.24	7852	997	87.14	88.26	87.31	89.39	0.00	0.23	11.51	1.13
2017	7716.07	7917	997	87.78	89.52	88.35	90.38	0.00	0.31	10.18	1.74
2018	8514.79	8582	997	97.30	97.73	97.49	97.97	2.15	2.14	0.13	0.43
2019	7537.35	7783	997	86.54	87.35	86.30	88.85	1.31	2.90	9.74	0.82
2020	7354.45	7546	997	84.81	85.09	83.98	85.91	1.83	5.34	9.57	0.28
2021	8574.34	8701	997	98.77	99.20	98.18	99.33	0.67	0.67	0.13	0.42
2022	7662.31	7833	997	87.73	88.70	87.73	89.42	0.00	0.00	11.30	0.97

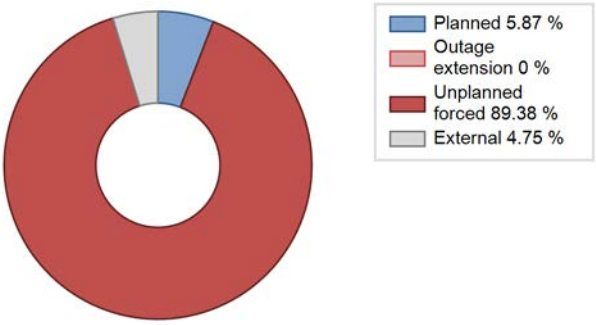
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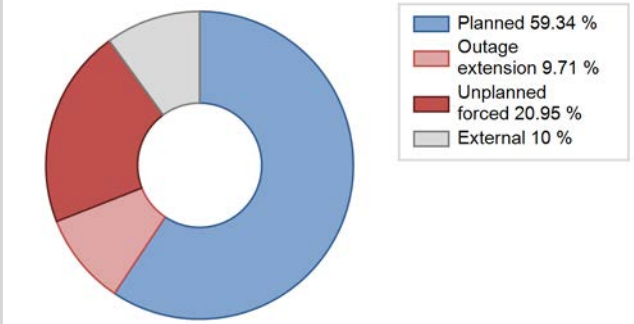
2023	7209.27	7521	997	82.38	85.13	82.55	85.86	0.92	0.79	14.08	2.75
2024	7372.32	7573	997	84.18	84.93	84.18	86.21	14.27	14.14	0.93	0.75

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		1210			211	
C.	Inspection, maintenance or repair combined with refuelling				644	38	
D.	Inspection, maintenance or repair without refuelling				27		
E.	Testing of plant systems or components				13	7	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				13		
J.	Grid limitation, failure or grid unavailability						4
L.	Human factor related					3	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				6		
Z.	Other				3	6	
Subtotal			1210		706	265	6
Total			**1210**			**977**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		5
13. Reactor Auxiliary Systems		21
14. Safety Systems		0
15. Reactor Cooling Systems		15
16. Steam generation systems	212	16
21. Fuel Handling and Storage Facilities		48
31. Turbine and auxiliaries		12
32. Feedwater and Main Steam System		51
33. Circulating Water System		6
34. Miscellaneous Systems		6
35. All other I&C Systems		1
41. Main Generator Systems	923	33
42. Electrical Power Supply Systems	75	47
Total	**1210**	**264**

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2024 Operating Experience

ES-10 COFRENTES SPAIN



Status at end of year	:	**Operational**
Operator	:	ID (IBERDROLA, S.A.)
Owner	:	ID (IBERDROLA, S.A.)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-6 (Mark 3)
Thermal power	:	3237 MWth
Gross electrical power	:	1102 MWe
Reference unit power (net)	:	1064 MWe

Key Dates

Construction Date	:	1975-09-09
Grid Date	:	1984-10-14
Commercial Date	:	1985-03-11
Age at end of year	:	40 years

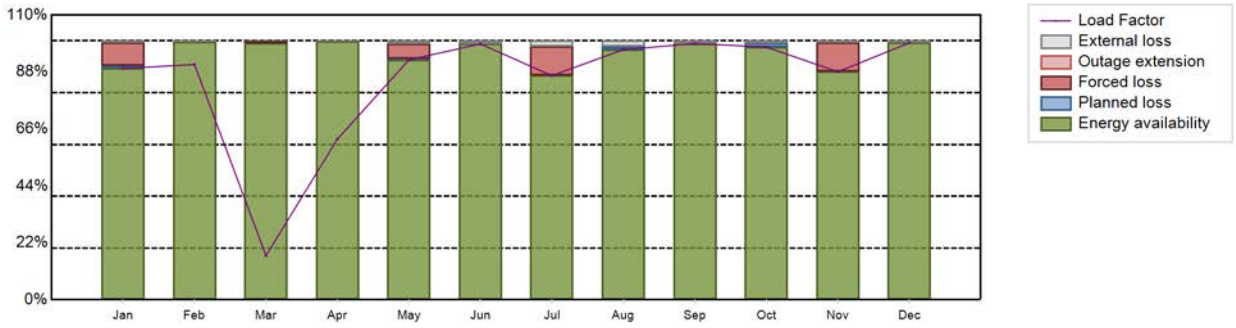
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	41
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	4.29
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	624
Fuel linear heat generation rate [kW/m]	:	20.03
Number of control rod assemblies	:	145
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7.26
Reactor outlet temperature [°C]	:	288
Number of SG	:	NA
Containment type	:	Single
Containment design pressure [MPa]	:	0.103
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	7.115
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7924.87 GW(e).h	Forced Loss Rate (FLR)	:	3.2 %
Energy Availability Factor (EAF)	:	95.53 %	Unplanned Capability Loss Factor (UCL)	:	3.19 %
Unit Capability Factor (UCF)	:	96.44 %	Planned Unavailability Factor (PUF)	:	0.37 %
Load Factor (LF)	:	84.79 %	Externally cause unavailability (XUF)	:	0.91 %
Operating Factor (OF)	:	91.44 %	Total off-line time	:	752 hours

Annual Summary



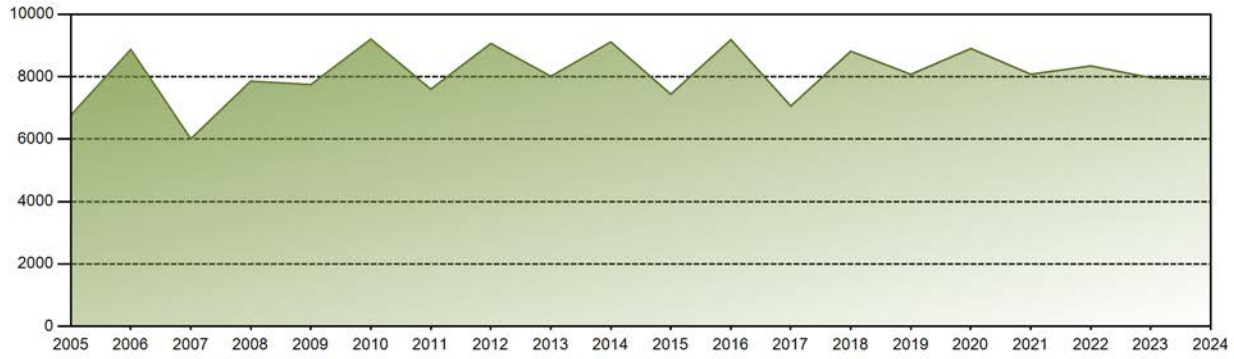
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	707.24	673.21	134.89	475.77	733.83	757.09	685.47	764.86	758.31	773.65	674.97	785.58	7924.87
EAF [%]	89.35	99.58	99.17	99.98	92.71	98.83	86.60	96.63	98.99	97.60	88.11	99.24	95.53
UCF [%]	89.92	100.00	99.17	100.00	93.85	100.00	88.77	98.68	100.00	98.49	88.76	100.00	96.44
LF [%]	89.34	90.91	17.06	62.10	92.70	98.83	86.59	96.62	98.99	97.60	88.11	99.24	84.79
OF [%]	93.95	100.00	26.11	92.22	100.00	100.00	93.68	100.00	100.00	100.00	92.36	100.00	91.44
FLR [%]	9.09	0.00	0.83	0.00	5.78	0.00	11.23	0.00	0.00	0.00	11.24	0.00	3.20
UCL [%]	8.99	0.00	0.83	0.00	5.76	0.00	11.23	0.00	0.00	0.00	11.24	0.00	3.19
PUF [%]	1.09	0.00	0.00	0.00	0.38	0.00	0.00	1.32	0.00	1.51	0.00	0.00	0.37
XUF [%]	0.57	0.42	0.00	0.02	1.15	1.17	2.17	2.05	1.01	0.89	0.65	0.76	0.91

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Historical Summary

Lifetime energy generation	:	310973.48 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.97 %
Cumulative Energy Availability Factor (EAF)	:	87.64 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.14 %
Cumulative Unit Capability Factor (UCF)	:	88.63 %	Cumulative Planned Unavailability Factor (PUF)	:	8.23 %
Cumulative Load Factor (LF)	:	87.26 %	Cumulative Externally cause unavailability (XUF)	:	0.99 %
Cumulative Operating Factor (OF)	:	90.24 %			

Electricity Production (net) [GWh]

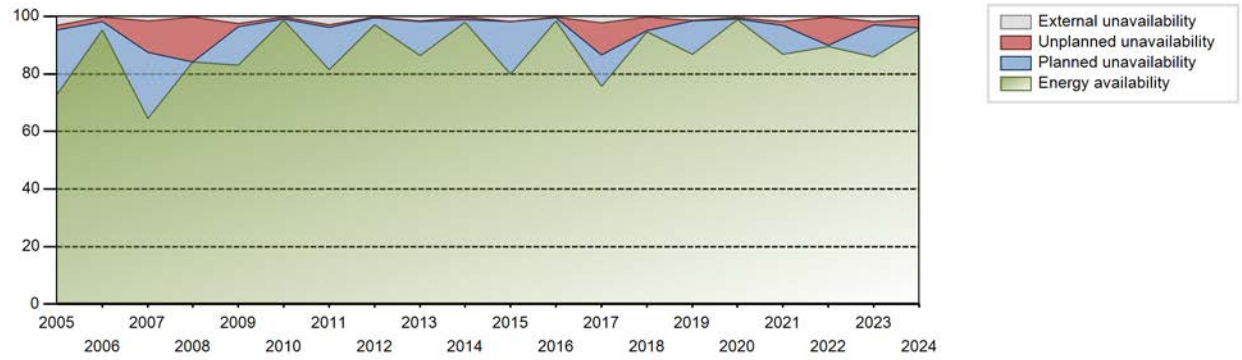


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	6142.48	7300	939	81.41	81.41	81.39	87.75	12.12	11.23	7.35	0.00
1986	6668.30	7487	939	81.07	81.96	81.07	85.47	2.10	1.75	16.29	0.89
1987	6883.08	7615	930	83.40	83.42	84.49	86.93	5.00	4.39	12.19	0.02
1988	7142.15	7850	930	85.51	85.74	87.43	89.37	2.18	1.91	12.35	0.23
1989	7052.24	7732	939	83.90	83.90	85.73	88.26	4.54	3.99	12.11	0.00
1990	7070.30	7560	939	85.10	85.10	85.95	86.30	4.12	3.66	11.24	0.00
1991	6999.63	7660	953	83.70	83.70	83.85	87.44	3.62	3.15	13.15	0.00
1992	7712.12	8376	939	91.87	91.87	93.50	95.36	3.17	3.01	5.12	0.00
1993	7016.23	7579	953	83.57	84.76	84.04	86.52	3.31	2.90	12.34	1.18
1994	6990.86	7553	953	83.55	85.06	83.74	86.22	1.05	0.90	14.04	1.51
1995	8186.97	8683	953	97.54	97.78	98.07	99.12	1.60	1.59	0.63	0.24
1996	7687.49	8215	953	90.88	91.90	91.83	93.52	1.09	1.01	7.08	1.02
1997	6893.65	7668	953	83.73	86.15	82.59	87.54	3.25	2.90	10.95	2.43
1998	8174.10	8546	993	96.56	96.56	93.97	97.56	2.86	2.85	0.59	0.00
1999	7491.64	8004	989	86.43	89.83	86.47	91.37	2.06	1.89	8.28	3.39
2000	7348.14	7808	989	84.59	86.87	84.58	88.89	1.76	1.56	11.57	2.28
2001	8278.15	8424	989	95.54	95.54	95.55	96.16	4.17	4.16	0.30	0.00
2002	7918.10	7875	1043	88.24	89.20	86.66	89.90	1.73	1.57	9.23	0.97
2003	8002.51	7742	1062	88.17	88.17	86.45	88.38	2.80	4.42	7.41	0.00
2004	8813.91	8457	1064	94.29	94.94	94.32	96.28	2.00	1.97	3.09	0.65
2005	6765.14	6768	1064	72.84	75.92	72.58	77.26	1.10	1.56	22.53	3.07
2006	8872.52	8492	1064	95.32	95.64	95.19	96.94	1.57	1.53	2.83	0.32
2007	6008.35	5898	1064	64.47	66.05	64.46	67.33	10.93	10.84	23.11	1.59
2008	7856.29	7643	1064	84.10	84.40	84.06	87.01	15.51	15.49	0.11	0.30
2009	7747.00	7618	1064	83.12	85.54	83.12	86.96	1.27	1.10	13.36	2.42
2010	9201.90	8760	1064	98.73	98.99	98.73	100.00	0.57	0.56	0.45	0.26
2011	7599.08	7564	1064	81.54	84.40	81.53	86.35	1.14	0.98	14.62	2.87
2012	9064.14	8686	1064	97.00	97.21	96.98	98.88	0.36	0.35	2.43	0.22
2013	8012.79	7800	1064	86.31	87.99	85.97	89.04	0.14	0.13	11.89	1.68
2014	9114.79	8760	1064	97.93	98.13	97.79	100.00	0.97	0.96	0.91	0.20
2015	7438.67	7325	1064	79.81	81.51	79.81	83.62	0.21	0.17	18.31	1.70
2016	9187.25	8784	1064	98.31	98.52	98.30	100.00	0.37	0.37	1.11	0.22
2017	7060.25	7030	1064	75.75	78.08	75.75	80.25	0.55	11.16	10.76	2.33
2018	8816.13	8436	1064	94.59	94.94	94.59	96.30	4.63	4.61	0.45	0.35
2019	8074.05	7854	1064	86.78	88.15	86.63	89.66	0.20	0.17	11.68	1.36
2020	8902.95	8784	1064	98.83	99.38	95.26	100.00	0.34	0.34	0.28	0.55
2021	8078.38	7887	1064	86.90	88.78	86.67	90.03	1.46	1.32	9.90	1.88

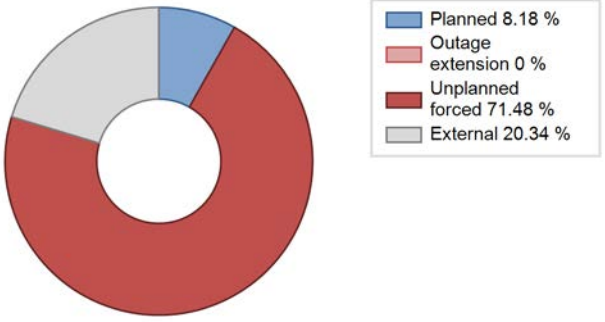
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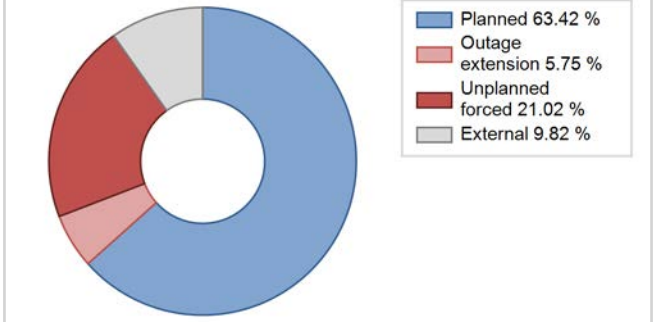
2022	8344.99	7944	1064	89.54	89.78	89.53	90.68	9.94	9.91	0.31	0.24
2023	7965.62	7784	1064	85.97	87.72	85.46	88.86	1.38	1.23	11.06	1.75
2024	7924.87	8032	1064	95.53	96.44	84.79	91.44	3.20	3.19	0.37	0.91

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		103			215	
B. Refuelling without maintenance				5		
C. Inspection, maintenance or repair combined with refuelling				574	2	
D. Inspection, maintenance or repair without refuelling				15		
E. Testing of plant systems or components				14		
J. Grid limitation, failure or grid unavailability						2
L. Human factor related		45			9	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
O. Load dispatching, prioritization			606			15
P. Fire					14	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				7		
Z. Other					8	
Subtotal		148	606	615	248	18
Total		**754**			**881**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		45
12. Reactor I&C Systems		44
13. Reactor Auxiliary Systems		3
15. Reactor Cooling Systems		6
16. Steam generation systems		0
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries	55	52
32. Feedwater and Main Steam System	92	30
34. Miscellaneous Systems		1
41. Main Generator Systems		19
42. Electrical Power Supply Systems		37
Total	**147**	**239**

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2024 Operating Experience

ES-11 TRILLO-1 SPAIN



Status at end of year	:	**Operational**
Operator	:	CNAT (CENTRALES NUCLEARES ALMARAZ-TRILLO (ID/UFG/ENDESA/HC/NUCLENOR))
Owner	:	ID/GN/HC (Iberdrola, Gas Natural, Hidroeléctrica del Cantábrico, Nuclenor)
Reactor Supplier	:	KWU (KRAFTWERK UNION, AG)
Turbine Supplier	:	KWU (KRAFTWERK UNION, AG)

Reactor Unit Details

Reactor type and model	:	PWR / PWR 3 loops
Thermal power	:	3010 MWth
Gross electrical power	:	1066 MWe
Reference unit power (net)	:	1003 MWe

Key Dates

Construction Date	:	1979-08-17
Grid Date	:	1988-05-23
Commercial Date	:	1988-08-06
Age at end of year	:	36 years

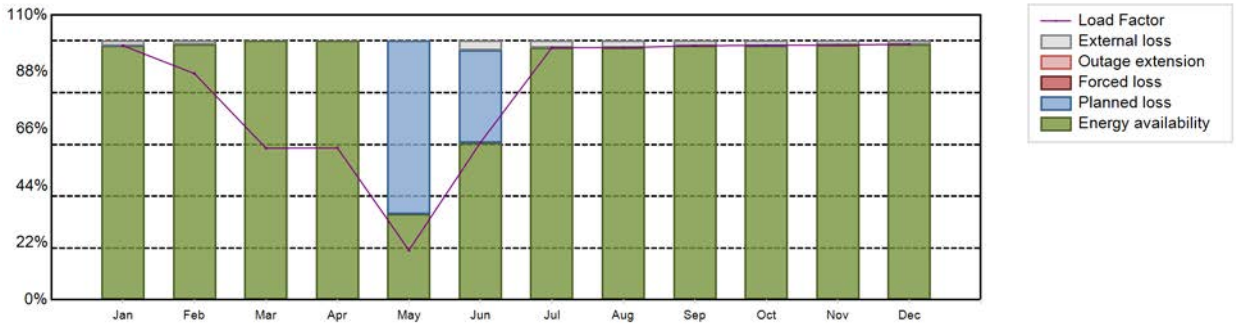
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.7
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	325.9
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	Double
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.538
Average fuel enrichment [% of U235]	:	4.20	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	22.6	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.44	HP cylinder inlet steam pressure [MPa]	:	6.261
Active core height/length [m]	:	3.4	Output voltage [kV]	:	27
Number of fissile fuel assemblies/bundles	:	177	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	20.71	Number of main condensate pumps	:	3
Number of control rod assemblies	:	52	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	4
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7128.47 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	89.84 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	91.39 %	Planned Unavailability Factor (PUF)	:	8.61 %
Load Factor (LF)	:	80.91 %	Externally cause unavailability (XUF)	:	1.55 %
Operating Factor (OF)	:	91.4 %	Total off-line time	:	755 hours

Annual Summary



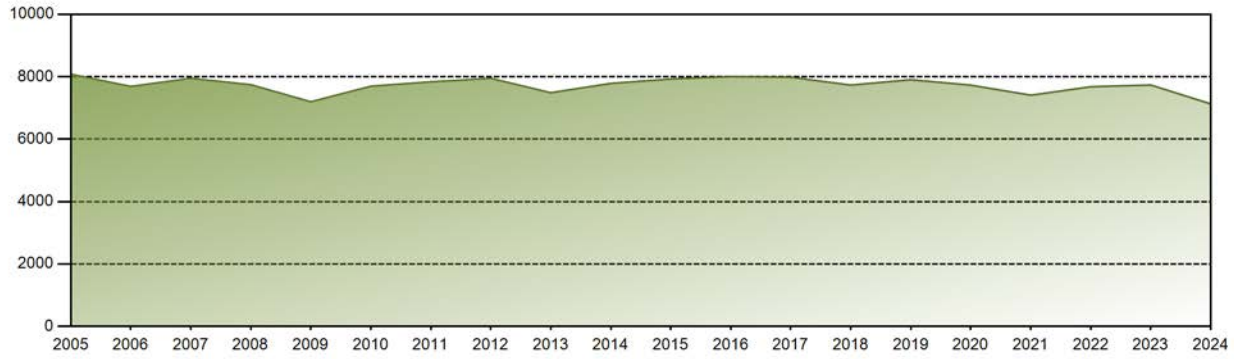
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	732.54	610.07	437.14	423.77	142.95	438.86	727.04	726.74	708.59	733.47	710.67	736.63	7128.47
EAF [%]	98.12	98.70	100.00	100.00	33.06	60.73	97.39	97.35	98.08	98.11	98.37	98.67	89.84
UCF [%]	99.91	100.00	100.00	100.00	33.06	64.31	100.00	100.00	100.00	99.93	100.00	100.00	91.39
LF [%]	98.17	87.39	58.58	58.68	19.16	60.77	97.43	97.39	98.12	98.29	98.41	98.71	80.91
OF [%]	100.00	100.00	100.00	100.00	33.06	64.31	100.00	100.00	100.00	100.00	100.00	100.00	91.40
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.09	0.00	0.00	0.00	66.94	35.69	0.00	0.00	0.00	0.07	0.00	0.00	8.61
XUF [%]	1.79	1.30	0.00	0.00	0.00	3.58	2.61	2.65	1.92	1.82	1.63	1.33	1.55

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Historical Summary

Lifetime energy generation	:	277117.76 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.32 %
Cumulative Energy Availability Factor (EAF)	:	87.39 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.46 %
Cumulative Unit Capability Factor (UCF)	:	88.03 %	Cumulative Planned Unavailability Factor (PUF)	:	9.51 %
Cumulative Load Factor (LF)	:	86.69 %	Cumulative Externally cause unavailability (XUF)	:	0.64 %
Cumulative Operating Factor (OF)	:	88.84 %			

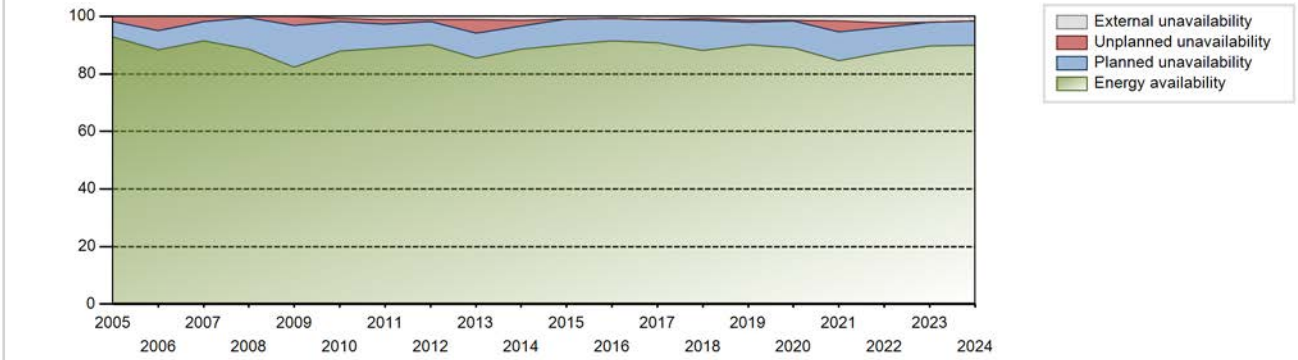
Electricity Production (net) [GWh]



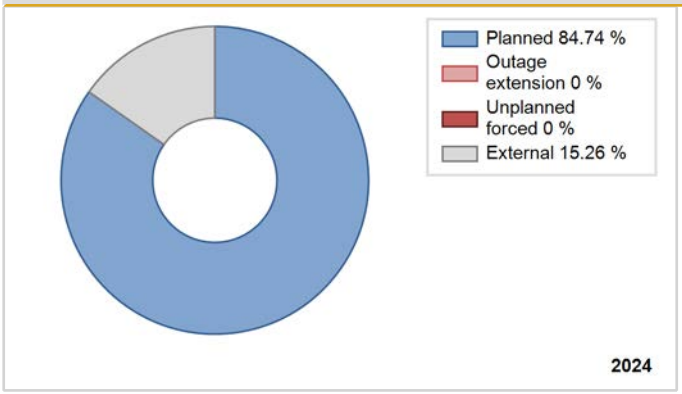
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	2896.23	3511	997	72.66	72.66	66.29	72.11	16.08	13.93	13.41	0.00
1989	7147.79	7665	974	83.77	83.79	83.77	87.50	1.38	1.17	15.04	0.02
1990	6372.44	7170	974	74.69	74.69	74.69	81.85	10.14	8.42	16.89	0.00
1991	6481.54	6891	974	75.97	75.97	75.97	78.66	5.72	4.61	19.43	0.00
1992	7938.46	8028	1000	90.37	90.37	90.37	91.39	2.05	1.89	7.74	0.00
1993	7395.86	7512	1000	84.43	84.43	84.43	85.75	3.95	3.47	12.10	0.00
1994	7927.69	8009	1000	90.99	90.99	90.50	91.43	0.29	0.27	8.74	0.00
1995	7472.62	7597	1000	85.78	86.43	85.30	86.72	0.08	0.07	13.51	0.64
1996	7626.31	7713	1000	87.34	87.37	86.82	87.81	1.25	1.11	11.52	0.03
1997	7765.45	8066	1000	89.30	91.85	88.65	92.08	0.17	0.15	7.99	2.55
1998	6589.73	6686	1000	75.77	76.10	75.23	76.32	23.89	23.88	0.02	0.33
1999	6828.82	6876	1000	78.01	78.03	77.95	78.48	3.34	2.69	19.28	0.02
2000	8206.49	8251	1000	93.62	93.68	93.41	93.92	0.32	0.30	6.02	0.06
2001	7907.41	7966	1000	90.63	90.66	90.27	90.94	2.42	2.25	7.09	0.03
2002	7827.00	7876	1000	89.61	89.65	89.34	89.90	0.01	0.01	10.34	0.04
2003	8114.66	8210	1003	93.10	93.10	92.46	93.71	1.36	1.84	5.07	0.00
2004	7980.12	8121	1003	91.50	91.50	90.57	92.44	2.04	2.82	5.68	0.00
2005	8080.62	8175	1003	92.94	92.94	91.97	93.32	0.28	1.74	5.32	0.00
2006	7687.80	7788	1003	88.45	88.59	87.50	88.90	1.53	4.92	6.50	0.14
2007	7948.88	8039	1003	91.44	91.50	90.47	91.77	0.33	1.86	6.64	0.05
2008	7743.95	7820	1003	88.53	88.66	87.90	89.03	0.36	0.32	11.02	0.13
2009	7197.10	7438	1003	82.38	82.48	81.91	84.91	3.56	3.05	14.47	0.09
2010	7695.50	7969	1003	87.85	88.54	87.59	90.97	0.92	1.01	10.44	0.70
2011	7835.70	7940	1003	89.14	90.38	89.18	90.64	1.50	1.52	8.10	1.24
2012	7948.78	8066	1003	90.26	91.33	90.22	91.83	0.14	0.68	7.99	1.07
2013	7487.11	7656	1003	85.43	86.56	85.21	87.40	3.47	4.81	8.63	1.12
2014	7785.49	7901	1003	88.65	89.96	88.61	90.19	0.00	2.13	7.90	1.31
2015	7926.99	8009	1003	90.24	91.21	90.22	91.43	0.00	0.00	8.79	0.97
2016	8004.55	8111	1003	91.44	92.23	90.85	92.34	0.00	0.00	7.77	0.80
2017	7983.09	8067	1003	90.86	91.90	90.86	92.09	0.09	0.08	8.02	1.04
2018	7732.00	7841	1003	88.12	88.79	88.00	89.51	0.65	0.65	10.56	0.67
2019	7905.28	8049	1003	90.23	91.61	89.97	91.88	0.01	0.59	7.80	1.38
2020	7729.61	7981	1003	89.12	90.39	87.73	90.86	0.29	0.26	9.35	1.26
2021	7408.21	7571	1003	84.57	86.25	84.32	86.43	4.19	3.77	9.98	1.68
2022	7679.74	7849	1003	87.37	89.54	87.41	89.60	1.74	1.59	8.88	2.17
2023	7734.72	8035	1003	89.61	91.68	88.03	91.72	0.05	0.04	8.28	2.06
2024	7128.47	8029	1003	89.84	91.39	80.91	91.40	0.00	0.00	8.61	1.55

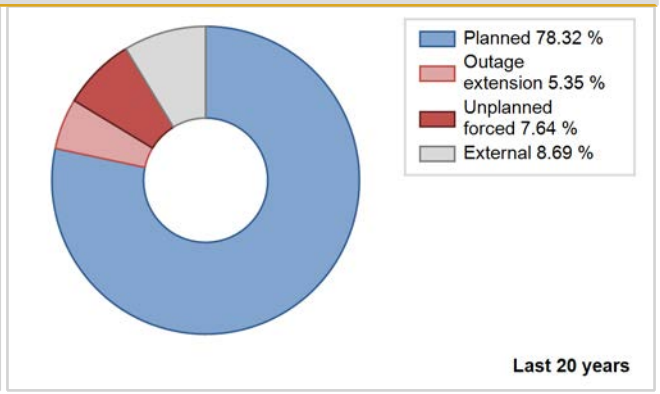
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					116	
C. Inspection, maintenance or repair combined with refuelling	755			789	6	
D. Inspection, maintenance or repair without refuelling				2		
P. Fire					2	
Subtotal	755			791	124	
Total	**755**			**915**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1988 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		3
13. Reactor Auxiliary Systems		12
15. Reactor Cooling Systems		26
16. Steam generation systems		8
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		28
32. Feedwater and Main Steam System		12
33. Circulating Water System		0
34. Miscellaneous Systems		2
41. Main Generator Systems		7
42. Electrical Power Supply Systems		12
Total		**114**

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2024 Operating Experience

ES-16 VANDELLOS-2 SPAIN



Status at end of year	:	**Operational**
Operator	:	ANAV (ASOCIACIÓN NUCLEAR ASCÓ-VANDELLÓS A.I.E. (ENDESA/ID))
Owner	:	EN/ID (ENDESA, IBERDROLA)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP
Thermal power	:	2941 MWth
Gross electrical power	:	1087 MWe
Reference unit power (net)	:	1047 MWe

Key Dates

Construction Date	:	1980-12-29
Grid Date	:	1987-12-12
Commercial Date	:	1988-03-08
Age at end of year	:	37 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.6
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	50500
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.92
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

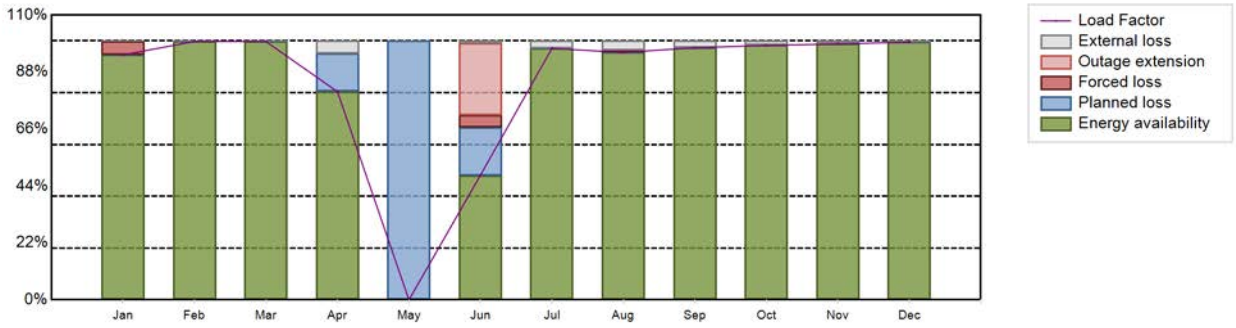
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	328.3
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.38
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.8
Output voltage [kV]	:	21
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7729.94 GW(e).h
Energy Availability Factor (EAF)	:	84.05 %
Unit Capability Factor (UCF)	:	85.55 %
Load Factor (LF)	:	84.05 %
Operating Factor (OF)	:	87.15 %

Forced Loss Rate (FLR)	:	1.02 %
Unplanned Capability Loss Factor (UCL)	:	3.16 %
Planned Unavailability Factor (PUF)	:	11.29 %
Externally cause unavailability (XUF)	:	1.5 %
Total off-line time	:	1129 hours

Annual Summary



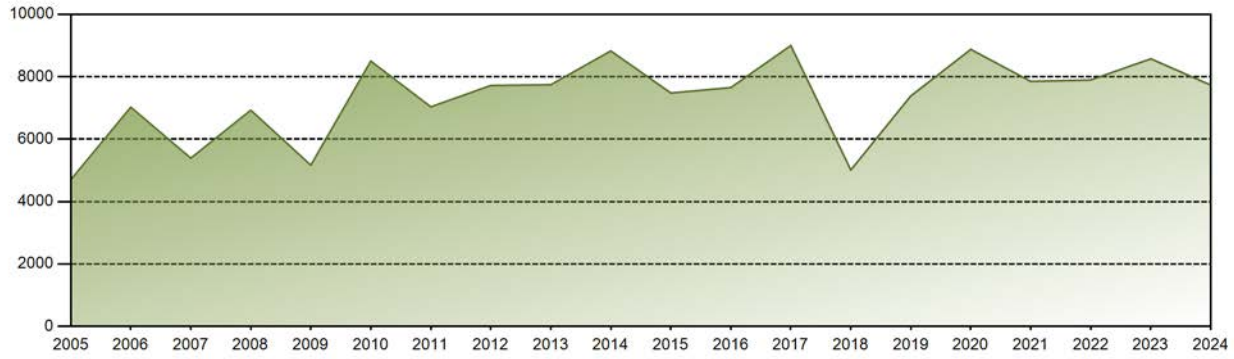
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	736.97	727.09	775.98	606.05	0.00	362.69	756.36	744.20	733.87	766.48	744.85	775.40	7729.94
EAF [%]	94.61	99.78	99.75	80.39	0.00	48.11	97.10	95.54	97.35	98.26	98.81	99.54	84.05
UCF [%]	94.81	99.91	99.88	85.26	0.00	49.00	99.85	99.19	99.85	99.85	99.83	99.87	85.55
LF [%]	94.61	99.78	99.75	80.39	0.00	48.11	97.10	95.54	97.35	98.26	98.81	99.54	84.05
OF [%]	97.72	100.00	100.00	86.67	0.00	62.22	100.00	100.00	100.00	100.00	100.00	100.00	87.15
FLR [%]	5.05	0.00	0.00	0.00	0.00	9.10	0.00	0.67	0.00	0.00	0.00	0.00	1.02
UCL [%]	5.04	0.00	0.00	0.00	0.00	32.61	0.00	0.66	0.00	0.00	0.00	0.00	3.16
PUF [%]	0.14	0.09	0.12	14.74	100.00	18.39	0.15	0.15	0.15	0.15	0.17	0.13	11.29
XUF [%]	0.21	0.14	0.13	4.86	0.00	0.89	2.75	3.65	2.50	1.59	1.03	0.33	1.50

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Historical Summary

Lifetime energy generation	:	272053.86 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.56 %
Cumulative Energy Availability Factor (EAF)	:	82.89 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.63 %
Cumulative Unit Capability Factor (UCF)	:	83.94 %	Cumulative Planned Unavailability Factor (PUF)	:	9.44 %
Cumulative Load Factor (LF)	:	82.82 %	Cumulative Externally cause unavailability (XUF)	:	1.05 %
Cumulative Operating Factor (OF)	:	85.16 %			

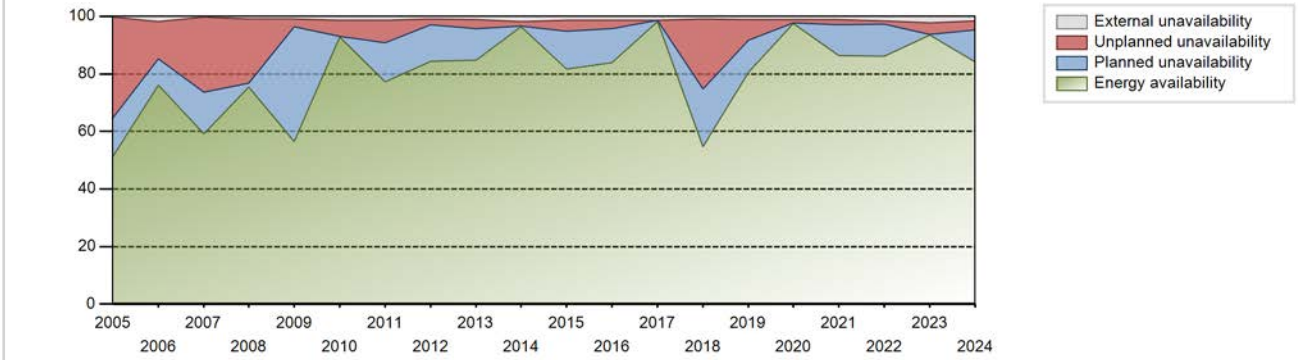
Electricity Production (net) [GWh]



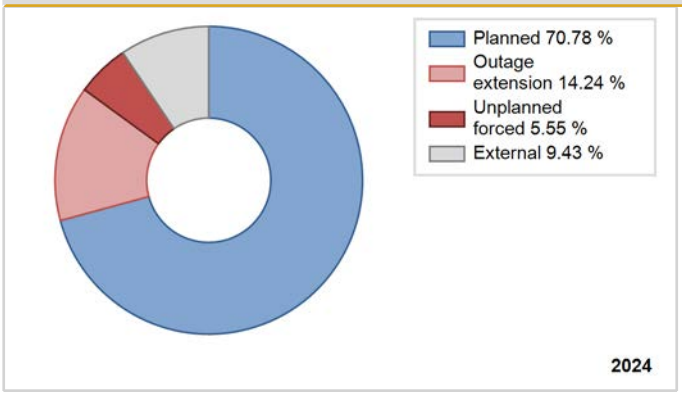
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	5101.90	6262	930	67.36	68.34	67.51	70.53	26.77	24.98	6.68	0.99
1989	5868.79	6357	943	70.58	70.62	71.04	72.57	22.13	20.07	9.31	0.04
1990	7334.29	7925	943	87.80	87.80	88.79	90.47	2.90	2.62	9.58	0.00
1991	7214.92	7825	953	86.31	88.49	86.42	89.33	2.06	1.86	9.65	2.18
1992	6718.20	7249	953	79.63	79.63	80.25	82.53	5.74	4.84	15.52	0.00
1993	6910.40	7377	961	82.41	84.33	82.09	84.21	7.95	7.28	8.39	1.92
1994	7208.44	7676	961	85.60	85.60	85.63	87.63	2.56	2.25	12.15	0.00
1995	7571.28	7957	961	89.48	89.48	89.94	90.83	0.59	0.53	9.98	0.00
1996	7511.43	7942	961	88.97	89.08	88.98	90.41	1.63	1.48	9.45	0.11
1997	7243.11	7961	961	85.51	88.66	86.05	90.89	1.25	1.12	10.22	3.16
1998	8359.01	8760	966	99.05	99.26	98.78	100.00	0.56	0.56	0.18	0.21
1999	7224.37	7430	1024	82.51	83.41	80.50	84.82	4.54	3.97	12.62	0.89
2000	7976.91	7852	1043	87.64	87.89	87.07	89.39	2.77	2.51	9.60	0.25
2001	9010.35	8727	1043	99.43	99.43	98.62	99.62	0.51	0.51	0.06	0.00
2002	8010.07	7881	1040	88.07	89.25	87.92	89.97	0.47	0.42	10.33	1.18
2003	8219.25	8067	1040	89.47	90.89	90.22	92.09	0.23	0.21	8.90	1.43
2004	8677.05	8429	1045	94.49	95.79	94.53	95.96	4.21	4.21	0.00	1.31
2005	4698.40	4657	1045	51.31	51.67	51.33	53.16	0.04	34.82	13.50	0.36
2006	7022.75	6882	1045	76.20	77.98	76.72	78.56	14.22	12.92	9.10	1.78
2007	5387.75	5313	1045	59.15	59.43	58.86	60.65	28.65	26.16	14.41	0.29
2008	6926.03	6922	1045	75.39	76.31	75.45	78.80	22.68	22.39	1.30	0.92
2009	5164.06	5241	1045	56.42	57.45	56.42	59.84	4.36	2.62	39.93	1.03
2010	8498.80	8293	1045	92.79	94.10	92.84	94.67	5.74	5.73	0.17	1.31
2011	7034.35	6894	1045	77.30	78.59	76.85	78.71	2.52	7.79	13.62	1.29
2012	7718.56	7549	1045	84.26	85.27	84.09	85.94	0.76	1.83	12.90	1.01
2013	7742.95	7676	1045	84.75	85.81	84.58	87.63	1.63	3.30	10.89	1.05
2014	8824.89	8663	1045	96.41	98.26	96.40	98.89	1.59	1.59	0.16	1.85
2015	7478.53	7353	1045	81.70	83.06	81.70	83.94	0.69	3.88	13.06	1.36
2016	7650.33	7568	1045	83.88	85.24	83.34	86.16	0.03	2.90	11.86	1.36
2017	8997.98	8760	1045	98.29	99.61	98.29	100.00	0.09	0.09	0.30	1.32
2018	5009.18	4947	1045	54.72	55.61	54.72	56.47	28.07	24.26	20.13	0.89
2019	7383.68	7293	1045	80.66	81.76	80.66	83.25	5.94	7.15	11.09	1.10
2020	8875.72	8784	1045	97.53	98.73	96.69	100.00	1.12	1.12	0.15	1.21
2021	7848.71	7758	1045	86.26	87.36	85.74	88.56	1.30	1.84	10.80	1.10
2022	7897.80	7759	1047	86.11	87.80	86.11	88.57	0.20	0.98	11.22	1.69
2023	8573.98	8444	1047	93.48	95.84	93.47	96.38	4.02	4.02	0.14	2.36
2024	7729.94	7655	1047	84.05	85.55	84.05	87.15	1.02	3.16	11.29	1.50

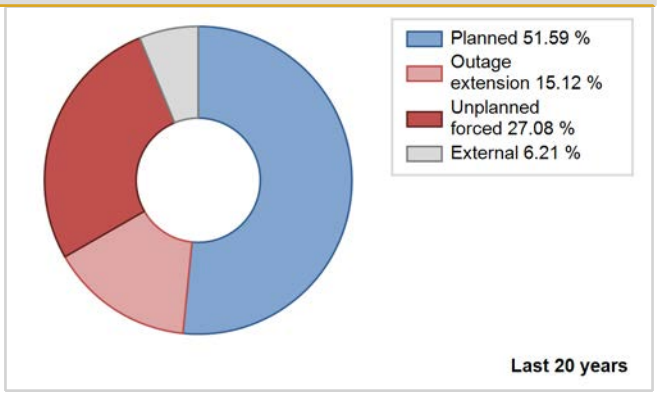
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		17			408	
C.	Inspection, maintenance or repair combined with refuelling	912			696	14	
D.	Inspection, maintenance or repair without refuelling				42		
E.	Testing of plant systems or components				3	1	
F.	Major backfitting, refurbishment or upgrading activities with refuelling					49	
J.	Grid limitation, failure or grid unavailability						8
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L.	Human factor related					10	
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						4
Z.	Other		200			9	
Subtotal		912	217		741	491	13
Total			**1129**			**1245**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1988 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		16
12. Reactor I&C Systems	17	52
13. Reactor Auxiliary Systems		85
15. Reactor Cooling Systems		89
16. Steam generation systems		1
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		13
32. Feedwater and Main Steam System		57
33. Circulating Water System		6
34. Miscellaneous Systems		3
41. Main Generator Systems		60
42. Electrical Power Supply Systems		81
Total	**17**	**464**

Highlights (2024)

In 2024, Vandellos II NPP produced 8042.909 gross GWh, slightly lower than expected gross 8158.587 GWh. These were the main events affecting the operation:
- On January 17th, reactor manual scram due to motegenerator malfunction to prevent safety injection.
- From April 27th to June 12th Refueling outage number 26 took place. This outage suffered an 8 days delay due to a number of different events; mainly attributed to containment polar crane modifications.
- On June 12th, during power ascension following completion of refueling outage, a steam leak on high pressure turbine was identified, which caused reduced power operation to fix, and delayed getting to 100% power.
- On August 20th a malfunction caused the main feedwater turbopump to go offline, causing a turbine runback to 70% RTP.

Due to these incidents, the load factor was 84.22%. The net production was 7729.943 GWh, versus expected 7837.633 GWh, resulting in a measured/expected ratio of 98.63%.

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2024 Operating Experience

SE-9 FORSMARK-1 SWEDEN



Status at end of year	:	**Operational**
Operator	:	FKA (FORSMARK KRAFTGRUPP AB)
Owner	:	FKA (FORSMARK KRAFTGRUPP AB)
Reactor Supplier	:	ABB ATOM (ABB ATOM (formerly ASEA-ATOM))
Turbine Supplier	:	STAL (STAL-LAVAL)

Reactor Unit Details

Reactor type and model	:	BWR / AA-III, BWR-2500
Thermal power	:	3234 MWth
Gross electrical power	:	1143 MWe
Reference unit power (net)	:	1104 MWe

Key Dates

Construction Date	:	1973-06-01
Grid Date	:	1980-06-06
Commercial Date	:	1980-12-10
Age at end of year	:	44 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.60
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	17
Average discharge burnup [MWd/t]	:	48000
Active core diameter [m]	:	4.51
Active core height/length [m]	:	3.68
Number of fissile fuel assemblies/bundles	:	676
Fuel linear heat generation rate [kW/m]	:	16
Number of control rod assemblies	:	161
Number of external reactor coolant loops	:	NA
Coolant type	:	H2O

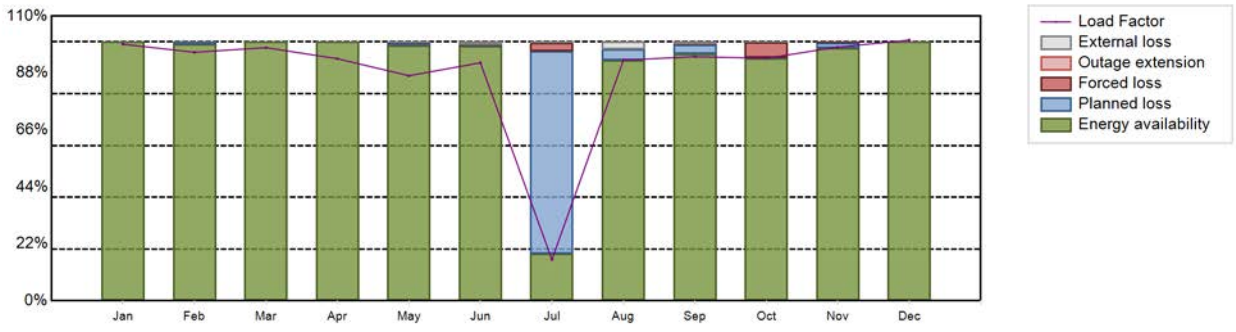
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	286
Number of SG	:	NA
Containment type	:	Single
Containment design pressure [MPa]	:	0.55
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	21.5
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8291.86 GW(e).h
Energy Availability Factor (EAF)	:	91.16 %
Unit Capability Factor (UCF)	:	91.65 %
Load Factor (LF)	:	88.49 %
Operating Factor (OF)	:	94.46 %

Forced Loss Rate (FLR)	:	0.96 %
Unplanned Capability Loss Factor (UCL)	:	0.89 %
Planned Unavailability Factor (PUF)	:	7.46 %
Externally cause unavailability (XUF)	:	0.49 %
Total off-line time	:	487 hours

Annual Summary



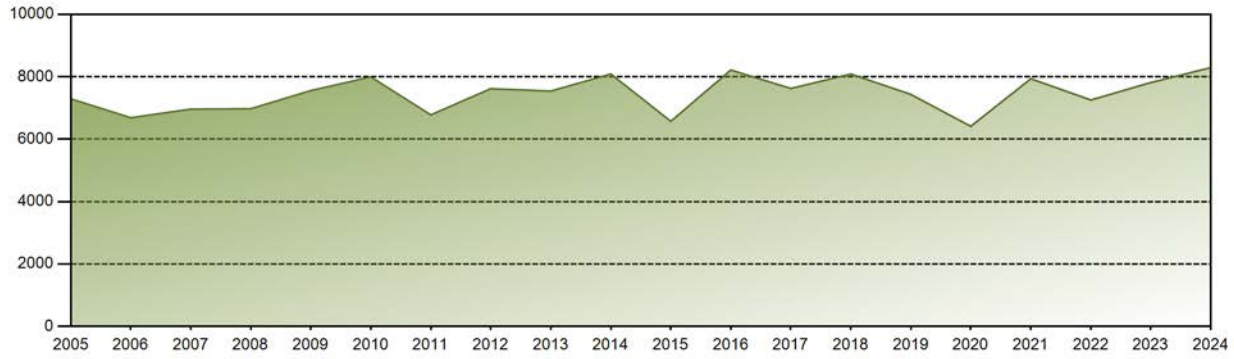
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	766.71	694.79	755.67	700.18	672.78	688.37	123.46	763.79	749.43	770.68	778.89	827.10	8291.86
EAF [%]	100.00	99.14	100.00	100.00	98.54	98.42	18.19	92.99	95.28	93.70	97.57	100.00	91.16
UCF [%]	100.00	99.14	100.00	100.00	98.83	99.43	18.48	95.90	96.28	93.95	97.57	100.00	91.65
LF [%]	99.09	95.99	97.79	93.51	86.95	91.93	15.96	92.99	94.28	93.70	97.99	100.70	88.49
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	34.54	100.00	100.00	100.00	100.00	100.00	94.46
FLR [%]	0.00	0.00	0.00	0.00	0.28	0.13	15.52	0.00	0.21	5.97	0.43	0.00	0.96
UCL [%]	0.00	0.00	0.00	0.00	0.28	0.13	3.39	0.00	0.20	5.96	0.42	0.00	0.89
PUF [%]	0.00	0.86	0.00	0.00	0.89	0.44	78.13	4.10	3.51	0.08	2.00	0.00	7.46
XUF [%]	0.00	0.00	0.00	0.00	0.30	1.01	0.29	2.91	1.01	0.25	0.00	0.00	0.49

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Historical Summary

Lifetime energy generation	:	311541.12 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.68 %
Cumulative Energy Availability Factor (EAF)	:	84.84 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.54 %
Cumulative Unit Capability Factor (UCF)	:	86.77 %	Cumulative Planned Unavailability Factor (PUF)	:	9.7 %
Cumulative Load Factor (LF)	:	83.1 %	Cumulative Externally cause unavailability (XUF)	:	1.92 %
Cumulative Operating Factor (OF)	:	90.03 %			

Electricity Production (net) [GWh]

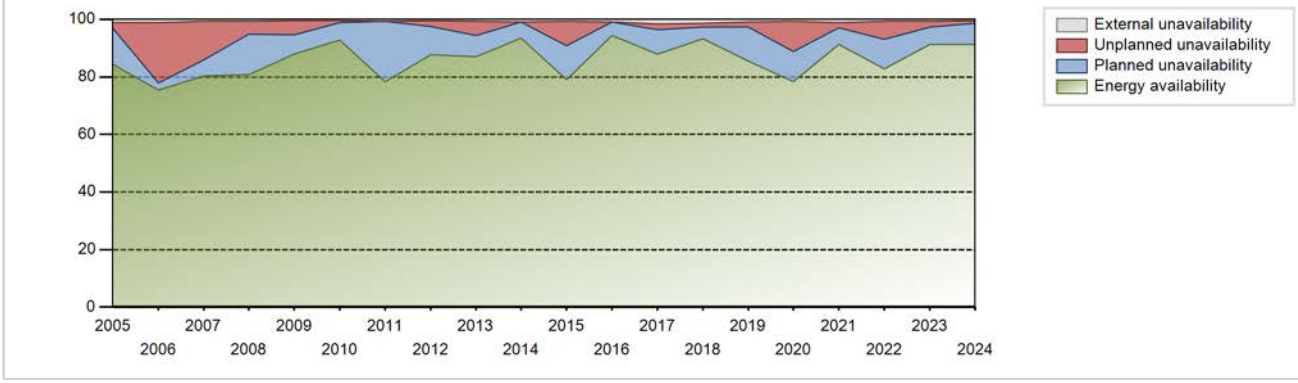


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	2200.90	5016	928	100.00	100.00	100.00	100.00	0.00	0.00	0.00	0.00
1981	6063.70	7305	900	76.91	76.91	76.91	83.39	8.70	7.33	15.76	0.00
1982	5548.10	7131	900	70.37	70.37	70.37	81.40	18.09	15.54	14.09	0.00
1983	5926.00	8095	900	75.17	75.17	75.16	92.41	15.95	14.26	10.57	0.00
1984	6461.80	8207	900	91.90	91.90	81.74	93.43	1.77	1.65	6.45	0.00
1985	5587.57	7773	900	79.42	79.42	70.87	88.73	1.82	1.48	19.10	0.00
1986	7317.15	8303	954	89.83	89.83	87.53	94.78	0.94	0.85	9.31	0.00
1987	6493.39	8291	970	79.45	79.45	76.42	94.65	0.29	0.23	20.32	0.00
1988	6852.84	7739	970	81.84	81.84	80.43	88.10	5.18	4.48	13.68	0.00
1989	6138.64	7907	969	85.46	85.46	72.30	90.26	2.53	2.22	12.32	0.00
1990	6257.49	7885	972	85.83	85.83	73.49	90.01	3.25	2.89	11.28	0.00
1991	7487.58	8122	968	88.26	90.58	88.30	92.72	0.11	0.10	9.32	2.32
1992	6833.64	8175	968	80.28	85.22	80.36	93.06	4.53	4.04	10.73	4.94
1993	7022.83	8010	968	82.73	91.93	82.81	91.43	1.46	1.36	6.70	9.20
1994	7398.21	8109	968	87.02	91.35	87.25	92.57	1.31	1.21	7.44	4.33
1995	7325.18	8173	968	86.19	91.29	86.39	93.30	2.45	2.29	6.42	5.11
1996	7311.38	8412	968	86.42	95.27	85.99	95.77	0.04	0.04	4.70	8.84
1997	5402.87	6255	968	64.57	64.57	63.54	71.21	0.55	0.36	35.08	0.00
1998	7307.70	8265	968	93.64	93.64	86.18	94.35	1.28	1.21	5.14	0.00
1999	7582.73	8420	968	96.29	96.69	89.42	96.12	0.04	0.04	3.27	0.40
2000	5730.82	7202	968	67.39	85.94	67.40	81.99	0.24	0.21	13.86	18.55
2001	7286.12	8482	968	86.25	94.77	85.92	96.83	0.84	0.80	4.43	8.51
2002	7143.77	7978	961	86.02	90.04	84.86	91.07	4.69	4.43	5.53	4.02
2003	7456.00	8093	961	88.49	88.49	88.56	92.38	0.52	1.36	10.15	0.00
2004	8032.28	8555	961	95.65	97.52	95.15	97.39	0.03	0.03	2.45	1.87
2005	7291.06	7648	1011	84.38	85.43	85.13	87.31	2.45	2.15	12.43	1.05
2006	6683.92	6806	995	75.43	76.50	75.47	77.69	21.61	21.09	2.40	1.07
2007	6961.43	7204	987	80.38	81.12	80.52	82.24	14.03	13.23	5.65	0.74
2008	6973.66	7442	978	80.76	81.41	81.10	84.71	3.25	4.51	14.07	0.65
2009	7555.38	8029	978	87.90	88.35	88.19	91.66	4.80	4.88	6.77	0.46
2010	7993.61	8283	978	92.83	93.38	93.30	94.55	0.09	0.49	6.13	0.55
2011	6776.59	7005	984	78.44	79.22	79.02	79.97	0.03	0.03	20.76	0.77
2012	7615.92	7938	984	87.69	88.16	88.11	90.37	2.25	2.03	9.80	0.48
2013	7539.63	7782	984	87.12	87.78	87.47	88.84	2.02	5.00	7.23	0.66
2014	8085.96	8307	984	93.54	94.41	93.81	94.83	0.05	0.05	5.54	0.87
2015	6570.19	7153	984	79.10	79.76	76.22	81.66	8.82	8.49	11.75	0.66
2016	8214.31	8421	984	94.49	95.40	95.04	95.87	0.04	0.04	4.56	0.91

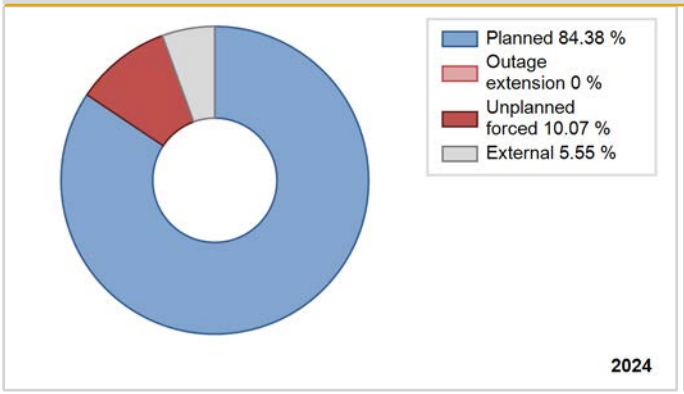
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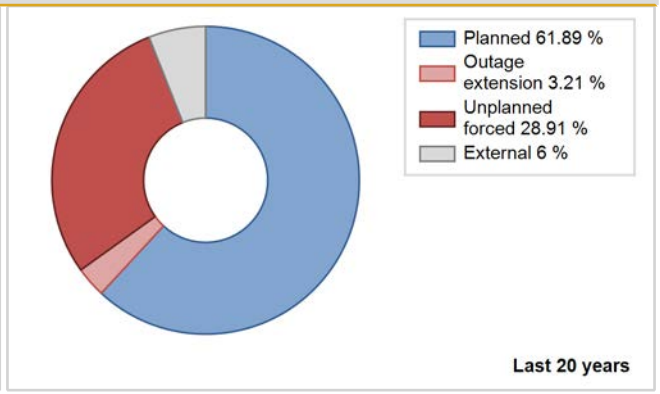
2017	7623.46	7994	984	87.85	89.45	88.44	91.26	1.34	2.03	8.52	1.60
2018	8087.58	8448	986	93.30	94.76	93.70	96.44	1.36	1.30	3.94	1.46
2019	7432.93	7699	990	85.54	86.35	85.87	87.89	2.06	1.81	11.83	0.81
2020	6410.35	7652	990	78.29	79.04	73.71	87.11	11.72	10.49	10.46	0.76
2021	7935.93	8295	990	91.17	92.33	91.51	94.69	1.86	1.75	5.92	1.16
2022	7253.90	7775	1040	82.88	83.64	82.94	88.76	6.45	6.29	10.07	0.75
2023	7813.50	8128	1040	91.20	91.92	85.76	92.79	1.11	2.01	6.07	0.72
2024	8291.86	8297	1104	91.16	91.65	88.49	94.46	0.96	0.89	7.46	0.49

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1980 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					140	
B.	Refuelling without maintenance				8		
C.	Inspection, maintenance or repair combined with refuelling	460			660		
D.	Inspection, maintenance or repair without refuelling				1		
E.	Testing of plant systems or components				3		
F.	Major backfitting, refurbishment or upgrading activities with refuelling				23		
H.	Nuclear regulatory requirements					6	
J.	Grid limitation, failure or grid unavailability						2
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						10
L.	Human factor related					25	
O.	Load dispatching, prioritization			27			1
P.	Fire					0	
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					5	
Subtotal		460		27	695	176	13
Total		**487**			**884**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	27	46
12. Reactor I&C Systems		13
13. Reactor Auxiliary Systems		17
14. Safety Systems		28
15. Reactor Cooling Systems		11
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		8
32. Feedwater and Main Steam System		2
34. Miscellaneous Systems		1
41. Main Generator Systems		3
42. Electrical Power Supply Systems		40
Total	**27**	**171**

RUP revision during the year (2024) due to power uprate

RUP at the end of previous year : 1040 [MWe]

Month	Capacity [MWe]	Power Uprate	Main modifications	Description
August	1104	Extended power uprate (>7%)	Fuel or core Primary systems Balance of plant I&C and monitoring systems	Last step inpower uprate project

Highlights (2024)

Annual outage in July .
Power uprate in August.
Tests due to the uprate, carried out in August, September and October.

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2024 Operating Experience

SE-11 FORSMARK-2 SWEDEN



Status at end of year	:	**Operational**
Operator	:	FKA (FORSMARK KRAFTGRUPP AB)
Owner	:	FKA (FORSMARK KRAFTGRUPP AB)
Reactor Supplier	:	ABB ATOM (ABB ATOM (formerly ASEA-ATOM))
Turbine Supplier	:	STAL (STAL-LAVAL)

Reactor Unit Details

Reactor type and model	:	BWR / AA-III, BWR-2500
Thermal power	:	3253 MWth
Gross electrical power	:	1160 MWe
Reference unit power (net)	:	1121 MWe

Key Dates

Construction Date	:	1975-01-01
Grid Date	:	1981-01-26
Commercial Date	:	1981-07-07
Age at end of year	:	43 years

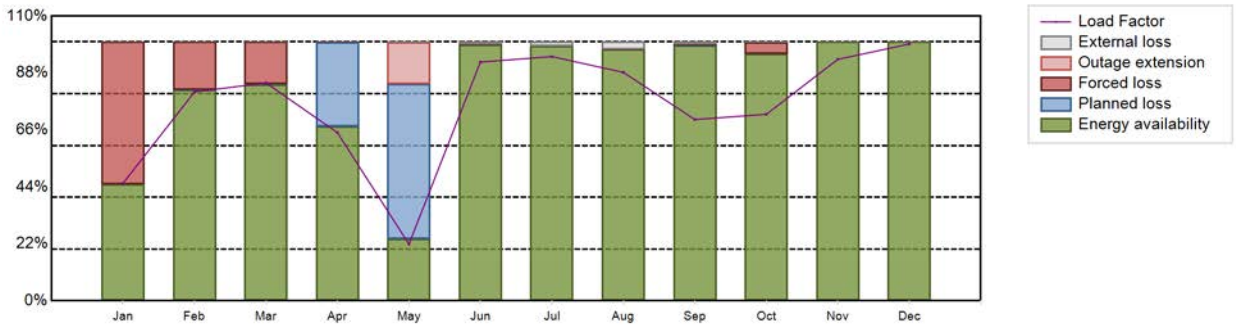
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	286
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.55
Average fuel enrichment [% of U235]	:	3.60	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	20	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	48000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	4.51	HP cylinder inlet steam pressure [MPa]	:	6.35
Active core height/length [m]	:	3.68	Output voltage [kV]	:	21.5
Number of fissile fuel assemblies/bundles	:	676	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	19	Number of main condensate pumps	:	4
Number of control rod assemblies	:	161	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	NA	Number of on-site safety related diesel generators	:	4
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7429.72 GW(e).h	Forced Loss Rate (FLR)	:	8.74 %
Energy Availability Factor (EAF)	:	82.41 %	Unplanned Capability Loss Factor (UCL)	:	9.32 %
Unit Capability Factor (UCF)	:	82.96 %	Planned Unavailability Factor (PUF)	:	7.72 %
Load Factor (LF)	:	75.45 %	Externally cause unavailability (XUF)	:	0.55 %
Operating Factor (OF)	:	89 %	Total off-line time	:	966 hours

Annual Summary



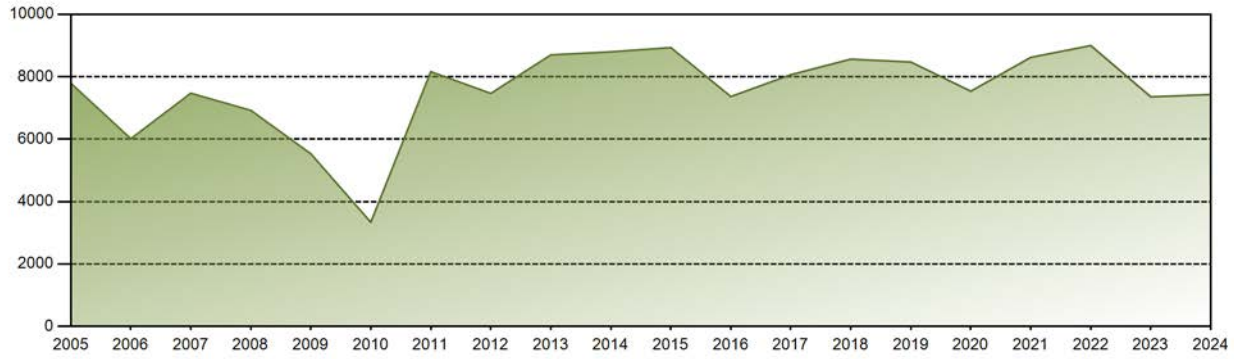
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	378.38	629.48	701.03	524.12	182.67	744.41	786.80	735.82	565.16	601.81	752.84	827.20	7429.72
EAF [%]	45.03	81.51	83.59	67.47	23.96	98.92	98.49	97.02	98.60	95.39	100.00	100.00	82.41
UCF [%]	45.03	81.51	83.59	67.47	24.21	99.87	100.00	99.83	99.39	95.64	100.00	100.00	82.96
LF [%]	45.37	80.68	84.17	64.94	21.90	92.23	94.34	88.23	70.02	72.06	93.28	99.18	75.45
OF [%]	100.00	100.00	87.75	68.33	27.42	100.00	100.00	100.00	100.00	85.64	100.00	100.00	89.00
FLR [%]	54.97	18.47	16.39	0.12	0.00	0.13	0.00	0.17	0.52	4.36	0.00	0.00	8.74
UCL [%]	54.97	18.47	16.38	0.08	16.13	0.13	0.00	0.17	0.52	4.36	0.00	0.00	9.32
PUF [%]	0.00	0.02	0.03	32.45	59.66	0.00	0.00	0.00	0.09	0.00	0.00	0.00	7.72
XUF [%]	0.00	0.00	0.00	0.00	0.25	0.95	1.51	2.81	0.79	0.24	0.00	0.00	0.55

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Historical Summary

Lifetime energy generation	:	309184.98 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.56 %
Cumulative Energy Availability Factor (EAF)	:	82.83 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.03 %
Cumulative Unit Capability Factor (UCF)	:	84.6 %	Cumulative Planned Unavailability Factor (PUF)	:	9.36 %
Cumulative Load Factor (LF)	:	80.86 %	Cumulative Externally cause unavailability (XUF)	:	1.78 %
Cumulative Operating Factor (OF)	:	89.21 %			

Electricity Production (net) [GWh]

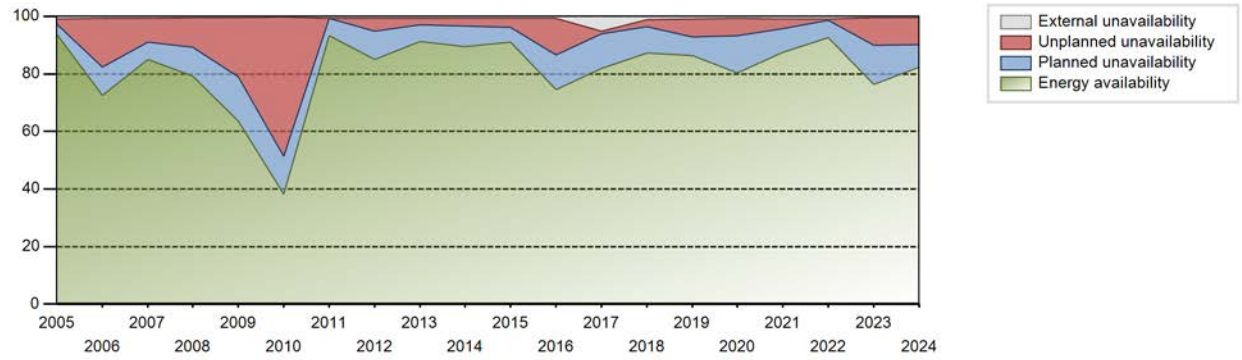


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	2870.70	3977	900	72.23	72.23	72.23	90.06	22.48	20.94	6.83	0.00
1982	5316.40	6076	900	67.40	67.40	67.43	69.36	24.62	22.01	10.58	0.00
1983	5484.40	7879	900	69.56	69.56	69.56	89.94	19.21	16.54	13.89	0.00
1984	5911.73	7442	900	82.56	82.57	74.78	84.72	7.71	6.90	10.53	0.01
1985	5735.38	8048	900	83.81	83.81	72.75	91.87	4.41	3.87	12.32	0.00
1986	6987.86	8231	938	86.54	86.54	84.99	93.96	2.06	1.82	11.64	0.00
1987	6553.84	8190	949	85.48	85.48	78.84	93.49	1.47	1.27	13.25	0.00
1988	6976.19	8032	963	83.19	83.19	82.47	91.44	4.17	3.62	13.19	0.00
1989	5943.42	8222	964	90.02	90.02	70.36	93.86	1.11	1.01	8.96	0.00
1990	6426.24	8119	972	88.64	88.64	75.47	92.68	0.20	0.18	11.18	0.00
1991	7155.18	8084	969	84.19	85.78	84.29	92.28	0.03	0.03	14.20	1.58
1992	6748.91	8294	969	79.22	86.22	79.29	94.42	2.04	1.79	11.98	7.00
1993	6715.51	7684	969	79.14	88.82	79.11	87.72	0.30	0.27	10.91	9.68
1994	7679.45	8194	969	90.44	92.53	90.47	93.54	0.94	0.88	6.60	2.08
1995	7149.21	8144	969	84.14	91.61	84.21	92.96	1.27	1.18	7.21	7.47
1996	7348.24	8135	969	86.21	91.24	86.32	92.60	2.72	2.55	6.20	5.03
1997	7325.29	7927	969	87.44	87.44	86.06	90.24	2.57	2.31	10.25	0.00
1998	7198.57	8240	969	91.87	92.09	84.80	94.06	3.00	2.84	5.06	0.22
1999	7292.27	8117	964	91.75	91.75	86.02	92.66	1.27	1.18	7.07	0.00
2000	5428.10	6939	964	66.32	79.62	64.10	79.00	6.00	5.08	15.30	13.30
2001	7399.55	8321	964	88.83	92.34	87.62	94.99	3.87	3.71	3.95	3.51
2002	6823.89	8155	959	82.20	89.92	81.02	93.09	3.82	3.57	6.51	7.72
2003	7303.88	7916	954	87.06	87.06	87.05	90.35	0.86	1.91	11.03	0.00
2004	7982.20	8529	954	95.21	96.92	95.25	97.10	0.12	0.12	2.96	1.71
2005	7790.11	8348	951	93.68	94.64	93.51	95.30	1.78	1.72	3.64	0.96
2006	6011.87	6426	951	72.49	73.11	72.16	73.36	18.80	16.93	9.97	0.61
2007	7470.12	7750	1000	85.03	85.67	85.27	88.46	8.07	8.39	5.94	0.64
2008	6920.12	7342	990	79.18	79.68	79.45	83.58	11.44	10.30	10.02	0.51
2009	5530.68	5902	990	63.57	64.13	63.77	67.37	5.11	20.46	15.42	0.56
2010	3334.15	7635	990	38.26	38.58	38.45	87.16	54.60	48.30	13.11	0.32
2011	8161.59	8259	996	93.23	93.92	93.82	94.28	0.07	0.07	6.01	0.68
2012	7464.89	7747	996	84.98	85.66	85.32	88.19	3.91	4.46	9.88	0.67
2013	8697.94	8239	1120	91.22	91.85	91.14	94.05	1.06	2.39	5.76	0.64
2014	8796.40	7991	1120	89.39	90.15	89.66	91.22	0.35	2.60	7.25	0.76
2015	8933.60	8107	1120	91.07	91.82	91.06	92.55	0.06	3.18	5.00	0.75
2016	7362.92	6927	1120	74.53	75.21	74.84	78.86	3.12	12.84	11.95	0.68
2017	8063.69	7721	1120	81.92	87.02	82.19	88.14	0.63	1.05	11.93	5.10

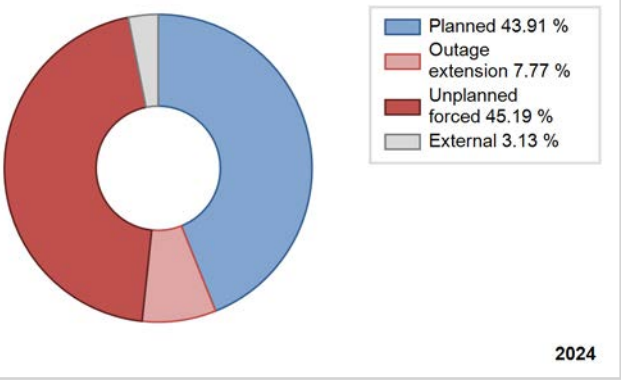
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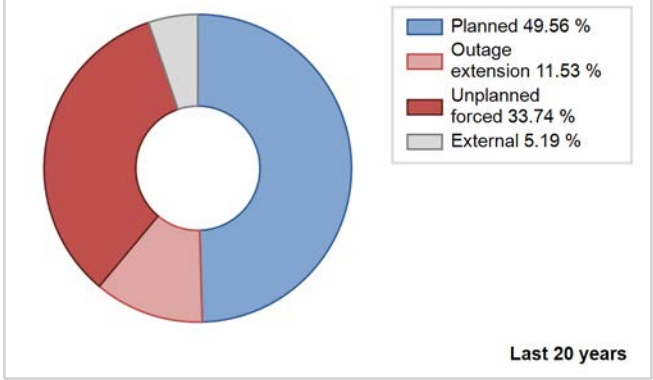
2018	8562.30	7890	1116	87.17	88.38	87.48	90.07	2.05	2.36	9.26	1.21
2019	8470.86	8183	1118	86.33	87.28	86.49	93.41	5.94	6.11	6.61	0.95
2020	7535.29	7356	1118	80.28	80.90	76.73	83.74	6.91	6.00	13.10	0.69
2021	8620.49	7943	1118	87.48	88.46	88.02	90.67	3.68	3.38	8.16	0.98
2022	8998.04	8254	1121	92.53	93.35	91.63	94.22	0.33	0.55	6.09	0.83
2023	7354.48	7506	1121	76.36	76.88	74.89	85.68	9.92	9.52	13.60	0.51
2024	7429.72	7818	1121	82.41	82.96	75.45	89.00	8.74	9.32	7.72	0.55

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		228			210	
B.	Refuelling without maintenance				4		
C.	Inspection, maintenance or repair combined with refuelling	648			601	8	
D.	Inspection, maintenance or repair without refuelling				46		
F.	Major backfitting, refurbishment or upgrading activities with refuelling				32		
H.	Nuclear regulatory requirements					18	
J.	Grid limitation, failure or grid unavailability						2
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						12
L.	Human factor related					16	
O.	Load dispatching, prioritization			90			2
P.	Fire					3	
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				3	6	
Z.	Other					1	
Subtotal		648	228	90	686	262	16
Total		**966**			**964**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	181	83
12. Reactor I&C Systems		6
13. Reactor Auxiliary Systems		6
14. Safety Systems	17	38
15. Reactor Cooling Systems		13
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		51
32. Feedwater and Main Steam System		5
34. Miscellaneous Systems		13
41. Main Generator Systems		0
42. Electrical Power Supply Systems	120	44
Total	**318**	**259**

Highlights (2024)

Annual outage in July.
Power reduction/prioritization wanted by the grid dispatcher to zero for the first time, in October.

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2024 Operating Experience

SE-14 FORSMARK-3 SWEDEN



Status at end of year	:	**Operational**
Operator	:	FKA (FORSMARK KRAFTGRUPP AB)
Owner	:	FKA (FORSMARK KRAFTGRUPP AB)
Reactor Supplier	:	ABB ATOM (ABB ATOM (formerly ASEA-ATOM))
Turbine Supplier	:	STAL (STAL-LAVAL)

Reactor Unit Details

Reactor type and model	:	BWR / AA-IV, BWR-3000
Thermal power	:	3300 MWth
Gross electrical power	:	1208 MWe
Reference unit power (net)	:	1172 MWe

Key Dates

Construction Date	:	1979-01-01
Grid Date	:	1985-03-05
Commercial Date	:	1985-08-18
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3.65
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	20
Average discharge burnup [MWd/t]	:	48000
Active core diameter [m]	:	4.6
Active core height/length [m]	:	3.68
Number of fissile fuel assemblies/bundles	:	700
Fuel linear heat generation rate [kW/m]	:	19
Number of control rod assemblies	:	169
Number of external reactor coolant loops	:	NA
Coolant type	:	H2O

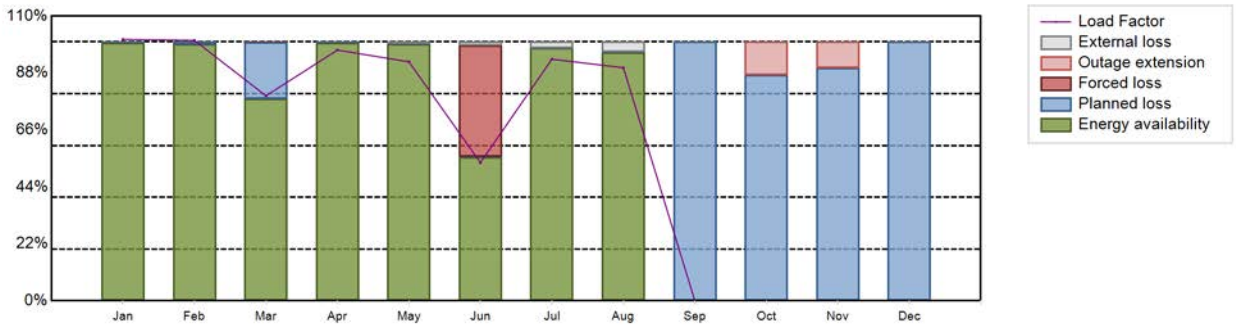
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	286
Number of SG	:	NA
Containment type	:	Single
Containment design pressure [MPa]	:	0.6
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	1
HP cylinder inlet steam pressure [MPa]	:	5.97
Output voltage [kV]	:	25
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	6
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6061.97 GW(e).h
Energy Availability Factor (EAF)	:	60.4 %
Unit Capability Factor (UCF)	:	61.07 %
Load Factor (LF)	:	58.88 %
Operating Factor (OF)	:	62.09 %

Forced Loss Rate (FLR)	:	5.48 %
Unplanned Capability Loss Factor (UCL)	:	5.45 %
Planned Unavailability Factor (PUF)	:	33.47 %
Externally cause unavailability (XUF)	:	0.68 %
Total off-line time	:	3330 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	880.47	820.47	689.56	817.28	804.96	450.36	813.74	785.13	0.00	0.00	0.00	0.00	6061.97
EAF [%]	99.59	99.20	78.13	99.68	99.14	55.46	97.51	95.84	0.00	0.07	0.00	0.00	60.40
UCF [%]	99.59	99.20	78.13	99.68	99.77	56.71	99.80	99.68	0.00	0.07	0.00	0.00	61.07
LF [%]	100.98	100.58	79.19	96.85	92.31	53.37	93.32	90.04	0.00	0.00	0.00	0.00	58.88
OF [%]	100.00	100.00	82.91	100.00	100.00	61.94	100.00	100.00	0.00	0.00	0.00	0.00	62.09
FLR [%]	0.00	0.00	0.03	0.00	0.00	43.22	0.00	0.00	0.00	0.00	0.00	0.00	5.48
UCL [%]	0.00	0.00	0.02	0.00	0.00	43.16	0.00	0.00	0.00	12.89	10.00	0.00	5.45
PUF [%]	0.41	0.80	21.85	0.32	0.23	0.13	0.20	0.32	100.00	87.04	90.00	100.00	33.47
XUF [%]	0.00	0.00	0.00	0.00	0.63	1.25	2.30	3.84	0.00	0.00	0.00	0.00	0.68

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Historical Summary

Lifetime energy generation	:	336019.86 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.32 %
Cumulative Energy Availability Factor (EAF)	:	85.07 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.25 %
Cumulative Unit Capability Factor (UCF)	:	87.1 %	Cumulative Planned Unavailability Factor (PUF)	:	9.65 %
Cumulative Load Factor (LF)	:	83.88 %	Cumulative Externally cause unavailability (XUF)	:	2.02 %
Cumulative Operating Factor (OF)	:	88.82 %			

Electricity Production (net) [GWh]

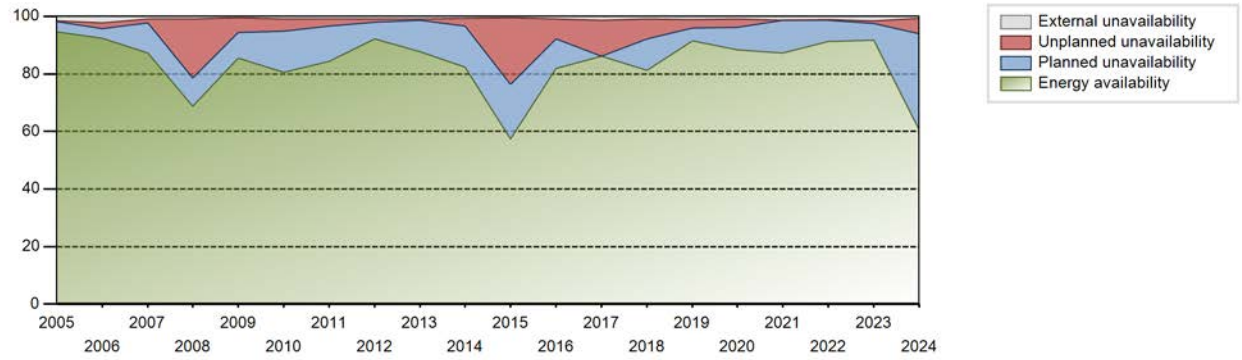


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	4155.51	4803	1068	95.52	95.52	86.55	96.82	4.15	4.14	0.35	0.00
1986	8069.60	7983	1060	88.36	88.36	86.90	91.13	3.39	3.11	8.54	0.00
1987	7038.90	7866	1063	77.86	77.86	75.59	89.79	2.25	1.79	20.35	0.00
1988	7462.87	7807	1068	80.40	80.40	79.55	88.88	4.38	3.69	15.91	0.00
1989	7367.20	7792	1118	85.77	85.77	75.16	88.95	0.79	0.68	13.55	0.00
1990	7942.08	8165	1150	80.07	91.32	78.84	93.21	1.97	1.84	6.84	11.26
1991	8665.07	8325	1155	85.61	87.47	85.64	95.03	0.00	0.00	12.53	1.86
1992	8176.17	7963	1197	81.18	89.45	77.76	90.65	0.50	0.45	10.10	8.27
1993	8457.86	8251	1158	83.40	93.17	83.38	94.19	1.43	1.35	5.48	9.77
1994	9228.82	8277	1158	90.92	93.42	90.98	94.49	0.65	0.61	5.97	2.50
1995	8930.86	8250	1158	88.19	92.77	88.04	94.18	1.84	1.74	5.49	4.58
1996	8819.19	8008	1158	86.71	89.09	86.70	91.17	1.42	1.29	9.63	2.38
1997	8955.24	8004	1158	89.94	89.94	88.04	91.12	1.20	1.09	8.97	0.00
1998	8960.71	8227	1158	93.75	93.92	88.33	93.92	0.50	0.48	5.60	0.17
1999	8825.52	8005	1155	90.95	91.14	87.08	91.38	1.57	1.46	7.41	0.18
2000	7933.87	8038	1155	87.71	94.92	78.07	91.51	0.69	0.66	4.43	7.21
2001	8182.42	7585	1155	81.77	86.23	80.87	86.59	0.06	0.05	13.71	4.46
2002	9079.36	8450	1158	91.22	94.96	89.50	96.46	1.85	1.79	3.24	3.74
2003	9100.31	8507	1155	89.93	89.93	89.94	97.11	0.02	1.50	8.57	0.00
2004	8973.49	7920	1185	87.68	89.39	87.69	90.16	0.42	0.38	10.23	1.71
2005	9868.82	8491	1190	94.57	96.23	94.73	96.93	0.08	0.08	3.68	1.66
2006	9600.51	8323	1170	92.39	94.61	92.23	95.01	2.12	2.05	3.34	2.22
2007	8992.59	7770	1170	87.26	88.24	87.74	88.70	0.11	1.19	10.57	0.98
2008	7109.80	6185	1170	68.84	69.71	69.18	70.41	2.42	20.59	9.70	0.86
2009	8815.50	7624	1170	85.49	86.01	86.01	87.03	5.03	5.11	8.88	0.52
2010	8320.23	7317	1170	80.61	81.44	81.18	83.53	5.16	4.43	14.13	0.83
2011	8691.28	7515	1170	84.34	85.36	84.80	85.79	2.71	2.37	12.27	1.01
2012	9520.47	8212	1170	92.14	93.00	92.64	93.49	1.32	1.25	5.75	0.86
2013	9021.75	7830	1170	87.63	88.60	88.02	89.38	0.53	0.47	10.94	0.96
2014	8471.77	7326	1170	82.30	83.08	82.66	83.63	2.08	2.59	14.33	0.78
2015	5662.11	5200	1167	57.40	57.84	55.39	59.36	3.65	23.22	18.94	0.44
2016	8439.79	7373	1167	81.89	82.79	82.33	83.94	7.71	6.92	10.29	0.89
2017	8842.13	7764	1167	86.18	87.48	86.49	88.63	12.48	12.47	0.05	1.29
2018	8357.50	7345	1159	81.28	82.12	82.08	83.85	7.86	7.01	10.87	0.84
2019	9465.61	8197	1172	91.53	92.65	92.20	93.57	2.68	3.02	4.33	1.12
2020	8864.05	7917	1172	88.29	89.12	86.10	90.13	3.36	3.10	7.78	0.83
2021	9022.92	7786	1172	87.17	88.52	87.89	88.88	0.07	0.06	11.42	1.35

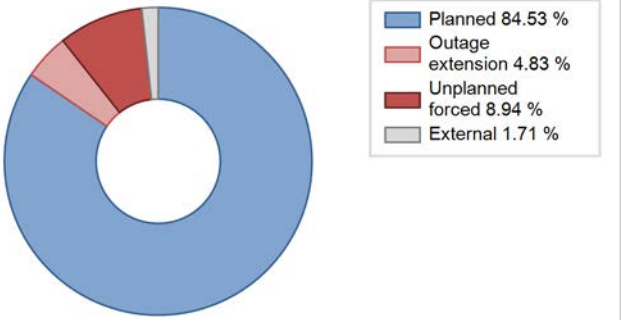
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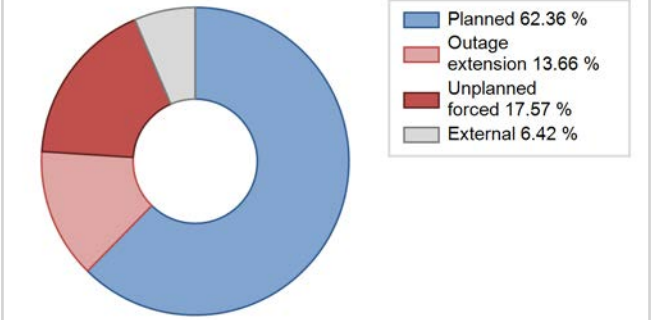
2022	9379.92	8153	1172	91.30	92.57	91.36	93.07	0.10	0.10	7.34	1.27
2023	9170.91	8223	1172	91.67	93.23	89.33	93.87	0.88	0.83	5.94	1.55
2024	6061.97	5454	1172	60.40	61.07	58.88	62.09	5.48	5.45	33.47	0.68

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		284			204	
B.	Refuelling without maintenance	128			3		
C.	Inspection, maintenance or repair combined with refuelling	2760			728		
D.	Inspection, maintenance or repair without refuelling				1		
E.	Testing of plant systems or components				3	2	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				7		
H.	Nuclear regulatory requirements					7	
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						5
L.	Human factor related					17	
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					2	
Z.	Other		168			5	1
Subtotal		2888	452		742	237	6
Total		**3340**			**985**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		50
12. Reactor I&C Systems		57
13. Reactor Auxiliary Systems		3
15. Reactor Cooling Systems		9
17. Safety I&C Systems (excluding reactor I&C)		5
31. Turbine and auxiliaries	168	23
32. Feedwater and Main Steam System	265	9
41. Main Generator Systems		53
42. Electrical Power Supply Systems	19	24
Total	**452**	**233**

Highlights (2024)

Normal production until outage which started 240901 except:
Fuel damage and leaking isolation valve March
One major accident with faulty operation by mainainance personell that caused automatic scram. Fault followed by valve problems that prolonged outage, June.
Planned long outage until 241018. Late september, damages on LP-turbine blades were discovered and that problem was not solved by 241231. (Today 250127, plan for start is 250131.)

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2024 Operating Experience

SE-12 OSKARSHAMN-3 SWEDEN



Status at end of year	:	**Operational**
Operator	:	OKG (OKG AKTIEBOLAG)
Owner	:	OKG (OKG AKTIEBOLAG)
Reactor Supplier	:	ABB ATOM (ABB ATOM (formerly ASEA-ATOM))
Turbine Supplier	:	STAL (STAL-LAVAL)

Reactor Unit Details

Reactor type and model	:	BWR / AA-IV, BWR-3000
Thermal power	:	3900 MWth
Gross electrical power	:	1450 MWe
Reference unit power (net)	:	1400 MWe

Key Dates

Construction Date	:	1980-05-01
Grid Date	:	1985-03-03
Commercial Date	:	1985-08-15
Age at end of year	:	39 years

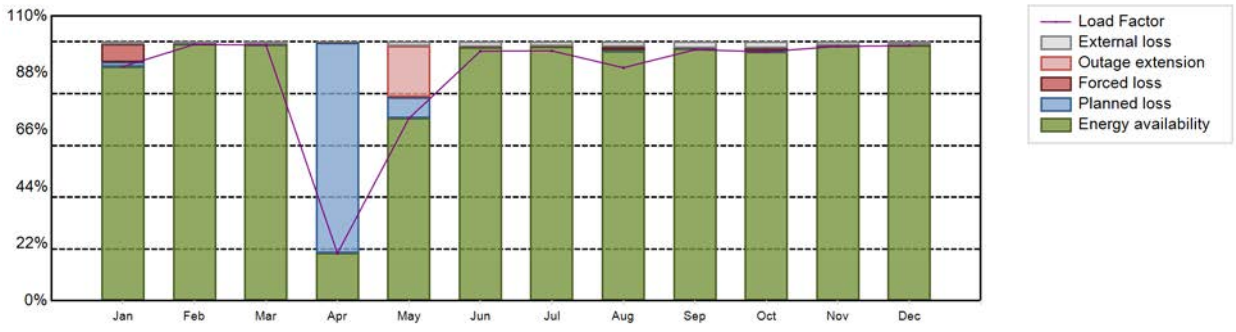
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	3
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	20
Average discharge burnup [MWd/t]	:	32000
Active core diameter [m]	:	4.6
Active core height/length [m]	:	3.68
Number of fissile fuel assemblies/bundles	:	700
Fuel linear heat generation rate [kW/m]	:	14.0
Number of control rod assemblies	:	169
Number of external reactor coolant loops	:	4
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7
Reactor outlet temperature [°C]	:	288
Number of SG	:	NA
Containment type	:	Single
Containment design pressure [MPa]	:	6
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.7
Output voltage [kV]	:	20.5
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	3
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	4
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	10767.64 GW(e).h
Energy Availability Factor (EAF)	:	88.37 %
Unit Capability Factor (UCF)	:	89.8 %
Load Factor (LF)	:	87.56 %
Operating Factor (OF)	:	91.45 %
Forced Loss Rate (FLR)	:	1.02 %
Unplanned Capability Loss Factor (UCL)	:	2.59 %
Planned Unavailability Factor (PUF)	:	7.61 %
Externally cause unavailability (XUF)	:	1.43 %
Total off-line time	:	751 hours

Annual Summary



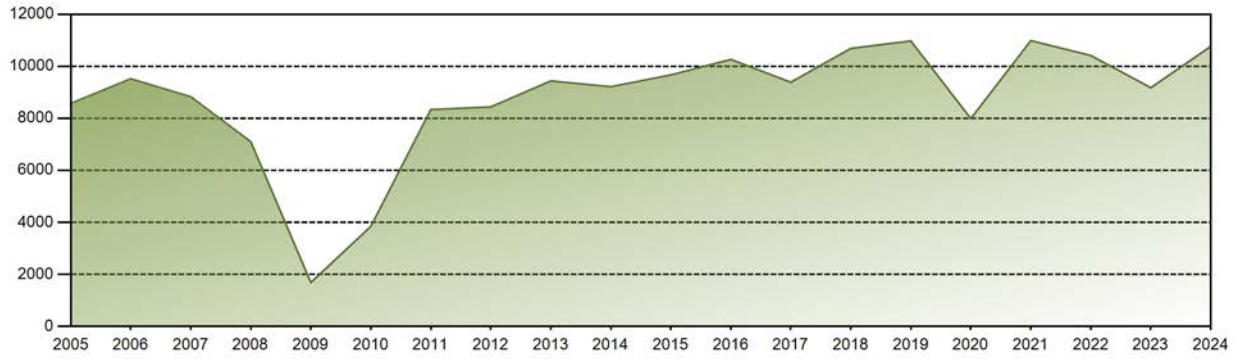
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	942.30	965.00	1027.68	185.08	734.08	972.00	1005.63	937.80	977.52	1003.42	990.56	1026.57	10767.64
EAF [%]	90.47	99.03	98.80	18.36	70.48	97.89	98.06	96.29	97.43	96.21	98.27	98.56	88.37
UCF [%]	91.26	99.73	99.69	18.60	72.16	99.78	99.80	98.17	99.70	98.49	99.75	99.78	89.80
LF [%]	90.47	99.03	98.80	18.36	70.48	96.43	96.55	90.03	96.98	96.21	98.27	98.56	87.56
OF [%]	100.00	100.00	100.00	19.31	77.15	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.45
FLR [%]	7.04	0.27	0.30	0.34	0.19	0.22	0.20	1.34	0.30	0.73	0.24	0.22	1.02
UCL [%]	6.91	0.27	0.30	0.06	19.78	0.22	0.20	1.33	0.30	0.73	0.24	0.22	2.59
PUF [%]	1.83	0.00	0.00	81.33	8.05	0.00	0.00	0.51	0.00	0.78	0.00	0.00	7.61
XUF [%]	0.79	0.69	0.90	0.24	1.69	1.89	1.74	1.88	2.26	2.29	1.48	1.22	1.43

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Historical Summary

Lifetime energy generation	:	336386.46 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.77 %
Cumulative Energy Availability Factor (EAF)	:	81.2 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.38 %
Cumulative Unit Capability Factor (UCF)	:	82.48 %	Cumulative Planned Unavailability Factor (PUF)	:	9.13 %
Cumulative Load Factor (LF)	:	78.66 %	Cumulative Externally cause unavailability (XUF)	:	1.28 %
Cumulative Operating Factor (OF)	:	85.2 %			

Electricity Production (net) [GWh]

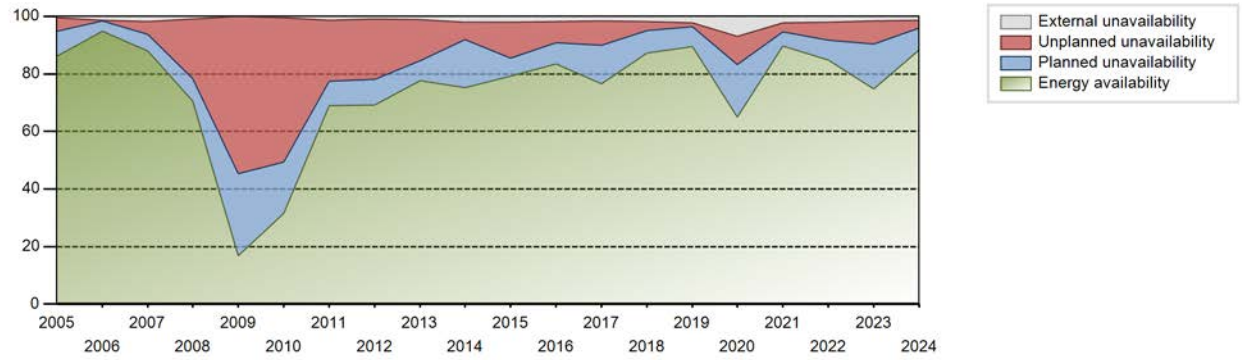


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	3848.48	4706	1055	92.98	92.98	79.25	93.38	7.02	7.02	0.00	0.00
1986	8386.93	8111	1060	91.91	91.91	90.39	92.59	2.32	2.18	5.91	0.00
1987	7057.96	7988	1065	89.40	89.64	75.65	91.19	4.29	4.02	6.34	0.24
1988	7311.93	7457	1060	83.60	83.89	78.44	84.89	9.70	9.01	7.11	0.29
1989	7788.21	8241	1035	92.77	93.12	84.38	94.08	0.86	0.81	6.07	0.36
1990	7640.22	7781	1060	83.25	84.13	83.16	88.82	4.65	4.10	11.76	0.88
1991	8935.78	8183	1160	90.92	91.57	87.94	93.41	1.13	1.05	7.38	0.65
1992	8270.64	7903	1160	89.45	90.08	81.17	89.97	0.06	0.06	9.86	0.63
1993	8339.49	8026	1160	90.86	91.71	82.07	91.62	1.83	1.71	6.58	0.85
1994	8480.44	7878	1160	88.39	89.09	83.46	89.93	0.75	0.67	10.24	0.70
1995	8828.15	7957	1160	87.55	89.79	86.88	90.83	2.60	2.39	7.82	2.24
1996	8518.40	7543	1153	84.55	85.14	84.10	85.86	1.62	1.40	13.46	0.59
1997	8970.42	8042	1155	89.79	90.95	88.65	91.79	0.50	0.45	8.59	1.16
1998	8032.25	7914	1155	88.68	89.33	79.39	90.34	2.89	2.66	8.01	0.65
1999	8516.73	7850	1155	88.91	89.72	84.17	89.60	0.34	0.30	9.98	0.81
2000	7219.13	8075	1155	91.20	91.20	71.16	91.93	4.10	3.90	4.91	0.00
2001	9051.96	8170	1155	91.80	92.56	89.47	93.26	2.74	2.61	4.83	0.76
2002	8883.98	8140	1155	92.24	92.24	87.80	92.91	2.05	1.93	5.82	0.00
2003	7678.01	6871	1155	76.19	77.96	75.89	78.44	16.30	15.52	6.52	1.77
2004	9318.51	8236	1149	92.44	93.04	92.32	93.75	1.12	1.05	5.90	0.61
2005	8573.43	7671	1149	86.17	86.72	85.18	87.57	5.08	4.65	8.64	0.55
2006	9522.49	8467	1149	94.94	96.29	94.60	96.64	0.18	0.29	3.42	1.36
2007	8829.23	7965	1150	87.82	89.56	87.63	90.91	4.57	4.50	5.94	1.75
2008	7100.89	6424	1152	70.43	71.36	70.23	73.13	3.22	20.73	7.91	0.93
2009	1684.68	1795	1152	16.76	16.82	16.70	20.49	5.39	54.69	28.48	0.06
2010	3841.75	4783	1400	31.57	31.96	31.33	54.60	48.60	50.26	17.78	0.39
2011	8337.26	7313	1400	69.08	70.41	67.98	83.48	16.29	21.24	8.35	1.33
2012	8438.86	6571	1400	69.15	70.08	68.62	74.81	17.19	21.04	8.88	0.93
2013	9439.44	7186	1400	77.59	78.85	76.97	82.03	14.89	14.07	7.08	1.26
2014	9215.46	7083	1400	75.14	77.29	75.14	80.86	3.78	5.98	16.73	2.15
2015	9668.25	7480	1400	79.13	81.16	78.83	85.39	13.23	12.48	6.37	2.03
2016	10265.41	7736	1400	83.47	85.27	83.47	88.07	6.41	7.33	7.40	1.80
2017	9387.81	6996	1400	76.55	78.20	76.55	79.86	5.30	8.37	13.44	1.65
2018	10688.89	7913	1400	87.32	89.26	87.16	90.33	2.79	3.00	7.75	1.93
2019	10976.04	8135	1400	89.50	91.78	89.50	92.87	0.77	1.35	6.86	2.29
2020	7988.94	6081	1400	64.97	71.99	64.97	69.24	4.23	9.78	18.23	7.02
2021	10989.44	8118	1400	89.63	91.83	89.62	92.68	0.25	3.17	5.01	2.20

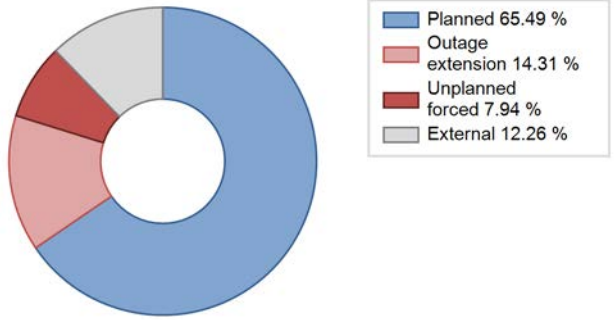
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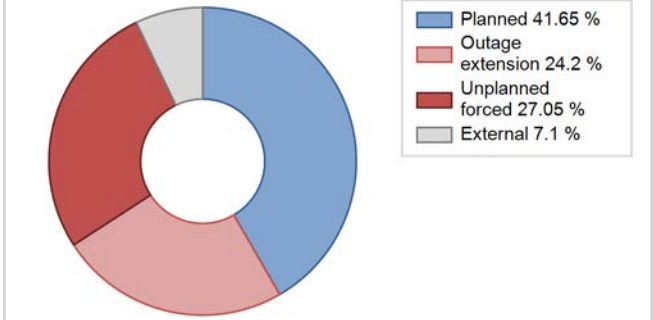
2022	10414.56	7785	1400	84.91	86.98	84.92	88.87	6.60	6.15	6.86	2.08
2023	9177.85	7089	1400	74.79	76.39	74.84	80.92	8.62	7.96	15.65	1.60
2024	10767.64	8033	1400	88.37	89.80	87.56	91.45	1.02	2.59	7.61	1.43

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		181			463	
C.	Inspection, maintenance or repair combined with refuelling	604			653	16	
D.	Inspection, maintenance or repair without refuelling				21	0	
E.	Testing of plant systems or components				1		
F.	Major backfitting, refurbishment or upgrading activities with refuelling				55		
H.	Nuclear regulatory requirements					30	
L.	Human factor related					18	
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					14	
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					2	
Z.	Other					16	12
Subtotal		604	181		730	559	12
Total		**785**			**1301**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		118
12. Reactor I&C Systems		9
13. Reactor Auxiliary Systems		13
14. Safety Systems		20
15. Reactor Cooling Systems	34	22
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		220
32. Feedwater and Main Steam System	147	73
33. Circulating Water System		2
34. Miscellaneous Systems		2
35. All other I&C Systems		0
41. Main Generator Systems		16
42. Electrical Power Supply Systems		8
Total	**181**	**504**

Highlights (2024)

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2024 Operating Experience

SE-7 RINGHALS-3 SWEDEN



Status at end of year	:	**Operational**
Operator	:	RAB (Ringhals AB)
Owner	:	RAB (Ringhals AB)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	STAL (STAL-LAVAL)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP
Thermal power	:	3135 MWth
Gross electrical power	:	1128 MWe
Reference unit power (net)	:	1081 MWe

Key Dates

Construction Date	:	1972-09-01
Grid Date	:	1980-09-07
Commercial Date	:	1981-09-09
Age at end of year	:	44 years

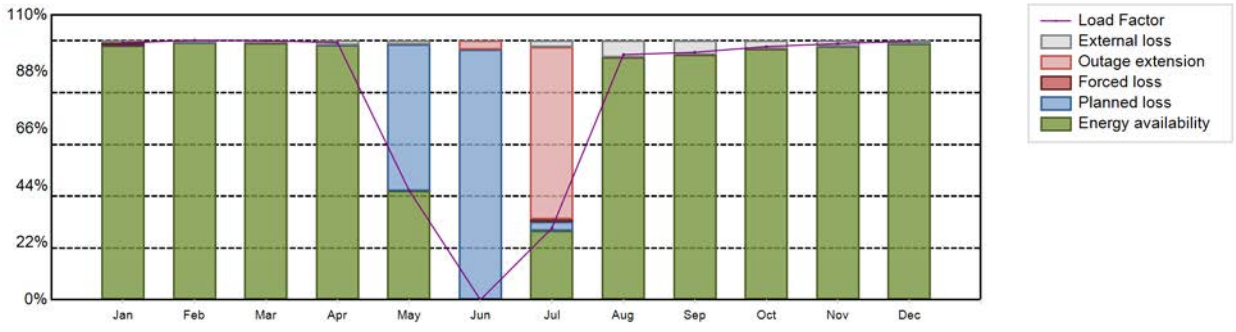
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.51
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	322
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.65
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	46000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.75
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7560.56 GW(e).h	Forced Loss Rate (FLR)	:	0.24 %
Energy Availability Factor (EAF)	:	78.75 %	Unplanned Capability Loss Factor (UCL)	:	6.13 %
Unit Capability Factor (UCF)	:	80.87 %	Planned Unavailability Factor (PUF)	:	13 %
Load Factor (LF)	:	79.62 %	Externally cause unavailability (XUF)	:	2.12 %
Operating Factor (OF)	:	81.48 %	Total off-line time	:	1627 hours

Annual Summary



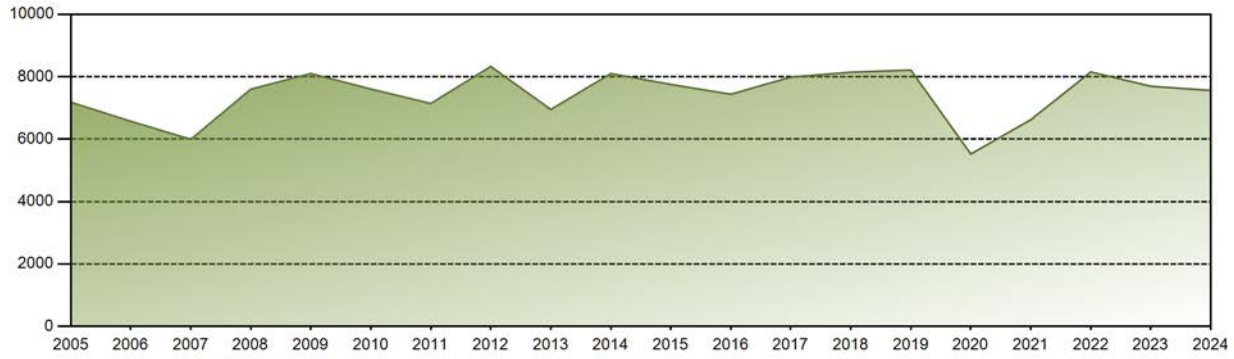
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	798.00	754.38	804.93	773.32	341.04	0.00	222.74	761.73	744.10	786.61	770.22	803.49	7560.56
EAF [%]	98.20	99.25	99.07	98.34	42.06	0.00	26.73	93.68	94.59	96.79	97.94	98.89	78.75
UCF [%]	98.77	99.98	99.98	99.96	43.51	0.00	28.98	99.92	99.98	99.89	99.98	99.99	80.87
LF [%]	99.22	100.27	100.08	99.36	42.40	0.00	27.70	94.71	95.60	97.80	98.96	99.90	79.62
OF [%]	100.00	100.00	100.00	100.00	45.16	0.00	32.93	100.00	100.00	100.00	100.00	100.00	81.48
FLR [%]	1.21	0.00	0.01	0.00	0.00	0.00	3.05	0.05	0.00	0.10	0.00	0.00	0.24
UCL [%]	1.21	0.00	0.01	0.00	0.00	3.47	67.62	0.05	0.00	0.10	0.00	0.00	6.13
PUF [%]	0.01	0.02	0.02	0.04	56.49	96.53	3.40	0.03	0.02	0.02	0.02	0.01	13.00
XUF [%]	0.57	0.73	0.91	1.62	1.46	0.00	2.25	6.25	5.39	3.10	2.04	1.10	2.12

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Historical Summary

Lifetime energy generation	:	288047.59 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.72 %
Cumulative Energy Availability Factor (EAF)	:	78.53 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.73 %
Cumulative Unit Capability Factor (UCF)	:	80.56 %	Cumulative Planned Unavailability Factor (PUF)	:	11.7 %
Cumulative Load Factor (LF)	:	77.14 %	Cumulative Externally cause unavailability (XUF)	:	2.04 %
Cumulative Operating Factor (OF)	:	84.37 %			

Electricity Production (net) [GWh]

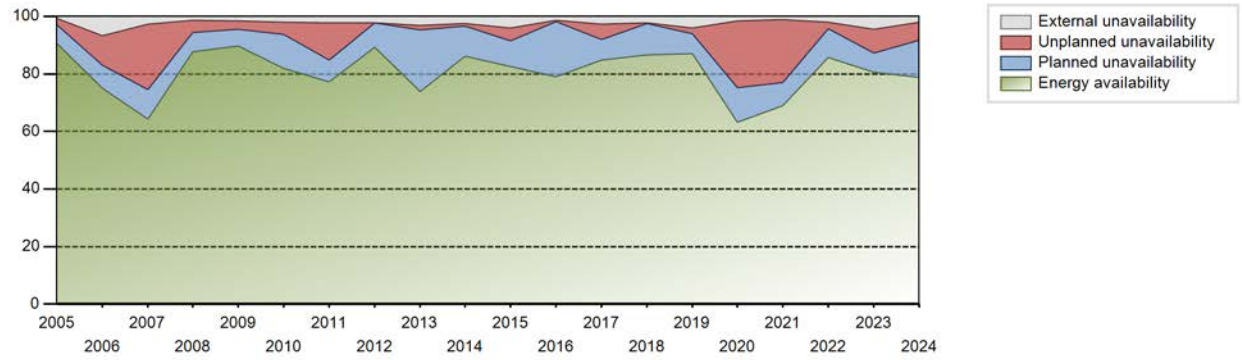


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	2859.20	4560	920	26.75	26.75	26.77	29.51	73.25	73.25	0.00	0.00
1982	1251.60	3680	915	15.62	15.62	15.61	42.01	73.78	43.95	40.43	0.00
1983	2909.90	5886	867	38.25	38.25	38.24	67.19	46.42	33.13	28.63	0.00
1984	5346.56	6450	915	72.44	72.44	66.52	73.43	15.69	13.48	14.07	0.00
1985	6090.25	7580	915	84.79	84.79	75.98	86.53	1.48	1.27	13.94	0.00
1986	6233.87	7026	915	78.79	78.79	77.77	80.21	2.40	1.94	19.28	0.00
1987	6169.21	7485	915	83.09	83.09	76.97	85.45	5.67	4.99	11.92	0.00
1988	6151.17	7645	915	77.14	77.14	76.53	87.03	8.53	7.19	15.67	0.00
1989	5829.68	7757	915	82.60	82.60	72.73	88.55	10.37	9.56	7.84	0.00
1990	5871.27	7855	915	74.05	74.18	73.25	89.67	18.98	17.38	8.44	0.13
1991	5923.60	8007	915	75.66	75.66	73.90	91.40	14.25	12.57	11.77	0.00
1992	5622.12	7941	915	82.27	82.33	69.95	90.40	3.55	3.03	14.64	0.06
1993	6685.76	7964	915	89.81	89.81	83.41	90.91	2.84	2.62	7.57	0.00
1994	6873.37	8097	918	86.13	86.13	85.47	92.43	0.58	0.50	13.37	0.00
1995	4873.56	6040	918	60.66	60.66	60.60	68.95	14.30	10.12	29.22	0.00
1996	6816.76	8166	910	87.31	92.49	85.28	92.96	0.60	0.56	6.95	5.18
1997	6581.42	8107	910	81.73	85.50	82.55	92.54	8.04	7.53	6.97	3.77
1998	6382.65	8008	915	81.30	90.17	79.63	91.42	2.57	2.38	7.45	8.87
1999	6975.98	7899	911	88.02	90.01	87.41	90.17	0.37	0.34	9.65	1.99
2000	6165.84	7966	911	89.53	92.26	77.05	90.69	0.69	0.65	7.09	2.73
2001	6285.26	7942	911	79.44	88.58	78.76	90.66	2.41	2.19	9.23	9.15
2002	6890.61	7930	915	88.77	90.83	85.97	90.53	0.85	0.78	8.39	2.06
2003	6714.60	7475	915	84.43	85.29	83.77	85.33	0.41	0.35	14.37	0.86
2004	7497.90	8295	915	93.86	93.98	93.29	94.43	1.65	1.58	4.44	0.11
2005	7181.56	8075	915	90.51	91.19	89.60	92.18	1.20	2.19	6.63	0.68
2006	6570.84	7249	1045	74.97	81.77	76.42	82.75	8.85	10.06	8.16	6.80
2007	5990.80	6565	1045	64.27	67.04	65.44	74.94	12.79	22.60	10.36	2.78
2008	7599.80	7980	985	87.79	89.22	87.84	90.85	3.48	4.26	6.52	1.43
2009	8102.89	8093	1044	89.73	91.37	89.85	92.39	2.34	2.81	5.82	1.64
2010	7605.45	7590	1051	81.87	84.02	82.61	86.64	1.60	4.14	11.84	2.16
2011	7141.61	7032	1057	77.21	79.48	77.13	80.27	12.93	12.98	7.54	2.28
2012	8327.82	8088	1064	89.17	91.41	89.59	92.08	0.10	0.12	8.47	2.24
2013	6949.96	6852	1064	73.84	76.99	74.57	78.22	1.74	1.59	21.41	3.15
2014	8099.92	7887	1062	86.23	88.68	86.97	90.03	1.09	0.98	10.35	2.44
2015	7753.27	7853	1063	82.47	86.55	83.26	89.65	2.73	4.47	8.98	4.08
2016	7437.54	7106	1065	78.91	80.36	79.64	80.90	0.16	0.44	19.20	1.45
2017	7988.55	8027	1065	84.88	87.54	85.63	91.63	5.76	5.35	7.11	2.66

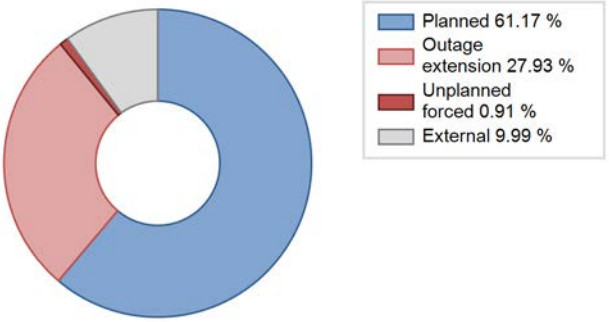
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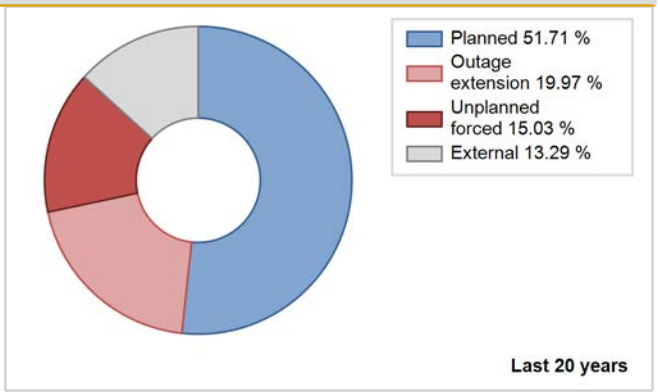
2018	8144.41	7821	1062	86.48	88.80	87.54	89.28	0.09	0.08	11.12	2.32
2019	8212.36	8107	1062	87.05	91.10	88.28	92.55	2.20	2.05	6.85	4.05
2020	5522.53	5452	1072	63.08	64.61	58.97	62.07	6.80	23.32	12.07	1.53
2021	6623.06	6214	1072	69.06	70.28	70.53	70.94	1.04	21.80	7.92	1.23
2022	8151.85	7780	1074	85.63	87.70	86.65	88.81	2.40	2.16	10.14	2.08
2023	7694.60	7503	1081	80.47	85.06	81.47	85.65	1.35	8.14	6.80	4.59
2024	7560.56	7157	1081	78.75	80.87	79.62	81.48	0.24	6.13	13.00	2.12

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		404			364	
C.	Inspection, maintenance or repair combined with refuelling	1103			761	14	
D.	Inspection, maintenance or repair without refuelling				175		
E.	Testing of plant systems or components		7		4	1	
J.	Grid limitation, failure or grid unavailability						2
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						12
L.	Human factor related		106			16	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z.	Other		8			12	
Subtotal		1103	525		940	407	15
Total		**1628**			**1362**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	114	29
12. Reactor I&C Systems	7	7
13. Reactor Auxiliary Systems	19	8
14. Safety Systems	105	55
15. Reactor Cooling Systems	137	45
16. Steam generation systems		105
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		29
31. Turbine and auxiliaries		32
32. Feedwater and Main Steam System	35	27
34. Miscellaneous Systems		1
35. All other I&C Systems		0
41. Main Generator Systems		14
42. Electrical Power Supply Systems		25
Total	**417**	**377**

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2024 Operating Experience

SE-10 RINGHALS-4 SWEDEN



Status at end of year	:	**Operational**
Operator	:	RAB (Ringhals AB)
Owner	:	RAB (Ringhals AB)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	STAL (STAL-LAVAL)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP
Thermal power	:	3300 MWth
Gross electrical power	:	1178 MWe
Reference unit power (net)	:	1130 MWe

Key Dates

Construction Date	:	1973-11-01
Grid Date	:	1982-06-23
Commercial Date	:	1983-11-21
Age at end of year	:	42 years

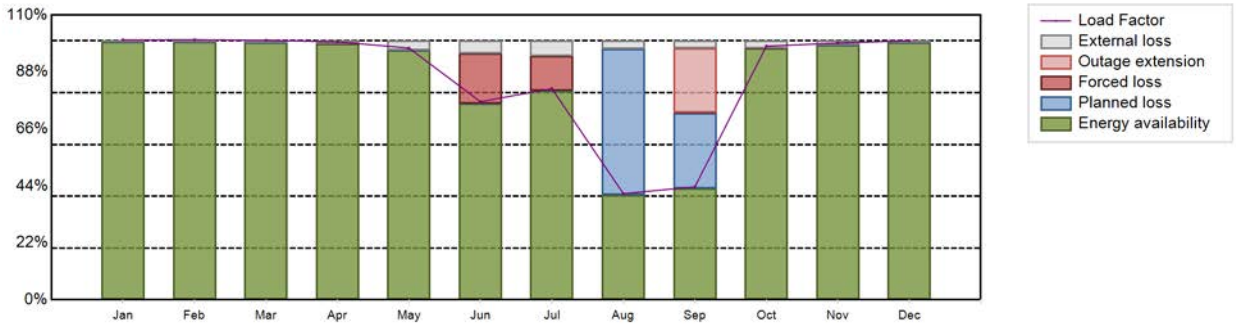
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.51
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	322
Fuel material	:	UO2	Number of SG	:	3
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	4.65
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	46000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.04	HP cylinder inlet steam pressure [MPa]	:	5.75
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	3	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8585.05 GW(e).h	Forced Loss Rate (FLR)	:	3.01 %
Energy Availability Factor (EAF)	:	85.76 %	Unplanned Capability Loss Factor (UCL)	:	4.77 %
Unit Capability Factor (UCF)	:	88.1 %	Planned Unavailability Factor (PUF)	:	7.13 %
Load Factor (LF)	:	86.49 %	Externally cause unavailability (XUF)	:	2.34 %
Operating Factor (OF)	:	91.31 %	Total off-line time	:	763 hours

Annual Summary



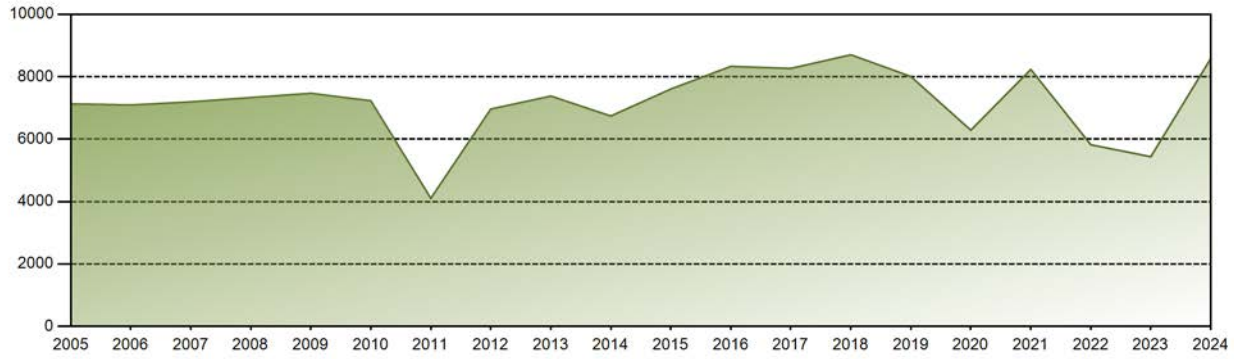
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	843.87	790.07	842.80	810.61	817.56	622.70	685.72	344.73	355.21	823.59	806.87	841.32	8585.05
EAF [%]	99.58	99.66	99.45	98.84	96.45	75.74	80.80	40.65	43.12	97.17	98.38	99.28	85.76
UCF [%]	99.98	99.98	99.97	99.98	99.99	80.62	86.71	43.89	46.03	99.96	99.99	99.99	88.10
LF [%]	100.37	100.46	100.25	99.63	97.25	76.54	81.56	41.00	43.66	97.96	99.17	100.07	86.49
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	45.56	50.28	100.00	100.00	100.00	91.31
FLR [%]	0.00	0.00	0.00	0.00	0.00	19.37	13.28	0.00	0.57	0.02	0.00	0.00	3.01
UCL [%]	0.00	0.00	0.00	0.00	0.00	19.37	13.28	0.00	25.12	0.02	0.00	0.00	4.77
PUF [%]	0.02	0.02	0.03	0.01	0.01	0.01	0.01	56.11	28.84	0.01	0.01	0.01	7.13
XUF [%]	0.41	0.32	0.52	1.15	3.54	4.88	5.91	3.24	2.91	2.80	1.61	0.71	2.34

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Historical Summary

Lifetime energy generation	:	278117.26 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.67 %
Cumulative Energy Availability Factor (EAF)	:	81.63 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.64 %
Cumulative Unit Capability Factor (UCF)	:	83.88 %	Cumulative Planned Unavailability Factor (PUF)	:	10.47 %
Cumulative Load Factor (LF)	:	79.14 %	Cumulative Externally cause unavailability (XUF)	:	2.26 %
Cumulative Operating Factor (OF)	:	85.96 %			

Electricity Production (net) [GWh]

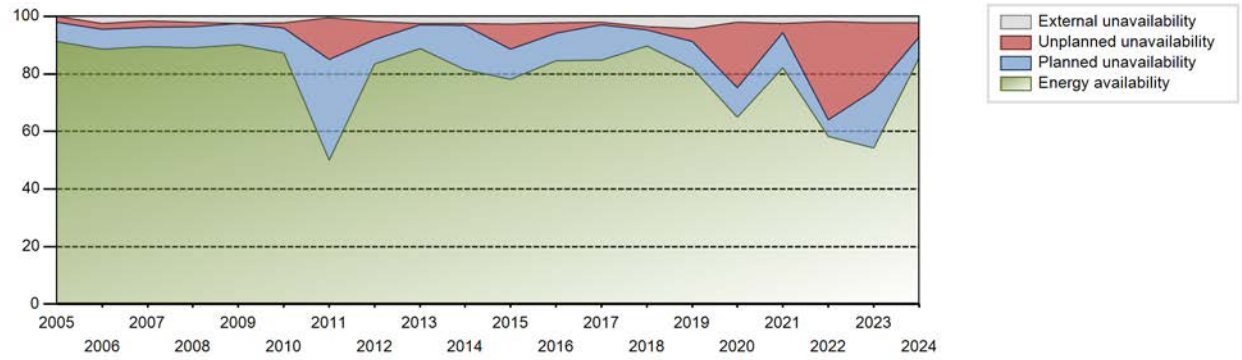


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	2653.10	4122	915	56.37	56.37	56.38	74.60	24.02	17.82	25.81	0.00
1984	5987.71	7517	915	82.17	82.26	74.50	85.58	9.40	8.53	9.21	0.09
1985	5923.72	7755	915	87.92	87.92	73.90	88.53	1.75	1.56	10.51	0.00
1986	5619.26	6839	915	70.67	70.67	70.11	78.07	9.98	7.83	21.50	0.00
1987	5665.94	7827	915	88.21	88.21	70.69	89.35	1.44	1.29	10.50	0.00
1988	6641.73	7945	915	83.43	83.43	82.64	90.45	0.68	0.57	16.00	0.00
1989	5536.82	7624	915	85.79	85.79	69.08	87.03	6.32	5.79	8.42	0.00
1990	6467.30	8080	915	89.11	89.11	80.69	92.24	0.88	0.79	10.10	0.00
1991	6916.15	8041	915	85.85	85.85	86.29	91.79	0.64	0.55	13.59	0.00
1992	6432.41	8156	915	90.03	90.09	80.03	92.85	1.18	1.08	8.83	0.06
1993	6342.34	7906	915	88.75	88.75	79.13	90.25	2.67	2.44	8.81	0.00
1994	6234.70	7476	914	84.84	84.84	77.87	85.34	7.04	6.43	8.74	0.00
1995	6251.70	7684	912	80.60	88.39	78.25	87.72	4.14	3.81	7.79	7.79
1996	6426.77	8067	912	79.62	91.83	80.22	91.84	0.63	0.58	7.58	12.21
1997	6372.26	7665	912	78.83	87.03	79.75	87.49	1.27	2.53	10.44	8.20
1998	6809.80	8146	915	86.52	92.52	84.96	92.99	0.71	0.66	6.82	6.00
1999	6986.83	8042	907	88.63	91.73	87.94	91.80	1.42	1.33	6.94	3.11
2000	4060.71	5898	907	63.43	66.52	50.97	67.14	25.24	22.46	11.01	3.10
2001	6623.98	7758	909	86.51	88.38	83.19	88.56	3.12	2.85	8.77	1.88
2002	5942.20	7056	915	75.53	80.25	74.13	80.55	5.38	4.57	15.19	4.72
2003	6996.51	7843	915	88.86	89.19	87.29	89.53	0.68	3.47	7.34	0.33
2004	7209.61	8092	915	92.10	92.10	89.70	92.12	1.15	1.45	6.45	0.00
2005	7129.78	8073	915	91.36	91.46	88.95	92.16	0.30	1.97	6.57	0.11
2006	7092.37	8054	907	88.68	91.15	89.26	91.94	1.55	2.13	6.72	2.48
2007	7192.87	8126	907	89.43	91.03	90.53	92.76	1.45	2.26	6.71	1.60
2008	7331.95	8046	935	88.97	91.12	89.27	91.60	0.87	1.43	7.46	2.15
2009	7467.66	8165	936	90.24	92.81	91.08	93.21	0.00	0.00	7.19	2.57
2010	7229.47	7948	935	87.33	89.57	88.27	90.73	0.96	1.84	8.59	2.23
2011	4102.44	4678	945	50.12	50.68	49.56	53.40	4.24	14.34	34.98	0.57
2012	6963.03	7541	940	83.57	85.49	83.96	85.85	0.95	6.20	8.30	1.92
2013	7379.26	8054	940	88.85	91.38	89.61	91.94	0.33	0.47	8.15	2.53
2014	6740.44	7396	938	81.47	83.99	81.93	84.43	0.80	0.68	15.33	2.52
2015	7604.79	7215	1115	78.03	80.73	78.92	82.36	9.62	8.63	10.63	2.70
2016	8331.54	7862	1106	84.63	86.92	84.92	89.50	3.98	3.60	9.48	2.28
2017	8265.10	7664	1106	84.84	86.88	85.31	87.49	1.02	0.89	12.22	2.04
2018	8702.45	8273	1102	89.78	93.43	90.08	94.44	1.07	1.01	5.56	3.65
2019	8008.02	7627	1117	81.90	86.23	82.67	87.07	0.36	4.31	9.46	4.33

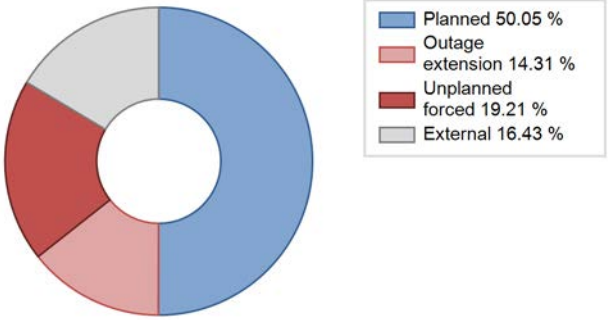
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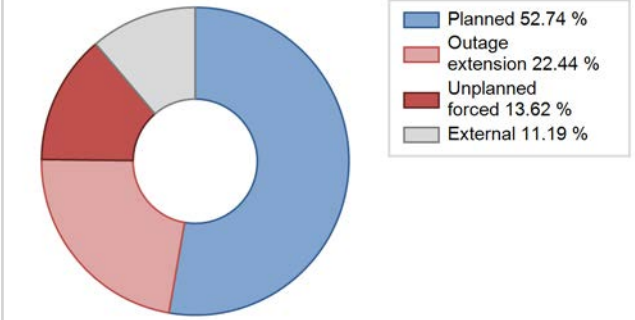
2020	6285.45	6739	1130	64.86	66.92	63.32	76.72	23.55	22.69	10.39	2.06
2021	8234.53	7649	1130	82.12	84.58	83.19	87.32	2.71	3.14	12.28	2.45
2022	5819.96	5318	1130	58.19	59.97	58.79	60.71	0.00	34.20	5.83	1.78
2023	5436.26	5196	1130	54.24	56.54	54.92	59.32	4.79	23.30	20.16	2.30
2024	8585.05	8021	1130	85.76	88.10	86.49	91.31	3.01	4.77	7.13	2.34

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1983 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		67			337	1
C. Inspection, maintenance or repair combined with refuelling	584			837	1	
D. Inspection, maintenance or repair without refuelling				146		
E. Testing of plant systems or components				28	13	
H. Nuclear regulatory requirements					2	
J. Grid limitation, failure or grid unavailability						0
L. Human factor related		112			19	
Z. Other				1	11	
Subtotal	584	179		1012	383	1
Total		**763**			**1396**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	20	73
12. Reactor I&C Systems		4
13. Reactor Auxiliary Systems		14
14. Safety Systems		17
15. Reactor Cooling Systems	39	175
16. Steam generation systems	10	28
21. Fuel Handling and Storage Facilities	6	1
31. Turbine and auxiliaries		8
32. Feedwater and Main Steam System		24
41. Main Generator Systems		2
42. Electrical Power Supply Systems	6	0
Total	**81**	**346**

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2024 Operating Experience

CH-1 BEZNAU-1 SWITZERLAND



Status at end of year	:	**Operational**
Operator	:	Axpo AG (Kernkraftwerk Beznau
Owner	:	Axpo AG (Kernkraftwerk Beznau
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	BBC (BROWN BOVERI ET CIE)

Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP
Thermal power	:	1130 MWth
Gross electrical power	:	380 MWe
Reference unit power (net)	:	365 MWe

Key Dates

Construction Date	:	1965-09-01
Grid Date	:	1969-07-17
Commercial Date	:	1969-12-09
Age at end of year	:	55 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2/MOX
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.68
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	17
Average discharge burnup [MWd/t]	:	42000
Active core diameter [m]	:	2.45
Active core height/length [m]	:	3.05
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	16.7
Number of control rod assemblies	:	17
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

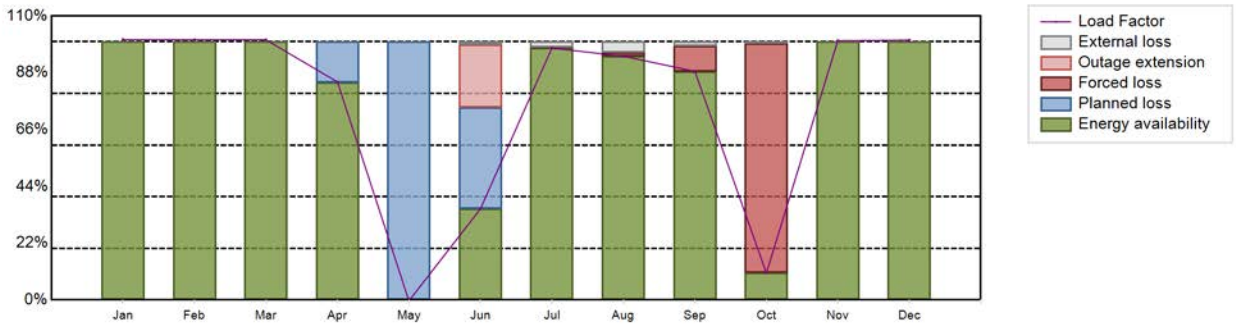
Operating coolant pressure [MPa]	:	15.3
Reactor outlet temperature [°C]	:	313
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	0.31
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	5.3
Output voltage [kV]	:	15
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	2
Number of FW pumps for full power operation	:	1
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	2436.4 GW(e).h
Energy Availability Factor (EAF)	:	75.72 %
Unit Capability Factor (UCF)	:	76.53 %
Load Factor (LF)	:	75.99 %
Operating Factor (OF)	:	76.76 %
Equivalent non-electrical energy generated (NEG)	:	40.95 GW(e).h

Forced Loss Rate (FLR)	:	10 %
Unplanned Capability Loss Factor (UCL)	:	10.48 %
Planned Unavailability Factor (PUF)	:	12.99 %
Externally cause unavailability (XUF)	:	0.81 %
Total off-line time	:	2041 hours

Annual Summary



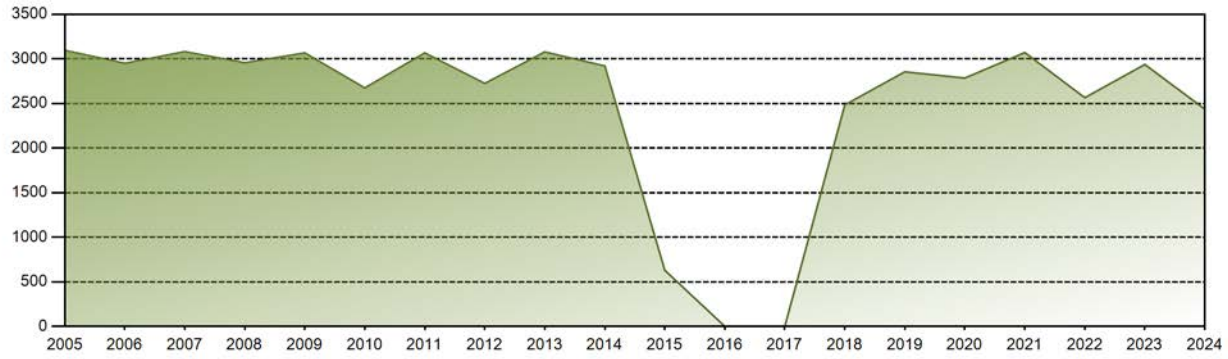
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	273.87	256.05	273.18	221.91	-0.89	92.68	264.94	256.36	232.71	28.38	263.90	273.32	2436.40
EAF [%]	100.00	100.00	100.00	84.28	0.00	35.27	97.56	94.40	88.55	10.44	100.00	100.00	75.72
UCF [%]	100.00	100.00	100.00	84.28	0.00	36.43	99.79	98.40	90.23	11.00	100.00	100.00	76.53
LF [%]	100.85	100.79	100.73	84.44	-0.33	35.27	97.56	94.40	88.55	10.44	100.42	100.65	75.99
OF [%]	100.00	100.00	100.00	84.72	0.00	37.64	100.00	98.79	90.42	11.41	100.00	100.00	76.76
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.21	1.60	9.77	89.00	0.00	0.00	10.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	24.17	0.21	1.60	9.77	89.00	0.00	0.00	10.48
PUF [%]	0.00	0.00	0.00	15.72	100.00	39.40	0.00	0.00	0.00	0.00	0.00	0.00	12.99
XUF [%]	0.00	0.00	0.00	0.00	0.00	1.17	2.23	4.00	1.68	0.56	0.00	0.00	0.81

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Historical Summary

Lifetime energy generation	:	138528.97 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.78 %
Cumulative Energy Availability Factor (EAF)	:	80.74 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.41 %
Cumulative Unit Capability Factor (UCF)	:	81.07 %	Cumulative Planned Unavailability Factor (PUF)	:	11.52 %
Cumulative Load Factor (LF)	:	80.36 %	Cumulative Externally cause unavailability (XUF)	:	0.33 %
Cumulative Operating Factor (OF)	:	82.29 %			

Electricity Production (net) [GWh]

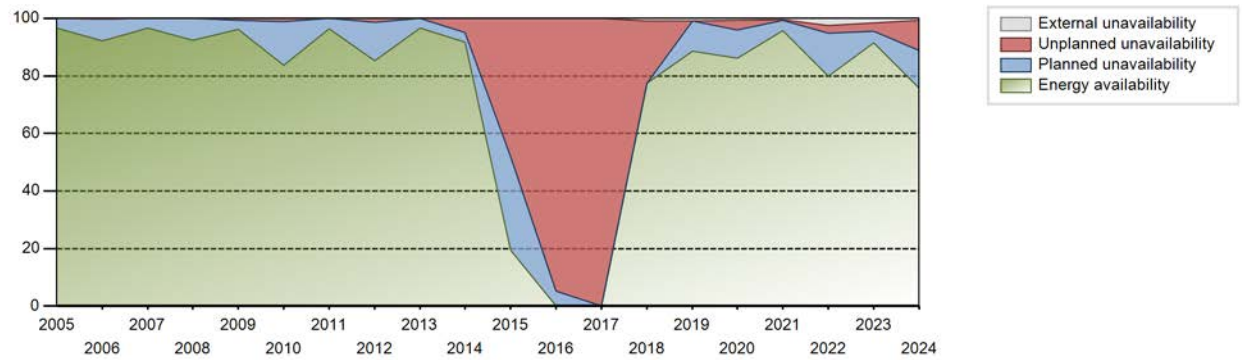


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1969	Data not provided										
1970	1947.00	5917	364	61.05	61.05	61.06	67.55	0.00	0.00	38.95	0.00
1971	1700.50	5123	364	58.99	58.99	53.33	58.48	27.48	22.35	18.66	0.00
1972	1402.90	5391	280	61.32	61.32	57.04	61.37	38.68	38.68	0.00	0.00
1973	1655.00	6654	350	71.57	71.57	53.98	75.96	8.53	6.67	21.76	0.00
1974	2346.70	7177	350	78.10	78.10	76.54	81.93	2.77	2.22	19.67	0.00
1975	2490.90	7490	350	81.22	81.22	81.24	85.50	5.62	4.83	13.95	0.00
1976	2548.10	7530	350	83.46	83.46	82.88	85.72	0.65	0.55	15.99	0.00
1977	2596.30	7592	350	85.21	85.21	84.68	86.67	2.68	2.34	12.44	0.00
1978	2761.90	8031	350	89.46	89.46	90.08	91.68	0.13	0.12	10.42	0.00
1979	2658.80	7746	350	86.11	86.11	86.72	88.42	0.01	0.01	13.88	0.00
1980	2650.50	7682	350	85.69	85.69	86.21	87.45	4.56	4.09	10.21	0.00
1981	2569.70	7486	350	83.46	83.46	83.81	85.46	5.43	4.79	11.74	0.00
1982	2566.90	7553	350	83.52	83.52	83.72	86.22	3.14	2.71	13.77	0.00
1983	2551.70	7546	350	83.49	83.49	83.23	86.14	0.64	0.54	15.97	0.00
1984	2732.94	8001	350	88.85	88.85	88.89	91.09	0.29	0.26	10.89	0.00
1985	2634.26	7906	350	86.01	86.01	85.92	90.25	4.17	3.74	10.25	0.00
1986	2496.27	7403	350	81.60	81.60	81.42	84.51	9.03	8.10	10.30	0.00
1987	2486.26	7256	350	80.71	80.71	81.09	82.83	1.90	1.56	17.73	0.00
1988	2566.55	7499	350	82.97	82.97	83.48	85.37	1.56	1.32	15.72	0.00
1989	2433.15	7062	350	78.65	78.65	79.36	80.62	7.30	6.19	15.16	0.00
1990	2562.48	7506	350	84.38	84.38	83.58	85.68	0.41	0.34	15.28	0.00
1991	2495.26	7430	350	83.48	83.48	81.38	84.82	1.61	1.36	15.16	0.00
1992	2477.39	7303	350	81.70	81.70	80.58	83.14	0.71	0.58	17.71	0.00
1993	2158.43	6241	350	69.37	69.88	70.40	71.24	1.02	0.72	29.39	0.52
1994	2686.88	7610	350	85.05	86.19	87.63	86.87	0.35	0.30	13.51	1.13
1995	2850.46	7993	350	90.15	90.48	92.97	91.24	0.32	0.29	9.23	0.33
1996	2753.18	7704	353	86.81	87.45	88.60	87.70	0.35	0.31	12.24	0.64
1997	2708.21	7731	365	85.12	87.46	84.70	88.25	0.18	0.16	12.38	2.35
1998	3183.13	8760	365	99.84	99.89	99.55	100.00	0.06	0.06	0.05	0.06
1999	2841.27	8074	365	88.60	91.33	88.86	92.17	0.15	0.13	8.54	2.72
2000	2539.20	7113	365	78.30	79.22	79.20	80.98	0.46	0.36	20.41	0.92
2001	3090.18	8504	365	96.76	96.76	96.65	97.08	0.00	0.00	3.24	0.00
2002	2908.78	8000	365	91.03	91.26	90.97	91.32	0.03	0.89	7.85	0.23
2003	3061.76	8494	365	96.18	96.92	95.76	96.96	0.00	0.00	3.08	0.74
2004	2801.17	7758	365	87.44	87.53	87.36	88.31	0.37	1.15	11.32	0.09
2005	3095.96	8491	365	96.64	96.67	96.82	96.92	0.01	0.01	3.32	0.03

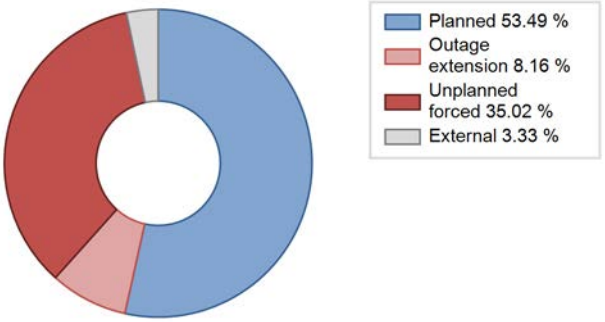
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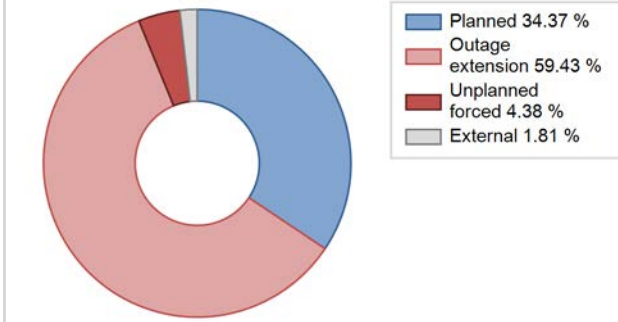
2006	2950.68	8114	365	92.19	92.35	92.28	92.63	0.01	0.01	7.65	0.15
2007	3081.34	8486	365	96.67	96.70	96.37	96.87	0.00	0.00	3.30	0.03
2008	2956.58	8143	365	92.45	92.45	92.22	92.70	0.11	0.10	7.44	0.00
2009	3067.33	8460	365	96.27	96.30	95.93	96.58	0.57	0.68	3.02	0.03
2010	2673.99	7347	365	83.66	83.66	83.63	83.87	0.04	1.13	15.21	0.00
2011	3067.13	8458	365	96.42	96.42	95.93	96.55	0.00	0.02	3.56	0.00
2012	2724.73	7508	365	85.26	85.26	84.98	85.47	0.02	1.32	13.42	0.00
2013	3078.45	8473	365	96.59	96.59	96.28	96.72	0.00	0.00	3.41	0.00
2014	2920.61	8047	365	91.64	91.64	91.34	91.86	4.87	4.88	3.48	0.00
2015	628.54	1715	365	19.56	19.56	19.66	19.58	0.00	47.99	32.46	0.00
2016	0.00	0	365	0.00	0.00	0.00	0.00	0.00	94.81	5.19	0.00
2017	0.00	0	365	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
2018	2483.69	6897	365	77.34	78.25	77.68	78.73	0.42	21.75	0.00	0.91
2019	2854.84	7851	365	88.65	89.60	89.29	89.62	0.00	0.00	10.40	0.95
2020	2784.66	7661	365	86.25	87.02	86.85	87.22	3.61	3.26	9.71	0.78
2021	3071.24	8449	365	95.64	96.21	96.05	96.45	0.09	0.08	3.71	0.57
2022	2564.59	7244	365	79.92	82.35	80.21	82.69	0.21	2.68	14.97	2.43
2023	2937.08	8377	365	91.52	93.14	91.86	95.63	2.40	2.81	4.05	1.62
2024	2436.40	6743	365	75.72	76.53	75.99	76.76	10.00	10.48	12.99	0.81

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1969 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		906			205	
B. Refuelling without maintenance				44		
C. Inspection, maintenance or repair combined with refuelling	1129			789		
D. Inspection, maintenance or repair without refuelling				12		
E. Testing of plant systems or components					0	
F. Major backfitting, refurbishment or upgrading activities with refuelling				61		
H. Nuclear regulatory requirements					429	
L. Human factor related					0	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
Z. Other		6			0	
Subtotal	1129	912		906	634	2
Total	**2041**			**1542**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1969 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	168	449
12. Reactor I&C Systems		66
13. Reactor Auxiliary Systems		9
14. Safety Systems		3
15. Reactor Cooling Systems		12
16. Steam generation systems	9	65
21. Fuel Handling and Storage Facilities		0
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System	729	23
35. All other I&C Systems		0
41. Main Generator Systems	6	0
42. Electrical Power Supply Systems		5
Total	**912**	**634**

Highlights (2024)

unplanned shutdown for repair of 220 kV cable and inspektion feedwatertanks

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2024 Operating Experience

CH-3 BEZNAU-2 SWITZERLAND

Status at end of year	:	**Operational**
Operator	:	Axpo AG (Kernkraftwerk Beznau
Owner	:	Axpo AG (Kernkraftwerk Beznau
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	BBC (BROWN BOVERI ET CIE)



Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP
Thermal power	:	1130 MWth
Gross electrical power	:	380 MWe
Reference unit power (net)	:	365 MWe

Key Dates

Construction Date	:	1968-01-01
Grid Date	:	1971-10-23
Commercial Date	:	1972-03-04
Age at end of year	:	53 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	4.68
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	17
Average discharge burnup [MWd/t]	:	42000
Active core diameter [m]	:	2.45
Active core height/length [m]	:	3.05
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	16.7
Number of control rod assemblies	:	25
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

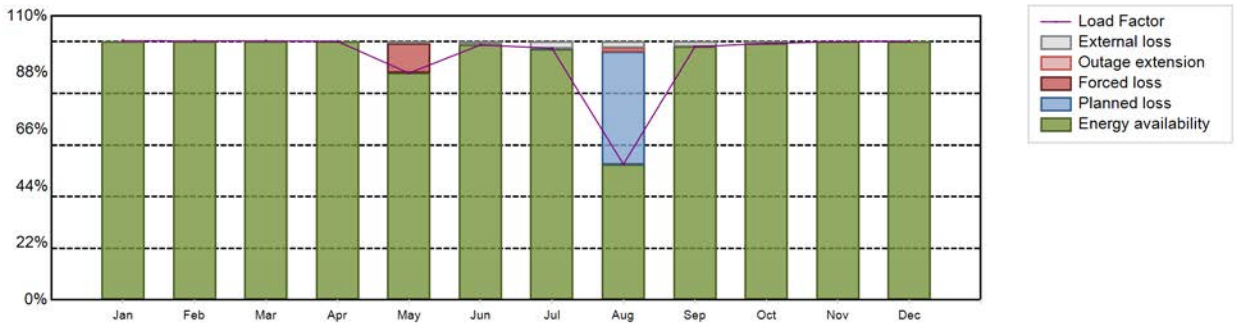
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	313
Number of SG	:	2
Containment type	:	Double
Containment design pressure [MPa]	:	0.31
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	5.3
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	2
Number of FW pumps for full power operation	:	1
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	3031.42 GW(e).h
Energy Availability Factor (EAF)	:	94.4 %
Unit Capability Factor (UCF)	:	95.17 %
Load Factor (LF)	:	94.55 %
Operating Factor (OF)	:	96.31 %
Equivalent non-electrical energy generated (NEG)	:	9.93 GW(e).h

Forced Loss Rate (FLR)	:	1.02 %
Unplanned Capability Loss Factor (UCL)	:	1.1 %
Planned Unavailability Factor (PUF)	:	3.72 %
Externally cause unavailability (XUF)	:	0.77 %
Total off-line time	:	324 hours

Annual Summary



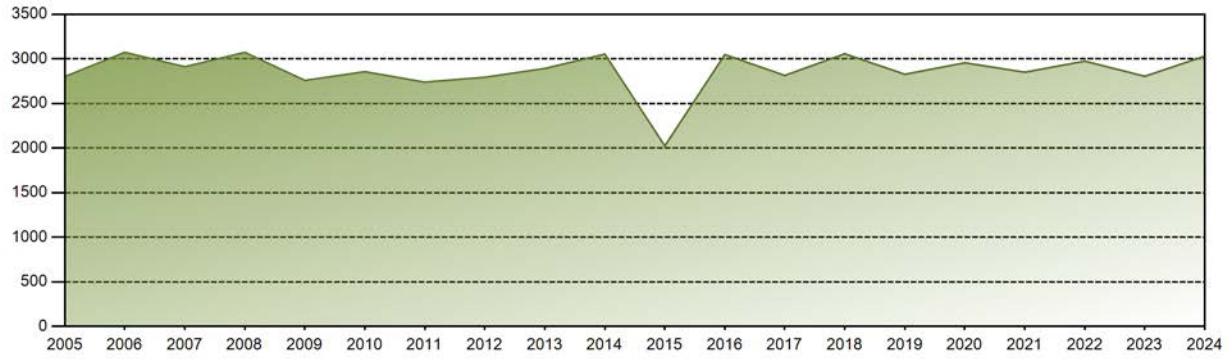
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	272.66	254.88	272.14	263.21	238.56	259.56	264.73	142.69	257.74	270.17	262.94	272.14	3031.42
EAF [%]	100.00	100.00	100.00	100.00	87.85	98.77	97.21	52.54	98.08	99.35	100.00	100.00	94.40
UCF [%]	100.00	100.00	100.00	100.00	88.44	100.00	99.73	54.86	100.00	100.00	100.00	100.00	95.17
LF [%]	100.40	100.33	100.35	100.16	87.85	98.77	97.48	52.54	98.08	99.35	100.05	100.21	94.55
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	56.45	100.00	100.00	100.00	100.00	96.31
FLR [%]	0.00	0.00	0.00	0.00	11.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02
UCL [%]	0.00	0.00	0.00	0.00	11.56	0.00	0.00	1.48	0.00	0.00	0.00	0.00	1.10
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.27	43.66	0.00	0.00	0.00	0.00	3.72
XUF [%]	0.00	0.00	0.00	0.00	0.59	1.23	2.52	2.32	1.92	0.65	0.00	0.00	0.77

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Historical Summary

Lifetime energy generation	:	146241.88 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.11 %
Cumulative Energy Availability Factor (EAF)	:	87.73 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.14 %
Cumulative Unit Capability Factor (UCF)	:	87.98 %	Cumulative Planned Unavailability Factor (PUF)	:	10.88 %
Cumulative Load Factor (LF)	:	87.96 %	Cumulative Externally cause unavailability (XUF)	:	0.26 %
Cumulative Operating Factor (OF)	:	89 %			

Electricity Production (net) [GWh]

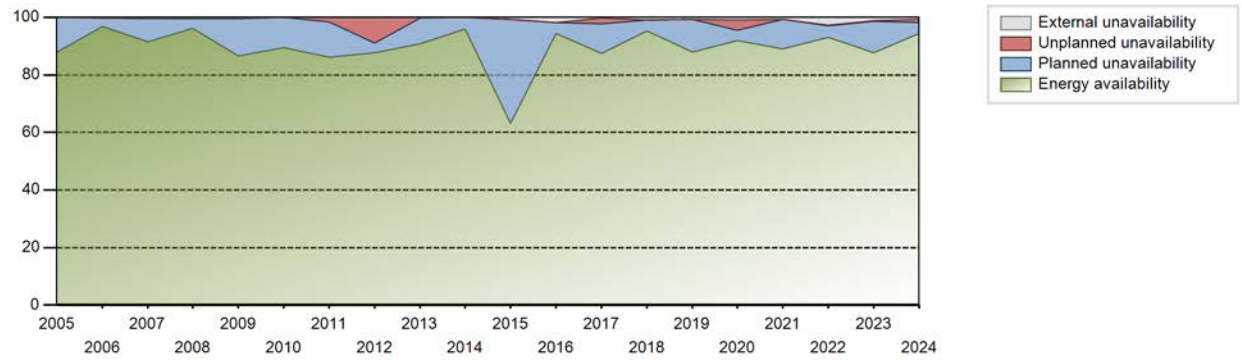


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1972	2618.50	7624	364	83.06	83.06	82.10	84.20	9.60	8.82	8.12	0.00
1973	2220.70	7042	350	78.45	78.45	72.43	80.39	1.91	1.53	20.02	0.00
1974	2527.80	7607	350	83.53	83.53	82.45	86.84	0.65	0.55	15.92	0.00
1975	2547.00	7503	350	83.05	83.05	83.07	85.65	3.98	3.45	13.50	0.00
1976	2652.20	7777	350	86.62	86.62	86.27	88.54	0.29	0.25	13.13	0.00
1977	2690.90	7758	350	85.55	85.55	87.77	88.56	0.67	0.58	13.87	0.00
1978	2753.10	7888	350	86.69	86.69	89.79	90.05	3.14	2.81	10.49	0.00
1979	2700.00	7835	350	86.70	86.70	88.06	89.44	2.84	2.54	10.77	0.00
1980	2559.00	7279	350	81.05	81.05	83.24	82.87	6.13	5.29	13.66	0.00
1981	2768.80	7868	350	88.77	88.77	90.31	89.82	0.13	0.11	11.12	0.00
1982	2722.10	7811	350	87.58	87.58	88.78	89.17	0.25	0.22	12.20	0.00
1983	2790.50	7977	350	89.60	89.60	91.01	91.06	0.70	0.63	9.77	0.00
1984	2724.21	7874	350	87.54	87.54	88.61	89.64	0.19	0.17	12.29	0.00
1985	2629.06	7647	350	84.95	84.95	85.75	87.29	2.99	2.62	12.44	0.00
1986	2769.81	7983	350	90.18	90.18	90.34	91.13	0.06	0.05	9.76	0.00
1987	2527.62	7535	350	82.38	82.38	82.44	86.02	2.34	1.98	15.64	0.00
1988	2630.19	7604	350	84.53	84.53	85.55	86.57	0.57	0.49	14.98	0.00
1989	2643.34	7614	350	85.11	85.11	86.21	86.92	0.65	0.55	14.34	0.00
1990	2636.07	7568	350	85.25	85.25	85.98	86.39	0.23	0.20	14.55	0.00
1991	2619.53	7551	350	84.48	84.48	85.44	86.20	0.37	0.31	15.21	0.00
1992	2375.90	6836	350	76.26	76.26	77.28	77.82	0.19	0.15	23.60	0.00
1993	2650.93	7517	350	84.86	85.09	86.46	85.81	0.25	0.21	14.70	0.23
1994	3062.80	8710	350	98.78	98.94	99.90	99.43	1.01	1.01	0.05	0.16
1995	2560.94	7247	350	82.58	82.72	83.53	82.73	0.41	0.34	16.94	0.14
1996	2754.10	7912	351	87.91	88.51	89.13	90.07	0.80	0.71	10.78	0.60
1997	3090.24	8732	357	99.54	99.54	98.81	99.68	0.18	0.18	0.28	0.01
1998	2717.82	7755	357	87.26	87.76	86.91	88.53	0.44	0.38	11.85	0.50
1999	2217.19	6322	357	70.28	70.68	70.90	72.17	3.67	2.69	26.62	0.41
2000	3071.03	8499	365	96.20	96.20	95.79	96.76	0.00	0.00	3.80	0.00
2001	2568.68	7107	365	80.67	80.68	80.34	81.13	0.33	0.27	19.05	0.01
2002	3012.01	8292	365	94.62	94.63	94.20	94.66	0.26	1.98	3.39	0.00
2003	2920.29	8070	365	91.85	92.05	91.33	92.12	0.79	0.74	7.21	0.20
2004	3099.37	8556	365	97.02	97.02	96.66	97.39	0.00	0.00	2.98	0.00
2005	2801.02	7728	365	87.84	87.95	87.60	88.22	0.01	0.01	12.03	0.11
2006	3073.23	8517	365	96.80	97.06	96.12	97.23	0.00	0.00	2.94	0.26
2007	2911.65	8063	365	91.46	91.48	91.06	92.04	0.15	0.41	8.11	0.02
2008	3073.36	8505	365	96.25	96.25	95.86	96.82	0.52	0.51	3.25	0.00

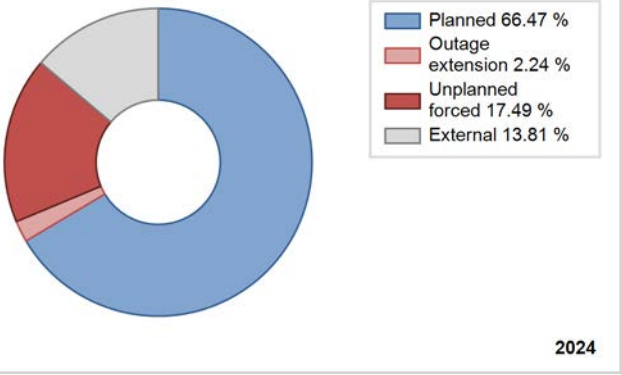
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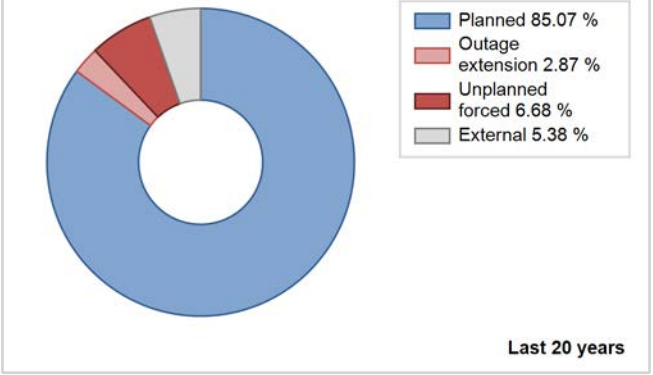
2009	2758.47	7615	365	86.56	86.67	86.27	86.93	0.52	0.45	12.88	0.10
2010	2856.53	7865	365	89.59	89.59	89.34	89.78	0.00	0.00	10.41	0.00
2011	2739.21	7564	365	86.11	86.11	85.67	86.35	0.00	1.68	12.21	0.00
2012	2793.97	7715	365	87.65	87.65	87.14	87.83	6.98	9.01	3.33	0.00
2013	2892.03	7968	365	90.82	90.82	90.45	90.96	0.00	0.18	9.00	0.00
2014	3053.52	8433	365	95.99	95.99	95.50	96.27	0.13	0.13	3.89	0.00
2015	2023.36	5611	365	63.18	63.87	63.28	64.05	0.00	0.00	36.13	0.68
2016	3048.37	8474	365	94.49	96.27	95.08	96.47	0.00	0.13	3.60	1.78
2017	2813.62	7735	365	87.42	87.75	88.00	88.30	1.18	1.94	10.31	0.33
2018	3057.41	8445	365	95.26	96.28	95.62	96.40	0.00	0.00	3.72	1.02
2019	2827.27	7790	365	88.01	88.73	88.42	88.93	0.06	0.05	11.22	0.72
2020	2956.04	8175	365	91.92	92.83	92.20	93.07	3.52	3.54	3.63	0.91
2021	2850.23	7871	365	89.08	89.69	89.14	89.85	0.00	0.00	10.31	0.61
2022	2974.93	8406	365	93.02	95.78	93.04	95.96	0.21	0.21	4.02	2.75
2023	2804.42	7819	365	87.65	88.69	87.71	89.26	0.31	0.34	10.97	1.04
2024	3031.42	8460	365	94.40	95.17	94.55	96.31	1.02	1.10	3.72	0.77

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1972 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		11			88	
B. Refuelling without maintenance	313			63		
C. Inspection, maintenance or repair combined with refuelling				734		
D. Inspection, maintenance or repair without refuelling				27		
F. Major backfitting, refurbishment or upgrading activities with refuelling				60		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L. Human factor related					1	
Subtotal	313	11		884	89	0
Total	**324**			**973**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1972 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	11	5
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		1
14. Safety Systems		1
15. Reactor Cooling Systems		21
16. Steam generation systems		18
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		3
33. Circulating Water System		3
34. Miscellaneous Systems		8
35. All other I&C Systems		1
42. Electrical Power Supply Systems		9
Total	**11**	**88**

Highlights (2024)

Shutdown of Turbogroup 22 for maintenance works on feedwater tank.

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2024 Operating Experience

CH-4 GOESGEN SWITZERLAND

Status at end of year	:	**Operational**
Operator	:	KKG (KERNKRAFTWERK GÖSGEN-DÄNIKEN AG)
Owner	:	KKG (KERNKRAFTWERK GÖSGEN-DÄNIKEN AG)
Reactor Supplier	:	KWU (KRAFTWERK UNION, AG)
Turbine Supplier	:	KWU (KRAFTWERK UNION, AG)

Reactor Unit Details

Reactor type and model	:	PWR / PWR 3 Loop
Thermal power	:	3002 MWth
Gross electrical power	:	1060 MWe
Reference unit power (net)	:	1010 MWe

Key Dates

Construction Date	:	1973-12-01
Grid Date	:	1979-02-02
Commercial Date	:	1979-11-01
Age at end of year	:	45 years

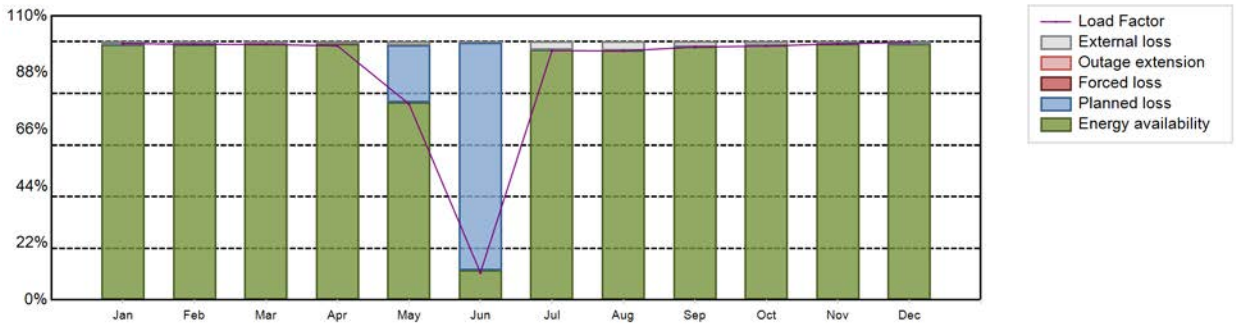
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	25
Average discharge burnup [MWd/t]	:	52000
Active core diameter [m]	:	3.24
Active core height/length [m]	:	3.58
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	22.6
Number of control rod assemblies	:	36
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.3
Reactor outlet temperature [°C]	:	324.5
Number of SG	:	3
Containment type	:	Double
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.65
Output voltage [kV]	:	27
Primary means of condenser cooling	:	Cooling towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	6
Non-electrical applications	:	PH

Annual Production Results (2024)

Net Energy Production	:	7922.08 GW(e).h
Energy Availability Factor (EAF)	:	89.43 %
Unit Capability Factor (UCF)	:	90.85 %
Load Factor (LF)	:	89.29 %
Operating Factor (OF)	:	91.17 %
Equivalent non-electrical energy generated (NEG)	:	21.44 GW(e).h
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	9.15 %
Externally cause unavailability (XUF)	:	1.42 %
Total off-line time	:	776 hours

Annual Summary



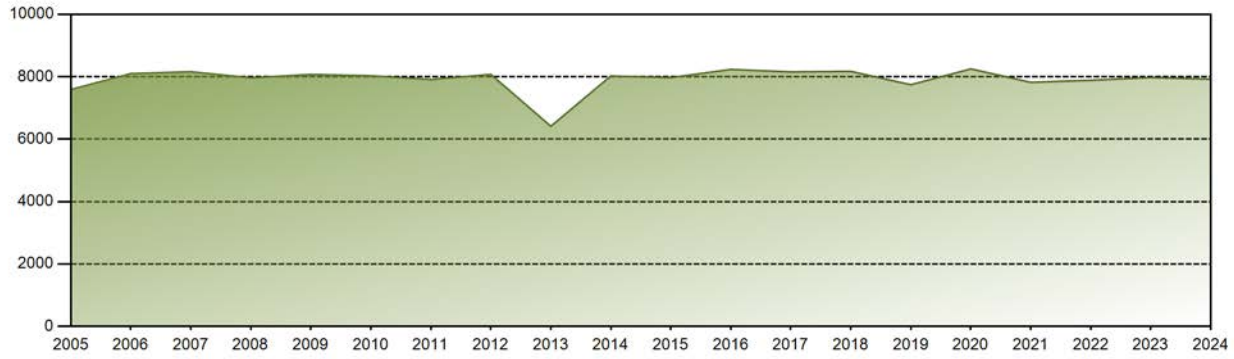
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	746.24	696.11	742.62	715.57	570.57	76.88	725.50	725.07	712.15	739.75	721.64	749.98	7922.08
EAF [%]	98.89	98.90	99.00	99.01	76.42	11.45	96.86	96.72	98.11	98.56	99.08	99.21	89.43
UCF [%]	99.96	99.98	99.98	99.95	77.70	11.81	99.87	99.98	99.98	99.98	99.97	99.98	90.85
LF [%]	99.31	99.03	98.96	98.40	75.93	10.57	96.55	96.49	97.93	98.31	99.24	99.81	89.29
OF [%]	100.00	100.00	100.00	100.00	77.96	15.00	100.00	100.00	100.00	100.00	100.00	100.00	91.17
FLR [%]	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.04	0.02	0.02	0.00	22.30	88.19	0.13	0.02	0.02	0.02	0.03	0.02	9.15
XUF [%]	1.06	1.07	0.97	0.94	1.28	0.36	3.01	3.27	1.87	1.42	0.90	0.77	1.42

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Historical Summary

Lifetime energy generation	:	337134.2 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.02 %
Cumulative Energy Availability Factor (EAF)	:	89.04 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.92 %
Cumulative Unit Capability Factor (UCF)	:	89.89 %	Cumulative Planned Unavailability Factor (PUF)	:	9.19 %
Cumulative Load Factor (LF)	:	89.36 %	Cumulative Externally cause unavailability (XUF)	:	0.85 %
Cumulative Operating Factor (OF)	:	90.74 %			

Electricity Production (net) [GWh]

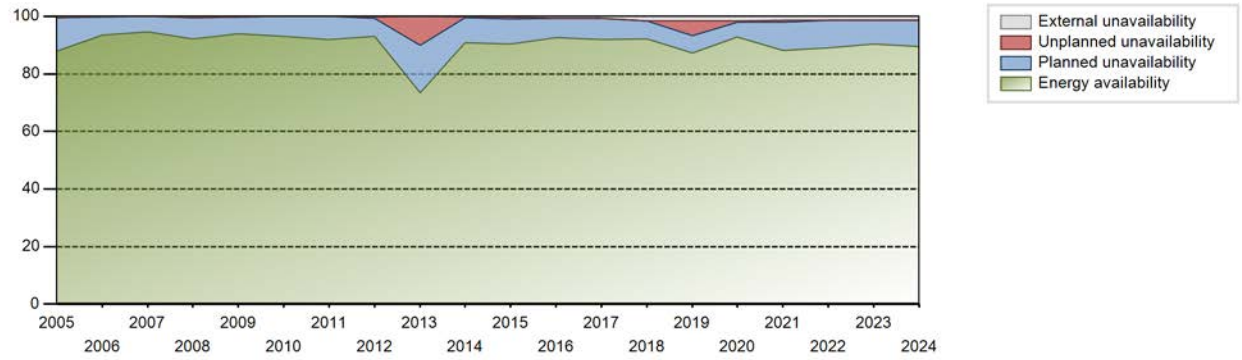


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1979	3398.70	4724	924	93.20	93.20	93.22	97.13	6.80	6.80	0.00	0.00
1980	5935.70	6819	920	73.47	73.47	73.45	77.63	9.11	7.37	19.16	0.00
1981	6527.60	7523	920	80.66	80.66	81.00	85.88	0.87	0.71	18.64	0.00
1982	6436.10	7665	920	79.81	79.81	79.86	87.50	5.99	5.08	15.10	0.00
1983	6891.60	7790	920	86.17	86.17	85.51	88.93	2.77	2.46	11.38	0.00
1984	7134.78	8015	900	89.85	90.60	90.25	91.25	0.54	0.50	8.91	0.75
1985	6747.72	7789	909	84.62	85.68	84.74	88.92	3.31	2.93	11.39	1.06
1986	6754.54	7386	941	82.76	84.14	81.94	84.32	0.03	0.02	15.83	1.38
1987	6910.34	7521	935	84.39	85.18	84.37	85.86	0.19	0.16	14.66	0.79
1988	6858.97	7476	936	83.36	84.71	83.42	85.11	0.11	0.09	15.20	1.35
1989	6878.68	7514	931	84.31	85.40	84.34	85.78	0.02	0.02	14.58	1.08
1990	7131.49	7983	929	87.61	89.42	87.63	91.13	0.04	0.03	10.55	1.81
1991	7141.94	7918	925	88.08	89.68	88.14	90.39	0.32	0.29	10.02	1.61
1992	7406.91	8107	934	90.16	92.11	90.23	92.29	0.04	0.03	7.85	1.95
1993	7408.12	8075	950	88.93	89.26	89.02	92.18	0.00	0.00	10.74	0.34
1994	7661.09	8102	947	91.07	92.13	92.35	92.49	0.00	0.00	7.87	1.06
1995	7820.85	8109	971	91.07	91.77	91.95	92.57	0.00	0.00	8.23	0.70
1996	7928.35	8204	986	91.54	93.40	91.54	93.40	0.00	0.00	6.60	1.86
1997	7967.77	8189	986	91.55	93.48	92.25	93.48	0.00	0.00	6.52	1.93
1998	7839.73	8179	986	90.77	93.18	90.77	93.37	0.00	0.00	6.82	2.42
1999	7533.93	7887	970	88.75	89.93	88.66	90.03	1.27	1.16	8.91	1.18
2000	7804.26	8089	970	91.66	92.02	91.59	92.09	0.43	0.40	7.58	0.36
2001	7870.47	8206	970	92.64	93.50	92.61	93.67	0.36	0.34	6.15	0.86
2002	7853.30	8154	970	92.34	92.89	92.42	93.08	1.55	1.46	5.64	0.56
2003	7988.68	8291	970	93.88	94.46	94.02	94.65	0.01	0.01	5.53	0.58
2004	8015.60	8300	970	93.79	94.31	94.07	94.49	0.24	0.23	5.46	0.52
2005	7588.23	7754	970	87.99	88.38	89.30	88.52	0.14	0.12	11.50	0.39
2006	8099.10	8230	970	93.59	93.74	95.31	93.95	0.10	0.10	6.17	0.15
2007	8158.91	8313	970	94.64	94.77	96.02	94.90	0.00	0.00	5.23	0.13
2008	7964.01	8148	970	92.19	92.63	93.47	92.76	0.00	0.00	7.37	0.44
2009	8072.42	8267	970	93.96	94.18	95.00	94.37	0.01	0.01	5.81	0.23
2010	8029.09	8220	970	93.11	93.21	94.49	93.84	0.01	0.00	6.78	0.10
2011	7910.31	8122	970	91.95	92.02	93.09	92.72	0.00	0.00	7.98	0.07
2012	8073.93	8281	985	93.12	93.35	93.32	94.27	0.51	0.48	6.17	0.23
2013	6410.20	6491	985	73.39	73.43	74.29	74.10	12.09	10.09	16.47	0.04
2014	8021.58	8029	1010	90.80	91.11	91.79	91.66	0.13	0.12	8.77	0.31
2015	7971.20	7980	1010	90.34	90.65	90.09	91.10	0.69	0.63	8.72	0.31

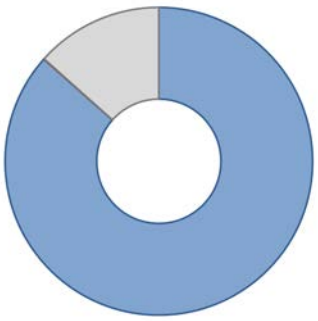
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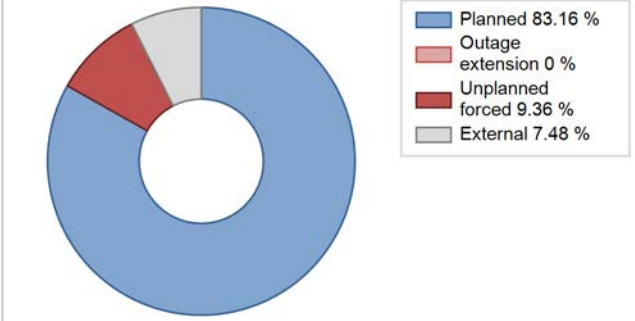
2016	8233.25	8232	1010	92.63	93.32	92.80	93.72	0.07	0.06	6.61	0.69
2017	8154.30	8148	1010	92.01	92.66	92.16	93.01	0.00	0.00	7.33	0.65
2018	8172.01	8244	1010	92.14	93.77	92.36	94.11	0.00	0.00	6.23	1.63
2019	7743.07	7835	1010	87.36	89.00	87.52	89.44	5.34	5.02	5.97	1.64
2020	8249.56	8360	1010	92.94	94.52	92.99	95.17	0.40	0.38	5.10	1.58
2021	7819.83	7900	1010	88.25	89.59	88.38	90.18	0.85	0.77	9.64	1.34
2022	7886.66	7968	1010	89.15	90.56	89.14	90.96	0.00	0.00	9.44	1.41
2023	7973.07	8058	1010	90.28	91.61	90.11	91.98	0.06	0.05	8.34	1.34
2024	7922.08	8008	1010	89.43	90.85	89.29	91.17	0.00	0.00	9.15	1.42

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1979 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					54	
C. Inspection, maintenance or repair combined with refuelling	777			757		
D. Inspection, maintenance or repair without refuelling				0		
E. Testing of plant systems or components				0	0	
J. Grid limitation, failure or grid unavailability						0
L. Human factor related					0	
Subtotal	777			757	54	0
Total	**777**			**811**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1979 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		0
15. Reactor Cooling Systems		0
16. Steam generation systems		1
31. Turbine and auxiliaries		3
32. Feedwater and Main Steam System		16
41. Main Generator Systems		22
42. Electrical Power Supply Systems		8
Total		**53**

Highlights (2024)

11.04.2024: Power reduction to 88 % due to a incorrectly inserted control rod.

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2024 Operating Experience

CH-5 LEIBSTADT SWITZERLAND



Status at end of year	:	**Operational**
Operator	:	KKL (KERNKRAFTWERK LEIBSTADT)
Owner	:	KKL (KERNKRAFTWERK LEIBSTADT)
Reactor Supplier	:	GETSCO (GENERAL ELECTRIC TECHNICAL SERVICES CO.)
Turbine Supplier	:	BBC (BROWN BOVERI ET CIE)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-6
Thermal power	:	3600 MWth
Gross electrical power	:	1285 MWe
Reference unit power (net)	:	1233 MWe

Key Dates

Construction Date	:	1974-01-01
Grid Date	:	1984-05-24
Commercial Date	:	1984-12-15
Age at end of year	:	40 years

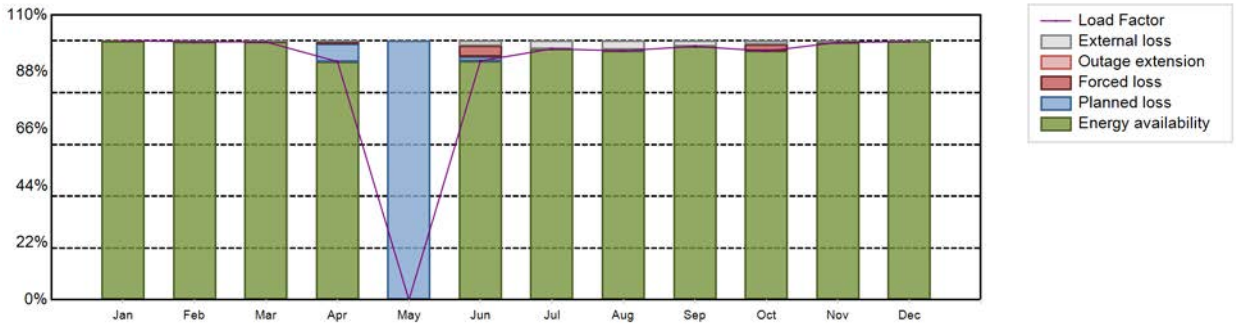
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.31
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	286
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	18	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	43000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.38	HP cylinder inlet steam pressure [MPa]	:	6.76
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	648	Primary means of condenser cooling	:	Cooling towers
Fuel linear heat generation rate [kW/m]	:	13.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	211	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9643.02 GW(e).h	Forced Loss Rate (FLR)	:	0.71 %
Energy Availability Factor (EAF)	:	89.01 %	Unplanned Capability Loss Factor (UCL)	:	0.64 %
Unit Capability Factor (UCF)	:	90.16 %	Planned Unavailability Factor (PUF)	:	9.2 %
Load Factor (LF)	:	89.03 %	Externally cause unavailability (XUF)	:	1.14 %
Operating Factor (OF)	:	91.07 %	Total off-line time	:	784 hours

Annual Summary



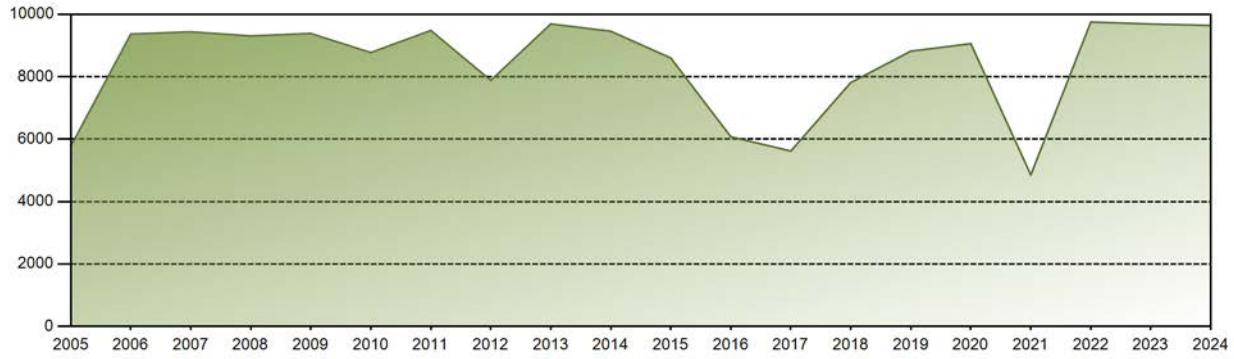
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	918.23	855.34	912.51	817.00	0.00	819.25	889.09	882.30	869.28	882.31	882.73	915.00	9643.02
EAF [%]	99.86	99.67	99.61	92.03	0.00	92.28	96.92	96.18	97.92	96.05	99.43	99.74	89.01
UCF [%]	99.86	99.81	99.95	92.52	0.00	94.24	100.00	99.58	100.00	97.40	100.00	100.00	90.16
LF [%]	100.10	99.67	99.61	92.03	0.00	92.28	96.92	96.18	97.92	96.05	99.43	99.74	89.03
OF [%]	100.00	100.00	100.00	95.00	1.61	97.78	100.00	100.00	100.00	100.00	100.00	100.00	91.07
FLR [%]	0.14	0.00	0.05	0.61	0.00	4.19	0.00	0.24	0.00	2.60	0.00	0.00	0.71
UCL [%]	0.14	0.00	0.05	0.57	0.00	4.13	0.00	0.24	0.00	2.60	0.00	0.00	0.64
PUF [%]	0.00	0.19	0.00	6.91	100.00	1.63	0.00	0.18	0.00	0.00	0.00	0.00	9.20
XUF [%]	0.00	0.14	0.35	0.49	0.00	1.96	3.08	3.40	2.08	1.35	0.57	0.26	1.14

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Historical Summary

Lifetime energy generation	:	327407.43 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.19 %
Cumulative Energy Availability Factor (EAF)	:	82.59 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.05 %
Cumulative Unit Capability Factor (UCF)	:	84.17 %	Cumulative Planned Unavailability Factor (PUF)	:	12.78 %
Cumulative Load Factor (LF)	:	82.74 %	Cumulative Externally cause unavailability (XUF)	:	1.57 %
Cumulative Operating Factor (OF)	:	86.19 %			

Electricity Production (net) [GWh]

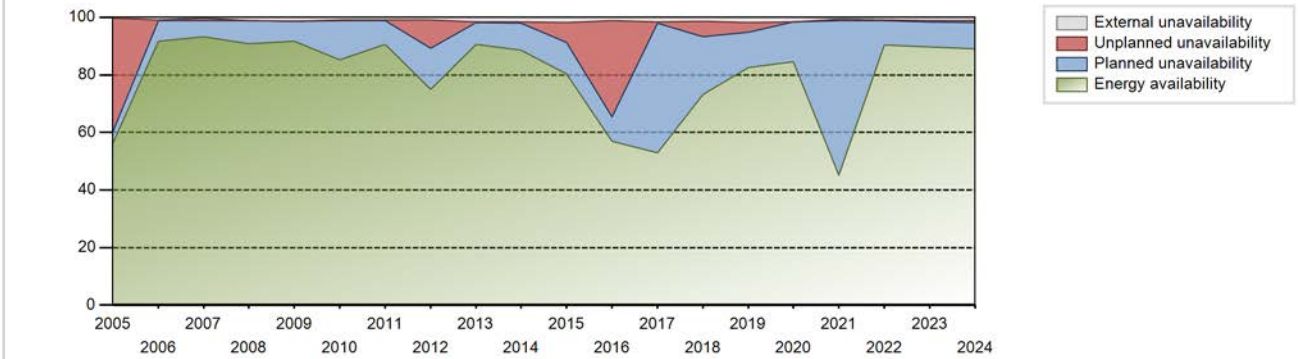


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	2.21	3361	1030	100.00	100.00	0.09	100.00	0.00	0.00	0.00	0.00
1985	6769.30	7233	951	80.12	80.12	81.24	82.57	1.82	1.48	18.40	0.00
1986	7209.23	7668	957	83.24	83.24	85.91	87.53	1.10	0.93	15.83	0.00
1987	7376.42	7917	990	85.24	85.24	85.06	90.38	0.50	0.43	14.33	0.00
1988	7003.53	7536	990	79.99	79.99	80.54	85.79	1.29	1.05	18.96	0.00
1989	7364.21	7671	990	85.52	85.52	84.92	87.57	1.37	1.19	13.29	0.00
1990	7596.23	7905	990	89.85	89.85	87.59	90.24	0.44	0.40	9.75	0.00
1991	7060.30	7580	990	81.27	86.01	81.41	86.53	0.56	0.48	13.51	4.74
1992	7537.62	7986	990	86.44	90.38	86.68	90.92	0.60	0.55	9.08	3.93
1993	7338.05	7898	990	84.38	89.14	84.61	90.16	0.46	0.41	10.44	4.76
1994	6988.22	7108	1003	79.42	81.37	79.51	81.14	1.34	1.10	17.53	1.95
1995	7673.83	7819	1030	84.18	89.07	85.05	89.26	1.53	1.38	9.55	4.89
1996	7705.13	7734	1030	84.75	87.58	85.16	88.05	0.17	0.15	12.26	2.83
1997	7762.50	7830	1030	86.20	89.23	86.03	89.38	0.69	0.62	10.15	3.03
1998	8046.20	8102	1030	88.21	92.35	89.18	92.49	0.03	0.03	7.62	4.14
1999	8319.99	8126	1080	86.82	91.82	87.94	92.76	0.01	0.01	8.17	5.00
2000	8823.19	8159	1115	89.48	92.32	90.09	92.88	0.50	0.47	7.21	2.84
2001	9089.77	8187	1115	90.38	91.17	93.06	93.46	0.22	0.20	8.63	0.78
2002	9173.83	8250	1115	90.83	91.47	93.92	94.18	1.83	1.71	6.83	0.64
2003	9309.34	8204	1165	90.08	90.92	91.21	93.64	0.00	0.00	9.08	0.84
2004	8692.04	7633	1165	84.89	85.74	84.94	86.90	1.33	1.16	13.10	0.86
2005	5768.08	5004	1165	56.34	56.51	56.51	57.12	41.21	39.61	3.88	0.17
2006	9367.04	8206	1165	91.70	92.72	91.79	93.68	0.02	0.02	7.26	1.02
2007	9436.80	8276	1165	93.23	93.43	92.46	94.46	1.09	1.03	5.55	0.20
2008	9307.65	8119	1165	90.72	91.86	90.95	92.43	0.07	0.06	8.07	1.14
2009	9385.05	8203	1165	91.69	93.12	91.96	93.64	0.04	0.03	6.85	1.42
2010	8774.54	7640	1165	85.14	86.14	85.98	87.21	0.30	0.26	13.60	1.00
2011	9481.35	8094	1190	90.71	91.56	90.95	92.40	0.22	0.21	8.24	0.84
2012	7881.30	6746	1190	74.92	75.92	75.40	76.80	0.13	9.82	14.26	1.00
2013	9691.67	8150	1220	90.59	92.15	90.68	93.04	0.20	0.18	7.66	1.56
2014	9457.60	7970	1220	88.49	90.08	88.49	90.98	0.51	0.46	9.46	1.59
2015	8598.52	7322	1220	80.45	82.39	80.45	83.57	7.57	6.75	10.87	1.94
2016	6075.41	5147	1220	57.01	58.19	56.70	58.60	0.00	33.33	8.48	1.18
2017	5618.75	5347	1220	52.86	54.52	52.57	61.04	0.65	0.36	45.13	1.66
2018	7812.96	7658	1220	73.11	74.43	73.11	87.42	6.86	5.48	20.09	1.32
2019	8819.52	7792	1220	82.54	84.38	82.52	88.95	3.67	3.22	12.40	1.84
2020	9058.71	7727	1220	84.53	86.02	84.53	87.97	0.04	0.03	13.95	1.49

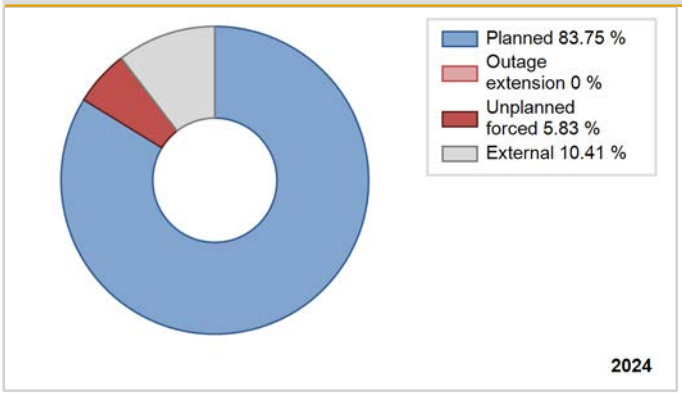
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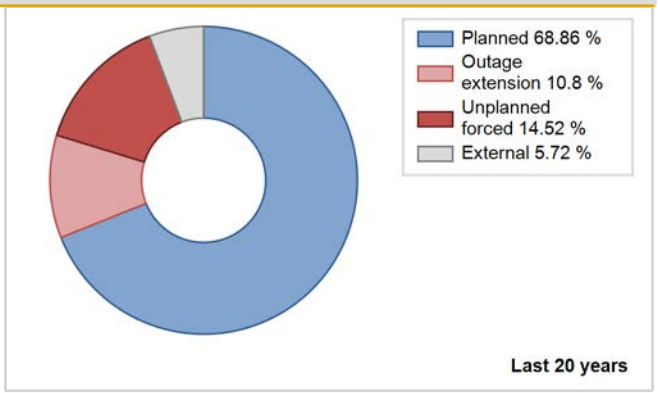
2021	4851.90	4102	1220	45.03	45.80	45.40	46.83	0.74	0.34	53.86	0.40
2022	9753.38	8048	1233	90.28	91.23	90.30	91.87	0.26	0.24	8.53	0.95
2023	9689.42	8016	1233	89.70	90.81	89.71	91.51	0.61	0.56	8.63	1.11
2024	9643.02	8000	1233	89.01	90.16	89.03	91.07	0.71	0.64	9.20	1.14

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		15			249	
C. Inspection, maintenance or repair combined with refuelling	768			906		
D. Inspection, maintenance or repair without refuelling				11		
E. Testing of plant systems or components				0	1	
H. Nuclear regulatory requirements					1	
L. Human factor related					5	
Z. Other				2		
Subtotal	768	15		919	256	
Total		**783**			**1175**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1984 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		96
12. Reactor I&C Systems		3
14. Safety Systems		11
15. Reactor Cooling Systems		3
16. Steam generation systems		2
31. Turbine and auxiliaries	15	19
32. Feedwater and Main Steam System		7
34. Miscellaneous Systems		2
35. All other I&C Systems		2
41. Main Generator Systems	0	108
Total	**15**	**253**

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2024 Operating Experience

TW-5 MAANSHAN-1 TAIWAN, CHINA

Status at end of year	:	**Permanent Shutdown**
Operator	:	TPC (Taiwan Power Co.)
Owner	:	TPC (Taiwan Power Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (WE 312)
Thermal power	:	2822 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	936 MWe

Key Dates

Construction Date	:	1978-08-21
Grid Date	:	1984-05-09
Commercial Date	:	1984-07-27
Age at end of year	:	40 years

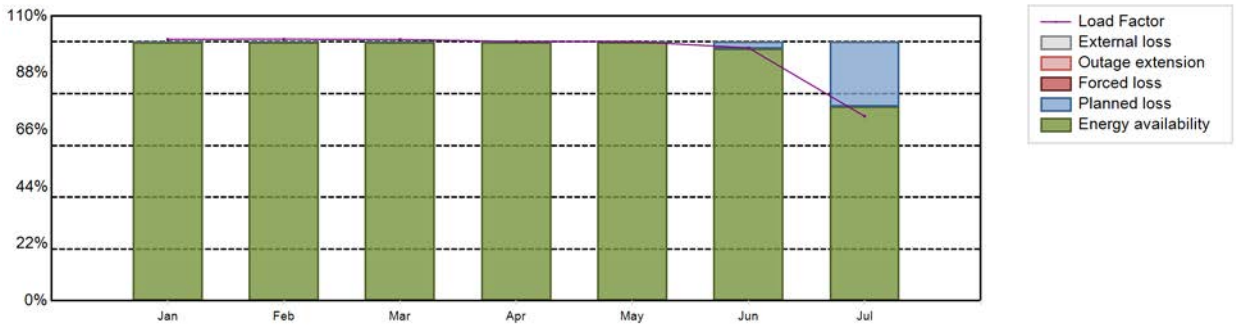
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	40
Average discharge burnup [MWd/t]	:	43000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.75
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	328.7
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	4.22
Secondary systems		
Number of turbine-generators per unit/reactor	:	3
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.56
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4543.97 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	96.24 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	96.24 %	Planned Unavailability Factor (PUF)	:	3.76 %
Load Factor (LF)	:	96.32 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	99.48 %	Total off-line time	:	26 hours

Annual Summary



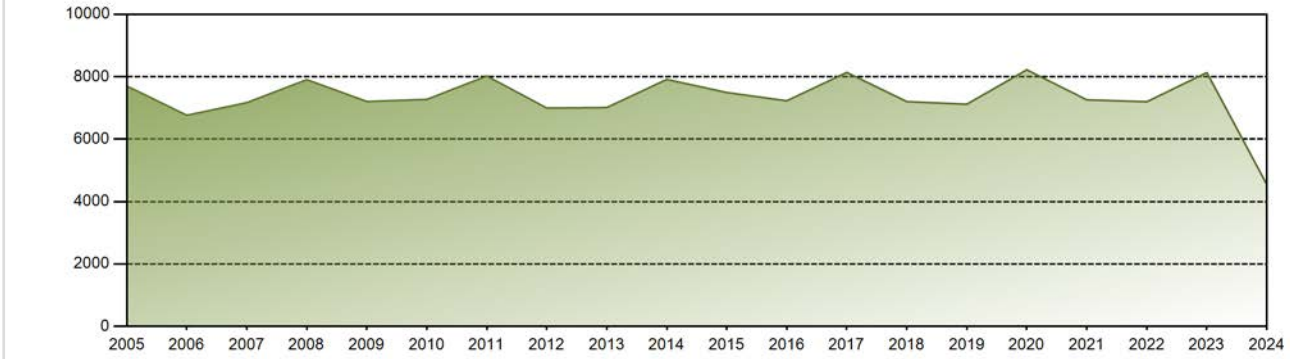
	Sep	Oct	Nov	Dec	Aug	Jan	Feb	Mar	Apr	May	Jun	Jul	Annual
GW(e)-h						703.35	658.53	702.90	675.13	697.36	658.42	448.27	4543.97
EAF [%]						99.96	99.95	99.95	99.81	99.87	97.48	74.99	96.24
UCF [%]						99.96	99.95	99.95	99.81	99.87	97.48	74.99	96.24
LF [%]						101.00	101.09	100.94	100.18	100.14	97.70	71.27	96.32
OF [%]						100.00	100.00	100.00	100.00	100.00	100.00	96.13	99.48
FLR [%]						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]						0.04	0.05	0.05	0.19	0.13	2.52	25.01	3.76
XUF [%]						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	266753.69 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.62 %
Cumulative Energy Availability Factor (EAF)	:	87.31 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.45 %
Cumulative Unit Capability Factor (UCF)	:	88.25 %	Cumulative Planned Unavailability Factor (PUF)	:	9.3 %
Cumulative Load Factor (LF)	:	88.18 %	Cumulative Externally cause unavailability (XUF)	:	0.93 %
Cumulative Operating Factor (OF)	:	88.33 %			

Electricity Production (net) [GWh]

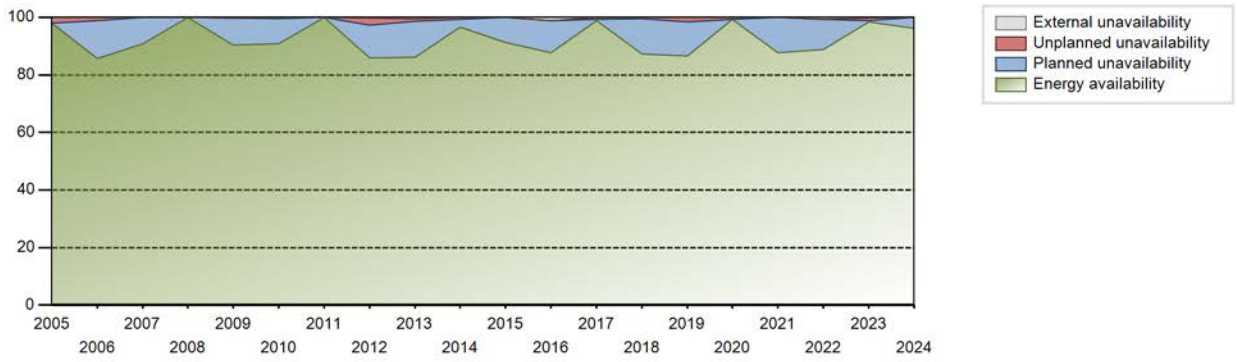


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984				Data not provided							
1985				"							
1986				"							
1987				"							
1988				"							
1989	5418.45	6305	890	65.98	66.28	69.50	71.97	27.44	25.06	8.66	0.30
1990	6098.90	7079	894	76.76	77.76	77.88	80.81	4.19	3.40	18.84	1.00
1991	6479.06	7368	890	82.72	84.01	83.10	84.11	2.67	2.30	13.68	1.30
1992	6038.78	6826	890	76.16	76.75	77.24	77.71	1.02	0.79	22.47	0.58
1993	6258.75	6930	890	78.48	78.48	80.28	79.11	5.43	4.50	17.01	0.00
1994	6322.62	7098	890	79.62	79.75	81.10	81.03	3.76	3.11	17.14	0.13
1995	6741.14	7495	890	84.36	84.51	86.46	85.56	0.67	0.57	14.92	0.14
1996	7537.00	8329	890	93.79	95.81	96.41	94.82	3.80	3.79	0.41	2.02
1997	5949.22	6752	890	74.35	74.80	76.31	77.08	11.04	9.28	15.92	0.45
1998	5514.47	6101	890	69.16	69.16	70.73	69.65	20.87	18.23	12.61	0.00
1999	7392.65	8328	890	92.61	96.34	94.82	95.07	1.56	1.53	2.13	3.73
2000	6729.03	7502	890	84.33	84.59	86.07	85.41	0.69	0.59	14.82	0.26
2001	5333.31	6046	890	67.57	86.08	68.41	69.02	2.66	2.35	11.56	18.52
2002	7800.80	8726	890	98.70	98.85	100.06	99.61	0.24	0.24	0.91	0.15
2003	6751.01	7579	890	86.23	87.35	86.59	86.52	0.04	0.04	12.62	1.11
2004	6793.74	7742	890	86.79	87.41	86.90	88.14	0.17	0.83	11.76	0.62
2005	7701.72	8693	890	97.97	98.09	98.79	99.24	1.88	1.88	0.04	0.11
2006	6763.25	7599	890	85.78	85.78	86.75	86.75	1.31	1.14	13.08	0.00
2007	7168.16	8001	890	90.81	90.86	91.94	91.34	0.09	0.08	9.06	0.06
2008	7904.88	8784	900	99.96	99.96	99.99	100.00	0.00	0.00	0.04	0.00
2009	7205.22	7959	918	90.31	90.52	90.33	90.86	0.07	0.06	9.41	0.21
2010	7272.45	8009	919	90.73	90.73	90.34	91.43	0.47	0.43	8.84	0.00
2011	8022.09	8760	918	99.87	99.91	99.76	100.00	0.00	0.00	0.09	0.03
2012	6994.76	7620	928	86.02	86.24	86.27	86.75	0.88	2.53	11.23	0.22
2013	7011.65	7615	926	86.11	86.62	86.44	86.93	0.98	0.86	12.53	0.51
2014	7913.59	8517	926	96.64	96.65	97.56	97.23	0.56	0.65	2.71	0.01
2015	7492.71	8035	936	91.27	91.27	91.38	91.72	0.01	0.01	8.72	0.00
2016	7228.08	7799	936	87.79	88.92	87.91	88.79	0.02	0.02	11.06	1.13
2017	8136.28	8682	936	98.85	98.85	99.23	99.11	0.74	0.73	0.42	0.00
2018	7201.98	7681	936	87.27	87.27	87.84	87.68	0.52	0.45	12.28	0.00
2019	7118.57	7652	936	86.50	86.61	86.82	87.35	1.75	1.54	11.84	0.12
2020	8222.12	8728	936	99.19	99.19	100.00	99.36	0.74	0.74	0.07	0.00

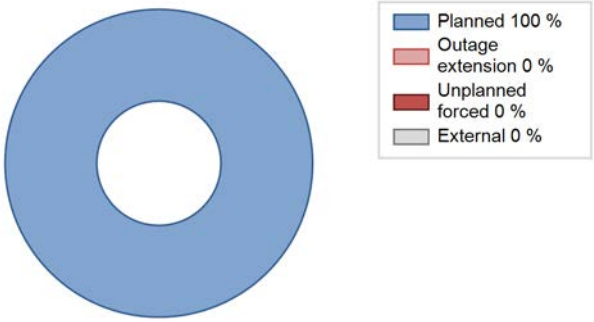
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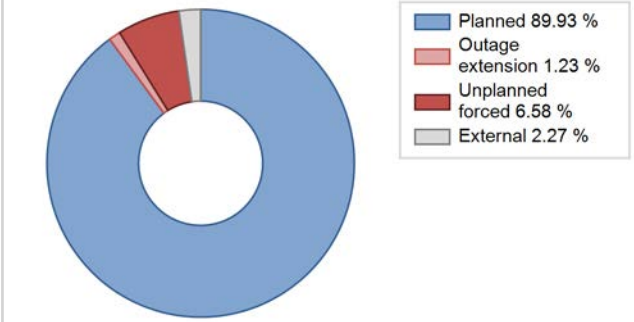
2021	7259.81	7716	936	87.75	87.75	88.54	88.08	0.03	0.03	12.22	0.00
2022	7197.97	7677	936	88.73	89.40	87.79	87.64	0.00	0.00	10.60	0.67
2023	8133.04	8704	936	98.37	98.73	99.19	99.36	0.77	0.77	0.50	0.36
2024	4543.97	5014	936	96.24	96.24	96.32	99.48	0.00	0.00	3.76	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					179	
B. Refuelling without maintenance				21		
C. Inspection, maintenance or repair combined with refuelling				743		
D. Inspection, maintenance or repair without refuelling				15		
E. Testing of plant systems or components				5		
H. Nuclear regulatory requirements					0	
J. Grid limitation, failure or grid unavailability						47
L. Human factor related					6	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						5
Z. Other						5
Subtotal				784	185	57
Total	**0**			**1026**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		59
13. Reactor Auxiliary Systems		6
15. Reactor Cooling Systems		16
16. Steam generation systems		16
31. Turbine and auxiliaries		12
32. Feedwater and Main Steam System		6
33. Circulating Water System		1
35. All other I&C Systems		0
41. Main Generator Systems		49
42. Electrical Power Supply Systems		27
Total		**192**

Highlights (2024)

2024/06/18 12:00 unit begin coastdown,2024/07/27 22:04 unit off-line.

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2024 Operating Experience

TW-6 MAANSHAN-2 TAIWAN, CHINA

Status at end of year	:	**Permanent Shutdown**
Operator	:	TPC (Taiwan Power Co.)
Owner	:	TPC (Taiwan Power Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (WE 312)
Thermal power	:	2822 MWth
Gross electrical power	:	951 MWe
Reference unit power (net)	:	938 MWe

Key Dates

Construction Date	:	1979-02-21
Grid Date	:	1985-02-25
Commercial Date	:	1985-05-18
Age at end of year	:	39 years

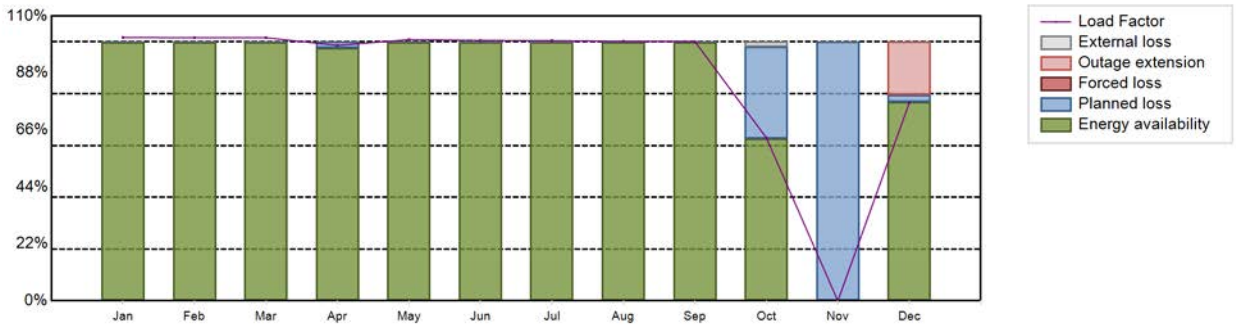
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	40
Average discharge burnup [MWd/t]	:	43000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.75
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	3
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	326
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	4.22
Secondary systems		
Number of turbine-generators per unit/reactor	:	3
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.56
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7182.87 GW(e).h
Energy Availability Factor (EAF)	:	86.45 %
Unit Capability Factor (UCF)	:	86.62 %
Load Factor (LF)	:	87.18 %
Operating Factor (OF)	:	86.98 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	1.73 %
Planned Unavailability Factor (PUF)	:	11.65 %
Externally cause unavailability (XUF)	:	0.16 %
Total off-line time	:	1144 hours

Annual Summary



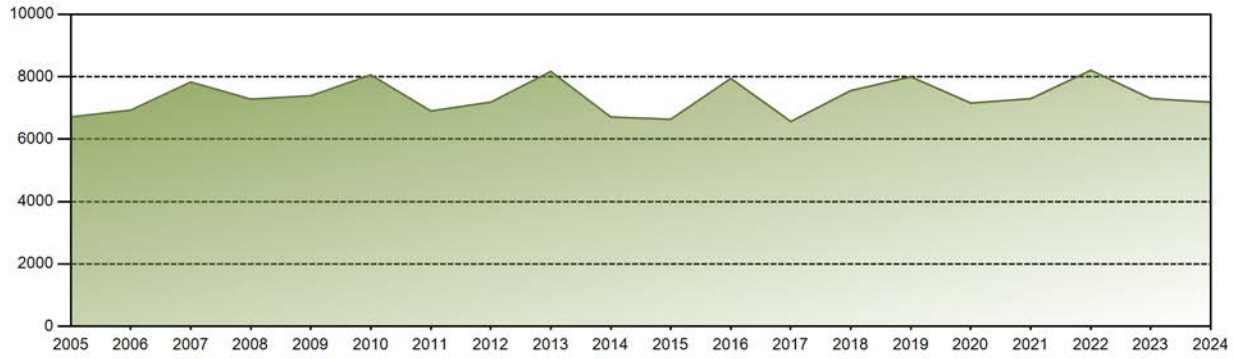
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	709.75	663.50	709.18	666.25	703.96	679.27	701.30	699.71	676.48	439.27	0.00	534.20	7182.87
EAF [%]	99.96	99.96	99.96	97.62	99.95	99.95	99.96	99.95	99.93	62.64	0.00	76.88	86.45
UCF [%]	99.96	99.96	99.96	97.62	99.95	99.95	99.96	99.95	99.93	64.57	0.00	76.88	86.62
LF [%]	101.70	101.63	101.62	98.65	100.87	100.58	100.49	100.26	100.17	62.94	0.00	76.55	87.18
OF [%]	100.00	100.00	100.00	98.89	100.00	100.00	100.00	100.00	100.00	65.05	0.00	79.03	86.98
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.41	1.73
PUF [%]	0.04	0.04	0.04	2.38	0.05	0.05	0.04	0.05	0.07	35.43	100.00	2.71	11.65
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.92	0.00	0.00	0.16

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Historical Summary

Lifetime energy generation	:	271079.71 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.89 %
Cumulative Energy Availability Factor (EAF)	:	86.7 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.22 %
Cumulative Unit Capability Factor (UCF)	:	87.81 %	Cumulative Planned Unavailability Factor (PUF)	:	9.97 %
Cumulative Load Factor (LF)	:	87.89 %	Cumulative Externally cause unavailability (XUF)	:	1.11 %
Cumulative Operating Factor (OF)	:	88.4 %			

Electricity Production (net) [GWh]

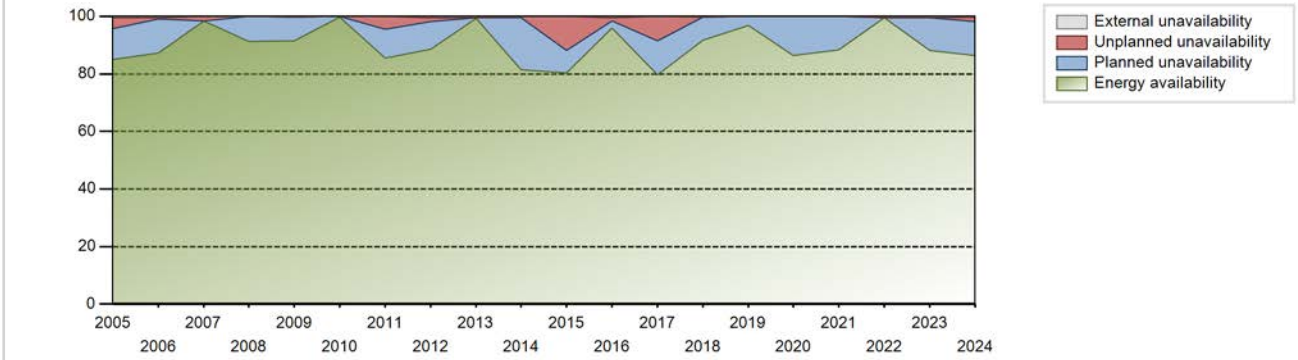


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	Data not provided										
1986	"										
1987	"										
1988	"										
1989	5283.33	6434	890	58.14	58.84	67.77	73.45	17.86	12.79	28.37	0.70
1990	6141.34	7143	896	77.26	78.82	78.24	81.54	3.72	3.05	18.13	1.56
1991	6187.13	7155	890	78.61	80.42	79.36	81.68	2.75	2.28	17.30	1.82
1992	5956.55	7541	890	75.50	84.28	76.19	85.85	0.35	0.29	15.43	8.78
1993	6550.99	7442	890	84.08	84.08	84.03	84.95	1.93	1.66	14.26	0.01
1994	7006.49	8216	890	88.69	93.29	89.87	93.79	2.78	2.67	4.04	4.60
1995	6118.58	6947	890	77.09	77.14	78.48	79.30	3.77	3.02	19.84	0.05
1996	6349.81	7091	890	79.75	80.99	81.22	80.73	5.79	4.98	14.03	1.24
1997	6415.41	7153	890	81.14	81.56	82.29	81.66	4.22	3.60	14.84	0.42
1998	7781.11	8557	890	97.23	97.39	99.80	97.68	1.53	1.51	1.09	0.17
1999	6628.36	7427	890	82.72	85.28	85.02	84.78	1.07	0.92	13.79	2.57
2000	6618.56	7401	890	82.59	84.10	84.66	84.26	1.54	1.32	14.58	1.51
2001	6993.79	7729	890	87.34	99.36	89.71	88.23	0.61	0.61	0.02	12.02
2002	6639.81	7507	890	82.42	82.42	85.17	85.70	3.83	3.28	14.30	0.00
2003	6737.60	7549	890	85.15	86.59	86.42	86.18	2.29	2.03	11.38	1.44
2004	7882.97	8784	890	99.51	99.55	100.83	100.00	0.40	0.40	0.05	0.03
2005	6709.97	7656	890	85.07	85.47	86.06	87.40	4.44	3.97	10.56	0.40
2006	6928.78	7729	890	87.23	87.69	88.87	88.23	0.47	0.41	11.90	0.46
2007	7829.87	8631	890	98.32	98.32	100.43	98.53	1.61	1.61	0.07	0.00
2008	7280.02	8036	908	91.25	91.25	91.28	91.48	0.01	0.01	8.73	0.00
2009	7389.24	8074	921	91.55	91.78	91.59	92.17	0.03	0.03	8.19	0.23
2010	8056.90	8760	922	99.81	99.81	99.75	100.00	0.12	0.12	0.08	0.00
2011	6901.46	7581	922	85.49	85.49	85.45	86.54	5.00	4.50	10.01	0.00
2012	7185.04	7851	922	88.67	89.10	88.72	89.38	0.00	1.31	9.59	0.43
2013	8167.87	8728	928	99.38	99.86	100.47	99.63	0.00	0.00	0.14	0.48
2014	6708.52	7198	928	81.42	81.43	82.52	82.17	0.69	0.57	18.01	0.01
2015	6637.10	7048	938	80.35	80.35	80.77	80.46	5.93	11.85	7.80	0.00
2016	7944.16	8472	938	95.89	96.40	96.42	96.45	0.32	1.11	2.49	0.51
2017	6564.98	7021	938	79.64	79.64	79.90	80.15	0.85	8.54	11.82	0.00
2018	7556.50	8065	938	91.78	91.97	91.96	92.07	0.00	0.00	8.03	0.19
2019	7998.06	8507	938	96.81	96.81	97.34	97.11	0.00	0.00	3.19	0.00
2020	7156.32	7616	938	86.34	86.34	86.85	86.70	0.01	0.00	13.65	0.00
2021	7297.31	7783	938	88.38	88.38	88.81	88.85	0.01	0.01	11.61	0.00

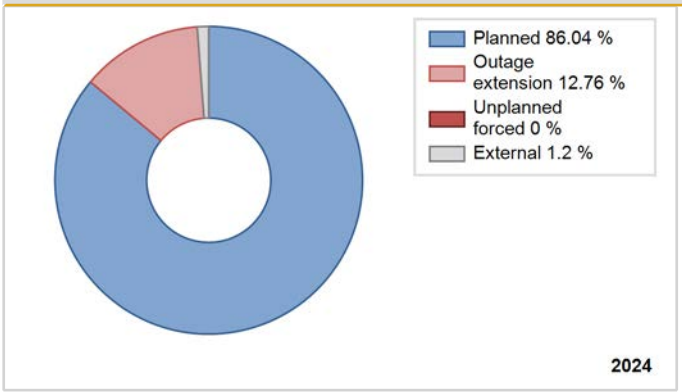
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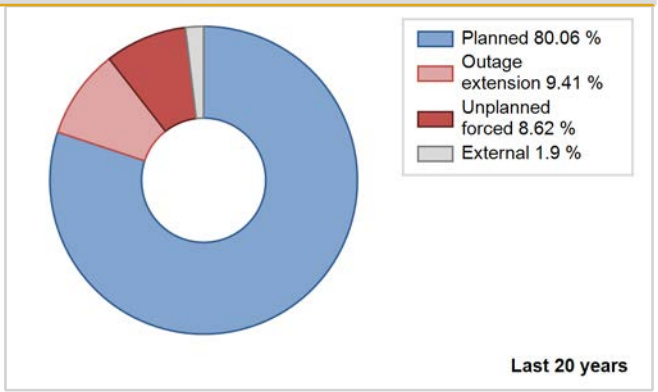
2022	8206.47	8731	938	99.55	99.94	99.87	99.67	0.00	0.00	0.06	0.39
2023	7300.69	7751	938	88.04	88.58	88.85	88.48	0.01	0.01	11.41	0.54
2024	7182.87	7640	938	86.45	86.62	87.18	86.98	0.00	1.73	11.65	0.16

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		152			149	
C. Inspection, maintenance or repair combined with refuelling	984			827	2	
D. Inspection, maintenance or repair without refuelling				8		
E. Testing of plant systems or components				1		
J. Grid limitation, failure or grid unavailability						29
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						8
Z. Other					1	
Subtotal	984	152		836	153	37
Total	**1136**			**1026**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	152	23
12. Reactor I&C Systems		29
13. Reactor Auxiliary Systems		3
15. Reactor Cooling Systems		22
16. Steam generation systems		5
31. Turbine and auxiliaries		13
32. Feedwater and Main Steam System		4
35. All other I&C Systems		3
41. Main Generator Systems		24
42. Electrical Power Supply Systems		56
Total	**152**	**182**

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2024 Operating Experience

UA-40 KHMELNITSKI-1 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	LMZ (JOINT-STOCK COMPANY "LENINGRADSKIY METALLICHESKIY ZAVOD")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1981-11-01
Grid Date	:	1987-12-31
Commercial Date	:	1988-08-13
Age at end of year	:	37 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary

No data found

	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.39 %
Cumulative Energy Availability Factor (EAF)	:	71.46 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.59 %
Cumulative Unit Capability Factor (UCF)	:	72.69 %	Cumulative Planned Unavailability Factor (PUF)	:	22.72 %
Cumulative Load Factor (LF)	:	71.16 %	Cumulative Externally cause unavailability (XUF)	:	1.23 %
Cumulative Operating Factor (OF)	:	74.03 %			

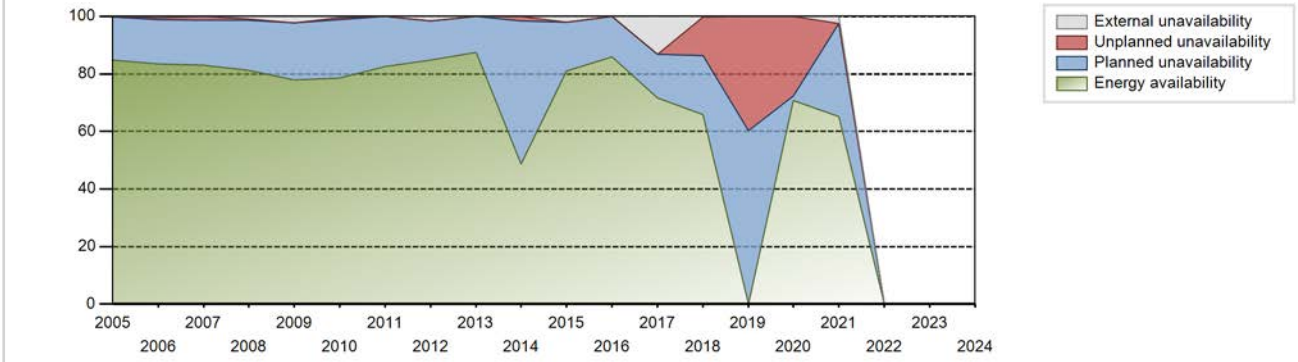
Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	3578.19	5266	950	67.05	67.05	61.13	74.95	32.78	32.70	0.25	0.00
1989	5872.26	6295	950	70.62	70.68	70.56	71.86	6.04	4.54	24.78	0.06
1990	6498.57	6870	950	77.35	77.35	78.09	78.42	7.25	6.05	16.60	0.00
1991	5172.49	5551	950	61.23	61.23	62.15	63.37	11.34	7.83	30.94	0.00
1992	6075.13	6167	950	66.53	67.62	72.80	70.21	3.06	2.13	30.25	1.09
1993	5487.72	5782	950	65.22	65.22	65.94	66.00	7.10	4.98	29.79	0.00
1994	6303.41	6775	950	75.51	76.05	75.74	77.34	4.68	3.74	20.21	0.54
1995	5700.26	6014	950	67.98	68.00	68.50	68.65	2.15	1.49	30.51	0.02
1996	4497.91	4854	950	53.90	54.25	53.90	55.26	15.74	10.13	35.62	0.34
1997	6152.10	6415	950	72.56	72.78	73.93	73.23	7.87	6.21	21.01	0.22
1998	5499.20	5904	950	65.82	67.08	66.08	67.40	0.11	0.08	32.85	1.26
1999	5526.69	6506	950	66.37	66.77	66.41	74.27	1.38	0.94	32.30	0.39
2000	5899.61	6541	950	70.36	74.25	70.70	74.46	0.92	0.69	25.06	3.89
2001	6167.28	6781	950	73.63	76.47	73.91	77.20	4.40	3.52	20.01	2.84
2002	6730.45	7049	950	79.90	80.26	80.88	80.47	0.08	0.06	19.68	0.35
2003	7137.70	7512	950	84.89	85.42	85.77	85.75	0.42	0.36	14.23	0.52
2004	6325.09	6935	950	75.42	80.92	75.80	78.95	1.33	1.09	17.99	5.51
2005	6862.81	7433	950	84.80	84.86	82.47	84.85	0.29	0.24	14.89	0.06
2006	6684.91	7407	950	83.49	83.88	80.33	84.55	0.97	0.83	15.29	0.39
2007	6905.26	7297	950	83.01	83.11	82.98	83.30	0.30	1.17	15.72	0.10
2008	6547.17	7237	950	81.31	82.29	78.46	82.39	0.35	0.29	17.42	0.98
2009	6380.56	7031	950	77.84	80.05	76.67	80.26	0.19	0.15	19.81	2.20
2010	6587.15	6966	950	78.60	79.10	79.15	79.52	0.73	0.58	20.32	0.50
2011	6967.34	7253	950	82.61	82.63	83.72	82.80	0.00	0.00	17.37	0.02
2012	7087.23	7592	950	84.70	86.33	84.93	86.43	0.00	0.00	13.67	1.64
2013	6877.19	7681	950	87.43	87.47	82.64	87.68	0.00	0.00	12.53	0.04
2014	3551.74	5920	950	48.60	48.60	42.68	67.58	3.32	1.67	49.73	0.00
2015	6753.90	7307	950	80.97	83.01	81.16	83.41	0.09	0.08	16.91	2.04
2016	7276.34	7568	950	85.98	86.05	87.20	86.16	0.01	0.01	13.94	0.07
2017	5807.27	7443	950	71.65	84.94	69.78	84.97	0.00	0.00	15.06	13.30
2018	5501.15	5799	950	65.75	65.93	66.10	66.20	16.98	13.49	20.58	0.19
2019	0.00	0	950	0.00	0.00	0.00	0.00	0.00	39.72	60.28	0.00
2020	5624.09	6255	950	70.86	70.86	67.40	71.21	0.22	27.58	1.56	0.01
2021	5455.12	5992	950	65.20	67.64	65.55	68.40	0.00	0.00	32.36	2.45
2022	Data not provided										
2023	"										
2024	"										

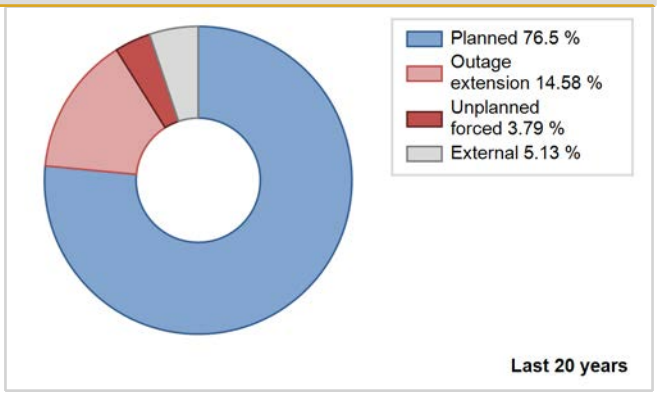
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1988 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					330	
C. Inspection, maintenance or repair combined with refuelling				1387		
D. Inspection, maintenance or repair without refuelling				173		
E. Testing of plant systems or components				10		
F. Major backfitting, refurbishment or upgrading activities with refuelling				169		
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						6
L. Human factor related					3	
Z. Other					1	
Subtotal				1739	334	6
Total		**0**			**2079**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1988 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		16
13. Reactor Auxiliary Systems		7
14. Safety Systems		1
15. Reactor Cooling Systems		14
16. Steam generation systems		5
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		14
32. Feedwater and Main Steam System		8
33. Circulating Water System		1
35. All other I&C Systems		1
41. Main Generator Systems		255
42. Electrical Power Supply Systems		3
Total		**327**

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2024 Operating Experience

UA-41 KHMELNITSKI-2 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	LMZ (JOINT-STOCK COMPANY "LENINGRADSKIY METALLICHESKIY ZAVOD")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1985-02-01
Grid Date	:	2004-08-07
Commercial Date	:	2005-12-15
Age at end of year	:	20 years

Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	16
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	322
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	40000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6
Active core height/length [m]	:	3.53	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	17.6	Number of main condensate pumps	:	-
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	0 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0 %	Total off-line time	:	hours

Annual Summary

No data found

	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

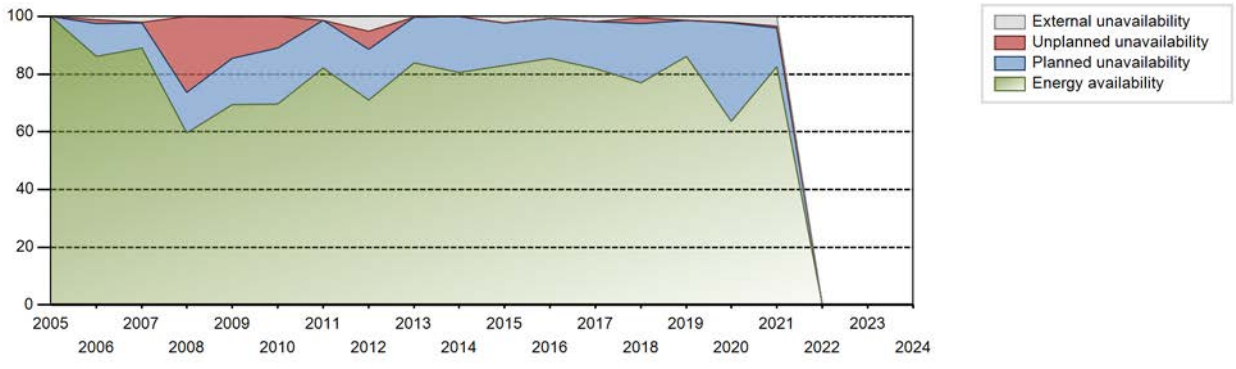
Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.56 %
Cumulative Energy Availability Factor (EAF)	:	78.34 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.83 %
Cumulative Unit Capability Factor (UCF)	:	79.76 %	Cumulative Planned Unavailability Factor (PUF)	:	16.41 %
Cumulative Load Factor (LF)	:	77.11 %	Cumulative Externally cause unavailability (XUF)	:	1.43 %
Cumulative Operating Factor (OF)	:	79.78 %			

Electricity Production (net) [GWh]



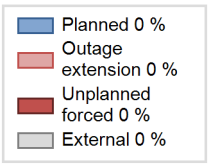
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2005	5581.51	6376	950	100.00	100.00	36.98	39.78	0.00	0.00	0.00	0.00
2006	7178.29	7697	950	86.15	87.36	86.26	87.87	1.35	1.19	11.45	1.21
2007	7213.44	8008	950	89.11	91.23	86.68	91.42	0.09	0.08	8.69	2.11
2008	4944.85	5263	950	59.64	59.69	59.26	59.92	30.51	26.20	14.11	0.04
2009	5841.16	6126	950	69.50	69.76	70.19	69.93	0.09	14.33	15.91	0.26
2010	5873.72	6124	950	69.64	69.67	70.58	69.91	13.47	10.84	19.49	0.03
2011	6845.60	7333	950	82.13	83.51	82.26	83.71	0.00	0.00	16.49	1.38
2012	5917.74	6774	950	71.02	76.29	70.92	77.12	7.49	6.17	17.54	5.26
2013	7027.15	7391	950	83.99	84.26	84.44	84.37	0.00	0.00	15.74	0.27
2014	6773.28	7121	950	80.58	80.70	81.39	81.29	0.00	0.00	19.30	0.12
2015	6042.26	7523	950	83.04	85.31	72.61	85.88	0.00	0.00	14.69	2.27
2016	6996.59	7587	950	85.44	86.24	83.84	86.37	0.00	0.00	13.76	0.79
2017	6908.09	7354	950	81.91	83.75	83.01	83.95	0.00	0.00	16.25	1.84
2018	6493.12	6816	950	77.09	77.55	78.02	77.81	2.52	2.01	20.44	0.46
2019	7219.58	7679	950	86.17	87.54	86.75	87.66	0.05	0.04	12.42	1.36
2020	4835.27	5785	950	63.67	65.82	57.94	65.86	0.02	0.02	34.16	2.15
2021	6913.03	7619	950	82.52	85.89	83.07	86.97	0.78	0.68	13.43	3.36
2022	Data not provided										
2023	"										
2024	"										

Key Factors in Last 20 Years [%]

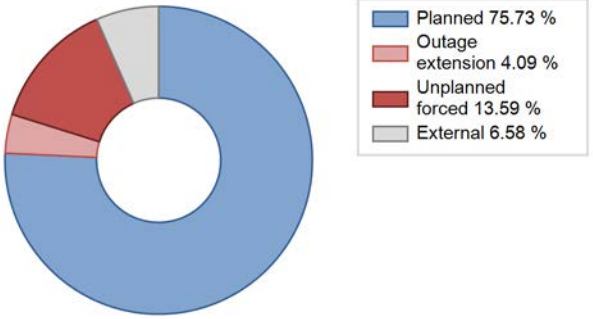


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Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2005 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					214	
C. Inspection, maintenance or repair combined with refuelling				1165		
D. Inspection, maintenance or repair without refuelling				32		
R. External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					65	
Subtotal				1197	279	
Total		**0**			**1476**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2005 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		7
14. Safety Systems		4
16. Steam generation systems		0
31. Turbine and auxiliaries		1
32. Feedwater and Main Steam System		3
41. Main Generator Systems		200
Total		**215**

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2024 Operating Experience

UA-27 RIVNE-1 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1375 MWth
Gross electrical power	:	420 MWe
Reference unit power (net)	:	381 MWe

Key Dates

Construction Date	:	1973-08-01
Grid Date	:	1980-12-22
Commercial Date	:	1981-09-22
Age at end of year	:	44 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	25
Average discharge burnup [MWd/t]	:	28600
Active core diameter [m]	:	2.88
Active core height/length [m]	:	2.5
Number of fissile fuel assemblies/bundles	:	313
Fuel linear heat generation rate [kW/m]	:	13.1
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	6
Coolant type	:	H2O

Operating coolant pressure [MPa]	:	12.3
Reactor outlet temperature [°C]	:	296
Number of SG	:	6
Containment type	:	Confinement
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	2
HP cylinder inlet steam pressure [MPa]	:	4.4
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	6
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary

No data found

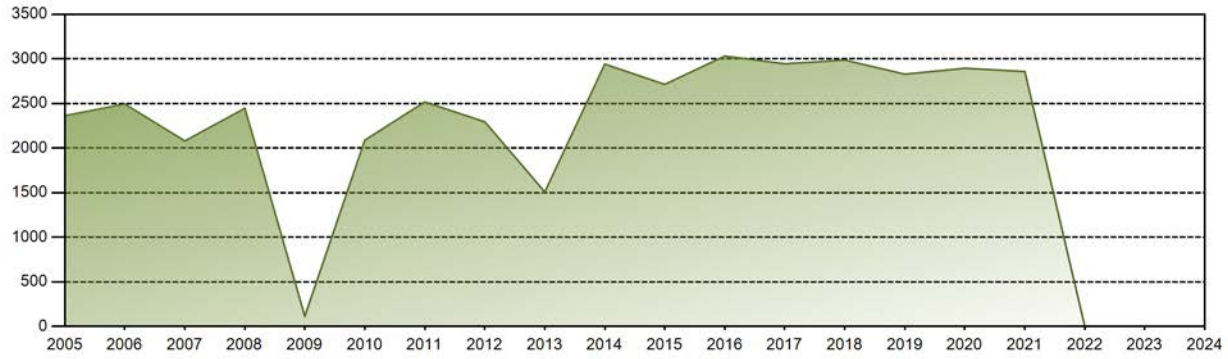
	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.69 %
Cumulative Energy Availability Factor (EAF)	:	79.21 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.22 %
Cumulative Unit Capability Factor (UCF)	:	79.98 %	Cumulative Planned Unavailability Factor (PUF)	:	17.81 %
Cumulative Load Factor (LF)	:	77.35 %	Cumulative Externally cause unavailability (XUF)	:	0.77 %
Cumulative Operating Factor (OF)	:	80.76 %			

Electricity Production (net) [GWh]

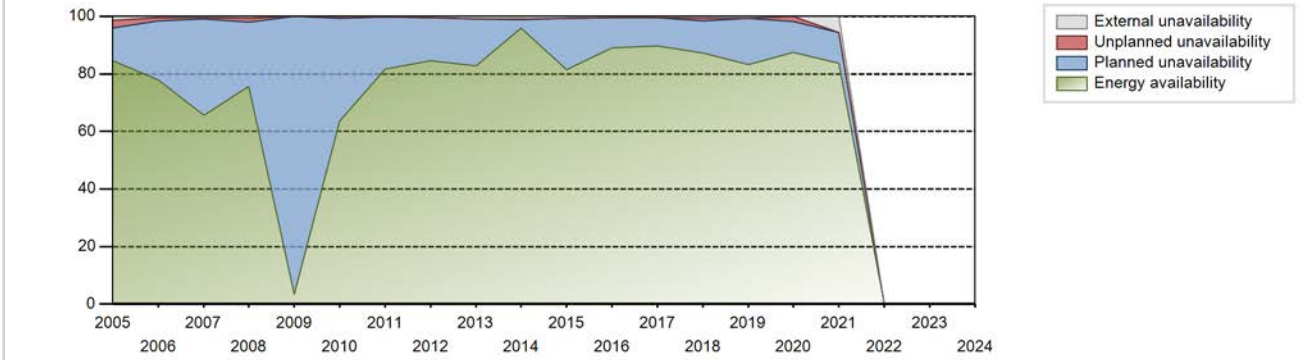


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	1685.10	6968	361	88.09	88.09	90.12	99.95	11.91	11.91	0.00	0.00
1982	1725.21	5498	361	51.94	51.94	54.55	62.76	13.79	8.31	39.75	0.00
1983	2036.59	6752	361	61.57	61.57	64.40	77.08	23.01	18.40	20.03	0.00
1984	2686.26	7782	361	82.48	82.48	84.71	88.59	6.69	5.92	11.60	0.00
1985	2664.82	7636	365	81.42	81.42	83.34	87.17	6.45	5.61	12.97	0.00
1986	2712.73	7606	361	77.54	77.54	85.78	86.83	10.18	8.79	13.67	0.00
1987	3040.76	7756	402	86.63	86.63	86.35	88.54	3.48	3.12	10.25	0.00
1988	2717.96	7877	361	86.02	86.02	85.71	89.67	3.35	2.98	11.00	0.00
1989	2823.85	7994	361	89.20	89.20	89.30	91.26	2.61	2.39	8.41	0.00
1990	2590.56	7265	361	79.27	79.27	81.92	82.93	4.30	3.57	17.17	0.00
1991	2640.06	7430	361	81.37	81.37	83.48	84.82	4.85	4.15	14.49	0.00
1992	3082.91	7989	403	87.29	88.47	87.00	90.95	1.66	1.49	10.04	1.18
1993	2584.41	7159	406	81.42	82.96	72.67	81.72	0.64	0.53	16.51	1.54
1994	2578.63	7378	361	81.70	81.75	81.54	84.22	0.81	0.67	17.59	0.05
1995	2747.40	7756	361	86.12	88.36	86.88	88.54	0.73	0.65	10.99	2.24
1996	2432.03	6960	361	76.70	78.99	76.70	79.23	1.97	1.59	19.42	2.29
1997	2701.14	7867	361	81.61	82.20	85.42	89.81	0.96	0.79	17.01	0.59
1998	2612.94	6912	361	77.76	78.11	82.63	78.90	1.39	1.10	20.79	0.35
1999	2240.49	6214	361	82.83	82.83	70.85	70.94	0.00	0.00	17.17	0.00
2000	2733.72	7580	361	82.63	85.70	86.21	86.29	2.16	1.89	12.41	3.06
2001	2753.81	7369	381	81.38	82.64	82.28	83.89	0.88	0.74	16.63	1.25
2002	2656.23	7242	381	79.91	81.04	79.59	82.67	2.33	1.93	17.02	1.14
2003	2816.14	7560	381	83.46	84.53	84.38	86.30	2.55	2.46	13.00	1.07
2004	2876.62	7914	381	86.54	87.91	85.95	90.10	2.25	2.02	10.06	1.37
2005	2362.64	7753	381	84.53	85.82	70.79	88.50	3.23	2.87	11.31	1.29
2006	2493.56	7012	381	77.99	78.43	74.71	80.05	1.38	1.10	20.47	0.44
2007	2079.02	5882	381	65.73	66.26	62.29	67.15	0.65	0.44	33.30	0.53
2008	2445.73	6815	381	75.60	76.22	73.08	77.58	1.76	1.36	22.42	0.62
2009	113.11	308	381	3.48	3.48	3.39	3.52	0.00	0.00	96.52	0.00
2010	2087.55	5572	381	63.70	64.20	62.55	63.61	0.33	0.21	35.59	0.49
2011	2517.09	6867	381	81.69	81.91	75.42	78.39	0.09	0.07	18.02	0.22
2012	2293.50	6596	381	84.59	85.11	68.53	75.09	0.00	0.00	14.89	0.53
2013	1507.59	4362	381	82.77	83.61	45.17	49.79	0.00	0.00	16.39	0.84
2014	2941.31	8052	381	95.95	96.88	88.13	91.92	0.24	0.24	2.88	0.94
2015	2713.77	7284	381	81.35	81.99	81.31	83.15	0.00	0.00	18.01	0.63
2016	3031.66	7918	381	89.07	89.60	90.59	90.14	0.00	0.00	10.40	0.53
2017	2944.90	7978	381	89.64	90.09	88.24	91.07	0.02	0.02	9.89	0.45

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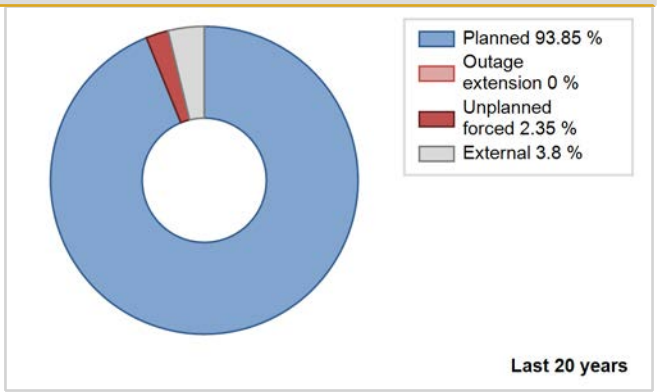
2018	2986.77	7778	381	87.24	87.99	89.49	88.79	1.00	0.89	11.12	0.75
2019	2828.40	7419	381	83.35	84.05	84.74	84.69	0.06	0.05	15.90	0.70
2020	2895.00	7773	381	87.57	87.57	86.50	88.49	1.91	1.71	10.72	0.00
2021	2858.07	7901	381	83.59	89.15	85.63	90.19	0.04	0.04	10.82	5.55
2022	Data not provided										
2023	"										
2024	"										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					35	
C. Inspection, maintenance or repair combined with refuelling				1261		
D. Inspection, maintenance or repair without refuelling				96		
J. Grid limitation, failure or grid unavailability						9
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						102
L. Human factor related					0	
M. Governmental requirements or court decisions					1	
Subtotal				1357	36	111
Total		**0**			**1504**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		6
13. Reactor Auxiliary Systems		2
14. Safety Systems		1
15. Reactor Cooling Systems		10
16. Steam generation systems		5
17. Safety I&C Systems (excluding reactor I&C)		0
32. Feedwater and Main Steam System		0
34. Miscellaneous Systems		1
35. All other I&C Systems		0
41. Main Generator Systems		2
42. Electrical Power Supply Systems		4
Total		**33**

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2024 Operating Experience

UA-28 RIVNE-2 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-213
Thermal power	:	1375 MWth
Gross electrical power	:	415 MWe
Reference unit power (net)	:	376 MWe

Key Dates

Construction Date	:	1973-10-01
Grid Date	:	1981-12-22
Commercial Date	:	1982-07-29
Age at end of year	:	43 years

Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	12.3
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	296
Fuel material	:	UO2	Number of SG	:	6
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	28600	Number of LP cylinders per turbine	:	2
Active core diameter [m]	:	2.88	HP cylinder inlet steam pressure [MPa]	:	4.4
Active core height/length [m]	:	2.5	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	349	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	13.1	Number of main condensate pumps	:	6
Number of control rod assemblies	:	37	Number of FW pumps for full power operation	:	4
Number of external reactor coolant loops	:	6	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	0 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0 %	Total off-line time	:	hours

Annual Summary

No data found

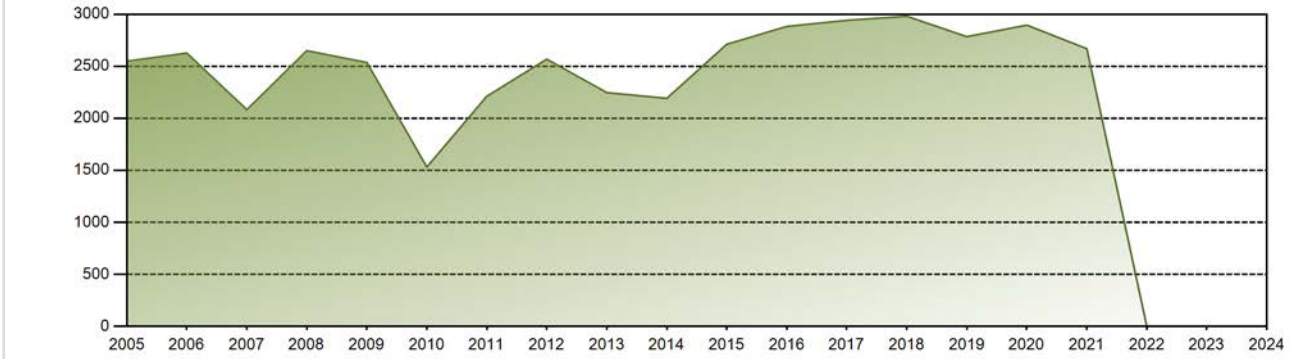
	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.24 %
Cumulative Energy Availability Factor (EAF)	:	80.39 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.73 %
Cumulative Unit Capability Factor (UCF)	:	81.51 %	Cumulative Planned Unavailability Factor (PUF)	:	15.76 %
Cumulative Load Factor (LF)	:	78.62 %	Cumulative Externally cause unavailability (XUF)	:	1.12 %
Cumulative Operating Factor (OF)	:	82.92 %			

Electricity Production (net) [GWh]

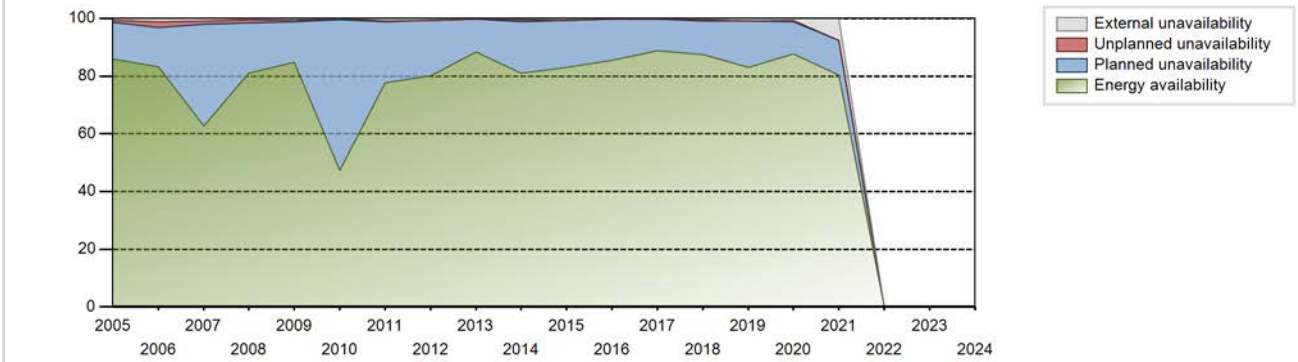


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1982	2062.20	8011	384	88.98	88.98	85.84	99.70	11.02	11.02	0.00	0.00
1983	1926.94	5572	384	58.00	58.00	57.28	63.61	9.34	5.98	36.02	0.00
1984	2808.20	7884	384	83.05	83.05	83.25	89.75	6.84	6.09	10.85	0.00
1985	2913.46	7994	384	86.04	86.04	86.61	91.26	6.57	6.05	7.91	0.00
1986	2891.75	7819	384	82.99	82.99	85.97	89.26	5.16	4.52	12.50	0.00
1987	3166.38	7649	416	86.26	86.26	86.89	87.32	1.88	1.65	12.09	0.00
1988	2778.30	7875	384	85.78	85.78	82.37	89.65	5.54	5.03	9.19	0.00
1989	2700.39	7989	384	86.27	86.27	80.28	91.20	4.14	3.73	10.01	0.00
1990	2798.97	7815	384	83.14	83.14	83.21	89.21	8.39	7.62	9.24	0.00
1991	2393.20	6560	384	70.99	70.99	71.14	74.89	5.07	3.79	25.22	0.00
1992	2983.74	7487	416	82.92	83.76	81.65	85.23	7.26	6.56	9.69	0.84
1993	2053.75	5981	406	64.35	66.00	57.75	68.28	24.88	21.86	12.14	1.65
1994	2690.67	7626	384	83.12	83.14	79.99	87.05	2.77	2.36	14.50	0.02
1995	2568.47	7215	384	76.36	79.58	76.36	82.36	0.86	0.69	19.72	3.23
1996	2783.13	7905	384	82.46	87.76	82.51	89.99	1.44	1.29	10.95	5.29
1997	2585.58	6847	384	76.50	77.60	76.86	78.16	3.29	2.64	19.76	1.10
1998	2739.64	7424	384	81.23	83.18	81.44	84.75	3.17	2.72	14.10	1.95
1999	2543.67	6958	384	75.47	77.96	75.62	79.43	2.35	1.88	20.16	2.49
2000	2718.18	7460	384	80.29	84.00	80.59	84.93	4.50	3.95	12.04	3.71
2001	2796.91	7691	376	83.23	86.63	84.68	87.56	1.38	1.21	12.16	3.40
2002	2861.82	7756	376	85.72	86.51	86.89	88.54	1.57	1.38	12.12	0.79
2003	2784.22	7376	376	81.60	82.65	84.53	84.20	1.55	1.30	16.06	1.04
2004	2999.69	8047	376	88.38	89.45	90.82	91.61	1.25	1.13	9.42	1.06
2005	2548.99	7527	376	85.95	86.54	77.39	85.92	0.98	0.85	12.60	0.59
2006	2627.46	7727	376	83.31	84.46	79.77	88.21	2.42	2.10	13.45	1.15
2007	2082.89	5672	376	62.75	63.70	63.24	64.75	1.59	1.03	35.28	0.94
2008	2650.26	7203	376	80.98	81.47	80.24	82.00	1.28	1.06	17.48	0.49
2009	2536.86	7603	376	84.82	85.56	77.02	86.79	0.54	0.46	13.97	0.74
2010	1531.71	4270	376	47.41	47.55	46.50	48.74	0.57	0.27	52.18	0.14
2011	2211.80	6632	376	77.68	78.67	67.15	75.71	0.27	0.22	21.11	0.99
2012	2568.64	7115	376	80.08	80.81	77.77	81.00	0.00	0.00	19.19	0.73
2013	2246.85	5886	376	88.35	88.63	68.22	67.19	0.00	0.00	11.37	0.28
2014	2192.26	6579	376	81.01	81.45	66.56	75.10	0.74	0.61	17.94	0.43
2015	2711.54	7363	376	83.05	83.71	82.32	84.05	0.00	0.00	16.29	0.66
2016	2883.55	7606	376	85.43	85.77	87.31	86.59	0.00	0.00	14.23	0.35
2017	2941.91	7890	376	88.88	89.15	89.32	90.07	0.01	0.01	10.84	0.27
2018	2981.26	7794	376	87.40	87.85	90.51	88.97	0.51	0.45	11.70	0.45

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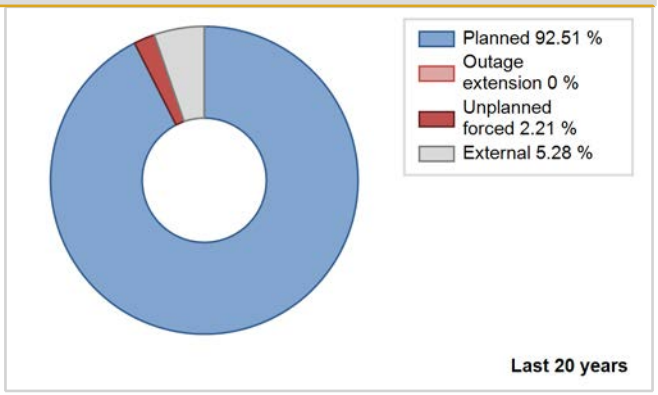
2019	2785.09	7395	376	83.01	83.84	84.56	84.42	0.00	0.00	16.16	0.82
2020	2896.19	7914	376	87.68	88.49	87.69	90.10	0.33	0.29	11.22	0.80
2021	2668.93	7788	376	80.28	87.95	81.03	88.90	0.00	0.00	12.05	7.68
2022	Data not provided										
2023	"										
2024	"										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1982 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					92	
C.	Inspection, maintenance or repair combined with refuelling				1046		
D.	Inspection, maintenance or repair without refuelling				150		
E.	Testing of plant systems or components				0		
J.	Grid limitation, failure or grid unavailability						8
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						61
L.	Human factor related					1	
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)					1	
Z.	Other				26		
Subtotal					1222	94	69
Total			**0**			**1385**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1982 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		11
13. Reactor Auxiliary Systems		2
15. Reactor Cooling Systems		5
16. Steam generation systems		56
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		0
32. Feedwater and Main Steam System		10
41. Main Generator Systems		2
42. Electrical Power Supply Systems		5
Total		**92**

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2024 Operating Experience

UA-29 RIVNE-3 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	LMZ (JOINT-STOCK COMPANY "LENINGRADSKIY METALLICHESKIY ZAVOD")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1980-02-01
Grid Date	:	1986-12-21
Commercial Date	:	1987-05-16
Age at end of year	:	38 years

Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.7
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	320
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	40000	Number of LP cylinders per turbine	:	4
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6.4
Active core height/length [m]	:	3.53	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	17.6	Number of main condensate pumps	:	8
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	0 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0 %	Total off-line time	:	hours

Annual Summary

No data found

	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.77 %
Cumulative Energy Availability Factor (EAF)	:	68.99 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.47 %
Cumulative Unit Capability Factor (UCF)	:	70.98 %	Cumulative Planned Unavailability Factor (PUF)	:	24.55 %
Cumulative Load Factor (LF)	:	65.51 %	Cumulative Externally cause unavailability (XUF)	:	1.99 %
Cumulative Operating Factor (OF)	:	72.09 %			

Electricity Production (net) [GWh]

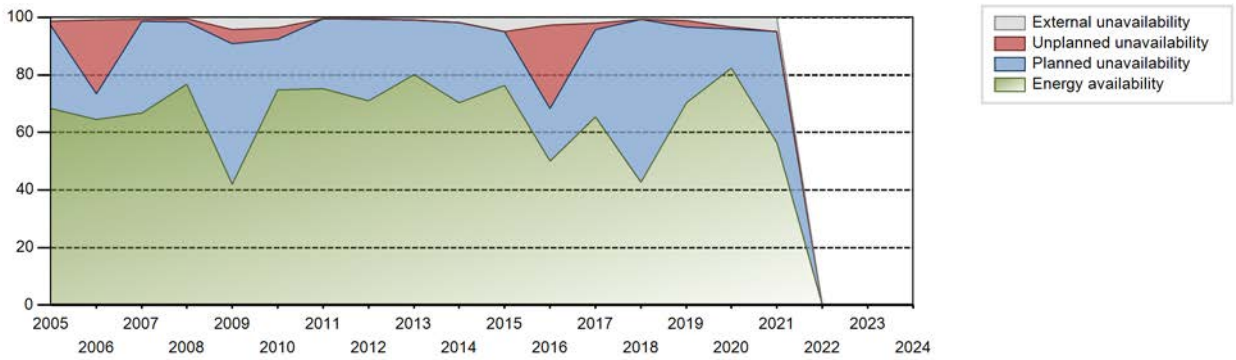


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	5202.19	6485	1000	82.32	82.32	70.62	79.97	13.74	13.11	4.57	0.00
1988	5661.32	6357	950	71.05	71.05	67.84	72.37	4.72	3.52	25.43	0.00
1989	6046.10	6771	950	75.08	75.08	72.65	77.29	8.99	7.42	17.50	0.00
1990	6360.06	6981	950	77.33	77.33	76.42	79.69	8.83	7.49	15.18	0.00
1991	5454.79	5971	950	66.02	66.02	65.55	68.16	4.54	3.14	30.84	0.00
1992	7084.94	7323	1000	82.18	82.20	80.66	83.37	5.22	4.53	13.27	0.02
1993	6195.07	6861	950	75.87	76.55	74.44	78.32	4.63	3.71	19.74	0.68
1994	5574.71	6042	950	67.67	67.67	66.99	68.97	0.88	0.60	31.73	0.01
1995	5018.27	5500	950	60.28	61.04	60.30	62.79	17.12	12.61	26.35	0.76
1996	5550.91	6064	950	66.52	66.77	66.52	69.03	10.54	7.87	25.36	0.26
1997	6249.62	6730	950	74.70	75.86	75.10	76.83	2.56	1.99	22.15	1.16
1998	5603.50	6036	950	67.32	68.22	67.33	68.90	1.01	0.70	31.08	0.90
1999	5303.46	6342	950	63.73	72.55	63.73	72.40	0.65	0.48	26.97	8.83
2000	4991.27	5641	950	59.81	72.39	59.81	64.22	14.22	12.00	15.61	12.58
2001	5783.63	6387	950	69.58	75.26	69.31	72.71	3.28	2.55	22.18	5.68
2002	5562.59	6320	950	68.37	69.77	66.84	72.15	2.05	1.46	28.77	1.40
2003	6250.46	6815	950	74.31	75.18	75.11	77.80	4.54	3.68	21.14	0.87
2004	6693.27	7321	950	83.21	84.16	80.21	83.34	0.79	0.67	15.17	0.95
2005	4768.06	6158	950	68.30	69.68	57.29	70.30	2.25	1.60	28.72	1.38
2006	4614.03	6777	950	64.56	65.57	55.44	77.36	28.11	25.64	8.79	1.01
2007	5317.21	6622	950	66.79	67.45	63.89	75.59	1.07	0.73	31.82	0.66
2008	6279.30	7097	950	76.83	77.28	75.25	80.79	1.36	1.06	21.65	0.45
2009	3134.99	4078	950	41.99	46.36	37.67	46.55	1.03	4.81	48.83	4.37
2010	5811.94	6731	950	74.80	78.49	69.84	76.84	4.76	3.92	17.59	3.69
2011	5945.19	7021	950	75.19	75.65	71.44	80.15	0.09	0.07	24.28	0.47
2012	5419.73	6665	950	71.01	71.40	64.95	75.88	0.40	0.29	28.31	0.39
2013	6064.61	7287	950	80.18	81.18	72.87	83.18	0.00	0.00	18.82	1.01
2014	5545.16	6863	950	70.34	72.09	66.63	78.34	0.00	0.00	27.91	1.76
2015	5591.79	7177	950	76.44	81.29	67.19	81.93	0.17	0.13	18.58	4.85
2016	3495.26	4654	950	50.00	52.72	41.89	52.98	35.38	28.87	18.41	2.72
2017	5339.44	6491	950	65.32	67.29	64.16	74.10	3.28	2.28	30.42	1.97
2018	3508.00	3886	950	42.77	43.40	42.15	44.36	0.00	0.00	56.60	0.63
2019	5764.88	6332	950	70.38	71.46	69.27	72.28	3.01	2.22	26.32	1.08
2020	4974.66	5791	950	82.41	85.86	59.61	65.93	0.65	0.56	13.57	3.46
2021	4578.27	5398	950	56.48	61.40	55.01	61.62	0.00	0.00	38.60	4.92
2022	Data not provided										
2023	"										

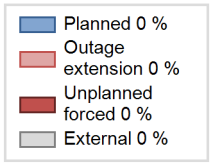
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2024	"

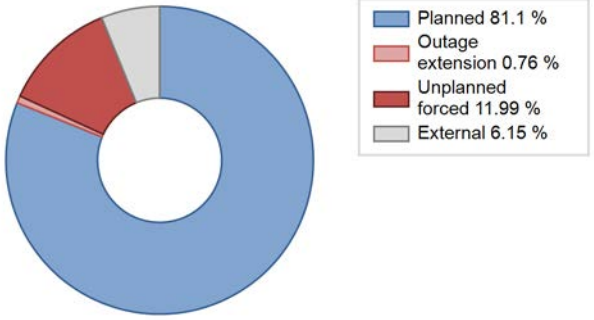
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024			1987 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					264	
C. Inspection, maintenance or repair combined with refuelling				1481		
D. Inspection, maintenance or repair without refuelling				237		
E. Testing of plant systems or components				15		
F. Major backfitting, refurbishment or upgrading activities with refuelling				145		
H. Nuclear regulatory requirements					10	
J. Grid limitation, failure or grid unavailability						4
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						61
L. Human factor related					5	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)						5
Z. Other					2	20
Subtotal				1878	281	90
Total		**0**			**2249**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		15
12. Reactor I&C Systems		21
13. Reactor Auxiliary Systems		11
15. Reactor Cooling Systems		14
16. Steam generation systems		18
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		25
32. Feedwater and Main Steam System		6
33. Circulating Water System		1
34. Miscellaneous Systems		0
35. All other I&C Systems		1
41. Main Generator Systems		158
42. Electrical Power Supply Systems		23
Total		**295**

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2024 Operating Experience

UA-69 RIVNE-4 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAA (PRODUCTION AMALGAMATION 'ATOMMASH', VOLGODONSK)
Turbine Supplier	:	LMZ (JOINT-STOCK COMPANY "LENINGRADSKIY METALLICHESKIY ZAVOD")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1986-08-01
Grid Date	:	2004-10-10
Commercial Date	:	2006-04-06
Age at end of year	:	20 years

Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.7
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	320
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	40000	Number of LP cylinders per turbine	:	4
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6.4
Active core height/length [m]	:	3.53	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	17.6	Number of main condensate pumps	:	8
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	0 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0 %	Total off-line time	:	hours

Annual Summary

No data found

	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

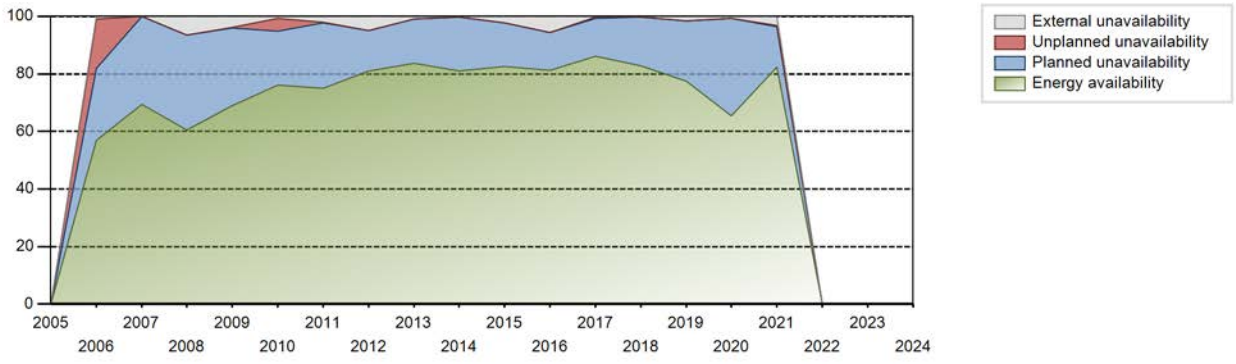
Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.37 %
Cumulative Energy Availability Factor (EAF)	:	75.95 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.19 %
Cumulative Unit Capability Factor (UCF)	:	78.09 %	Cumulative Planned Unavailability Factor (PUF)	:	20.73 %
Cumulative Load Factor (LF)	:	70.95 %	Cumulative Externally cause unavailability (XUF)	:	2.14 %
Cumulative Operating Factor (OF)	:	81.97 %			

Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2006	4781.15	6030	950	57.03	57.93	51.75	65.55	22.84	17.15	24.92	0.90
2007	5560.92	7657	950	69.47	69.56	66.82	87.41	0.06	0.05	30.39	0.09
2008	4368.65	7058	950	60.44	66.88	52.35	80.35	0.03	0.02	33.10	6.43
2009	5402.74	8171	950	68.89	72.82	64.92	93.28	0.01	0.01	27.17	3.93
2010	6135.99	7001	950	76.13	76.78	73.73	79.92	3.68	4.52	18.70	0.65
2011	5471.04	6764	950	75.03	77.08	65.74	77.21	0.34	0.26	22.66	2.06
2012	6260.55	7558	950	80.98	85.81	75.02	86.04	0.00	0.00	14.19	4.84
2013	5045.41	7451	950	83.70	84.65	60.63	85.06	0.00	0.00	15.35	0.95
2014	6177.79	7076	950	81.10	81.44	74.23	80.78	0.00	0.00	18.56	0.34
2015	6503.98	7456	950	82.53	84.82	78.15	85.11	0.00	0.00	15.18	2.28
2016	6728.75	7643	950	81.15	86.72	80.63	87.01	0.00	0.00	13.28	5.56
2017	7107.65	7577	950	86.10	86.29	85.41	86.50	0.52	0.45	13.26	0.19
2018	6819.17	7282	950	82.74	83.00	81.94	83.13	0.00	0.00	17.00	0.26
2019	6398.38	6930	950	77.46	79.01	76.89	79.11	0.00	0.00	20.99	1.55
2020	5031.02	5698	950	65.39	66.07	60.29	64.87	0.00	0.00	33.93	0.68
2021	6818.65	7547	950	82.44	85.57	81.94	86.15	0.53	0.46	13.97	3.14
2022	Data not provided										
2023	"										
2024	"										

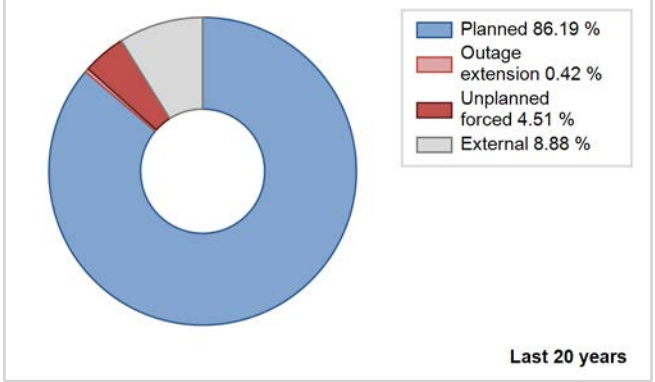
Key Factors in Last 20 Years [%]



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Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2006 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					38	
C. Inspection, maintenance or repair combined with refuelling				1171		
D. Inspection, maintenance or repair without refuelling				114		
H. Nuclear regulatory requirements					7	
J. Grid limitation, failure or grid unavailability						1
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						22
Subtotal				1285	45	23
Total		**0**			**1353**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2006 to 2024 Average hours lost per reactor-year
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		0
41. Main Generator Systems		34
42. Electrical Power Supply Systems		2
Total		**37**

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2024 Operating Experience

UA-44 SOUTH UKRAINE-1 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAA (PRODUCTION AMALGAMATION 'ATOMMASH', VOLGODONSK)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-302
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1976-08-01
Grid Date	:	1982-12-31
Commercial Date	:	1983-12-02
Age at end of year	:	42 years

Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	16
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	322
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	40000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6
Active core height/length [m]	:	3.53	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	17.6	Number of main condensate pumps	:	-
Number of control rod assemblies	:	49	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	0 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0 %	Total off-line time	:	hours

Annual Summary

No data found

	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.55 %
Cumulative Energy Availability Factor (EAF)	:	68.05 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.2 %
Cumulative Unit Capability Factor (UCF)	:	70.37 %	Cumulative Planned Unavailability Factor (PUF)	:	25.43 %
Cumulative Load Factor (LF)	:	67.29 %	Cumulative Externally cause unavailability (XUF)	:	2.32 %
Cumulative Operating Factor (OF)	:	72.27 %			

Electricity Production (net) [GWh]

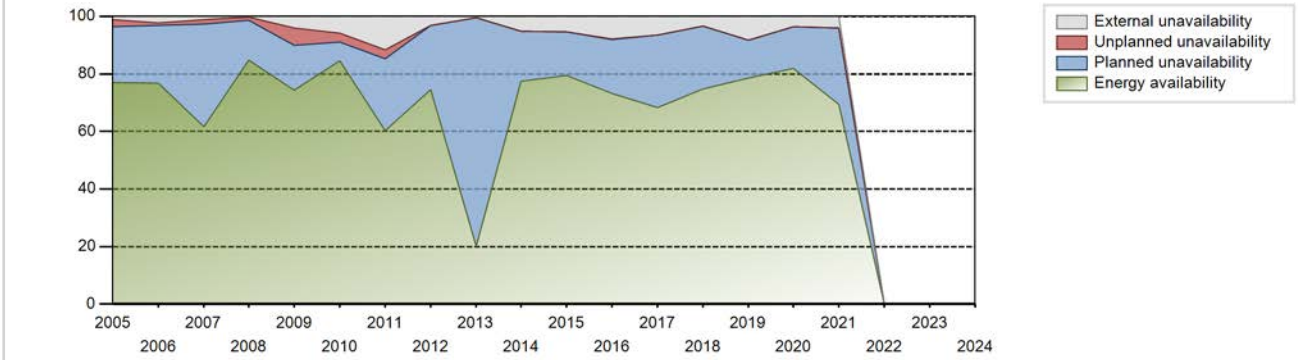


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	2558.83	3708	950	95.23	95.23	95.74	95.30	4.77	4.77	0.00	0.00
1984	6075.07	6364	950	71.66	71.66	72.80	72.45	11.12	8.97	19.38	0.00
1985	6939.15	7148	950	81.13	81.45	83.38	81.60	1.37	1.13	17.42	0.32
1986	6176.11	6735	950	73.47	74.05	74.21	76.88	14.47	12.53	13.42	0.58
1987	6385.87	6642	1000	75.58	75.58	72.90	75.82	5.05	4.02	20.40	0.00
1988	5467.47	6177	950	65.90	65.90	65.52	70.32	15.80	12.36	21.73	0.00
1989	2501.58	3321	950	30.85	30.85	30.06	37.91	42.57	22.87	46.29	0.00
1990	6174.36	7063	950	74.99	75.25	74.19	80.63	9.55	7.95	16.81	0.26
1991	3865.86	5532	950	46.47	46.47	46.45	63.14	28.83	18.83	34.70	0.00
1992	4946.83	6142	833	49.06	49.21	67.58	69.92	8.67	4.67	46.12	0.15
1993	5277.81	5650	950	61.36	62.30	63.42	64.50	7.30	4.91	32.80	0.93
1994	5117.43	5667	950	58.65	58.67	61.49	64.69	2.48	1.49	39.84	0.02
1995	5438.63	6212	950	65.35	66.10	65.35	70.91	3.84	2.64	31.25	0.75
1996	5138.24	5549	950	61.57	62.12	61.57	63.17	1.41	0.89	36.99	0.55
1997	6196.06	6416	950	72.47	73.01	74.45	73.24	1.18	0.87	26.12	0.53
1998	6164.95	6477	950	73.10	73.65	74.08	73.94	0.09	0.06	26.28	0.55
1999	5558.92	5920	950	66.55	67.14	66.80	67.58	0.16	0.11	32.75	0.59
2000	5203.05	5677	950	61.21	63.93	62.35	64.63	5.56	3.76	32.31	2.71
2001	5563.71	6015	950	66.58	68.32	66.67	68.48	4.66	3.34	28.34	1.74
2002	4254.82	4625	950	50.87	52.19	51.13	52.80	33.66	26.48	21.33	1.32
2003	6008.24	6612	950	72.58	74.23	72.20	75.48	1.58	1.19	24.58	1.65
2004	6988.95	7592	950	83.96	85.04	83.75	86.43	1.54	1.88	13.07	1.08
2005	6068.49	6926	950	77.06	78.26	72.92	79.06	0.66	2.40	19.34	1.19
2006	6345.12	6988	950	76.89	79.05	76.25	79.77	1.25	1.00	19.95	2.16
2007	5159.76	5562	950	61.58	62.75	62.00	63.49	2.25	1.44	35.81	1.17
2008	6895.39	7484	950	84.80	85.10	82.63	85.20	1.37	1.18	13.72	0.30
2009	3790.57	5368	950	74.25	78.30	45.55	61.28	7.22	6.10	15.60	4.06
2010	5151.44	6335	950	84.63	90.56	61.90	72.32	3.14	2.94	6.50	5.93
2011	5026.85	6632	950	60.33	72.00	60.40	75.71	4.16	3.13	24.87	11.66
2012	6524.13	7508	950	74.58	77.82	78.18	85.47	0.00	0.00	22.18	3.23
2013	1765.53	1987	950	20.15	20.63	21.22	22.68	0.00	0.00	79.37	0.48
2014	6420.56	7547	950	77.35	82.51	77.15	86.15	0.00	0.00	17.49	5.15
2015	6728.34	7777	950	79.55	84.90	80.85	88.78	0.11	0.09	15.01	5.35
2016	5810.19	7451	950	73.14	81.07	69.63	84.82	0.29	0.24	18.70	7.93
2017	5642.42	6828	950	68.27	74.69	67.80	77.95	0.00	0.00	25.31	6.42
2018	6487.01	6914	950	74.80	78.20	77.95	78.93	0.00	0.00	21.80	3.40
2019	6763.16	7700	950	78.59	86.81	81.27	87.90	0.00	0.00	13.19	8.22

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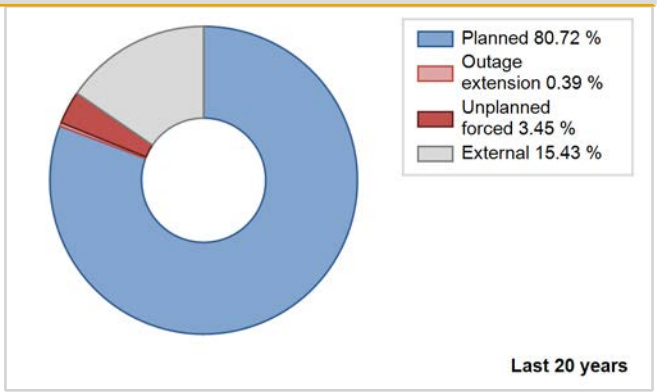
2020	6521.17	7528	950	81.97	85.67	78.15	85.70	0.00	0.00	14.33	3.70
2021	5824.46	6517	950	69.42	73.54	69.99	74.39	0.06	0.04	26.42	4.12
2022					Data not provided						
2023					"						
2024					"						

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1983 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					282	
C. Inspection, maintenance or repair combined with refuelling				1607		
D. Inspection, maintenance or repair without refuelling				255		
E. Testing of plant systems or components				7	1	
J. Grid limitation, failure or grid unavailability						1
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						98
L. Human factor related					1	
Z. Other					26	1
Subtotal				1869	310	100
Total		**0**			**2279**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		9
14. Safety Systems		1
15. Reactor Cooling Systems		4
16. Steam generation systems		135
31. Turbine and auxiliaries		40
32. Feedwater and Main Steam System		5
33. Circulating Water System		1
34. Miscellaneous Systems		1
35. All other I&C Systems		1
41. Main Generator Systems		79
42. Electrical Power Supply Systems		2
Total		**278**

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2024 Operating Experience

UA-45 SOUTH UKRAINE-2 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAA (PRODUCTION AMALGAMATION 'ATOMMASH', VOLGODONSK)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-338
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1981-07-01
Grid Date	:	1985-01-06
Commercial Date	:	1985-04-06
Age at end of year	:	39 years

Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	16
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	322
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	40000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6
Active core height/length [m]	:	3.53	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	17.6	Number of main condensate pumps	:	-
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	0 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0 %	Total off-line time	:	hours

Annual Summary

No data found

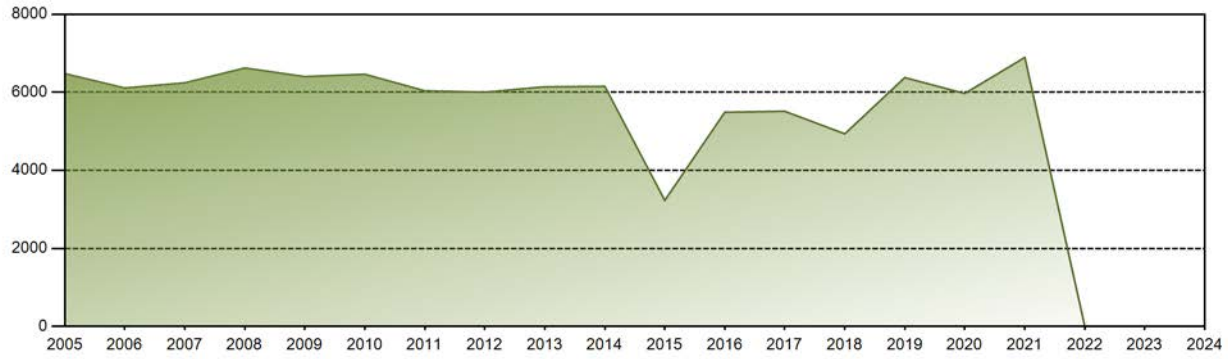
	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	11.61 %
Cumulative Energy Availability Factor (EAF)	:	65.19 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.91 %
Cumulative Unit Capability Factor (UCF)	:	67.56 %	Cumulative Planned Unavailability Factor (PUF)	:	23.52 %
Cumulative Load Factor (LF)	:	65.47 %	Cumulative Externally cause unavailability (XUF)	:	2.38 %
Cumulative Operating Factor (OF)	:	71.99 %			

Electricity Production (net) [GWh]

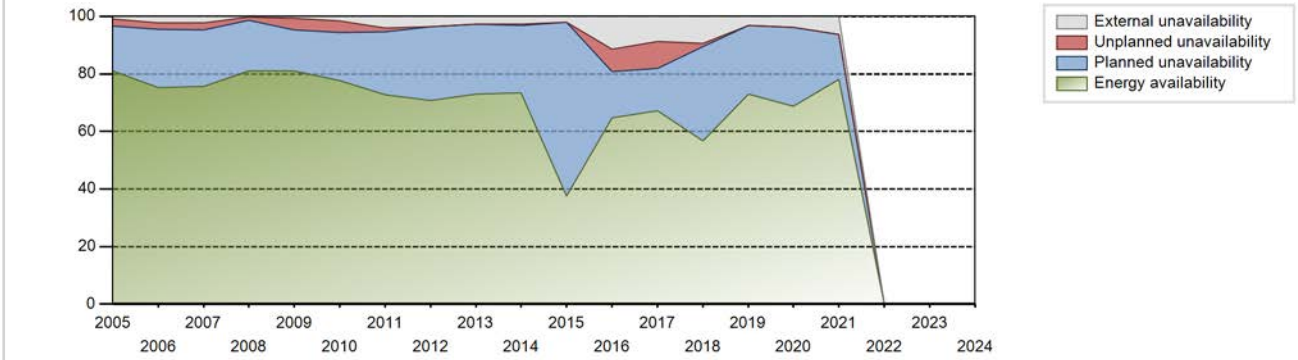


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	5603.65	6379	950	73.30	73.30	74.42	74.59	9.42	7.63	19.07	0.00
1986	5565.48	6315	950	66.25	67.00	66.88	72.09	10.56	7.91	25.09	0.75
1987	1641.67	1941	1000	22.04	22.04	18.74	22.16	77.96	77.96	0.00	0.00
1988	4850.58	5198	950	57.38	57.38	58.13	59.18	32.69	27.86	14.75	0.00
1989	4437.30	6674	950	54.29	54.29	53.32	76.19	32.49	26.12	19.59	0.00
1990	1768.96	4522	950	21.87	21.87	21.26	51.62	58.65	31.02	47.11	0.00
1991	6209.76	6722	950	72.04	72.04	74.62	76.74	9.16	7.26	20.70	0.00
1992	6412.13	6574	1000	71.66	72.91	73.00	74.84	4.84	3.71	23.38	1.25
1993	5204.03	6570	950	61.71	64.00	62.53	75.00	20.57	16.58	19.43	2.28
1994	3958.54	6471	950	46.86	47.32	47.57	73.87	34.13	24.52	28.16	0.46
1995	5429.43	6514	950	65.24	66.12	65.24	74.36	1.62	1.09	32.80	0.87
1996	4593.75	5590	950	55.05	55.43	55.05	63.64	22.85	16.42	28.15	0.38
1997	6326.54	7400	950	75.38	77.16	76.02	84.47	9.00	7.63	15.21	1.78
1998	4542.39	4867	950	53.97	55.15	54.58	55.56	1.29	0.72	44.13	1.18
1999	5537.94	6372	950	66.42	72.01	66.55	72.74	0.05	0.03	27.95	5.59
2000	4103.49	4486	950	49.17	50.04	49.17	51.07	34.95	26.88	23.08	0.86
2001	6206.51	6869	950	74.40	74.75	74.38	78.20	5.14	4.05	21.20	0.36
2002	6057.20	6565	950	72.65	74.16	72.79	74.94	0.54	0.40	25.44	1.51
2003	5507.74	5868	950	65.82	66.18	66.18	66.98	1.34	0.90	32.92	0.36
2004	6899.71	7647	950	82.23	86.14	82.68	87.06	1.32	1.15	12.71	3.92
2005	6479.16	7243	950	81.07	82.01	77.86	82.68	2.80	2.36	15.63	0.93
2006	6110.19	6847	950	75.28	77.53	73.42	78.16	2.94	2.35	20.12	2.25
2007	6241.70	6892	950	75.76	77.95	75.00	78.68	3.03	2.44	19.61	2.19
2008	6623.64	7248	950	81.11	81.38	79.37	82.51	1.25	1.03	17.59	0.27
2009	6402.79	7213	950	80.99	81.64	76.94	82.34	3.01	4.04	14.32	0.66
2010	6461.48	7326	950	77.75	79.43	77.64	83.63	4.79	4.00	16.57	1.69
2011	6039.15	7003	950	72.87	76.96	72.57	79.94	1.58	1.23	21.80	4.09
2012	6002.99	6723	950	70.69	74.30	71.94	76.54	0.00	0.00	25.70	3.61
2013	6141.18	7160	950	73.00	75.60	73.79	81.74	0.21	0.16	24.24	2.60
2014	6152.37	6846	950	73.46	76.22	73.93	78.15	0.47	0.36	23.42	2.76
2015	3228.28	3537	950	37.51	39.53	38.79	40.38	0.00	0.00	60.47	2.03
2016	5489.65	6776	950	64.76	76.28	65.79	77.14	9.18	7.71	16.02	11.51
2017	5513.69	6693	950	67.21	75.93	66.25	76.40	11.01	9.40	14.67	8.72
2018	4935.64	5822	950	56.71	66.11	59.31	66.46	1.68	1.13	32.76	9.40
2019	6377.49	6698	950	72.95	76.08	76.63	76.46	0.00	0.00	23.92	3.13
2020	5970.49	6393	950	68.83	72.63	71.55	72.78	0.00	0.00	27.37	3.80
2021	6894.09	7435	950	78.19	84.48	82.84	84.87	0.00	0.00	15.52	6.30

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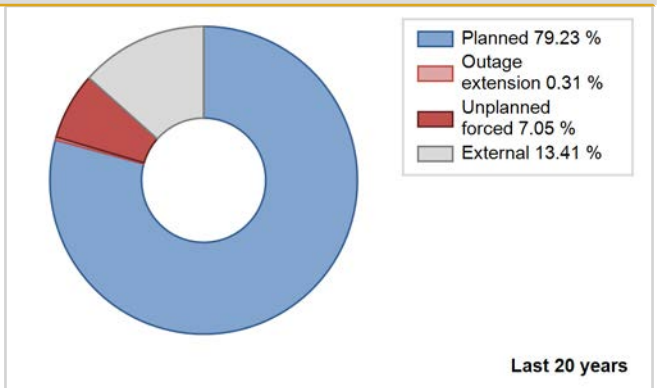
2022	Data not provided
2023	"
2024	"

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					358	
C. Inspection, maintenance or repair combined with refuelling				1360		
D. Inspection, maintenance or repair without refuelling				306		
E. Testing of plant systems or components				7		
F. Major backfitting, refurbishment or upgrading activities with refuelling				131		
H. Nuclear regulatory requirements					4	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						4
L. Human factor related					1	
Z. Other					39	
Subtotal				1804	402	4
Total		**0**			**2210**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		39
12. Reactor I&C Systems		6
14. Safety Systems		0
15. Reactor Cooling Systems		19
16. Steam generation systems		238
17. Safety I&C Systems (excluding reactor I&C)		7
31. Turbine and auxiliaries		18
32. Feedwater and Main Steam System		22
34. Miscellaneous Systems		3
41. Main Generator Systems		42
42. Electrical Power Supply Systems		1
Total		**395**

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2024 Operating Experience

UA-48 SOUTH UKRAINE-3 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAA (PRODUCTION AMALGAMATION 'ATOMMASH', VOLGODONSK)
Turbine Supplier	:	LMZ (JOINT-STOCK COMPANY "LENINGRADSKIY METALLICHESKIY ZAVOD")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1984-11-01
Grid Date	:	1989-09-20
Commercial Date	:	1989-12-29
Age at end of year	:	35 years

Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	16
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	322
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	5
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	12	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	40000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.16	HP cylinder inlet steam pressure [MPa]	:	6
Active core height/length [m]	:	3.53	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	163	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	17.6	Number of main condensate pumps	:	-
Number of control rod assemblies	:	61	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	3
Coolant type	:	H2O	**Non-electrical applications**	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	0 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	0 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	0 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	0 %	Total off-line time	:	hours

Annual Summary

No data found

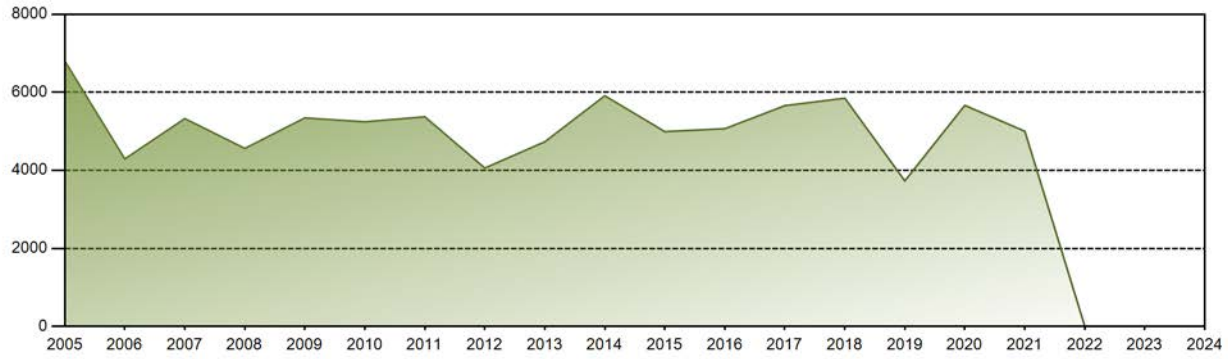
	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.95 %
Cumulative Energy Availability Factor (EAF)	:	68.34 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.91 %
Cumulative Unit Capability Factor (UCF)	:	71.76 %	Cumulative Planned Unavailability Factor (PUF)	:	24.32 %
Cumulative Load Factor (LF)	:	66.34 %	Cumulative Externally cause unavailability (XUF)	:	3.42 %
Cumulative Operating Factor (OF)	:	73.8 %			

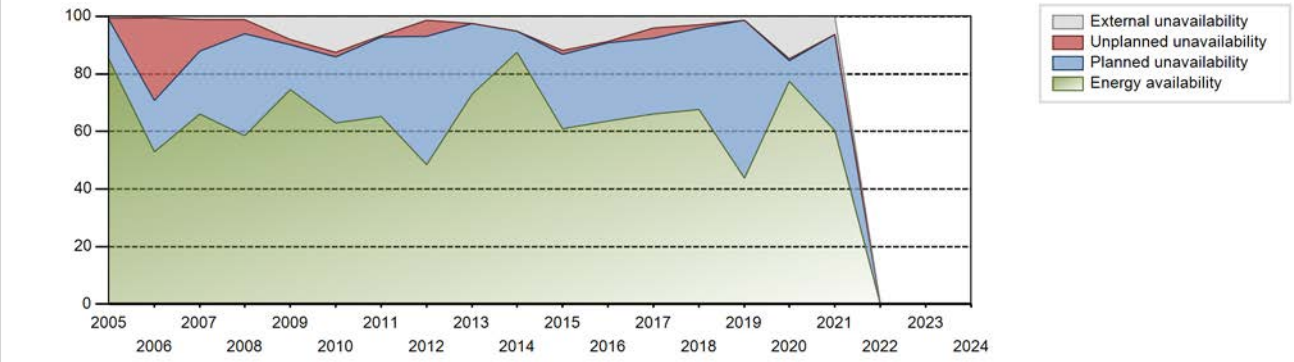
Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	1299.66	1992	950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1990	5691.56	6408	950	69.37	69.37	68.39	73.15	13.24	10.58	20.05	0.00
1991	5762.83	6996	950	69.95	70.40	69.25	79.86	13.28	10.78	18.82	0.44
1992	6458.14	6646	1000	75.25	75.25	73.52	75.66	2.82	2.18	22.57	0.00
1993	6043.39	6527	950	71.69	72.78	72.62	74.51	7.90	6.24	20.98	1.08
1994	5565.05	6223	950	66.43	66.46	66.87	71.04	4.67	3.26	30.28	0.03
1995	4954.78	6300	950	59.54	60.17	59.54	71.92	0.37	0.22	39.61	0.63
1996	6155.02	7463	950	73.76	76.41	73.76	84.96	11.29	9.73	13.86	2.66
1997	6514.77	7079	950	77.70	79.75	78.28	80.81	0.61	0.49	19.76	2.05
1998	5850.99	6396	950	69.91	70.99	70.31	73.01	1.81	1.31	27.70	1.09
1999	5464.32	6244	950	65.51	67.19	65.66	71.28	0.00	0.00	32.81	1.68
2000	5909.66	6588	950	70.58	73.34	70.82	75.00	4.15	3.18	23.49	2.76
2001	6136.35	6985	950	73.71	76.29	73.53	79.52	8.00	6.64	17.08	2.58
2002	6335.16	7043	950	75.97	77.54	76.13	80.40	3.23	2.59	19.87	1.57
2003	6036.52	6680	950	73.11	74.31	72.54	76.26	4.34	3.37	22.32	1.20
2004	6625.11	7246	950	79.93	82.00	79.39	82.49	3.82	3.26	14.74	2.07
2005	6801.04	7548	950	84.99	85.73	81.72	86.16	0.47	0.40	13.87	0.73
2006	4290.89	4734	950	53.02	53.61	51.56	54.04	34.76	28.57	17.83	0.59
2007	5326.10	5978	950	66.13	67.27	64.00	68.24	14.05	11.00	21.73	1.14
2008	4560.77	5961	950	58.58	59.66	54.65	67.86	7.69	4.97	35.37	1.08
2009	5343.14	7024	950	74.56	82.64	64.20	80.18	2.09	1.76	15.60	8.08
2010	5243.17	6778	950	62.88	75.43	63.00	77.37	2.05	1.58	22.99	12.54
2011	5372.61	6404	950	65.16	71.95	64.56	73.11	0.63	0.46	27.59	6.80
2012	4058.36	4448	950	48.46	49.74	48.63	50.64	0.00	5.68	44.58	1.28
2013	4731.07	6704	950	73.05	75.60	56.85	76.53	0.00	0.00	24.40	2.55
2014	5911.15	6781	950	87.39	92.52	71.03	77.41	0.00	0.00	7.48	5.13
2015	4993.40	6481	950	60.94	72.89	60.00	73.98	1.58	1.17	25.95	11.95
2016	5067.23	6445	950	63.58	72.23	60.72	73.37	0.71	0.52	27.26	8.65
2017	5657.50	6219	950	66.08	70.15	67.98	70.99	4.71	3.47	26.38	4.07
2018	5849.13	6260	950	67.57	70.40	70.29	71.46	1.81	1.30	28.30	2.83
2019	3729.04	4031	950	43.76	45.05	44.81	46.02	0.00	0.00	54.95	1.29
2020	5664.51	8490	950	77.55	92.38	67.88	96.65	0.69	0.64	6.97	14.84
2021	5003.02	5913	950	60.35	66.68	60.12	67.50	0.00	0.00	33.32	6.33
2022	Data not provided										
2023	"										
2024	"										

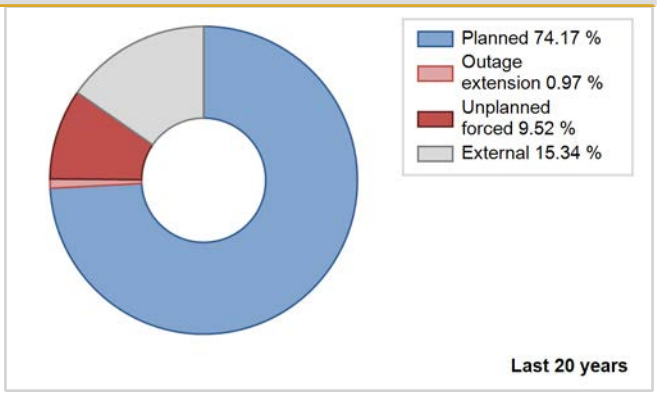
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					188	
C. Inspection, maintenance or repair combined with refuelling				1623		
D. Inspection, maintenance or repair without refuelling				201		
E. Testing of plant systems or components				11		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						59
L. Human factor related					0	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					14	
Subtotal				1835	202	59
Total		**0**			**2096**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1989 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		2
13. Reactor Auxiliary Systems		0
15. Reactor Cooling Systems		1
16. Steam generation systems		5
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		17
32. Feedwater and Main Steam System		1
33. Circulating Water System		0
34. Miscellaneous Systems		2
35. All other I&C Systems		1
41. Main Generator Systems		154
42. Electrical Power Supply Systems		1
Total		**188**

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2024 Operating Experience

UA-54 ZAPOROZHYE-1 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1980-04-01
Grid Date	:	1984-12-10
Commercial Date	:	1985-12-25
Age at end of year	:	40 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary

No data found

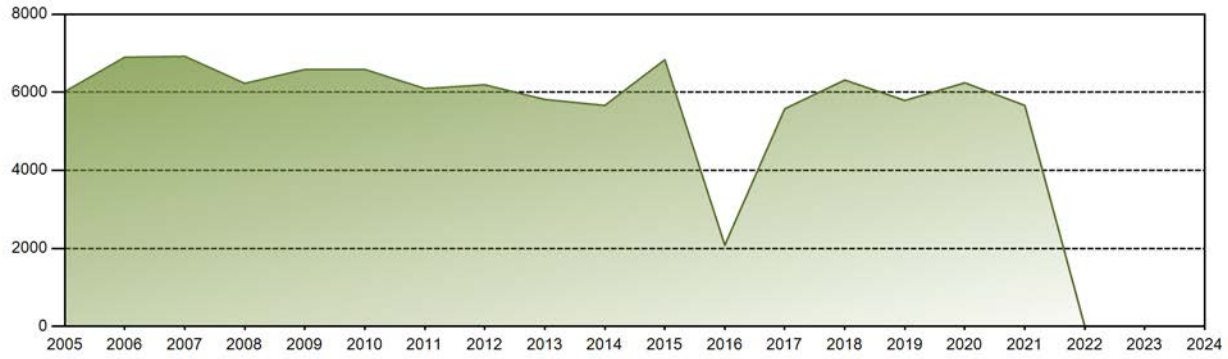
	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.93 %
Cumulative Energy Availability Factor (EAF)	:	66.74 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.26 %
Cumulative Unit Capability Factor (UCF)	:	68.94 %	Cumulative Planned Unavailability Factor (PUF)	:	25.81 %
Cumulative Load Factor (LF)	:	65.24 %	Cumulative Externally cause unavailability (XUF)	:	2.2 %
Cumulative Operating Factor (OF)	:	71.11 %			

Electricity Production (net) [GWh]

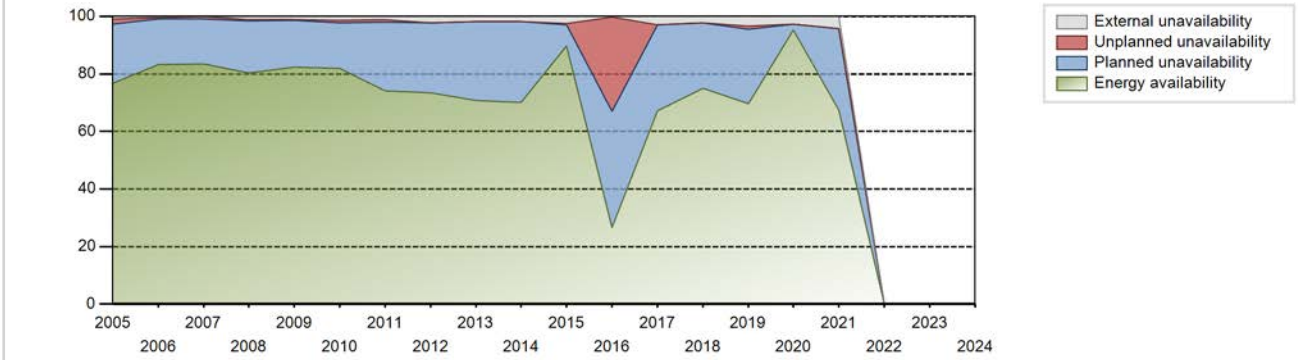


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	4051.06	5893	950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1986	4826.26	5580	950	58.26	61.54	57.99	63.70	19.03	14.46	24.00	3.28
1987	6720.93	7205	1000	80.82	80.82	76.72	82.25	8.64	7.64	11.54	0.00
1988	5170.41	6225	950	67.21	67.37	61.96	70.87	18.83	15.63	17.00	0.17
1989	0.00	0	950	0.00	0.00	0.00	0.00	100.00	9.86	90.14	0.00
1990	4668.70	5684	950	56.40	58.79	56.10	64.89	20.08	14.77	26.45	2.39
1991	5332.22	6343	950	64.25	68.51	64.07	72.41	10.27	7.84	23.65	4.27
1992	6103.50	6739	950	67.84	70.30	73.14	76.72	7.99	6.10	23.60	2.46
1993	4209.71	6591	950	52.14	53.46	50.59	75.24	39.69	35.18	11.36	1.32
1994	3770.96	5062	950	45.49	45.50	45.31	57.79	26.88	16.73	37.77	0.01
1995	3557.27	4213	950	42.75	44.87	42.75	48.09	3.78	1.76	53.37	2.13
1996	4299.48	5224	950	51.52	53.54	51.52	59.47	11.20	6.75	39.71	2.02
1997	4070.63	5531	950	48.91	53.86	48.91	63.14	2.16	1.19	44.95	4.94
1998	5517.47	6122	950	66.28	68.73	66.30	69.89	2.70	1.90	29.37	2.45
1999	5992.45	7422	950	72.01	84.01	72.01	84.73	1.25	1.06	14.93	12.01
2000	4222.71	4589	950	50.26	52.04	50.60	52.24	6.12	3.39	44.57	1.78
2001	5847.06	6434	950	69.93	71.84	70.07	73.25	1.17	0.85	27.30	1.92
2002	6734.96	7334	950	80.57	83.21	80.93	83.72	1.80	1.52	15.26	2.64
2003	6596.43	7223	950	78.96	81.85	79.26	82.45	2.33	1.95	16.20	2.89
2004	6748.27	7290	950	80.60	82.64	80.87	82.99	0.50	0.42	16.94	2.04
2005	6018.79	6823	950	76.81	77.76	72.32	77.89	2.21	1.75	20.49	0.95
2006	6899.02	7380	950	83.32	83.75	82.90	84.25	0.48	0.40	15.85	0.43
2007	6921.01	7406	950	83.51	83.61	83.17	84.54	0.97	0.82	15.57	0.10
2008	6227.72	6748	950	80.28	81.37	74.63	76.82	0.64	0.53	18.10	1.09
2009	6584.42	7174	950	82.38	83.43	79.12	81.89	0.45	0.38	16.19	1.06
2010	6586.76	7396	950	81.88	83.27	79.15	84.43	1.13	0.95	15.78	1.38
2011	6095.13	6702	950	74.11	75.35	73.24	76.51	1.02	0.78	23.88	1.24
2012	6191.10	6765	950	73.43	75.59	74.19	77.02	0.00	0.00	24.41	2.15
2013	5816.74	6585	950	70.70	72.48	69.90	75.17	0.00	0.00	27.52	1.78
2014	5661.63	6397	950	70.17	72.02	68.03	73.03	0.00	0.00	27.98	1.85
2015	6835.34	8147	950	89.73	92.17	82.14	93.00	0.58	0.53	7.29	2.44
2016	2082.50	2431	950	26.65	27.02	24.96	27.68	0.01	32.72	40.26	0.37
2017	5577.73	6302	950	67.23	70.21	67.02	71.94	0.00	0.00	29.79	2.98
2018	6314.69	7144	950	75.10	77.32	75.88	81.55	0.00	0.00	22.68	2.22
2019	5790.20	6601	950	69.55	72.98	69.58	75.35	1.55	1.15	25.87	3.43
2020	6243.86	7106	950	95.29	98.09	74.82	80.90	0.00	0.00	1.91	2.80
2021	5662.83	6491	950	67.46	71.81	68.05	74.10	0.00	0.00	28.19	4.35

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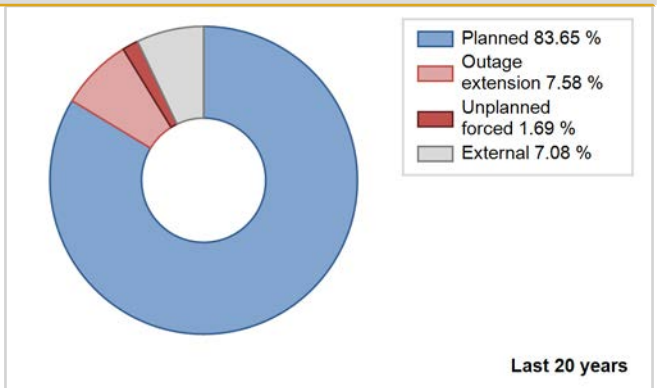
2022	Data not provided
2023	"
2024	"

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					203	
C. Inspection, maintenance or repair combined with refuelling				1457	20	
D. Inspection, maintenance or repair without refuelling				437		
E. Testing of plant systems or components				4		
F. Major backfitting, refurbishment or upgrading activities with refuelling				97	74	
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						64
L. Human factor related					7	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						5
Z. Other					2	
Subtotal				1995	306	69
Total		**0**			**2370**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		28
15. Reactor Cooling Systems		20
16. Steam generation systems		53
17. Safety I&C Systems (excluding reactor I&C)		5
31. Turbine and auxiliaries		33
32. Feedwater and Main Steam System		22
33. Circulating Water System		2
34. Miscellaneous Systems		9
35. All other I&C Systems		0
41. Main Generator Systems		22
42. Electrical Power Supply Systems		9
Total		**205**

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2024 Operating Experience

UA-56 ZAPOROZHYE-2 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1981-01-01
Grid Date	:	1985-07-22
Commercial Date	:	1986-02-15
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary

No data found

	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.82 %
Cumulative Energy Availability Factor (EAF)	:	68.49 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.9 %
Cumulative Unit Capability Factor (UCF)	:	71.03 %	Cumulative Planned Unavailability Factor (PUF)	:	25.07 %
Cumulative Load Factor (LF)	:	66.21 %	Cumulative Externally cause unavailability (XUF)	:	2.54 %
Cumulative Operating Factor (OF)	:	72.63 %			

Electricity Production (net) [GWh]

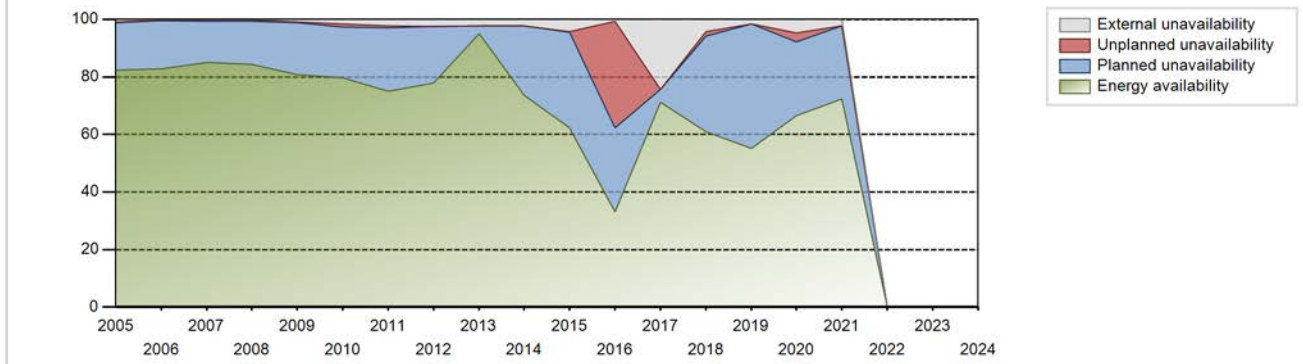


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	5651.61	6417	950	65.51	68.22	65.41	70.29	13.53	10.68	21.10	2.72
1987	6058.32	6675	1000	76.04	76.04	69.16	76.20	13.47	11.84	12.12	0.00
1988	6088.56	7253	950	81.18	81.18	72.96	82.57	7.45	6.53	12.29	0.00
1989	3050.89	3393	950	45.14	45.14	36.66	38.73	7.00	3.40	51.47	0.00
1990	1869.06	2165	950	22.35	22.55	22.46	24.71	8.56	2.11	75.34	0.21
1991	4583.92	5112	950	55.40	56.13	55.08	58.36	17.35	11.78	32.09	0.73
1992	6551.69	7016	950	76.24	77.66	78.51	79.87	5.49	4.51	17.84	1.42
1993	4386.11	6194	950	53.80	56.55	52.71	70.71	27.05	20.97	22.48	2.75
1994	4103.48	5924	950	49.83	49.93	49.31	67.63	8.00	4.34	45.73	0.10
1995	5051.78	7329	950	60.70	63.47	60.70	83.66	15.01	11.21	25.32	2.76
1996	5373.03	6247	950	64.39	67.53	64.39	71.12	5.44	3.88	28.59	3.14
1997	6081.68	6745	950	73.01	76.47	73.08	77.00	0.35	0.27	23.26	3.46
1998	4922.76	5601	950	58.97	62.95	59.15	63.94	1.01	0.64	36.41	3.98
1999	5476.01	5887	950	65.68	66.94	65.80	67.20	0.00	0.00	33.06	1.26
2000	5626.40	6281	950	67.42	70.74	67.42	71.51	1.31	0.94	28.33	3.31
2001	5867.65	6422	950	70.59	72.47	70.31	73.11	1.37	1.01	26.52	1.88
2002	6315.64	6834	950	75.87	78.84	75.89	78.01	0.78	0.62	20.54	2.97
2003	6742.38	7387	950	80.89	83.75	81.02	84.33	0.33	0.28	15.97	2.86
2004	6944.29	7531	950	83.15	85.99	83.22	85.74	0.39	0.33	13.68	2.85
2005	6303.15	7332	950	82.41	83.38	75.74	83.70	0.35	0.29	16.33	0.97
2006	6644.71	7297	950	82.82	83.03	79.85	83.30	0.38	0.31	16.66	0.21
2007	7064.48	7528	950	85.13	85.34	84.89	85.94	0.60	0.51	14.15	0.21
2008	6763.54	7470	950	84.26	84.58	81.05	85.04	0.36	0.31	15.11	0.33
2009	6127.91	7206	950	80.90	81.79	73.64	82.26	0.35	0.29	17.92	0.89
2010	6674.39	7180	950	79.78	81.39	80.20	81.96	1.25	1.03	17.58	1.61
2011	6155.30	6881	950	75.09	77.42	73.96	78.55	0.82	0.64	21.94	2.33
2012	6046.81	7202	950	77.80	80.19	72.46	81.99	0.00	0.00	19.81	2.39
2013	5857.28	7464	950	95.09	97.30	70.38	85.21	0.00	0.00	2.70	2.22
2014	6307.66	6811	950	73.55	75.75	75.80	77.75	0.12	0.09	24.16	2.19
2015	5210.05	5982	950	62.35	66.53	62.61	68.29	0.53	0.36	33.11	4.18
2016	2595.13	3041	950	33.12	33.78	31.10	34.62	3.99	37.03	29.19	0.65
2017	5361.20	8387	950	71.31	95.66	64.42	95.74	0.00	0.00	4.34	24.35
2018	5104.80	5883	950	61.06	65.34	61.34	67.16	2.42	1.62	33.04	4.28
2019	4691.92	5002	950	55.07	56.59	56.38	57.10	0.00	0.00	43.41	1.52
2020	5114.55	5783	950	66.52	71.24	61.29	65.84	0.13	3.07	25.70	4.71
2021	6238.32	6587	950	72.36	74.57	74.96	75.19	0.18	0.13	25.29	2.22
2022	Data not provided										

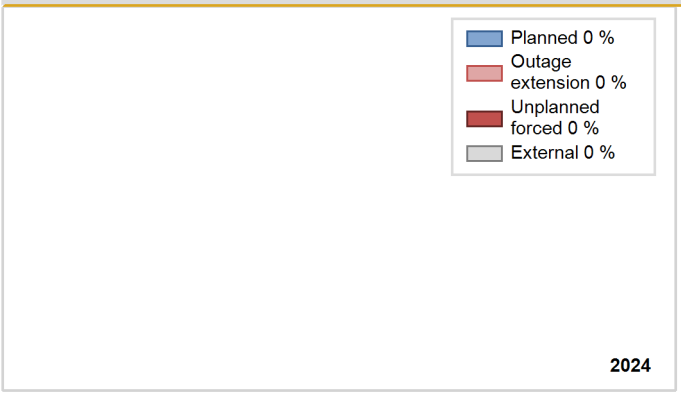
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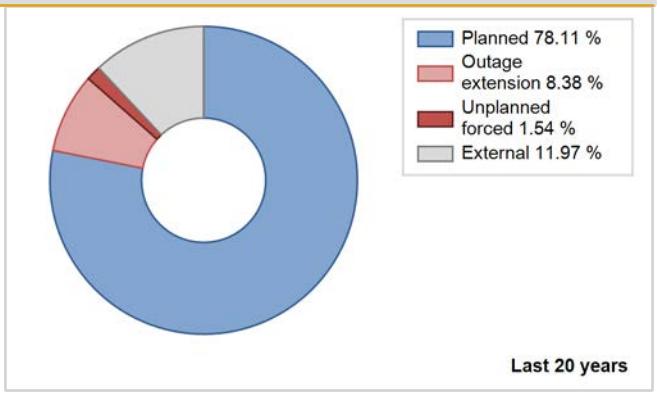
2023	"
2024	"

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					251	
C. Inspection, maintenance or repair combined with refuelling				1444		
D. Inspection, maintenance or repair without refuelling				307		
E. Testing of plant systems or components				3		
F. Major backfitting, refurbishment or upgrading activities with refuelling				64	81	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						52
L. Human factor related					2	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
Z. Other					1	
Subtotal				1818	335	56
Total		**0**			**2209**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		0
14. Safety Systems		7
15. Reactor Cooling Systems		12
16. Steam generation systems		142
17. Safety I&C Systems (excluding reactor I&C)		3
31. Turbine and auxiliaries		22
32. Feedwater and Main Steam System		5
34. Miscellaneous Systems		6
35. All other I&C Systems		5
41. Main Generator Systems		39
42. Electrical Power Supply Systems		7
Total		**255**

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2024 Operating Experience

UA-78 ZAPOROZHYE-3 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1982-04-01
Grid Date	:	1986-12-10
Commercial Date	:	1987-03-05
Age at end of year	:	38 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary

No data found

	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.32 %
Cumulative Energy Availability Factor (EAF)	:	71.38 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.54 %
Cumulative Unit Capability Factor (UCF)	:	74.09 %	Cumulative Planned Unavailability Factor (PUF)	:	23.37 %
Cumulative Load Factor (LF)	:	69.64 %	Cumulative Externally cause unavailability (XUF)	:	2.71 %
Cumulative Operating Factor (OF)	:	76.51 %			

Electricity Production (net) [GWh]

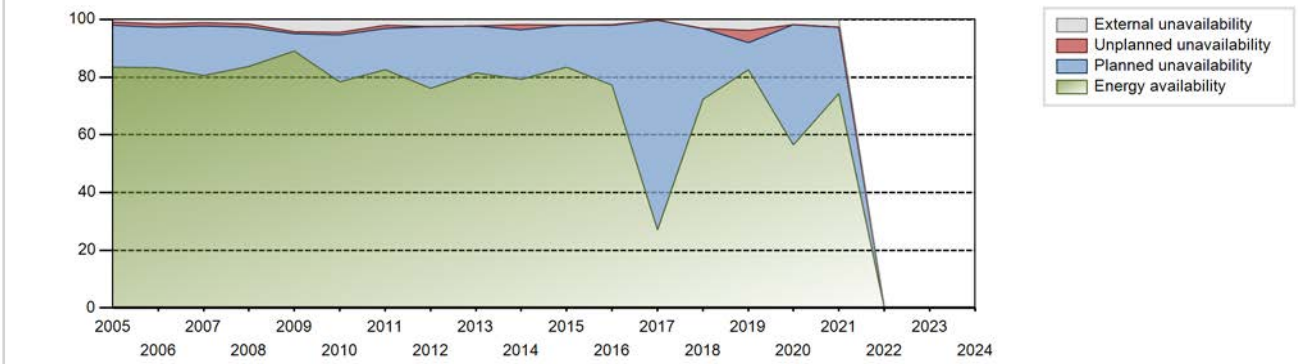


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	6690.98	7222	1000	80.32	80.32	78.39	80.15	4.02	3.37	16.31	0.00
1988	6414.29	7077	950	81.35	81.35	76.87	80.57	5.32	4.57	14.08	0.00
1989	6614.43	7373	950	80.85	80.85	79.48	84.17	3.97	3.34	15.80	0.00
1990	5625.32	6166	950	67.66	68.10	67.60	70.39	15.26	12.26	19.64	0.44
1991	4958.75	5877	950	59.91	61.09	59.59	67.09	11.90	8.25	30.66	1.18
1992	4140.90	5274	950	50.54	53.97	49.62	60.04	9.62	5.74	40.28	3.43
1993	5416.55	7263	950	66.01	67.60	65.09	82.91	19.21	16.08	16.32	1.59
1994	4273.71	6068	950	52.51	52.53	51.35	69.27	4.07	2.23	45.24	0.02
1995	4027.80	5804	950	48.38	49.72	48.40	66.26	1.31	0.66	49.62	1.35
1996	4940.20	6096	950	59.20	62.34	59.20	69.40	6.67	4.45	33.21	3.14
1997	4869.79	6544	950	58.52	70.09	58.52	74.70	3.99	2.91	27.00	11.57
1998	4953.19	6316	950	59.52	63.14	59.52	72.10	2.25	1.45	35.41	3.62
1999	5114.49	6162	950	61.46	64.75	61.46	70.34	5.25	3.59	31.66	3.29
2000	6123.23	6875	950	73.01	76.56	73.38	78.27	1.98	1.55	21.89	3.56
2001	6307.79	7027	950	75.72	80.85	75.59	80.00	2.63	2.18	16.97	5.13
2002	6602.04	7470	950	79.17	84.44	79.33	85.27	1.52	1.30	14.25	5.27
2003	6588.92	7236	950	79.01	81.93	79.17	82.60	0.63	0.52	17.55	2.92
2004	6308.69	7371	950	75.50	85.42	75.60	83.91	1.34	1.16	13.43	9.91
2005	6224.11	7229	950	83.55	84.38	74.79	82.52	1.30	1.11	14.51	0.83
2006	6048.05	7031	950	83.30	84.83	72.68	80.26	1.41	1.21	13.95	1.53
2007	6631.37	7268	950	80.48	81.72	79.68	82.97	1.34	1.11	17.17	1.24
2008	6843.24	7589	950	83.67	85.31	82.01	86.40	1.12	0.97	13.72	1.64
2009	6504.34	7996	950	88.93	93.15	78.16	91.28	0.85	0.80	6.05	4.22
2010	6319.92	7341	950	78.31	82.70	75.93	83.79	1.12	0.94	16.36	4.38
2011	6791.75	7569	950	82.59	84.71	81.61	86.40	1.27	1.09	14.20	2.12
2012	6178.42	6984	950	76.02	78.41	74.04	79.51	0.00	0.00	21.59	2.39
2013	5420.54	6518	950	81.45	83.61	65.14	74.41	0.00	0.00	16.39	2.16
2014	6279.95	7159	950	79.18	80.92	75.46	81.72	2.36	1.95	17.13	1.74
2015	6983.04	7557	950	83.36	85.40	83.91	86.27	0.08	0.07	14.53	2.04
2016	6593.10	7004	950	77.21	79.08	79.01	79.74	0.24	0.19	20.73	1.87
2017	2314.02	2440	950	27.17	27.49	27.81	27.85	0.00	0.00	72.51	0.32
2018	6166.88	6623	950	72.39	75.52	74.10	75.61	0.00	0.00	24.48	3.13
2019	6950.92	7590	950	82.52	86.42	83.52	86.64	4.52	4.09	9.49	3.90
2020	4771.20	5136	950	56.51	58.30	57.18	58.47	0.00	0.00	41.70	1.80
2021	6271.69	6748	950	74.25	76.86	75.36	77.03	0.00	0.00	23.14	2.61
2022	Data not provided										
2023	"										

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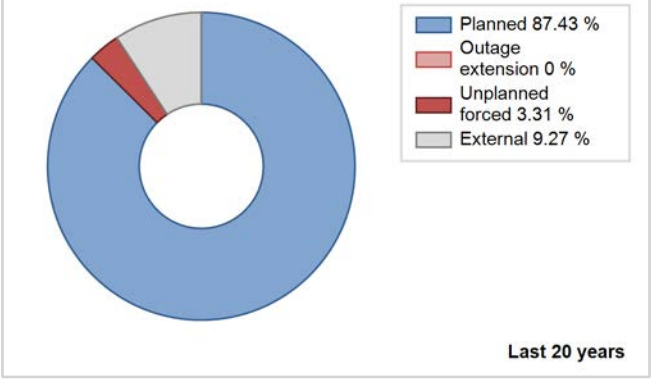
2024	"

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1987 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					67	
C.	Inspection, maintenance or repair combined with refuelling				1431		
D.	Inspection, maintenance or repair without refuelling				133		
E.	Testing of plant systems or components				12	2	
F.	Major backfitting, refurbishment or upgrading activities with refuelling				167		
J.	Grid limitation, failure or grid unavailability						7
K.	Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						50
L.	Human factor related					5	
R.	External restrictions on supply and services (lack of funds due to delayed payments from customers, disputes in fuel industries, fuel-rationing, labour strike outside the plant , spare part delivery problems etc.)						7
Z.	Other				1	3	
Subtotal					1744	77	64
Total			**0**			**1885**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		3
13. Reactor Auxiliary Systems		2
14. Safety Systems		5
15. Reactor Cooling Systems		1
16. Steam generation systems		9
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		3
32. Feedwater and Main Steam System		8
33. Circulating Water System		1
34. Miscellaneous Systems		5
35. All other I&C Systems		1
41. Main Generator Systems		26
42. Electrical Power Supply Systems		9
Total		**73**

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2024 Operating Experience

UA-79 ZAPOROZHYE-4 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1983-04-01
Grid Date	:	1987-12-18
Commercial Date	:	1988-04-14
Age at end of year	:	37 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary

No data found

	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.84 %
Cumulative Energy Availability Factor (EAF)	:	72.95 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.22 %
Cumulative Unit Capability Factor (UCF)	:	75.23 %	Cumulative Planned Unavailability Factor (PUF)	:	22.54 %
Cumulative Load Factor (LF)	:	71.45 %	Cumulative Externally cause unavailability (XUF)	:	2.28 %
Cumulative Operating Factor (OF)	:	76.34 %			

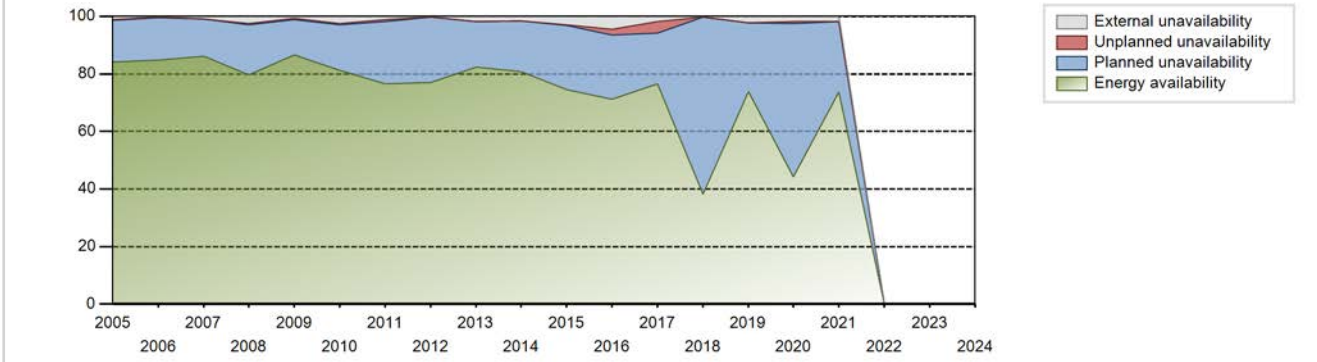
Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	6431.44	7143	950	79.07	79.07	76.53	79.96	6.22	5.25	15.68	0.00
1989	5828.07	6613	950	73.08	73.08	70.03	75.49	10.85	8.90	18.02	0.00
1990	6637.35	7393	950	78.86	79.78	79.76	84.39	8.99	7.88	12.34	0.92
1991	4259.50	5114	950	51.08	51.25	51.18	58.38	23.69	15.91	32.84	0.17
1992	6962.30	6961	1000	78.56	78.81	79.26	79.25	2.75	2.23	18.96	0.25
1993	6118.75	6821	950	73.37	74.09	73.53	77.87	12.30	10.39	15.52	0.72
1994	5888.70	6718	950	71.28	71.41	70.76	76.69	2.19	1.60	26.99	0.13
1995	4717.10	5902	950	56.68	58.41	56.68	67.37	5.56	3.44	38.15	1.73
1996	5372.18	6372	950	64.38	66.26	64.38	72.54	6.81	4.84	28.89	1.89
1997	6284.42	7060	950	75.52	79.93	75.52	80.59	2.47	2.03	18.04	4.42
1998	6022.02	6839	950	72.36	74.04	72.36	78.07	3.06	2.33	23.62	1.68
1999	3921.35	4630	950	47.12	49.83	47.12	52.85	0.58	0.29	49.88	2.71
2000	6708.40	7423	950	80.29	83.81	80.39	84.51	0.90	0.77	15.42	3.52
2001	6091.25	7884	950	73.15	89.85	72.99	89.75	0.42	0.38	9.77	16.70
2002	6337.06	6895	950	76.15	78.53	76.15	78.71	0.05	0.04	21.43	2.38
2003	6736.32	7248	950	80.87	82.45	80.95	82.74	0.04	0.04	17.52	1.58
2004	6537.56	7247	950	78.27	88.49	78.34	82.50	0.21	0.19	11.32	10.22
2005	6511.87	7498	950	84.10	85.13	78.25	85.59	0.36	0.30	14.56	1.04
2006	6621.84	7186	950	84.82	85.16	79.57	82.03	0.25	0.21	14.63	0.34
2007	7027.84	7645	950	86.22	87.10	84.45	87.27	0.02	0.02	12.88	0.88
2008	6031.59	7265	950	79.65	82.20	72.28	82.71	0.56	0.46	17.34	2.55
2009	6121.29	7111	950	86.67	87.28	73.56	81.18	0.52	0.46	12.27	0.61
2010	6388.85	7086	950	81.31	83.77	76.77	80.89	0.60	0.51	15.72	2.46
2011	6353.81	6892	950	76.58	77.65	76.35	78.68	1.01	0.80	21.56	1.06
2012	6403.06	6941	950	77.11	77.44	76.73	79.02	0.00	0.00	22.56	0.33
2013	6404.96	7580	950	82.40	84.16	76.96	86.53	0.00	0.00	15.84	1.76
2014	6582.83	7375	950	80.89	82.57	79.10	84.19	0.00	0.00	17.43	1.68
2015	6334.43	6921	950	74.46	77.41	76.12	79.01	0.18	0.14	22.45	2.95
2016	5903.10	6670	950	71.13	75.53	70.74	75.93	2.66	2.07	22.40	4.40
2017	6363.95	7006	950	76.50	78.35	76.47	79.98	4.79	3.94	17.71	1.84
2018	3220.41	3407	950	38.17	38.54	38.70	38.89	0.00	0.00	61.46	0.37
2019	6249.05	6673	950	73.81	75.98	75.09	76.18	0.00	0.00	24.02	2.17
2020	3748.24	4055	950	44.18	45.91	44.92	46.16	0.00	0.82	53.27	1.74
2021	5685.03	6170	950	73.58	75.41	68.31	70.43	0.10	0.08	24.51	1.83
2022	Data not provided										
2023	"										
2024	"										

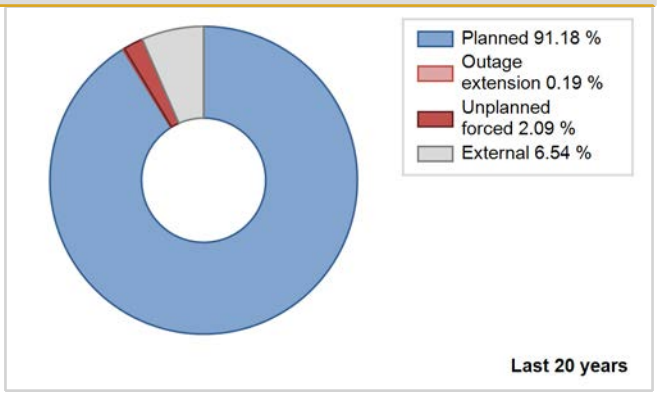
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					100	
C. Inspection, maintenance or repair combined with refuelling				1362		
D. Inspection, maintenance or repair without refuelling				354		
E. Testing of plant systems or components				10	0	
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						63
L. Human factor related					18	
Subtotal				1726	118	63
Total		**0**			**1907**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1988 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		19
12. Reactor I&C Systems		5
13. Reactor Auxiliary Systems		3
14. Safety Systems		3
15. Reactor Cooling Systems		6
16. Steam generation systems		12
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		7
32. Feedwater and Main Steam System		4
34. Miscellaneous Systems		1
35. All other I&C Systems		0
41. Main Generator Systems		51
42. Electrical Power Supply Systems		3
Total		**115**

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2024 Operating Experience

UA-126 ZAPOROZHYE-5 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1985-11-01
Grid Date	:	1989-08-14
Commercial Date	:	1989-10-27
Age at end of year	:	35 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary

No data found

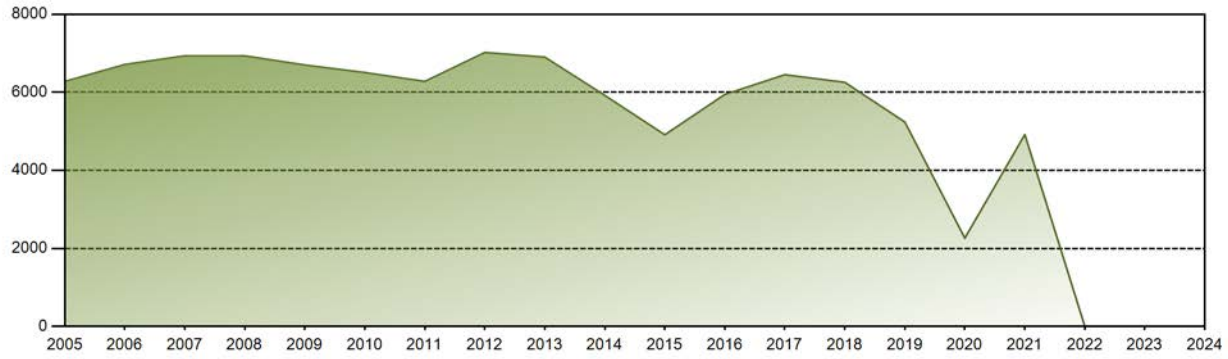
	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.95 %
Cumulative Energy Availability Factor (EAF)	:	73.35 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.82 %
Cumulative Unit Capability Factor (UCF)	:	75.31 %	Cumulative Planned Unavailability Factor (PUF)	:	21.87 %
Cumulative Load Factor (LF)	:	71.77 %	Cumulative Externally cause unavailability (XUF)	:	1.96 %
Cumulative Operating Factor (OF)	:	76.95 %			

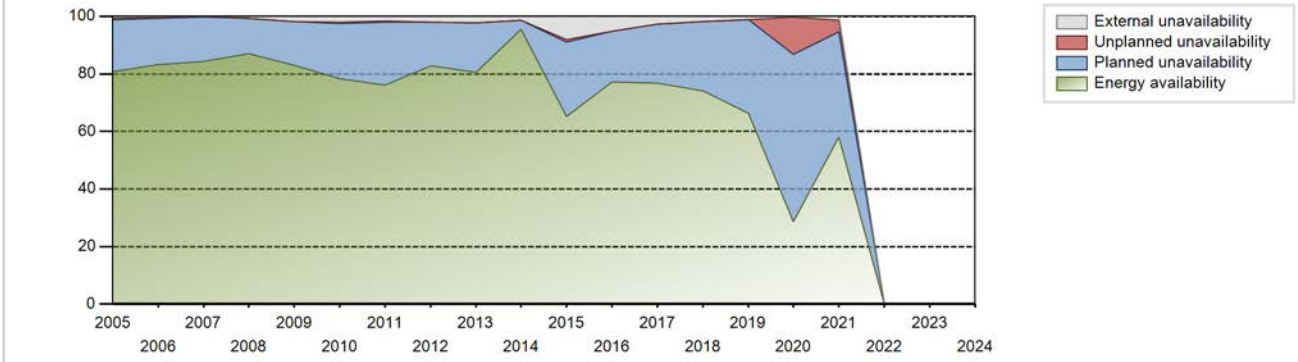
Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	2147.46	2938	950	85.59	85.59	80.54	86.20	10.02	9.54	4.88	0.00
1990	4678.67	6002	950	56.65	57.92	56.22	68.52	20.69	15.11	26.98	1.27
1991	6554.93	7319	950	78.38	79.49	78.77	83.55	8.70	7.57	12.94	1.11
1992	6898.80	7032	1000	79.16	80.12	78.54	80.05	2.62	2.15	17.73	0.95
1993	5661.77	6735	950	68.26	68.92	68.03	76.88	13.97	11.19	19.88	0.66
1994	4858.94	6779	950	59.12	59.13	58.39	77.39	20.05	14.83	26.04	0.02
1995	5391.90	6506	950	64.73	66.00	64.79	74.27	4.95	3.44	30.56	1.27
1996	6126.05	6799	950	73.41	74.14	73.41	77.40	2.38	1.81	24.05	0.73
1997	6381.48	6705	950	75.77	76.23	76.68	76.54	2.33	1.82	21.95	0.46
1998	5856.23	6249	950	70.12	70.72	70.37	71.34	1.34	0.96	28.31	0.60
1999	5070.20	5525	950	60.60	62.96	60.93	63.07	0.00	0.00	37.04	2.36
2000	6286.64	6928	950	74.89	77.87	75.34	78.87	1.02	0.80	21.34	2.97
2001	5890.83	6751	950	70.66	76.19	70.59	76.86	1.90	1.48	22.33	5.54
2002	6222.49	6983	950	74.55	80.79	74.77	79.71	1.22	0.99	18.21	6.25
2003	6585.47	7107	950	79.00	80.20	79.13	81.13	8.06	7.03	12.77	1.20
2004	6826.67	7551	950	81.62	85.58	81.81	85.96	0.28	0.24	14.18	3.97
2005	6278.94	6975	950	80.79	81.48	75.45	79.62	0.66	0.54	17.98	0.69
2006	6713.60	7297	950	83.28	83.72	80.67	83.30	0.24	0.20	16.08	0.44
2007	6936.51	7408	950	84.26	84.29	83.35	84.57	0.18	0.15	15.56	0.03
2008	6935.93	7708	950	86.95	87.59	83.12	87.75	0.06	0.06	12.35	0.64
2009	6700.77	7445	950	83.02	84.88	80.52	84.99	0.01	0.01	15.11	1.86
2010	6507.63	7081	950	78.30	80.42	78.20	80.83	0.36	0.29	19.29	2.13
2011	6280.40	6861	950	76.04	77.71	75.47	78.32	0.41	0.32	21.97	1.67
2012	7022.33	7545	950	82.91	84.95	84.15	85.89	0.00	0.00	15.05	2.04
2013	6903.10	7381	950	80.66	82.98	82.95	84.26	0.00	0.00	17.02	2.31
2014	5920.96	7601	950	95.58	97.01	71.15	86.77	0.00	0.00	2.99	1.44
2015	4911.23	6519	950	65.24	73.21	59.01	74.41	1.31	0.97	25.82	7.96
2016	5945.32	7345	950	77.23	82.48	71.25	83.62	0.00	0.00	17.52	5.26
2017	6452.82	7052	950	76.79	79.39	77.54	80.50	0.00	0.00	20.61	2.60
2018	6256.59	6742	950	74.12	75.95	75.18	76.96	0.00	0.00	24.05	1.83
2019	5239.69	5999	950	66.35	67.56	62.96	68.48	0.00	0.00	32.44	1.21
2020	2261.14	2546	950	28.52	28.71	27.10	28.98	0.00	13.11	58.18	0.18
2021	4915.79	5255	950	58.02	59.36	59.07	59.99	0.27	4.00	36.64	1.34
2022	Data not provided										
2023	"										
2024	"										

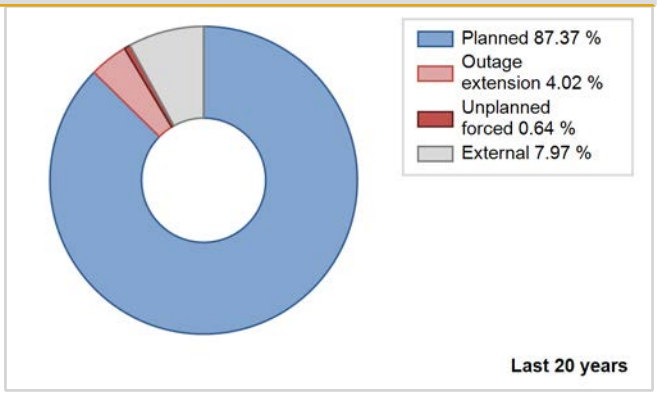
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					97	
C. Inspection, maintenance or repair combined with refuelling				1386		
D. Inspection, maintenance or repair without refuelling				138		
E. Testing of plant systems or components				14		
F. Major backfitting, refurbishment or upgrading activities with refuelling				145		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						41
L. Human factor related					5	
Z. Other					1	
Subtotal				1683	103	41
Total		**0**			**1827**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1989 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		4
14. Safety Systems		33
15. Reactor Cooling Systems		7
16. Steam generation systems		34
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		5
32. Feedwater and Main Steam System		4
41. Main Generator Systems		5
42. Electrical Power Supply Systems		5
Total		**98**

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2024 Operating Experience

UA-127 ZAPOROZHYE-6 UKRAINE



Status at end of year	:	**Operational**
Operator	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Owner	:	NNEGC (State Enterprise “National Nuclear Energy Generating Company ‘Energoatom”)
Reactor Supplier	:	PAIP (PRODUCTION AMALGAMATION IZHORSKY PLANT ATOMMASH,VOLGODONSK,RUSSIA)
Turbine Supplier	:	KTP (Kharkiv Turbine Plant "Turboatom")

Reactor Unit Details

Reactor type and model	:	PWR / VVER V-320
Thermal power	:	3000 MWth
Gross electrical power	:	1000 MWe
Reference unit power (net)	:	950 MWe

Key Dates

Construction Date	:	1986-06-01
Grid Date	:	1995-10-19
Commercial Date	:	1996-09-17
Age at end of year	:	29 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	12
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.16
Active core height/length [m]	:	3.53
Number of fissile fuel assemblies/bundles	:	163
Fuel linear heat generation rate [kW/m]	:	17.6
Number of control rod assemblies	:	61
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

Operating coolant pressure [MPa]	:	16
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	5
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1500
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	2
Number of on-site safety related diesel generators	:	3
Non-electrical applications	:	DH

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	0 %
Unit Capability Factor (UCF)	:	0 %
Load Factor (LF)	:	0 %
Operating Factor (OF)	:	0 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary

No data found

	Jan	Oct	Nov	Dec	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
GW(e)-h												
EAF [%]												
UCF [%]												
LF [%]												
OF [%]												
FLR [%]												
UCL [%]												
PUF [%]												
XUF [%]												

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.53 %
Cumulative Energy Availability Factor (EAF)	:	78.62 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.43 %
Cumulative Unit Capability Factor (UCF)	:	80.73 %	Cumulative Planned Unavailability Factor (PUF)	:	18.84 %
Cumulative Load Factor (LF)	:	77.76 %	Cumulative Externally cause unavailability (XUF)	:	2.11 %
Cumulative Operating Factor (OF)	:	80.51 %			

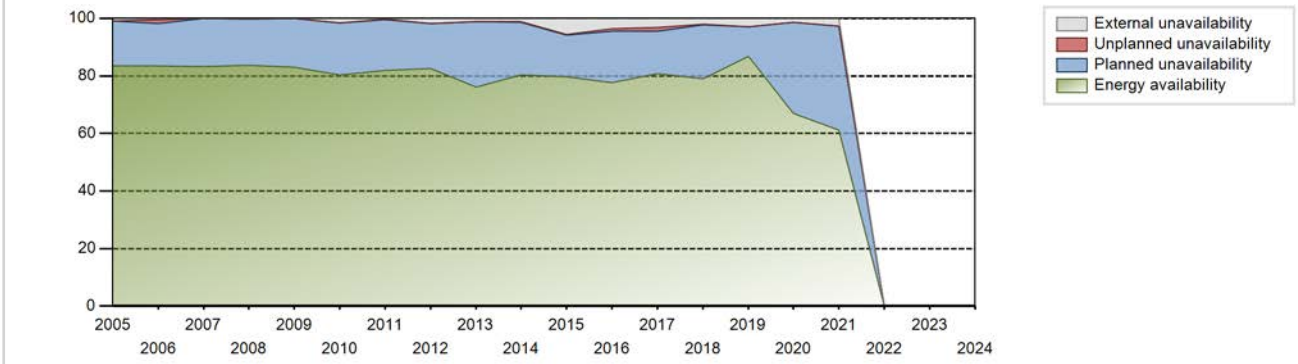
Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1996	6403.54	7871	950	85.50	87.53	85.50	87.87	0.00	0.00	12.47	2.02
1997	6332.68	6640	950	75.18	75.50	76.10	75.80	0.96	0.73	23.77	0.32
1998	6132.18	6766	950	73.41	76.19	73.69	77.24	1.09	0.84	22.97	2.78
1999	6165.39	6934	950	74.09	78.37	74.09	79.16	0.42	0.33	21.30	4.28
2000	5844.18	6191	950	69.29	70.13	70.03	70.48	1.55	1.11	28.76	0.84
2001	6336.18	7118	950	75.23	80.10	75.93	81.03	1.51	1.23	18.68	4.86
2002	6790.62	7393	950	80.96	83.41	81.60	84.39	1.54	1.31	15.28	2.46
2003	7006.44	7590	950	83.47	86.29	84.19	86.64	0.40	0.35	13.37	2.82
2004	6867.82	7715	950	81.73	87.35	82.30	87.83	0.43	0.38	12.27	5.62
2005	5850.74	6557	950	83.53	84.47	70.30	74.85	0.00	0.00	15.53	0.95
2006	6855.00	7317	950	83.56	84.01	82.37	83.53	1.49	1.27	14.73	0.45
2007	6756.35	7275	950	83.33	83.35	81.19	83.05	0.09	0.08	16.57	0.02
2008	6355.28	6888	950	83.70	83.85	76.16	78.42	0.00	0.00	16.15	0.15
2009	6964.63	7285	950	82.94	82.98	83.69	83.16	0.01	0.01	17.01	0.04
2010	6583.55	7181	950	80.27	81.80	79.11	81.97	0.09	0.08	18.12	1.53
2011	6820.92	7254	950	81.91	82.14	81.96	82.81	0.20	0.17	17.70	0.22
2012	6911.00	7496	950	82.65	84.48	82.82	85.34	0.00	0.00	15.52	1.82
2013	6356.96	6819	950	76.01	77.15	76.39	77.84	0.00	0.00	22.85	1.14
2014	6704.13	7217	950	80.32	81.47	80.56	82.39	0.38	0.31	18.22	1.14
2015	6863.82	7601	950	79.76	85.37	82.48	86.77	0.29	0.24	14.38	5.61
2016	6179.42	7225	950	77.58	81.27	74.05	82.25	0.86	0.71	18.02	3.70
2017	6473.26	7450	950	80.76	83.98	77.78	85.05	1.60	1.37	14.65	3.22
2018	6907.39	7188	950	79.07	81.03	83.00	82.05	0.37	0.30	18.67	1.95
2019	7356.44	8015	950	86.83	89.70	88.40	91.50	0.04	0.04	10.26	2.86
2020	4998.20	5492	950	67.05	68.32	59.90	62.52	0.00	0.00	31.68	1.27
2021	5338.28	5693	950	61.27	63.92	64.15	64.99	0.00	0.00	36.08	2.65
2022	Data not provided										
2023	"										
2024	"										

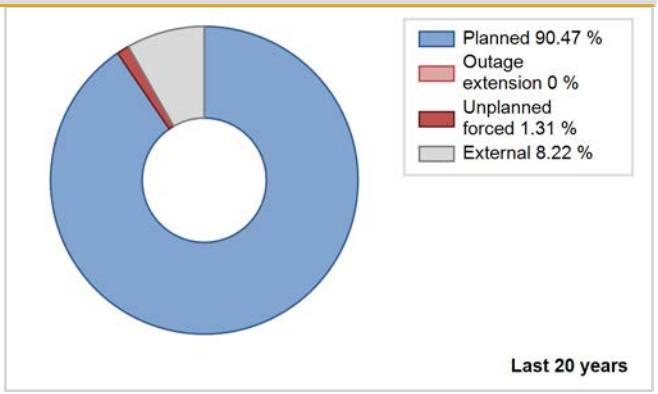
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1996 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					26	
C. Inspection, maintenance or repair combined with refuelling				1383		
D. Inspection, maintenance or repair without refuelling				58		
E. Testing of plant systems or components				16		
J. Grid limitation, failure or grid unavailability						0
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						69
Subtotal				1457	26	69
Total		**0**			**1552**	

Equipment Related Unplanned Full Outages, Analysis by System

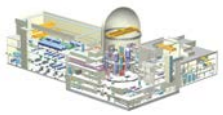
System	2024	1996 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		1
14. Safety Systems		1
15. Reactor Cooling Systems		5
16. Steam generation systems		6
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		5
32. Feedwater and Main Steam System		0
34. Miscellaneous Systems		1
35. All other I&C Systems		1
41. Main Generator Systems		3
42. Electrical Power Supply Systems		2
Total		**26**

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2024 Operating Experience

AE-01 BARAKAH-1 UNITED ARAB EMIRATES

Status at end of year	:	**Operational**
Operator	:	NAWAH (Nawah Energy Company)
Owner	:	ENEC (Emirates Nuclear Energy Corporation)
Reactor Supplier	:	KEPCO (Korea Electric Power Corporation)
Turbine Supplier	:	KEPCO (Korea Electric Power Corporation)



Reactor Unit Details

Reactor type and model	:	PWR / APR-1400
Thermal power	:	3983 MWth
Gross electrical power	:	1417 MWe
Reference unit power (net)	:	1337 MWe

Key Dates

Construction Date	:	2012-07-19
Grid Date	:	2020-08-19
Commercial Date	:	2021-04-01
Age at end of year	:	4 years

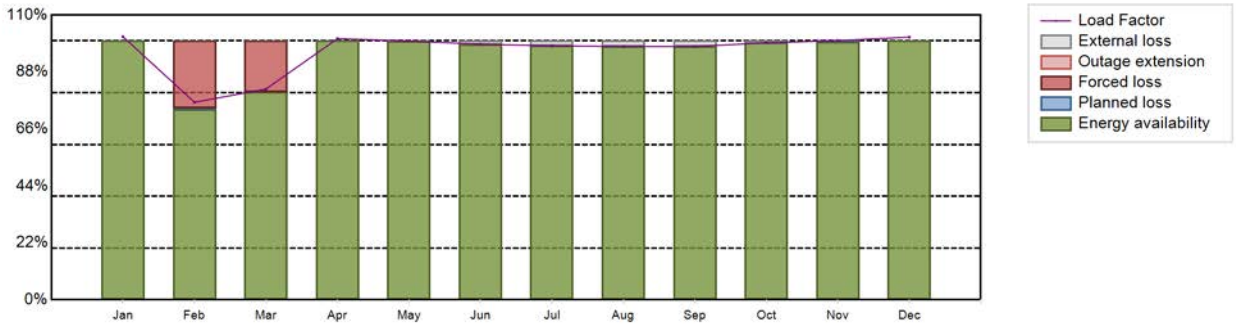
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.513
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	323.9
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.414
Average fuel enrichment [% of U235]	:	2.66	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	28914	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.647	HP cylinder inlet steam pressure [MPa]	:	6.629
Active core height/length [m]	:	3.81	Output voltage [kV]	:	27
Number of fissile fuel assemblies/bundles	:	241	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	47.572	Number of main condensate pumps	:	3
Number of control rod assemblies	:	81	Number of FW pumps for full power operation	:	3
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	11297.9 GW(e).h	Forced Loss Rate (FLR)	:	3.74 %
Energy Availability Factor (EAF)	:	95.5 %	Unplanned Capability Loss Factor (UCL)	:	3.73 %
Unit Capability Factor (UCF)	:	96.17 %	Planned Unavailability Factor (PUF)	:	0.09 %
Load Factor (LF)	:	96.2 %	Externally cause unavailability (XUF)	:	0.67 %
Operating Factor (OF)	:	96.53 %	Total off-line time	:	305 hours

Annual Summary



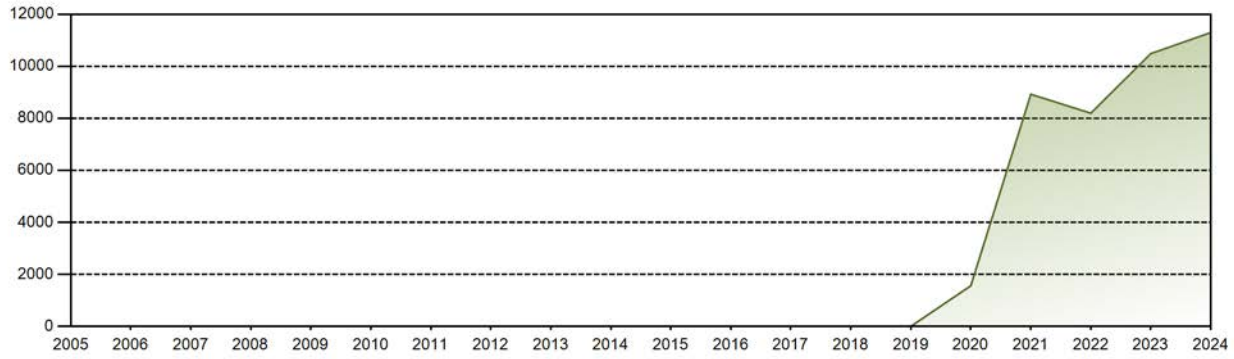
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1010.87	710.02	809.79	970.98	994.44	950.13	975.91	973.35	942.04	987.20	963.79	1009.37	11297.89
EAF [%]	100.00	73.56	80.24	100.00	99.97	98.70	98.11	97.85	97.86	99.24	99.51	100.00	95.50
UCF [%]	100.00	73.56	80.24	100.00	100.00	100.00	99.96	99.90	100.00	99.92	99.51	100.00	96.17
LF [%]	101.62	76.30	81.41	100.87	99.97	98.70	98.11	97.85	97.86	99.24	100.12	101.47	96.20
OF [%]	100.00	73.99	83.33	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	96.53
FLR [%]	0.00	26.12	19.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.74
UCL [%]	0.00	26.01	19.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.73
PUF [%]	0.00	0.44	0.00	0.00	0.00	0.00	0.04	0.10	0.00	0.08	0.49	0.00	0.09
XUF [%]	0.00	0.00	0.00	0.00	0.03	1.30	1.86	2.05	2.14	0.68	0.00	0.00	0.67

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Historical Summary

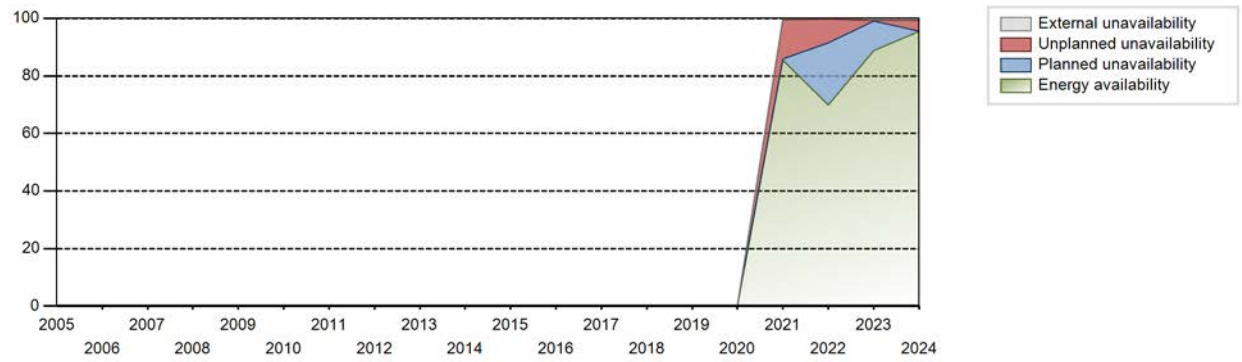
Lifetime energy generation	:	40470.72 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.39 %
Cumulative Energy Availability Factor (EAF)	:	84.9 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6 %
Cumulative Unit Capability Factor (UCF)	:	85.48 %	Cumulative Planned Unavailability Factor (PUF)	:	8.52 %
Cumulative Load Factor (LF)	:	85.3 %	Cumulative Externally cause unavailability (XUF)	:	0.58 %
Cumulative Operating Factor (OF)	:	87.26 %			

Electricity Production (net) [GWh]

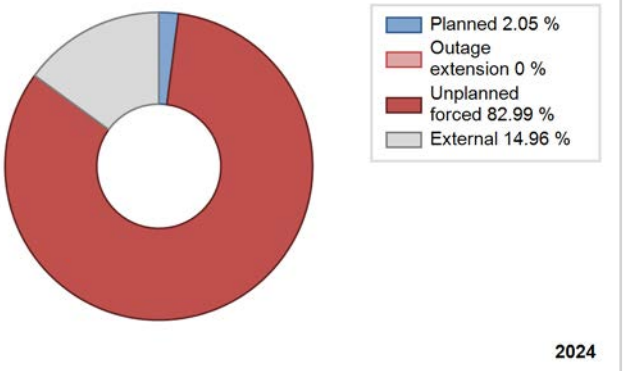


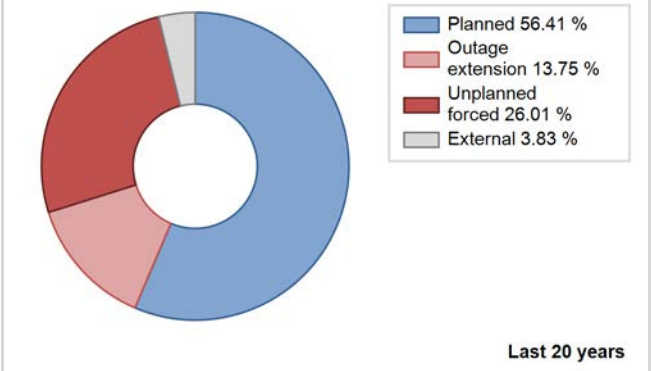
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2021	8926.09	6763	1417	85.44	85.98	85.49	91.77	13.54	13.47	0.55	0.54
2022	8196.79	6269	1337	69.89	70.18	69.99	71.56	0.53	8.26	21.55	0.30
2023	10488.13	7906	1337	88.87	89.66	89.55	90.25	0.06	0.05	10.29	0.79
2024	11297.90	8479	1337	95.50	96.17	96.20	96.53	3.74	3.73	0.09	0.67

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2021 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		305			303	
C. Inspection, maintenance or repair combined with refuelling				612		
D. Inspection, maintenance or repair without refuelling				323		
Z. Other					339	
Subtotal		305		935	642	
Total		**305**			**1577**	

Equipment Related Unplanned Full Outages, Analysis by System

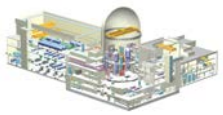
System	2024	2021 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		116
33. Circulating Water System		92
41. Main Generator Systems	305	76
Total	**305**	**284**

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2024 Operating Experience

AE-02 BARAKAH-2 UNITED ARAB EMIRATES

Status at end of year	:	**Operational**
Operator	:	NAWAH (Nawah Energy Company)
Owner	:	ENEC (Emirates Nuclear Energy Corporation)
Reactor Supplier	:	KEPCO (Korea Electric Power Corporation)
Turbine Supplier	:	KEPCO (Korea Electric Power Corporation)



Reactor Unit Details

Reactor type and model	:	PWR / APR-1400
Thermal power	:	3983 MWth
Gross electrical power	:	1417 MWe
Reference unit power (net)	:	1337 MWe

Key Dates

Construction Date	:	2013-04-15
Grid Date	:	2021-09-14
Commercial Date	:	2022-03-24
Age at end of year	:	3 years

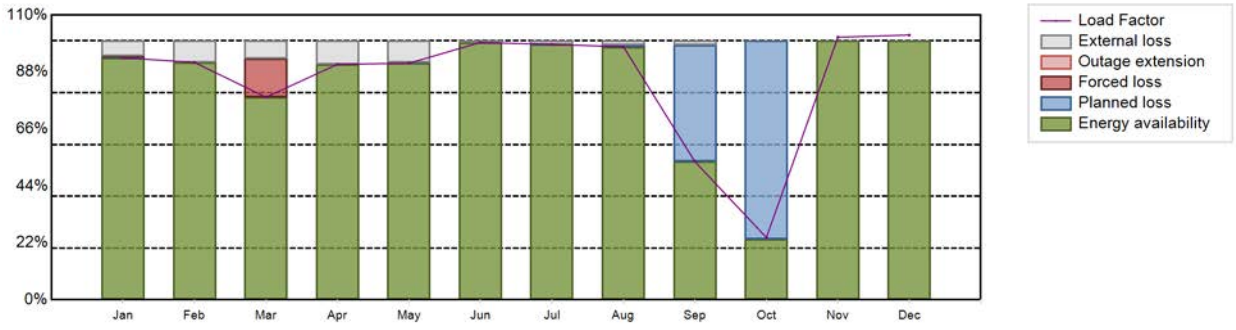
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.513
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	323.9
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.414
Average fuel enrichment [% of U235]	:	2.66	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	28914	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	3.647	HP cylinder inlet steam pressure [MPa]	:	6.629
Active core height/length [m]	:	3.81	Output voltage [kV]	:	27
Number of fissile fuel assemblies/bundles	:	241	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.9	Number of main condensate pumps	:	3
Number of control rod assemblies	:	81	Number of FW pumps for full power operation	:	2
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10003.55 GW(e).h	Forced Loss Rate (FLR)	:	1.45 %
Energy Availability Factor (EAF)	:	84.82 %	Unplanned Capability Loss Factor (UCL)	:	1.3 %
Unit Capability Factor (UCF)	:	88.45 %	Planned Unavailability Factor (PUF)	:	10.25 %
Load Factor (LF)	:	85.18 %	Externally cause unavailability (XUF)	:	3.63 %
Operating Factor (OF)	:	90.45 %	Total off-line time	:	839 hours

Annual Summary



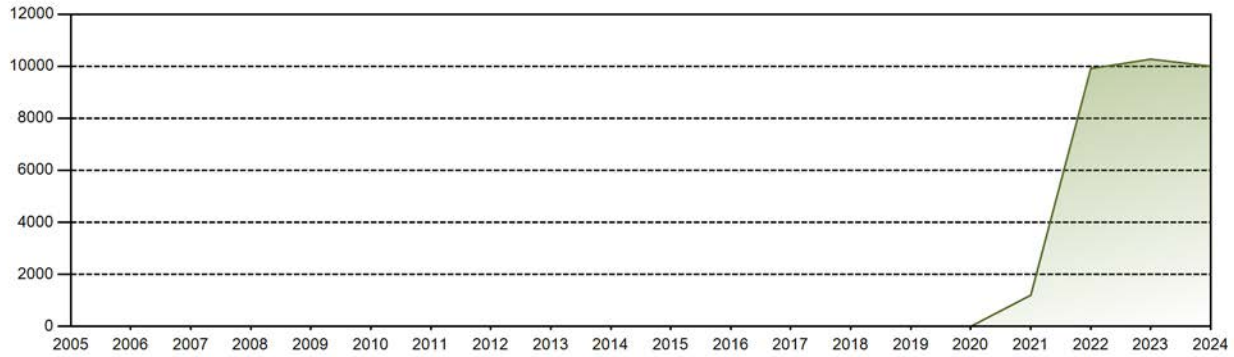
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	930.00	853.16	778.61	875.41	909.12	956.81	981.17	972.31	513.93	239.42	976.28	1017.33	10003.55
EAF [%]	93.49	91.68	78.27	90.94	91.39	99.39	98.64	97.75	53.39	23.50	100.00	100.00	84.82
UCF [%]	99.42	100.00	85.05	100.00	99.80	100.00	99.91	99.43	55.11	23.50	100.00	100.00	88.45
LF [%]	93.49	91.68	78.27	90.94	91.39	99.39	98.64	97.75	53.39	24.07	101.42	102.27	85.18
OF [%]	100.00	100.00	87.10	100.00	100.00	100.00	100.00	100.00	63.47	35.48	100.00	100.00	90.45
FLR [%]	0.41	0.00	14.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.45
UCL [%]	0.41	0.00	14.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30
PUF [%]	0.16	0.00	0.00	0.00	0.20	0.00	0.09	0.57	44.89	76.50	0.00	0.00	10.25
XUF [%]	5.93	8.32	6.78	9.06	8.41	0.61	1.28	1.68	1.72	0.00	0.00	0.00	3.63

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Historical Summary

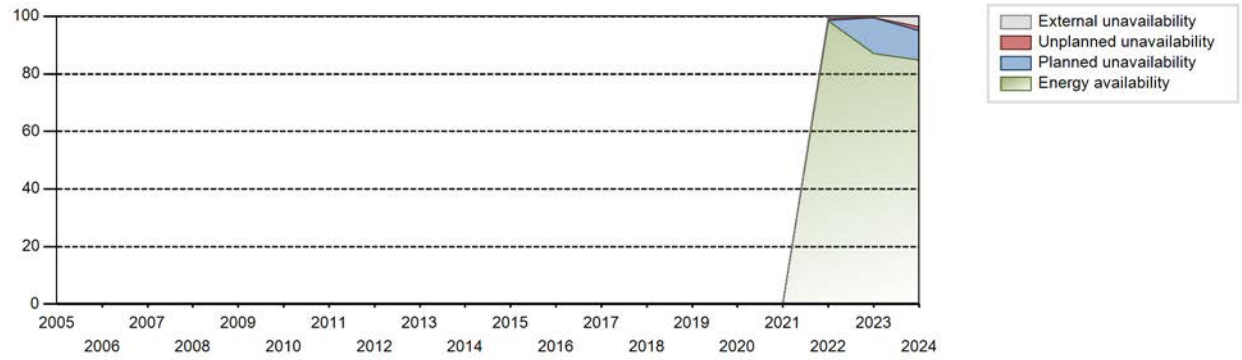
Lifetime energy generation	:	31392.44 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.7 %
Cumulative Energy Availability Factor (EAF)	:	89.38 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.65 %
Cumulative Unit Capability Factor (UCF)	:	91.05 %	Cumulative Planned Unavailability Factor (PUF)	:	8.3 %
Cumulative Load Factor (LF)	:	89.64 %	Cumulative Externally cause unavailability (XUF)	:	1.68 %
Cumulative Operating Factor (OF)	:	92.23 %			

Electricity Production (net) [GWh]

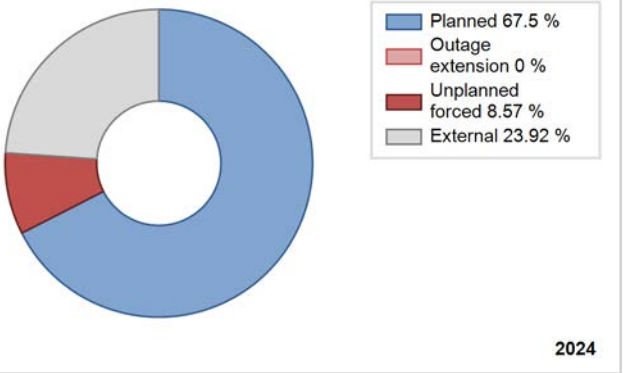


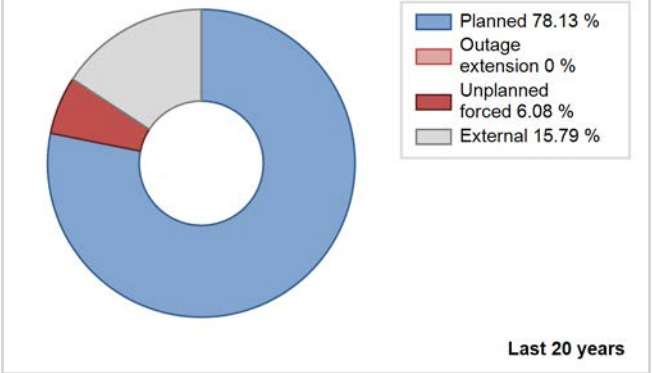
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2022	9914.13	7723	1337	98.44	99.11	98.12	100.00	0.61	0.61	0.28	0.67
2023	10274.57	7723	1337	87.12	87.59	87.73	88.16	0.02	0.02	12.39	0.48
2024	10003.55	7945	1337	84.82	88.45	85.18	90.45	1.45	1.30	10.25	3.63

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2022 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		96			260	
C. Inspection, maintenance or repair combined with refuelling	743			647		
D. Inspection, maintenance or repair without refuelling				356		
Subtotal	743	96		1003	260	
Total		**839**			**1263**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2022 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		17
15. Reactor Cooling Systems		90
31. Turbine and auxiliaries		78
41. Main Generator Systems	96	29
Total	**96**	**214**

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2024 Operating Experience

AE-03 BARAKAH-3 UNITED ARAB EMIRATES

Status at end of year	:	**Operational**
Operator	:	NAWAH (Nawah Energy Company)
Owner	:	ENEC (Emirates Nuclear Energy Corporation)
Reactor Supplier	:	KEPCO (Korea Electric Power Corporation)
Turbine Supplier	:	KEPCO (Korea Electric Power Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / APR-1400
Thermal power	:	3983 MWth
Gross electrical power	:	1417 MWe
Reference unit power (net)	:	1337 MWe

Key Dates

Construction Date	:	2014-09-24
Grid Date	:	2022-10-08
Commercial Date	:	2023-02-24
Age at end of year	:	2 years

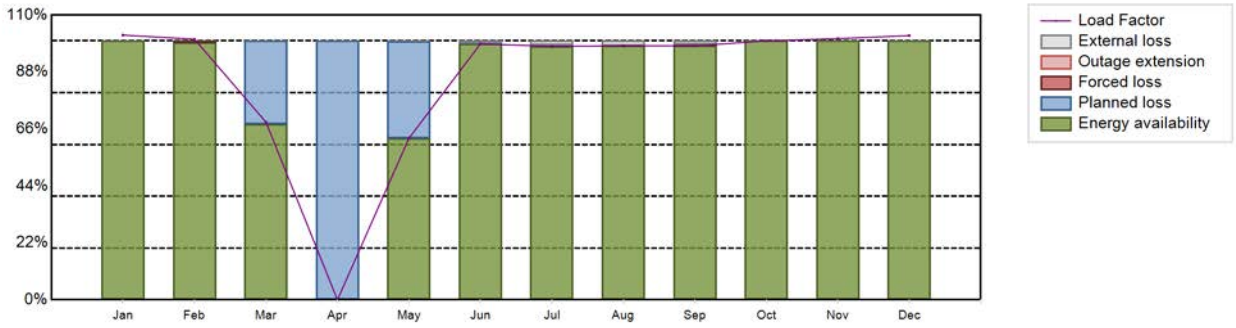
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	-
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	28914	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10083.68 GW(e).h	Forced Loss Rate (FLR)	:	0.11 %
Energy Availability Factor (EAF)	:	85.24 %	Unplanned Capability Loss Factor (UCL)	:	0.09 %
Unit Capability Factor (UCF)	:	85.76 %	Planned Unavailability Factor (PUF)	:	14.15 %
Load Factor (LF)	:	85.86 %	Externally cause unavailability (XUF)	:	0.51 %
Operating Factor (OF)	:	86.65 %	Total off-line time	:	1173 hours

Annual Summary



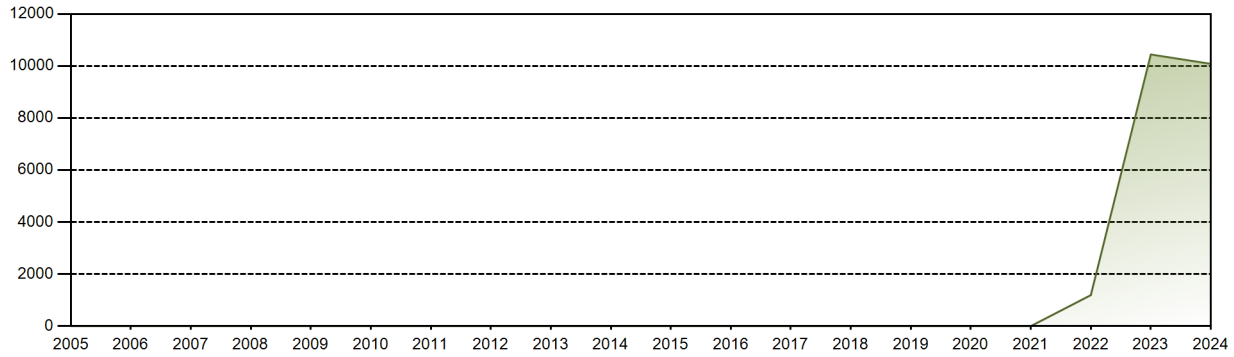
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	1017.05	936.74	682.86	0.00	620.79	951.57	973.79	975.66	944.17	994.94	971.04	1015.08	10083.68
EAF [%]	100.00	99.31	67.78	0.00	62.41	98.85	97.90	98.08	98.08	100.00	100.00	100.00	85.24
UCF [%]	100.00	99.31	67.78	0.00	62.67	99.82	99.42	100.00	99.55	100.00	100.00	100.00	85.76
LF [%]	102.24	100.66	68.65	0.00	62.41	98.85	97.90	98.08	98.08	100.02	100.87	102.05	85.86
OF [%]	100.00	100.00	68.01	0.00	71.10	100.00	100.00	100.00	100.00	100.00	100.00	100.00	86.65
FLR [%]	0.00	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.11
UCL [%]	0.00	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.09
PUF [%]	0.00	0.00	32.22	100.00	37.33	0.18	0.58	0.00	0.00	0.00	0.00	0.00	14.15
XUF [%]	0.00	0.00	0.00	0.00	0.26	0.97	1.52	1.92	1.47	0.00	0.00	0.00	0.51

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Historical Summary

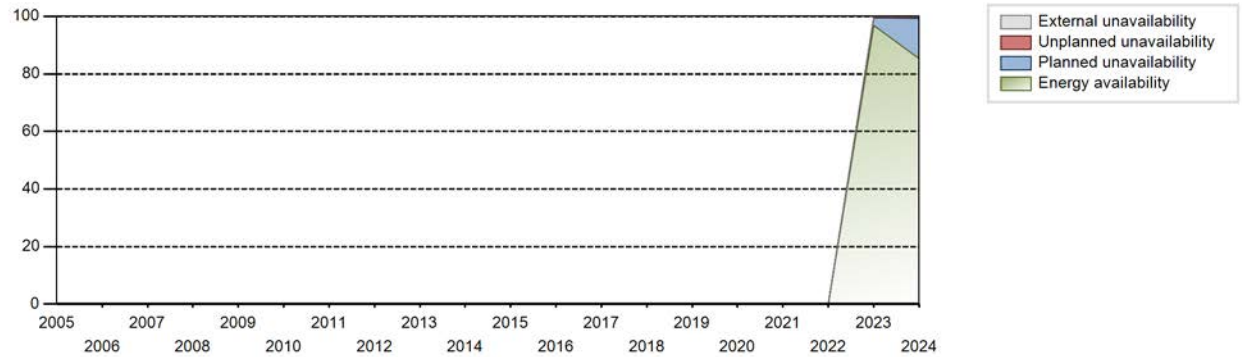
Lifetime energy generation	:	21716.04 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.05 %
Cumulative Energy Availability Factor (EAF)	:	90.52 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.05 %
Cumulative Unit Capability Factor (UCF)	:	91.04 %	Cumulative Planned Unavailability Factor (PUF)	:	8.91 %
Cumulative Load Factor (LF)	:	91.24 %	Cumulative Externally cause unavailability (XUF)	:	0.52 %
Cumulative Operating Factor (OF)	:	91.68 %			

Electricity Production (net) [GWh]

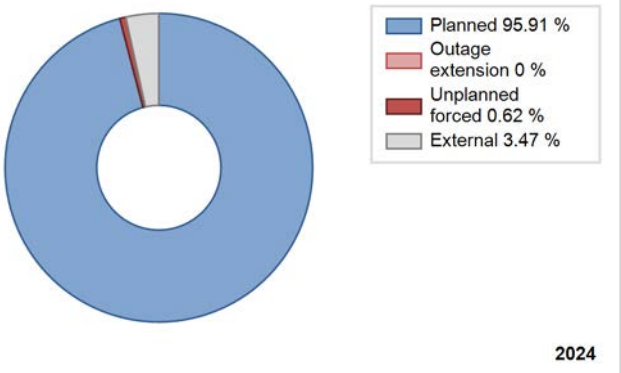


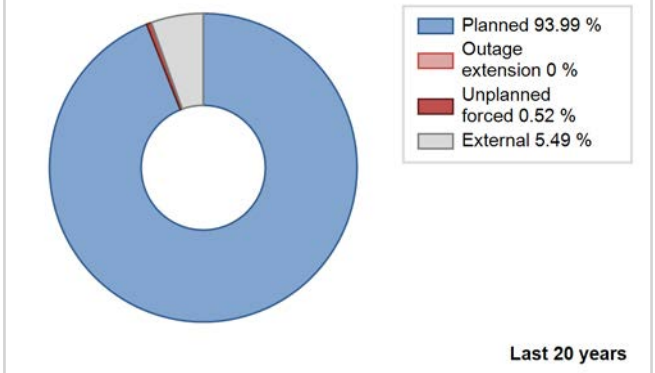
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2023	10442.83	7865	1337	96.83	97.36	97.68	97.70	0.00	0.00	2.64	0.53
2024	10083.68	7611	1337	85.24	85.76	85.86	86.65	0.11	0.09	14.15	0.51

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2023 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					45	
C. Inspection, maintenance or repair combined with refuelling	1173			640		
D. Inspection, maintenance or repair without refuelling				92		
E. Testing of plant systems or components				535		
Subtotal	1173			1267	45	
Total	**1173**			**1312**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2023 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		37
Total		**37**

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2024 Operating Experience

AE-04 BARAKAH-4 UNITED ARAB EMIRATES

Status at end of year	:	**Operational**
Operator	:	NAWAH (Nawah Energy Company)
Owner	:	ENEC (Emirates Nuclear Energy Corporation)
Reactor Supplier	:	KEPCO (Korea Electric Power Corporation)
Turbine Supplier	:	KEPCO (Korea Electric Power Corporation)

Reactor Unit Details

Reactor type and model	:	PWR / APR-1400
Thermal power	:	3983 MWth
Gross electrical power	:	1417 MWe
Reference unit power (net)	:	1337 MWe

Key Dates

Construction Date	:	2015-07-30
Grid Date	:	2024-03-23
Commercial Date	:	2024-09-05
Age at end of year	:	0 years

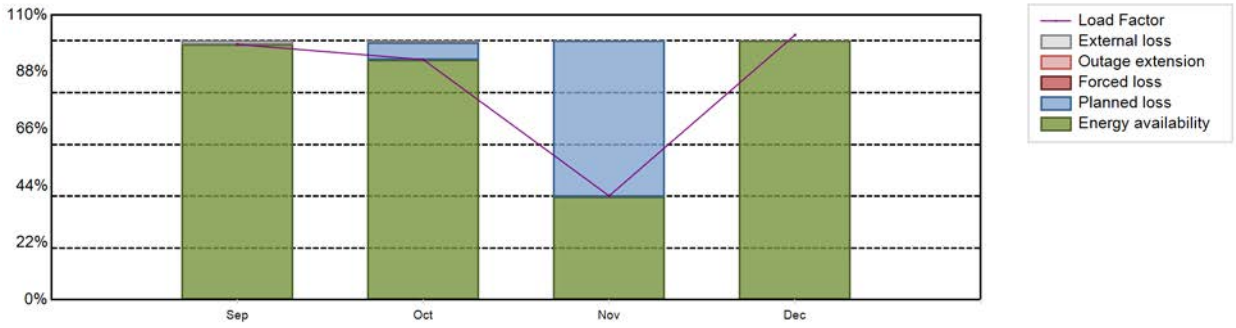
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	-
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	1500
Average discharge burnup [MWd/t]	:	28914	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	2
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5119.36 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	83.04 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	83.53 %	Planned Unavailability Factor (PUF)	:	16.47 %
Load Factor (LF)	:	83.7 %	Externally cause unavailability (XUF)	:	0.49 %
Operating Factor (OF)	:	89.75 %	Total off-line time	:	1929 hours

Annual Summary



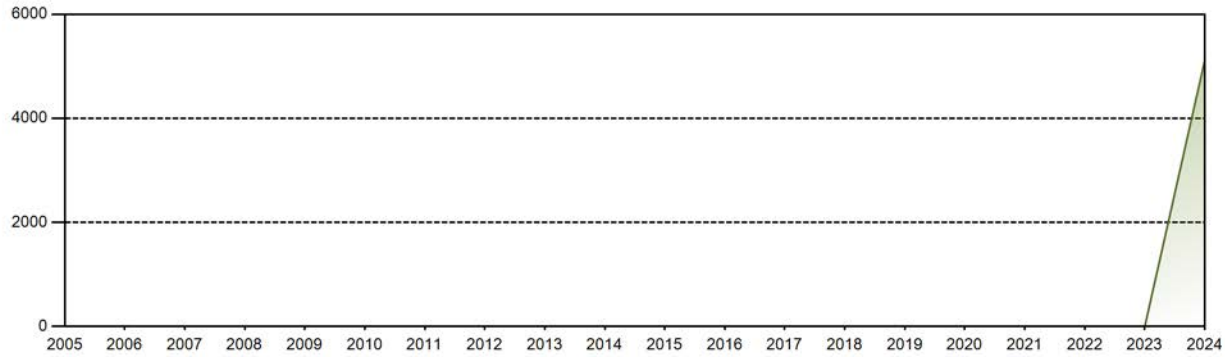
	Jan	Feb	Mar	Apr	Aug	May	Jun	Jul	Sep	Oct	Nov	Dec	Annual
GW(e)-h									949.40	922.98	386.56	1017.61	3276.55
EAF [%]									98.63	92.79	39.85	100.00	83.04
UCF [%]									100.00	93.38	39.85	100.00	83.53
LF [%]									98.63	92.79	40.16	102.30	83.70
OF [%]									100.00	99.87	58.47	100.00	89.75
FLR [%]									0.00	0.00	0.00	0.00	0.00
UCL [%]									0.00	0.00	0.00	0.00	0.00
PUF [%]									0.00	6.62	60.15	0.00	16.47
XUF [%]									1.37	0.60	0.00	0.00	0.49

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Historical Summary

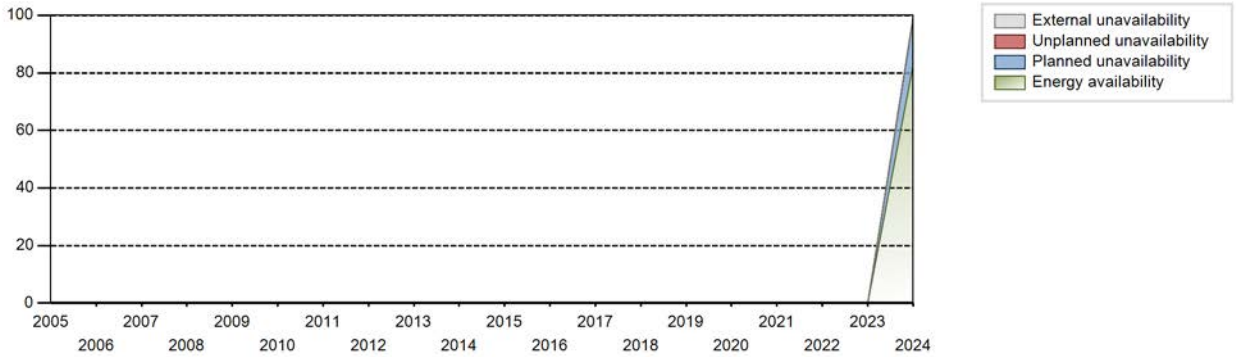
Lifetime energy generation	:	5119.36 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0 %
Cumulative Energy Availability Factor (EAF)	:	83.04 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0 %
Cumulative Unit Capability Factor (UCF)	:	83.53 %	Cumulative Planned Unavailability Factor (PUF)	:	16.47 %
Cumulative Load Factor (LF)	:	83.7 %	Cumulative Externally cause unavailability (XUF)	:	0.49 %
Cumulative Operating Factor (OF)	:	89.75 %			

Electricity Production (net) [GWh]

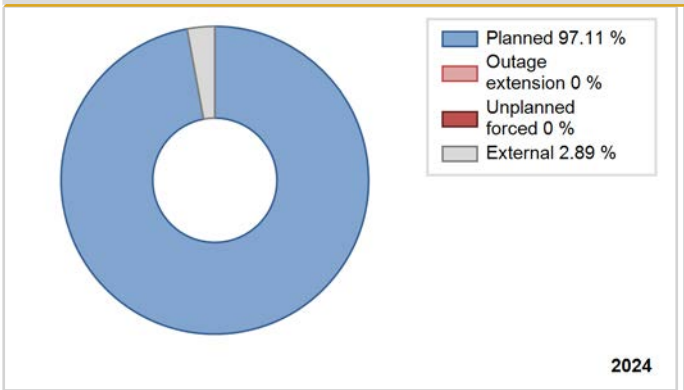


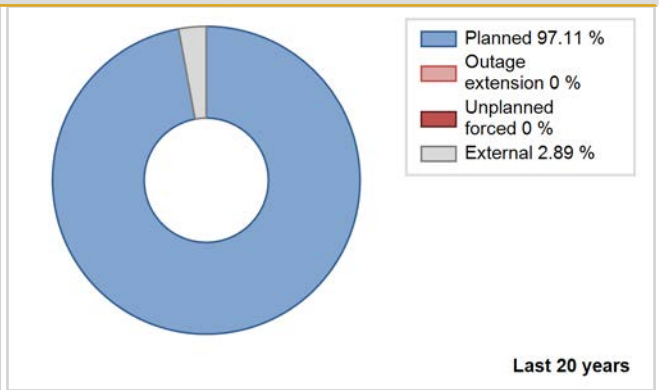
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2024	5119.36	4886	1337	83.04	83.53	83.70	89.75	0.00	0.00	16.47	0.49

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2024 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
E. Testing of plant systems or components	1722	135		5166	405	
Subtotal	1722	135		5166	405	
Total	**1857**			**5571**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2024 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	135	162
Total	**135**	**162**

Highlights (2024)

Unit 4 first connection to the grid was 23 Mar 2024.
Unit 4 commercial date 05 Sep 2024

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2024 Operating Experience

GB-19A HARTLEPOOL A-1 UNITED KINGDOM



Status at end of year	:	**Operational**
Operator	:	EDF UK (EDF Energy)
Owner	:	EDF UK (EDF Energy)
Reactor Supplier	:	NPC (NUCLEAR POWER CO., LTD.)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	GCR / AGR
Thermal power	:	1500 MWth
Gross electrical power	:	655 MWe
Reference unit power (net)	:	590 MWe

Key Dates

Construction Date	:	1968-10-01
Grid Date	:	1983-08-01
Commercial Date	:	1989-04-01
Age at end of year	:	41 years

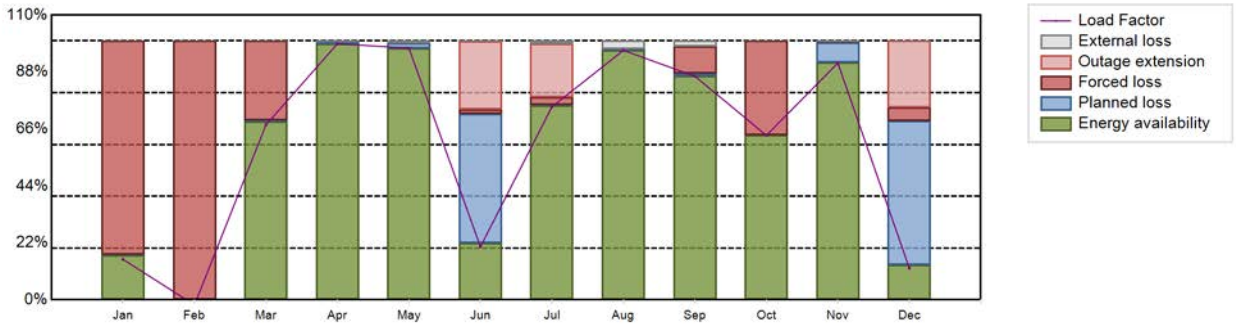
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	4.14
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	650
Fuel material	:	UO2	Number of SG	:	8
Refuelling type	:	OFF-line	Containment type	:	NA
Moderator material	:	GRAPHITE	Containment design pressure [MPa]	:	NA
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	4	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	7.5	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	9.37	HP cylinder inlet steam pressure [MPa]	:	15.96
Active core height/length [m]	:	8.3	Output voltage [kV]	:	23
Number of fissile fuel assemblies/bundles	:	2592	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.8	Number of main condensate pumps	:	2
Number of control rod assemblies	:	44	Number of FW pumps for full power operation	:	1
Number of external reactor coolant loops	:	8	Number of on-site safety related diesel generators	:	NA
Coolant type	:	CO2	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	3129.03 GW(e).h	Forced Loss Rate (FLR)	:	26.57 %
Energy Availability Factor (EAF)	:	61.05 %	Unplanned Capability Loss Factor (UCL)	:	28.4 %
Unit Capability Factor (UCF)	:	61.74 %	Planned Unavailability Factor (PUF)	:	9.86 %
Load Factor (LF)	:	60.38 %	Externally cause unavailability (XUF)	:	0.69 %
Operating Factor (OF)	:	68.64 %	Total off-line time	:	2755 hours

Annual Summary



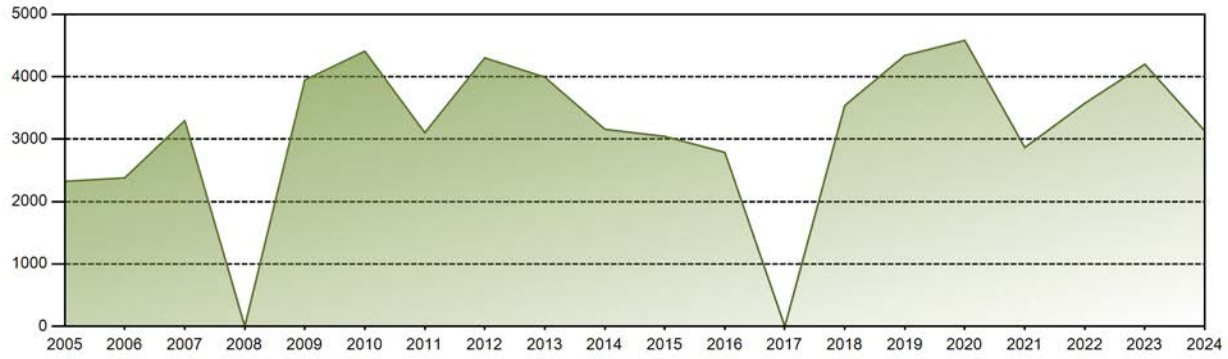
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	68.59	-8.09	296.30	420.20	426.66	87.18	327.10	422.93	366.88	279.19	388.48	53.60	3129.03
EAF [%]	17.25	0.00	68.79	98.92	97.20	21.97	75.12	96.35	86.37	63.52	91.58	13.42	61.05
UCF [%]	17.25	0.00	68.79	99.27	98.18	22.08	76.34	99.49	88.38	63.52	91.97	13.42	61.74
LF [%]	15.63	-1.97	67.59	98.92	97.20	20.52	74.52	96.35	86.37	63.52	91.45	12.21	60.38
OF [%]	17.47	0.00	71.87	100.00	100.00	24.72	87.90	100.00	100.00	100.00	94.72	23.92	68.64
FLR [%]	82.71	100.00	30.81	0.00	0.00	7.31	3.88	0.00	10.76	36.48	0.32	28.00	26.57
UCL [%]	82.52	100.00	30.63	0.00	0.00	28.05	23.56	0.00	10.65	36.48	0.30	30.81	28.40
PUF [%]	0.23	0.00	0.59	0.73	1.82	49.88	0.10	0.51	0.97	0.00	7.74	55.77	9.86
XUF [%]	0.00	0.00	0.00	0.35	0.98	0.11	1.21	3.14	2.02	0.00	0.39	0.00	0.69

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Historical Summary

Lifetime energy generation	:	133160.39 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	9.45 %
Cumulative Energy Availability Factor (EAF)	:	69.92 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	15.61 %
Cumulative Unit Capability Factor (UCF)	:	70.1 %	Cumulative Planned Unavailability Factor (PUF)	:	14.29 %
Cumulative Load Factor (LF)	:	68.51 %	Cumulative Externally cause unavailability (XUF)	:	0.18 %
Cumulative Operating Factor (OF)	:	73.36 %			

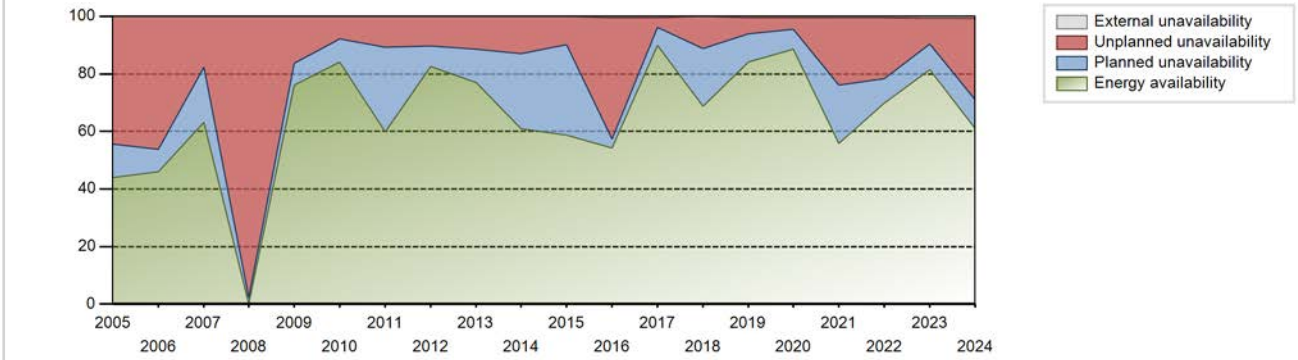
Electricity Production (net) [GWh]



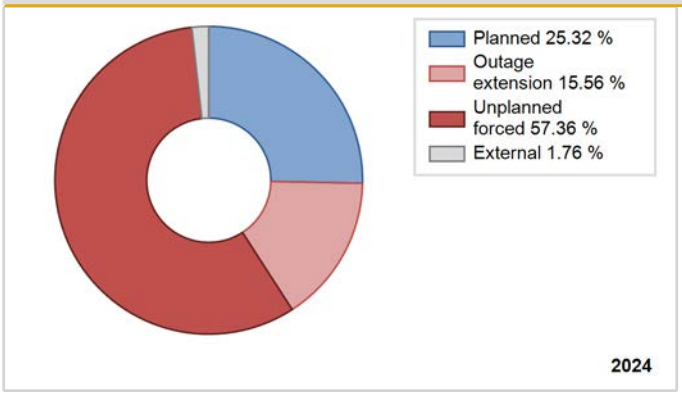
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	1829.47	4683	539	72.77	72.77	39.07	45.19	0.00	0.00	27.23	0.00
1990	1698.68	3486	487	40.12	40.12	39.89	39.90	18.89	9.35	50.53	0.00
1991	2953.39	6791	625	75.05	75.05	54.09	77.74	8.77	7.21	17.74	0.00
1992	2910.40	6156	510	63.46	63.64	64.09	69.14	10.21	7.24	29.12	0.18
1993	4449.59	7802	582	87.11	87.44	87.44	89.31	4.07	3.71	8.85	0.32
1994	4296.60	7716	605	81.36	81.70	81.29	88.32	7.88	6.99	11.31	0.34
1995	3584.24	5937	605	67.72	67.72	67.44	67.59	15.59	12.51	19.78	0.00
1996	4518.01	7691	605	85.63	85.67	85.02	87.56	1.91	1.67	12.66	0.04
1997	4441.68	7644	605	83.58	83.85	83.58	87.02	10.14	9.46	6.69	0.27
1998	3892.34	7108	605	73.52	73.52	73.24	80.92	10.20	8.35	18.13	0.00
1999	5000.14	8369	605	94.38	94.38	94.09	95.28	1.57	1.50	4.12	0.00
2000	4757.35	8153	605	88.63	89.52	89.52	92.82	2.84	2.62	7.86	0.89
2001	4291.19	7301	605	80.93	81.00	80.75	83.12	4.86	4.14	14.87	0.07
2002	4627.85	7965	605	87.51	87.51	87.32	90.92	4.42	4.05	8.44	0.00
2003	4583.30	7856	605	86.63	86.63	86.48	89.68	7.09	6.61	6.76	0.00
2004	1942.67	3385	605	36.88	36.88	36.56	38.54	0.50	35.99	27.13	0.00
2005	2322.93	4829	605	43.94	43.94	43.83	55.13	48.91	44.39	11.67	0.00
2006	2378.89	4291	605	45.94	45.94	45.45	48.98	35.63	46.29	7.77	0.00
2007	3295.79	5680	595	63.08	63.08	63.23	64.84	3.17	17.69	19.23	0.00
2008	0.00	0	595	0.00	0.00	0.00	0.00	0.00	97.78	2.22	0.00
2009	3945.95	6986	595	76.04	76.04	75.71	79.75	4.77	16.31	7.65	0.00
2010	4407.41	7547	595	84.16	84.16	84.56	86.15	4.84	7.89	7.95	0.00
2011	3102.64	5514	595	59.86	59.86	59.53	62.95	2.28	10.66	29.48	0.00
2012	4301.94	7613	595	82.47	82.47	82.31	86.67	4.83	10.31	7.22	0.00
2013	3992.35	7557	595	76.93	76.93	76.60	86.27	6.24	11.50	11.57	0.00
2014	3158.04	5782	595	60.92	60.92	60.59	66.00	3.01	12.87	26.21	0.00
2015	3043.14	6817	595	58.76	58.76	58.38	77.82	1.04	9.74	31.50	0.00
2016	2787.18	5559		54.36	54.78	53.33	63.29	39.82	42.11	3.11	0.42
2017	0.00			89.89	90.31	89.65	92.23	1.07	3.36	6.33	0.42
2018	3539.00	6101	590	68.66	68.72	68.47	69.65	0.01	11.07	20.21	0.06
2019	4340.04	7677	590	84.16	84.67	83.97	87.64	4.63	5.62	9.71	0.51
2020	4581.72	8063	590	88.58	88.96	88.41	91.79	1.36	4.17	6.87	0.39
2021	2865.20	5562	590	55.89	56.44	55.44	63.49	17.44	23.24	20.33	0.55
2022	3574.26	6437	590	69.78	70.34	69.16	73.48	0.92	21.15	8.51	0.56
2023	4199.98	7553	590	81.55	82.26	81.26	86.22	7.76	8.82	8.91	0.72
2024	3129.03	6029	590	61.05	61.74	60.38	68.64	26.57	28.40	9.86	0.69

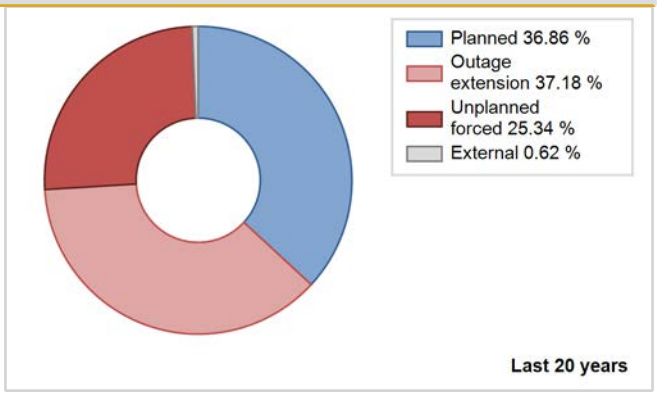
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1989 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		1518			1083	
B. Refuelling without maintenance	805			256	15	
C. Inspection, maintenance or repair combined with refuelling				516	8	
D. Inspection, maintenance or repair without refuelling				719		
E. Testing of plant systems or components					12	
G. Major backfitting, refurbishment or upgrading activities without refuelling				60	26	
H. Nuclear regulatory requirements					110	
J. Grid limitation, failure or grid unavailability						5
L. Human factor related					6	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					39	
Z. Other		431		21	97	
Subtotal	805	1949		1572	1396	5
Total	**2754**			**2973**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1989 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		370
12. Reactor I&C Systems		17
13. Reactor Auxiliary Systems		28
15. Reactor Cooling Systems		24
16. Steam generation systems		253
17. Safety I&C Systems (excluding reactor I&C)		2
21. Fuel Handling and Storage Facilities	431	120
31. Turbine and auxiliaries		65
32. Feedwater and Main Steam System	1518	128
33. Circulating Water System		51
41. Main Generator Systems		100
42. Electrical Power Supply Systems		51
Total	**1949**	**1209**

Highlights (2024)

Significant outage for steam valve inspection/repair

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2024 Operating Experience

GB-19B HARTLEPOOL A-2 UNITED KINGDOM

Status at end of year	:	**Operational**
Operator	:	EDF UK (EDF Energy)
Owner	:	EDF UK (EDF Energy)
Reactor Supplier	:	NPC (NUCLEAR POWER CO., LTD.)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))



Reactor Unit Details

Reactor type and model	:	GCR / AGR
Thermal power	:	1500 MWth
Gross electrical power	:	655 MWe
Reference unit power (net)	:	595 MWe

Key Dates

Construction Date	:	1968-10-01
Grid Date	:	1984-10-31
Commercial Date	:	1989-04-01
Age at end of year	:	40 years

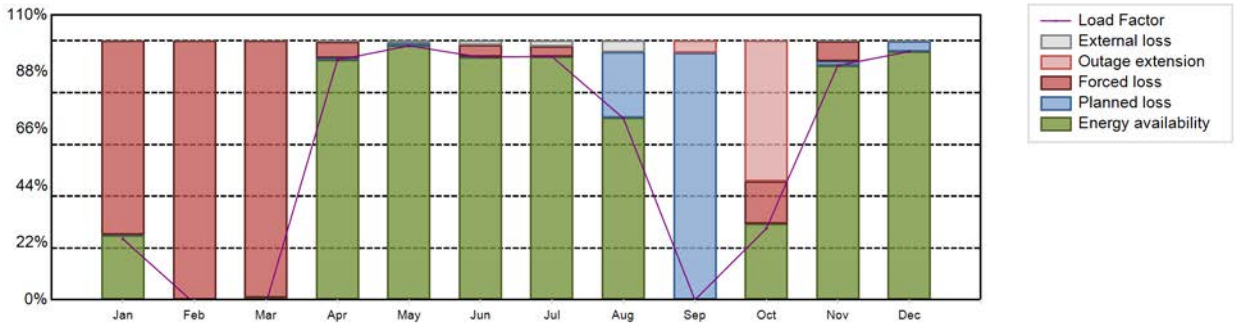
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	4.14
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	650
Fuel material	:	UO2	Number of SG	:	8
Refuelling type	:	OFF-line	Containment type	:	NA
Moderator material	:	GRAPHITE	Containment design pressure [MPa]	:	NA
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	4	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	7.5	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	9.37	HP cylinder inlet steam pressure [MPa]	:	15.96
Active core height/length [m]	:	8.3	Output voltage [kV]	:	23
Number of fissile fuel assemblies/bundles	:	2592	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.8	Number of main condensate pumps	:	2
Number of control rod assemblies	:	44	Number of FW pumps for full power operation	:	1
Number of external reactor coolant loops	:	8	Number of on-site safety related diesel generators	:	-
Coolant type	:	CO2	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	2985.52 GW(e).h	Forced Loss Rate (FLR)	:	30.66 %
Energy Availability Factor (EAF)	:	57.72 %	Unplanned Capability Loss Factor (UCL)	:	30.84 %
Unit Capability Factor (UCF)	:	58.54 %	Planned Unavailability Factor (PUF)	:	10.62 %
Load Factor (LF)	:	57.12 %	Externally cause unavailability (XUF)	:	0.82 %
Operating Factor (OF)	:	63.3 %	Total off-line time	:	3224 hours

Annual Summary



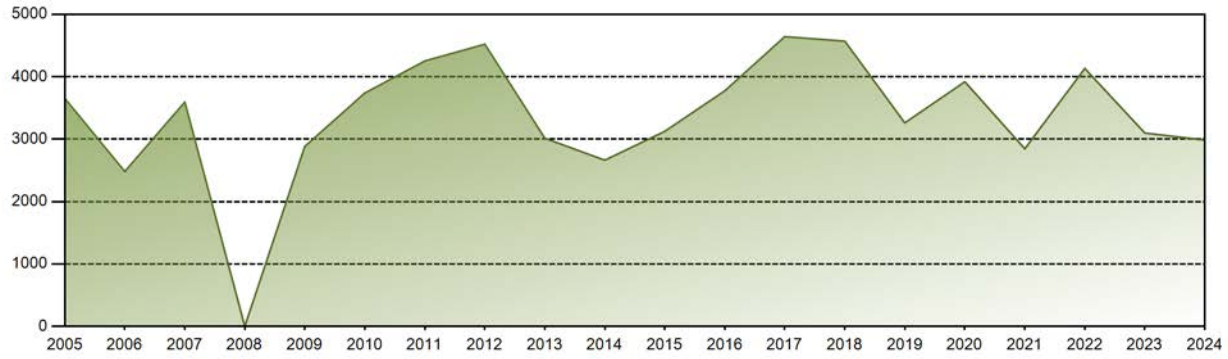
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	103.95	-5.52	-6.13	396.83	434.23	401.56	415.90	310.40	-0.02	122.12	387.68	424.52	2985.52
EAF [%]	24.98	0.00	0.90	92.63	98.09	93.74	93.95	70.39	0.00	29.27	90.50	95.90	57.72
UCF [%]	24.98	0.00	0.90	92.91	99.07	95.41	96.10	74.80	0.00	29.27	90.69	95.93	58.54
LF [%]	23.48	-1.33	-1.39	92.63	98.09	93.74	93.95	70.12	-0.01	27.55	90.50	95.90	57.12
OF [%]	27.15	0.00	3.23	100.00	100.00	100.00	100.00	75.54	0.00	51.01	100.00	100.00	63.30
FLR [%]	74.95	100.00	99.10	6.47	0.00	4.38	3.90	0.00	0.00	36.17	7.69	0.00	30.66
UCL [%]	74.76	100.00	99.10	6.43	0.00	4.37	3.89	0.00	4.51	70.73	7.55	0.00	30.84
PUF [%]	0.26	0.00	0.00	0.66	0.93	0.22	0.01	25.20	95.49	0.00	1.76	4.07	10.62
XUF [%]	0.00	0.00	0.00	0.28	0.97	1.67	2.15	4.41	0.00	0.00	0.20	0.03	0.82

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Historical Summary

Lifetime energy generation	:	127132.87 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	12.84 %
Cumulative Energy Availability Factor (EAF)	:	70.69 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	14.63 %
Cumulative Unit Capability Factor (UCF)	:	70.9 %	Cumulative Planned Unavailability Factor (PUF)	:	14.47 %
Cumulative Load Factor (LF)	:	69.59 %	Cumulative Externally cause unavailability (XUF)	:	0.2 %
Cumulative Operating Factor (OF)	:	74.32 %			

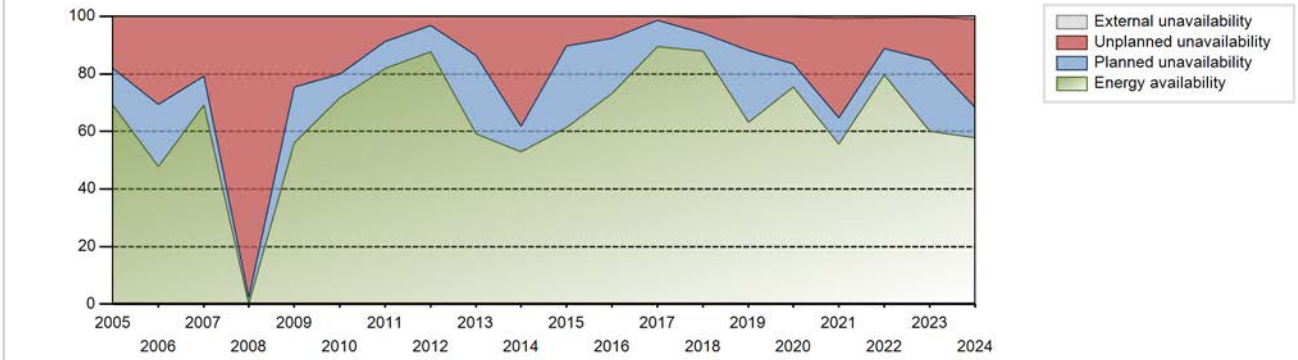
Electricity Production (net) [GWh]



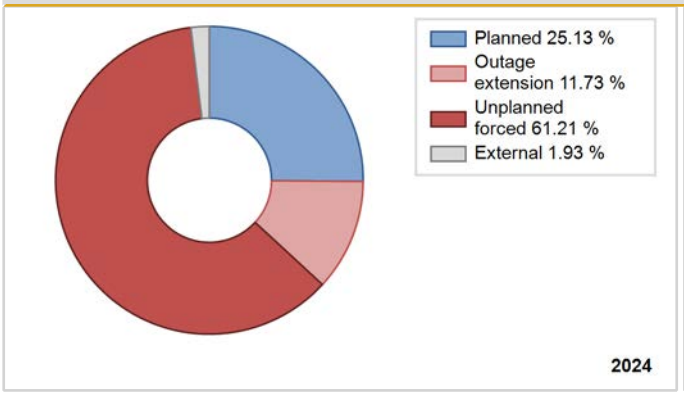
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	2234.82	4689	421	100.00	100.00	80.61	71.03	0.00	0.00	0.00	0.00
1990	3238.38	6796	487	74.14	74.14	76.04	77.79	3.08	2.36	23.50	0.00
1991	1855.91	3755	625	55.12	55.12	33.99	42.98	0.80	0.44	44.44	0.00
1992	4316.78	7923	571	87.01	87.32	84.86	88.98	3.53	3.20	9.49	0.31
1993	4264.64	7682	582	83.76	84.88	83.81	87.93	5.92	5.34	9.78	1.12
1994	3703.92	6612	605	69.91	70.24	70.08	75.69	12.80	10.31	19.45	0.33
1995	3750.74	6149	605	70.85	70.85	70.58	70.00	19.56	17.23	11.92	0.00
1996	4370.30	8131	605	82.13	82.24	82.24	92.57	4.95	4.28	13.48	0.10
1997	4127.88	6954	605	77.18	77.95	77.67	79.17	4.70	3.84	18.21	0.76
1998	4555.10	7973	605	85.58	85.99	85.71	90.77	7.89	7.37	6.64	0.40
1999	4472.45	7808	605	83.64	84.43	84.16	88.89	8.54	7.89	7.68	0.79
2000	4265.86	7463	605	80.27	80.27	80.27	84.96	2.23	1.83	17.90	0.00
2001	4635.88	8092	605	87.46	87.46	87.23	92.12	1.55	1.38	11.16	0.00
2002	4910.32	8383	605	92.73	92.73	92.65	95.70	0.24	1.22	6.05	0.00
2003	3488.43	6258	605	66.45	66.45	65.82	71.44	16.79	15.26	18.29	0.00
2004	3380.61	6016	605	64.01	64.01	63.61	68.49	4.29	18.18	17.81	0.00
2005	3651.64	6428	605	69.24	69.24	68.90	73.38	5.76	18.05	12.71	0.00
2006	2481.11	4455	605	47.76	47.76	47.41	50.86	35.15	30.49	21.76	0.00
2007	3593.55	6514	595	69.15	69.15	68.95	74.36	22.97	20.73	10.12	0.00
2008	0.00	0	595	0.00	0.00	0.00	0.00	100.00	97.73	2.27	0.00
2009	2882.06	5360	595	55.98	55.98	55.29	61.19	26.57	24.54	19.48	0.00
2010	3738.08	6674	595	71.70	71.70	71.72	76.19	7.77	20.13	8.17	0.00
2011	4251.62	7533	595	81.90	81.90	81.57	85.99	2.84	8.65	9.45	0.00
2012	4520.16	7880	585	87.66	87.66	87.96	89.71	1.11	3.22	9.11	0.00
2013	3014.48	5517	585	59.23	59.23	58.82	62.98	17.79	13.57	27.20	0.00
2014	2662.28	5290	585	52.88	52.88	51.95	60.39	39.79	38.24	8.88	0.00
2015	3124.82	6811	585	61.35	61.35	60.98	77.75	4.50	10.22	28.43	0.00
2016	3773.67	6842		73.22	73.25	73.44	77.89	5.02	7.54	19.22	0.03
2017	4641.82	7980		89.54	89.54	90.58	91.10	0.43	1.29	9.16	0.00
2018	4569.78	7950	595	88.02	88.52	87.67	90.75	5.59	5.36	6.13	0.50
2019	3259.78	5910	595	63.11	63.38	62.54	67.47	4.53	11.49	25.14	0.27
2020	3919.40	7232	595	75.41	75.72	74.99	82.33	7.28	16.17	8.11	0.31
2021	2845.55	5404	595	55.66	56.28	54.59	61.69	14.32	34.70	9.02	0.62
2022	4132.36	7447	595	79.62	80.18	79.28	85.01	3.70	10.57	9.25	0.56
2023	3097.65	5573	595	60.00	60.33	59.43	63.62	4.34	14.95	24.72	0.33
2024	2985.52	5560	595	57.72	58.54	57.12	63.30	30.66	30.84	10.62	0.82

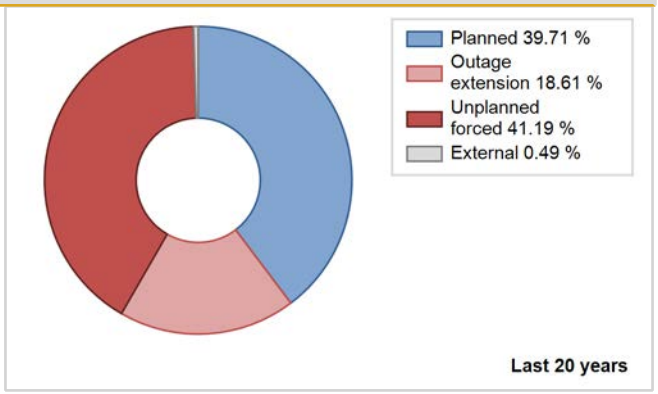
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1989 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		2355			1067	
B. Refuelling without maintenance	870			238	7	
C. Inspection, maintenance or repair combined with refuelling				637	28	
D. Inspection, maintenance or repair without refuelling				460		
E. Testing of plant systems or components					4	
G. Major backfitting, refurbishment or upgrading activities without refuelling				59	10	
H. Nuclear regulatory requirements					36	
L. Human factor related					5	
P. Fire					16	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					0	
Z. Other				89	50	
Subtotal	870	2355		1483	1223	
Total	**3225**			**2706**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1989 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		312
12. Reactor I&C Systems		24
13. Reactor Auxiliary Systems		12
15. Reactor Cooling Systems	398	72
16. Steam generation systems		153
21. Fuel Handling and Storage Facilities		53
31. Turbine and auxiliaries		63
32. Feedwater and Main Steam System	1958	162
33. Circulating Water System		50
34. Miscellaneous Systems		2
41. Main Generator Systems		88
42. Electrical Power Supply Systems		17
Total	**2356**	**1008**

Highlights (2024)

Significant outage for steam valve inspection/repair

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2024 Operating Experience

GB-20A HEYSHAM A-1 UNITED KINGDOM

Status at end of year	:	**Operational**
Operator	:	EDF UK (EDF Energy)
Owner	:	EDF UK (EDF Energy)
Reactor Supplier	:	NPC (NUCLEAR POWER CO., LTD.)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	GCR / AGR
Thermal power	:	1500 MWth
Gross electrical power	:	625 MWe
Reference unit power (net)	:	485 MWe

Key Dates

Construction Date	:	1970-12-01
Grid Date	:	1983-07-09
Commercial Date	:	1989-04-01
Age at end of year	:	41 years

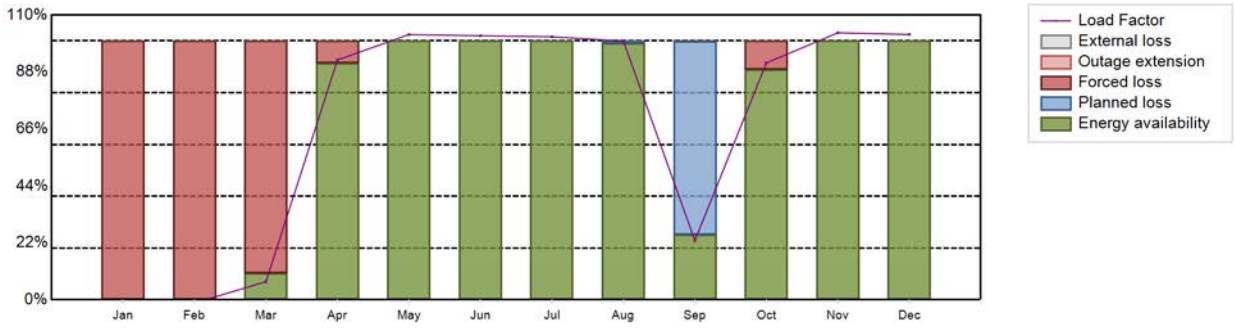
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	4
Part of the core refuelled [%]	:	7.5
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	9.37
Active core height/length [m]	:	8.3
Number of fissile fuel assemblies/bundles	:	2592
Fuel linear heat generation rate [kW/m]	:	16.8
Number of control rod assemblies	:	44
Number of external reactor coolant loops	:	8
Coolant type	:	CO2
Operating coolant pressure [MPa]	:	4.14
Reactor outlet temperature [°C]	:	650
Number of SG	:	8
Containment type	:	NA
Containment design pressure [MPa]	:	NA
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	15.96
Output voltage [kV]	:	23
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	2
Number of FW pumps for full power operation	:	1
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2932.77 GW(e).h
Energy Availability Factor (EAF)	:	68.16 %
Unit Capability Factor (UCF)	:	68.16 %
Load Factor (LF)	:	68.84 %
Operating Factor (OF)	:	70.64 %
Forced Loss Rate (FLR)	:	27.33 %
Unplanned Capability Loss Factor (UCL)	:	25.63 %
Planned Unavailability Factor (PUF)	:	6.21 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	2579 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	-5.39	-4.28	25.37	323.44	369.74	356.19	366.60	360.61	79.98	330.58	360.15	369.79	2932.77
EAF [%]	0.00	0.00	10.26	91.49	100.00	100.00	100.00	99.09	25.05	88.96	100.00	100.00	68.16
UCF [%]	0.00	0.00	10.26	91.49	100.00	100.00	100.00	99.09	25.05	88.96	100.00	100.00	68.16
LF [%]	-1.49	-1.27	7.04	92.62	102.47	102.00	101.60	99.94	22.90	91.49	103.14	102.48	68.84
OF [%]	0.00	0.00	22.07	100.00	100.00	100.00	100.00	100.00	29.72	92.75	100.00	100.00	70.64
FLR [%]	100.00	100.00	89.74	8.51	0.00	0.00	0.00	0.00	0.68	11.04	0.00	0.00	27.33
UCL [%]	100.00	100.00	89.74	8.51	0.00	0.00	0.00	0.00	0.17	11.04	0.00	0.00	25.63
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91	74.78	0.00	0.00	0.00	6.21
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	122692.13 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	14.49 %
Cumulative Energy Availability Factor (EAF)	:	68.3 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	16.77 %
Cumulative Unit Capability Factor (UCF)	:	68.56 %	Cumulative Planned Unavailability Factor (PUF)	:	14.67 %
Cumulative Load Factor (LF)	:	67.68 %	Cumulative Externally cause unavailability (XUF)	:	0.26 %
Cumulative Operating Factor (OF)	:	73.36 %			

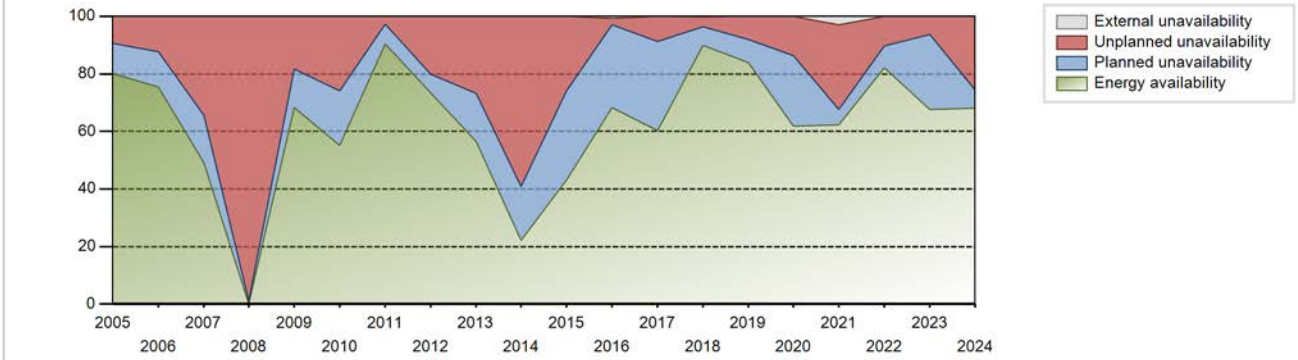
Electricity Production (net) [GWh]



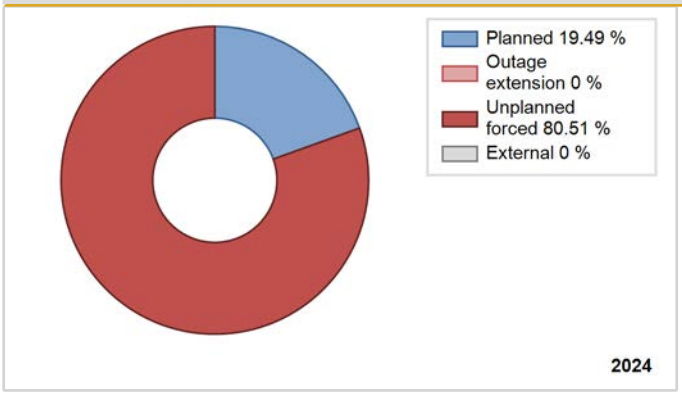
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	3045.30	7113	420	100.00	100.00	84.82	82.53	0.00	0.00	0.00	0.00
1990	1786.74	4096	487	43.38	43.38	41.95	46.89	3.74	1.68	54.94	0.00
1991	3826.17	7279	621	86.45	86.45	70.53	83.32	0.31	0.27	13.28	0.00
1992	2764.17	5981	550	55.59	55.76	56.44	67.17	21.28	15.07	29.17	0.17
1993	3638.22	6643	555	74.28	75.00	75.04	76.04	19.28	17.92	7.09	0.71
1994	4563.37	8128	575	90.40	90.54	90.85	93.04	2.99	2.79	6.67	0.14
1995	2808.87	4794	575	55.94	55.89	55.61	54.58	29.33	23.19	20.92	-0.06
1996	4056.80	7674	575	80.19	80.32	80.32	87.36	7.13	6.16	13.52	0.13
1997	4298.79	7757	575	84.53	85.38	85.11	88.31	7.92	7.35	7.27	0.86
1998	3766.08	6950	575	73.77	74.84	74.56	79.12	9.74	8.07	17.09	1.07
1999	4549.83	7990	575	89.73	90.35	90.08	90.96	0.61	0.55	9.09	0.62
2000	4587.90	8230	575	90.39	90.84	90.84	93.69	3.02	2.83	6.34	0.44
2001	4034.58	6959	575	77.62	78.03	79.88	79.22	10.61	9.26	12.71	0.41
2002	4445.53	7921	575	87.93	88.39	88.26	90.42	1.67	2.60	9.01	0.46
2003	3746.22	6783	575	74.40	74.75	74.37	77.43	20.02	18.71	6.54	0.35
2004	2638.07	4951	575	52.51	52.83	52.23	56.36	23.49	32.08	15.09	0.31
2005	4033.07	7458	575	80.14	80.14	80.07	85.14	5.25	9.34	10.52	0.00
2006	3839.08	7229	575	75.50	75.50	75.23	82.52	13.70	12.20	12.29	0.00
2007	2498.55	4892	585	49.07	49.07	48.76	55.84	34.75	34.38	16.54	0.00
2008	0.00	0	585	0.00	0.00	0.00	0.00	100.00	98.85	1.15	0.00
2009	3478.25	6363	585	68.38	68.38	67.87	72.64	16.25	18.31	13.31	0.00
2010	2826.72	5117	585	55.09	55.09	55.16	58.41	14.73	25.92	18.99	0.00
2011	4627.86	8225	585	90.48	90.48	90.31	93.89	2.86	2.74	6.78	0.00
2012	3749.04	7055	585	73.38	73.38	72.96	80.32	21.36	20.03	6.59	0.00
2013	2833.02	5384	585	56.60	56.60	55.28	61.46	8.93	26.72	16.68	0.00
2014	1073.88	2841	580	22.17	22.17	21.14	32.43	35.42	59.13	18.70	0.00
2015	2167.04	6886	580	43.07	43.07	42.65	78.61	7.13	25.99	30.94	0.00
2016	3472.18	7663		68.39	69.17	68.15	87.24	1.00	2.11	28.72	0.77
2017	0.00			60.19	60.19	59.91	72.91	0.00	8.83	30.98	0.00
2018	3857.56	8018	485	89.94	90.12	90.80	91.53	1.73	3.36	6.52	0.18
2019	3581.24	7826	485	84.01	84.09	84.29	89.34	4.73	7.97	7.94	0.08
2020	2648.85	5639	485	61.95	61.97	62.18	64.20	9.49	13.52	24.50	0.03
2021	2657.70	5625	485	62.39	65.24	62.55	64.21	27.48	29.48	5.28	2.85
2022	3567.83	7363	485	82.08	82.08	83.98	84.05	1.48	10.18	7.74	0.00
2023	2909.14	6271	485	67.65	67.67	68.47	71.59	7.37	6.29	26.03	0.02
2024	2932.77	6205	485	68.16	68.16	68.84	70.64	27.33	25.63	6.21	0.00

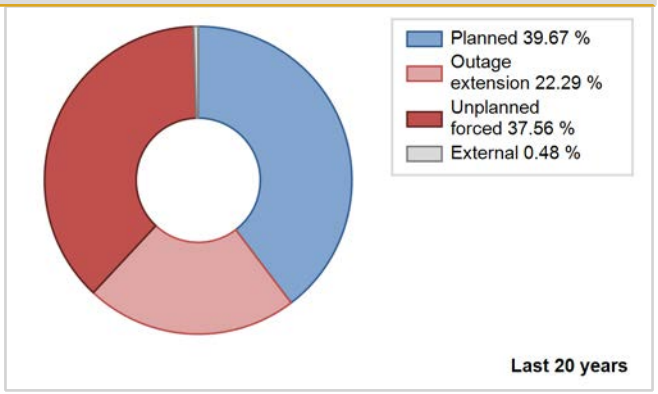
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1989 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		2073			922	
B. Refuelling without maintenance	506			189	4	
C. Inspection, maintenance or repair combined with refuelling				762	149	
D. Inspection, maintenance or repair without refuelling				459		
E. Testing of plant systems or components					71	
G. Major backfitting, refurbishment or upgrading activities without refuelling				47	5	
H. Nuclear regulatory requirements					50	
J. Grid limitation, failure or grid unavailability						9
L. Human factor related					54	
Z. Other				50	39	6
Subtotal	506	2073		1507	1294	15
Total	**2579**			**2816**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1989 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		307
12. Reactor I&C Systems		23
13. Reactor Auxiliary Systems		35
14. Safety Systems		25
15. Reactor Cooling Systems		56
16. Steam generation systems		197
21. Fuel Handling and Storage Facilities		26
31. Turbine and auxiliaries		57
32. Feedwater and Main Steam System	2073	105
33. Circulating Water System		111
34. Miscellaneous Systems		12
41. Main Generator Systems		64
42. Electrical Power Supply Systems		28
Total	**2073**	**1046**

Highlights (2024)

Significant outage for steam valve inspection/repair

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2024 Operating Experience

GB-20B HEYSHAM A-2 UNITED KINGDOM

Status at end of year	:	**Operational**
Operator	:	EDF UK (EDF Energy)
Owner	:	EDF UK (EDF Energy)
Reactor Supplier	:	NPC (NUCLEAR POWER CO., LTD.)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	GCR / AGR
Thermal power	:	1500 MWth
Gross electrical power	:	625 MWe
Reference unit power (net)	:	575 MWe

Key Dates

Construction Date	:	1970-12-01
Grid Date	:	1984-10-11
Commercial Date	:	1989-04-01
Age at end of year	:	40 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	4
Part of the core refuelled [%]	:	7.5
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	9.37
Active core height/length [m]	:	8.3
Number of fissile fuel assemblies/bundles	:	2592
Fuel linear heat generation rate [kW/m]	:	15.6
Number of control rod assemblies	:	44
Number of external reactor coolant loops	:	8
Coolant type	:	CO2

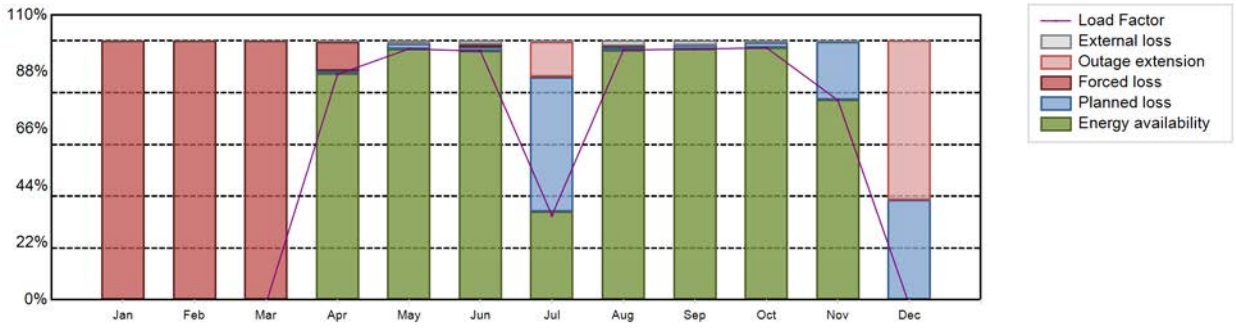
Operating coolant pressure [MPa]	:	4.14
Reactor outlet temperature [°C]	:	650
Number of SG	:	8
Containment type	:	NA
Containment design pressure [MPa]	:	NA
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	15.96
Output voltage [kV]	:	23
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	2
Number of FW pumps for full power operation	:	1
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2836.46 GW(e).h
Energy Availability Factor (EAF)	:	56.84 %
Unit Capability Factor (UCF)	:	57.49 %
Load Factor (LF)	:	56.16 %
Operating Factor (OF)	:	59.51 %

Forced Loss Rate (FLR)	:	31.06 %
Unplanned Capability Loss Factor (UCL)	:	32.24 %
Planned Unavailability Factor (PUF)	:	10.27 %
Externally cause unavailability (XUF)	:	0.66 %
Total off-line time	:	3557 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	-7.27	-3.61	-6.52	360.41	414.66	397.64	139.49	412.81	400.80	417.15	319.16	-8.26	2836.46
EAF [%]	0.00	0.00	0.00	87.43	96.93	96.05	34.08	96.50	96.81	97.38	77.28	0.00	56.84
UCF [%]	0.00	0.00	0.00	87.78	98.09	97.52	34.47	98.36	98.37	98.13	77.62	0.00	57.49
LF [%]	-1.70	-0.90	-1.53	87.06	96.93	96.05	32.61	96.50	96.81	97.38	77.09	-1.93	56.16
OF [%]	0.00	0.00	0.00	94.17	100.00	100.00	40.32	100.00	100.00	100.00	80.00	0.00	59.51
FLR [%]	100.00	100.00	100.00	11.29	0.00	0.91	0.90	0.48	0.00	0.00	0.00	0.00	31.06
UCL [%]	100.00	100.00	100.00	11.18	0.00	0.90	13.66	0.47	0.00	0.00	0.00	61.41	32.24
PUF [%]	0.00	0.00	0.00	1.05	1.91	1.58	51.87	1.17	1.63	1.87	22.38	38.59	10.27
XUF [%]	0.00	0.00	0.00	0.34	1.16	1.47	0.39	1.86	1.56	0.75	0.33	0.00	0.66

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Historical Summary

Lifetime energy generation	:	118570.92 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	16.87 %
Cumulative Energy Availability Factor (EAF)	:	66.62 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	19.32 %
Cumulative Unit Capability Factor (UCF)	:	67.13 %	Cumulative Planned Unavailability Factor (PUF)	:	13.55 %
Cumulative Load Factor (LF)	:	65.83 %	Cumulative Externally cause unavailability (XUF)	:	0.51 %
Cumulative Operating Factor (OF)	:	72.9 %			

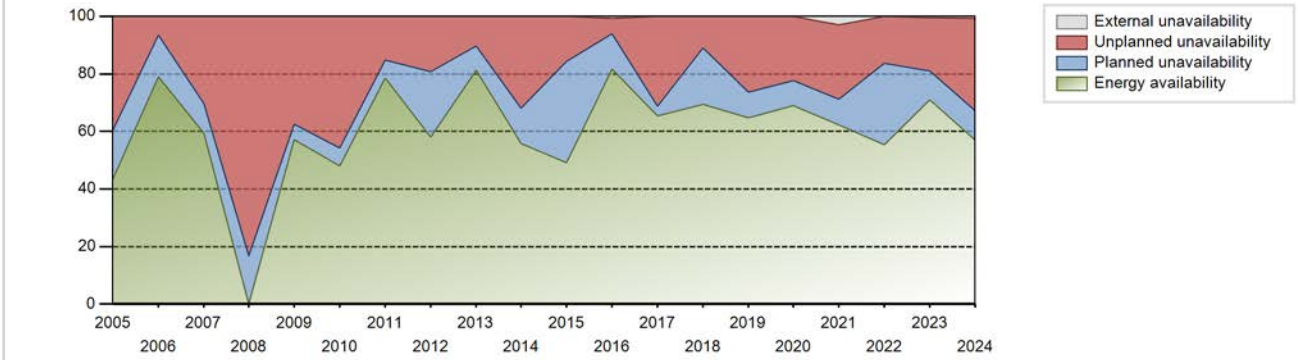
Electricity Production (net) [GWh]



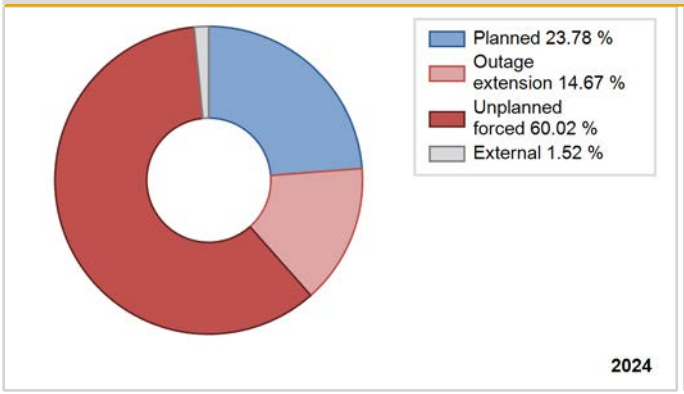
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	2505.64	5507	470	100.00	100.00	90.38	83.43	0.00	0.00	0.00	0.00
1990	3044.18	6690	487	71.98	71.98	71.48	76.58	9.35	7.42	20.59	0.00
1991	2647.73	5132	622	64.65	64.99	48.73	58.75	2.53	1.69	33.32	0.34
1992	3548.13	6951	550	72.79	74.58	72.45	78.07	11.81	9.99	15.43	1.79
1993	4336.47	7886	555	88.10	88.50	89.44	90.27	2.78	2.53	8.97	0.40
1994	3707.46	6652	575	72.83	75.31	73.81	76.14	3.02	2.34	22.34	2.48
1995	3367.50	5772	575	66.95	66.95	66.67	65.71	23.46	20.52	12.54	0.00
1996	3561.87	6836	575	70.47	70.80	70.52	77.82	5.27	3.94	25.26	0.33
1997	4443.31	8026	575	86.91	88.25	87.97	91.37	2.71	2.45	9.30	1.33
1998	4497.56	7999	575	86.67	89.32	89.05	91.06	2.11	1.93	8.75	2.65
1999	3712.69	6570	575	71.74	73.78	73.51	74.80	13.67	11.69	14.53	2.04
2000	4342.62	7946	575	86.13	86.25	85.98	90.46	6.15	5.66	8.09	0.13
2001	4495.02	8187	575	89.27	90.80	89.00	93.20	0.92	0.84	8.35	1.54
2002	3407.89	6313	575	68.12	68.34	67.66	72.07	12.45	13.80	17.86	0.21
2003	3646.95	6595	575	72.53	72.53	72.40	75.29	22.51	21.07	6.41	0.00
2004	1974.61	3805	575	39.74	39.90	39.09	43.32	57.95	54.98	5.12	0.16
2005	2112.60	3869	575	43.66	43.66	41.94	44.17	41.69	39.47	16.87	0.00
2006	3972.25	7735	575	79.00	79.00	78.86	88.30	7.51	6.42	14.59	0.00
2007	2981.62	6280	575	59.35	59.35	59.19	71.69	15.78	30.34	10.31	0.00
2008	0.00	0	575	0.01	0.01	0.00	0.00	0.00	83.27	16.72	0.00
2009	2865.50	6414	575	57.24	57.24	56.89	73.22	20.33	37.55	5.21	0.00
2010	2421.73	5862	575	48.08	48.08	48.08	66.92	48.53	45.68	6.24	0.00
2011	3942.22	8117	575	78.49	78.49	78.27	92.66	16.25	15.22	6.29	0.00
2012	2891.72	5565	575	58.04	58.04	57.25	63.35	23.21	19.20	22.76	0.00
2013	4022.80	7464	575	81.31	81.31	79.87	85.21	10.40	10.40	8.30	0.00
2014	2775.28	5385	575	55.75	55.75	55.10	61.47	34.05	31.86	12.39	0.00
2015	2456.79	5498	575	49.20	49.20	48.77	62.76	3.19	15.71	35.08	0.00
2016	4116.58	7646		81.77	82.40	81.50	87.04	4.15	5.50	12.10	0.63
2017	0.00			65.46	65.46	64.89	79.17	27.60	31.28	3.25	0.00
2018	3493.12	7015	575	69.50	69.50	69.35	80.08	12.90	11.02	19.48	0.00
2019	3233.76	6648	575	64.84	64.84	64.20	75.89	25.72	26.31	8.85	0.00
2020	3464.20	7036	575	69.05	69.05	68.59	80.10	15.74	22.38	8.57	0.00
2021	3103.23	6412	575	62.30	65.17	61.61	73.20	27.52	25.90	8.93	2.87
2022	2762.77	5825	575	55.31	55.41	54.85	66.50	15.46	16.29	28.30	0.10
2023	3553.41	6771	575	71.08	71.54	70.55	77.29	13.20	18.51	9.95	0.46
2024	2836.46	5227	575	56.84	57.49	56.16	59.51	31.06	32.24	10.27	0.66

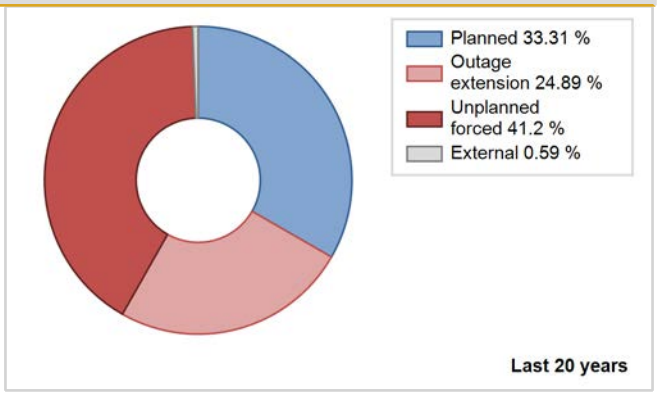
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1989 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		2682			901	
B. Refuelling without maintenance	807			238	6	
C. Inspection, maintenance or repair combined with refuelling				659	19	
D. Inspection, maintenance or repair without refuelling				452	201	
E. Testing of plant systems or components				6	18	
G. Major backfitting, refurbishment or upgrading activities without refuelling				16	29	
H. Nuclear regulatory requirements					94	
J. Grid limitation, failure or grid unavailability						17
L. Human factor related					3	
P. Fire					3	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					137	
Z. Other		68		94	73	5
Subtotal	807	2750		1465	1484	22
Total		**3557**			**2971**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1989 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		466
12. Reactor I&C Systems		29
13. Reactor Auxiliary Systems		9
14. Safety Systems		34
15. Reactor Cooling Systems		72
16. Steam generation systems		179
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities	68	39
31. Turbine and auxiliaries	216	91
32. Feedwater and Main Steam System	2393	105
33. Circulating Water System		117
34. Miscellaneous Systems		5
41. Main Generator Systems	73	38
42. Electrical Power Supply Systems		66
Total	**2750**	**1251**

Highlights (2024)

Significant outage for steam valve inspection/repair

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2024 Operating Experience

GB-22A HEYSHAM B-1 UNITED KINGDOM

Status at end of year	:	**Operational**
Operator	:	EDF UK (EDF Energy)
Owner	:	EDF UK (EDF Energy)
Reactor Supplier	:	NPC (NUCLEAR POWER CO., LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	GCR / AGR
Thermal power	:	1550 MWth
Gross electrical power	:	680 MWe
Reference unit power (net)	:	620 MWe

Key Dates

Construction Date	:	1980-08-01
Grid Date	:	1988-07-12
Commercial Date	:	1989-04-01
Age at end of year	:	36 years

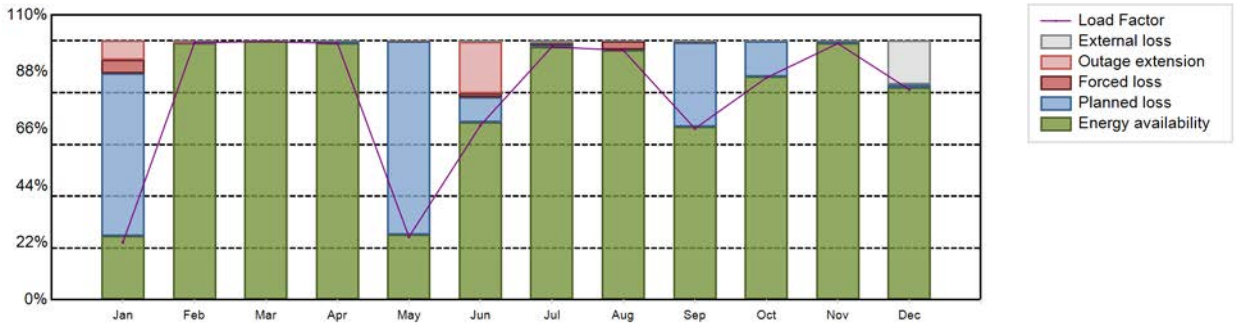
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	ON-line
Moderator material	:	GRAPHITE
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	2
Part of the core refuelled [%]	:	3
Average discharge burnup [MWd/t]	:	27000
Active core diameter [m]	:	9.46
Active core height/length [m]	:	8.31
Number of fissile fuel assemblies/bundles	:	332
Fuel linear heat generation rate [kW/m]	:	16.8
Number of control rod assemblies	:	89
Number of external reactor coolant loops	:	NA
Coolant type	:	CO2
Operating coolant pressure [MPa]	:	4.3
Reactor outlet temperature [°C]	:	635
Number of SG	:	4
Containment type	:	NA
Containment design pressure [MPa]	:	NA
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	15.9
Output voltage [kV]	:	23.5
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	2
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4249.11 GW(e).h	Forced Loss Rate (FLR)	:	1.15 %
Energy Availability Factor (EAF)	:	78.54 %	Unplanned Capability Loss Factor (UCL)	:	3.25 %
Unit Capability Factor (UCF)	:	80.14 %	Planned Unavailability Factor (PUF)	:	16.62 %
Load Factor (LF)	:	78.02 %	Externally cause unavailability (XUF)	:	1.6 %
Operating Factor (OF)	:	82.06 %	Total off-line time	:	1576 hours

Annual Summary



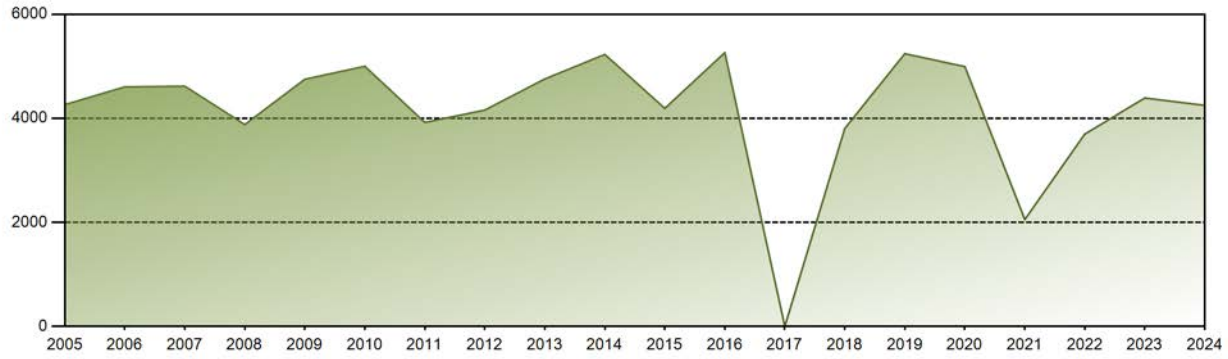
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	102.67	428.65	459.77	442.15	112.13	300.75	450.71	444.35	295.27	396.10	441.93	374.64	4249.11
EAF [%]	24.65	99.22	99.80	99.05	25.08	68.49	97.71	96.33	66.93	86.24	99.00	81.95	78.54
UCF [%]	24.65	99.22	99.81	99.08	25.11	68.83	98.62	96.49	67.41	86.33	99.02	98.75	80.14
LF [%]	22.26	99.33	99.81	99.05	24.31	67.37	97.71	96.33	66.14	85.75	99.00	81.22	78.02
OF [%]	38.31	100.00	100.00	100.00	25.67	76.53	100.00	100.00	68.06	91.14	100.00	86.69	82.06
FLR [%]	17.93	0.00	0.00	0.00	0.87	2.12	0.66	3.27	0.10	0.00	0.00	0.00	1.15
UCL [%]	12.64	0.76	0.00	0.00	0.22	21.45	0.66	3.26	0.07	0.00	0.00	0.00	3.25
PUF [%]	62.71	0.02	0.19	0.92	74.66	9.72	0.73	0.25	32.52	13.67	0.98	1.25	16.62
XUF [%]	0.00	0.00	0.00	0.03	0.03	0.34	0.91	0.16	0.48	0.09	0.02	16.80	1.60

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Historical Summary

Lifetime energy generation	:	150105.46 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.71 %
Cumulative Energy Availability Factor (EAF)	:	78.61 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.96 %
Cumulative Unit Capability Factor (UCF)	:	79.23 %	Cumulative Planned Unavailability Factor (PUF)	:	14.81 %
Cumulative Load Factor (LF)	:	77.93 %	Cumulative Externally cause unavailability (XUF)	:	0.63 %
Cumulative Operating Factor (OF)	:	83.03 %			

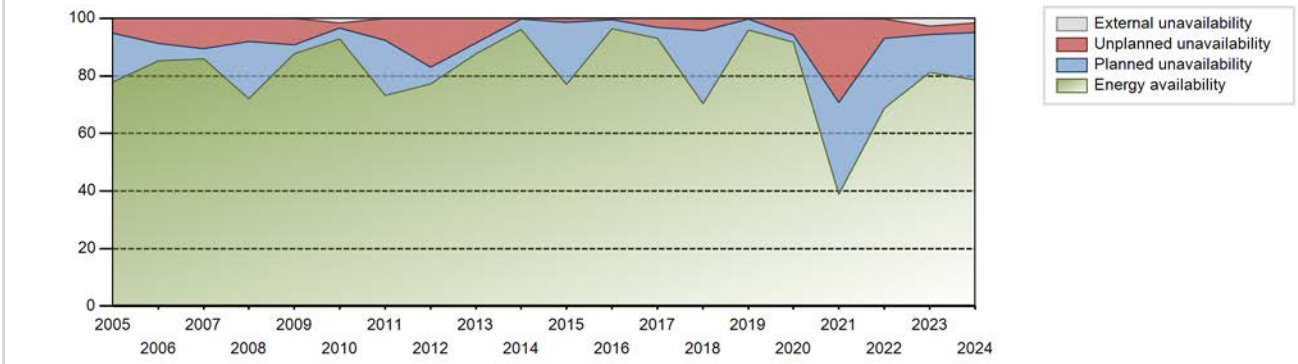
Electricity Production (net) [GWh]



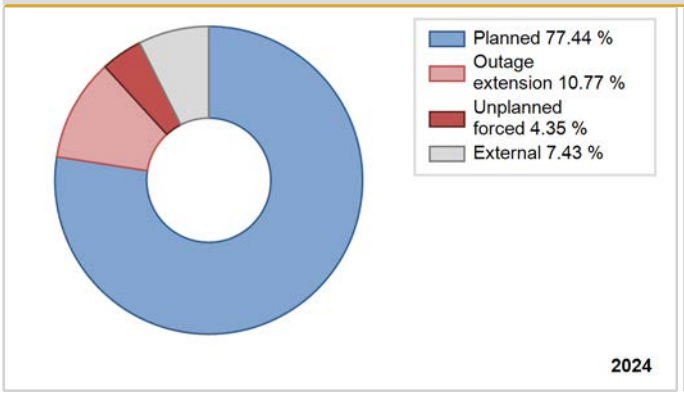
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	2204.46	4454	615	56.92	56.92	22.19	35.13	0.00	0.00	43.08	0.00
1990	1487.04	3509	615	27.75	27.75	27.68	40.17	1.22	0.34	71.91	0.00
1991	1465.40	2786	615	36.89	36.89	27.28	31.89	3.91	1.50	61.61	0.00
1992	4095.95	7240	615	74.85	80.22	74.80	81.31	3.95	3.30	16.48	5.37
1993	4498.15	7376	622	82.29	83.72	82.70	84.43	2.77	2.38	13.89	1.44
1994	4181.11	7255	625	75.62	79.11	76.58	83.05	2.13	1.72	19.17	3.49
1995	5193.85	8286	625	94.47	94.88	94.61	94.33	1.61	1.55	3.57	0.41
1996	4707.35	7699	625	84.98	85.74	85.74	87.65	3.25	2.88	11.38	0.76
1997	4152.78	7105	625	75.23	75.92	75.64	80.89	7.88	6.49	17.59	0.68
1998	5019.39	8688	625	90.49	91.70	91.43	98.91	1.20	1.12	7.18	1.21
1999	4235.45	7212	625	76.55	77.42	77.15	82.10	9.49	8.12	14.46	0.87
2000	4415.35	7502	625	79.95	80.43	80.43	85.41	16.32	15.69	3.89	0.48
2001	5240.97	8534	625	91.45	92.02	95.46	97.15	4.27	4.10	3.88	0.57
2002	4413.96	7501	625	80.82	80.82	80.62	85.63	4.45	4.31	14.88	0.00
2003	5045.34	8444	625	92.04	92.15	92.15	96.39	4.77	4.61	3.23	0.11
2004	4115.67	7250	625	75.33	75.36	74.97	82.54	22.13	21.42	3.22	0.03
2005	4262.48	7317	625	77.95	77.95	77.85	83.53	6.10	5.20	16.84	0.00
2006	4603.97	8057	625	85.22	85.22	85.12	91.97	9.11	8.66	6.12	0.00
2007	4617.34	8006	615	85.83	85.83	85.71	91.39	8.94	10.48	3.69	0.00
2008	3879.33	7038	615	72.11	72.11	71.81	80.12	5.87	8.03	19.87	0.00
2009	4750.20	8497	620	87.70	87.78	87.64	97.00	4.23	9.12	3.10	0.07
2010	5000.04	8637	620	92.80	94.43	92.06	98.60	1.27	1.81	3.76	1.63
2011	3920.77	6772	605	73.23	73.23	73.98	77.31	1.87	7.70	19.07	0.00
2012	4158.33	7238	610	77.15	77.15	77.61	82.40	17.30	16.90	5.95	0.00
2013	4756.06	8071	610	87.70	87.70	89.00	92.13	8.74	8.48	3.82	0.00
2014	5228.25	8760	610	96.22	96.22	97.84	100.00	0.11	0.19	3.59	0.00
2015	4191.06	7038	615	77.11	77.19	77.79	80.34	1.79	1.41	21.41	0.08
2016	5262.55	8784		96.35	96.35	97.42	100.00	0.04	0.48	3.16	0.00
2017	0.00			93.14	93.17	94.04	97.15	1.40	3.03	3.80	0.03
2018	3805.18	6598	620	70.39	70.55	70.06	75.32	4.18	4.22	25.23	0.16
2019	5242.90	8760	620	95.96	96.03	96.53	100.00	0.19	0.25	3.72	0.07
2020	4993.67	8549	620	91.65	91.89	91.69	97.32	5.71	5.57	2.55	0.23
2021	2054.15	3862	620	38.85	38.88	37.82	44.09	26.63	29.19	31.94	0.02
2022	3697.11	6340	620	68.65	68.93	68.07	72.37	7.12	6.68	24.39	0.29
2023	4391.00	7598	620	81.19	83.86	80.85	86.74	3.16	2.86	13.28	2.66
2024	4249.11	7208	620	78.54	80.14	78.02	82.06	1.15	3.25	16.62	1.60

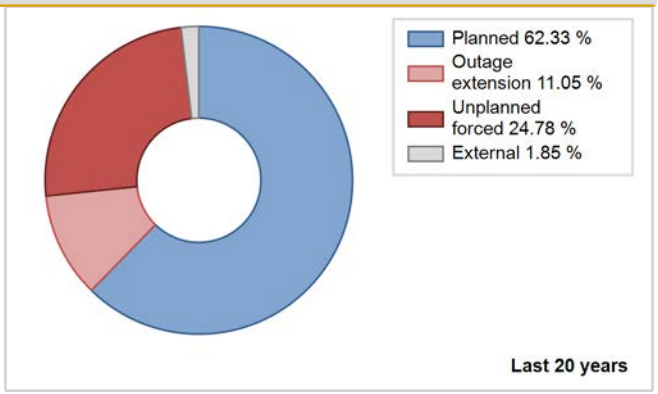
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		102			278	
B. Refuelling without maintenance	1375			103		
C. Inspection, maintenance or repair combined with refuelling				604	30	
D. Inspection, maintenance or repair without refuelling				152	4	
E. Testing of plant systems or components				1	4	
J. Grid limitation, failure or grid unavailability			99			34
L. Human factor related					21	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				82	21	
Z. Other					42	9
Subtotal	1375	102	99	942	400	43
Total	**1576**			**1385**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1989 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		35
12. Reactor I&C Systems	102	14
15. Reactor Cooling Systems		4
16. Steam generation systems	1	21
21. Fuel Handling and Storage Facilities		33
31. Turbine and auxiliaries		107
32. Feedwater and Main Steam System		88
41. Main Generator Systems		16
42. Electrical Power Supply Systems	99	53
Total	**202**	**371**

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2024 Operating Experience

GB-22B HEYSHAM B-2 UNITED KINGDOM

Status at end of year	:	**Operational**
Operator	:	EDF UK (EDF Energy)
Owner	:	EDF UK (EDF Energy)
Reactor Supplier	:	NPC (NUCLEAR POWER CO., LTD.)
Turbine Supplier	:	NEI.P (NEI PARSONS)

Reactor Unit Details

Reactor type and model	:	GCR / AGR
Thermal power	:	1550 MWth
Gross electrical power	:	680 MWe
Reference unit power (net)	:	620 MWe

Key Dates

Construction Date	:	1980-08-01
Grid Date	:	1988-11-11
Commercial Date	:	1989-04-01
Age at end of year	:	36 years

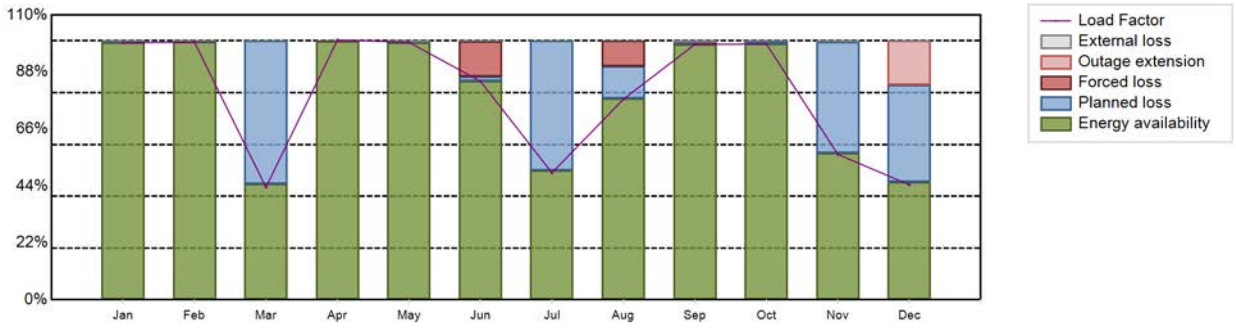
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	4.3
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	635
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	NA
Moderator material	:	GRAPHITE	Containment design pressure [MPa]	:	NA
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	2	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	3	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	27000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	9.46	HP cylinder inlet steam pressure [MPa]	:	15.9
Active core height/length [m]	:	8.31	Output voltage [kV]	:	23.5
Number of fissile fuel assemblies/bundles	:	332	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.8	Number of main condensate pumps	:	2
Number of control rod assemblies	:	89	Number of FW pumps for full power operation	:	1
Number of external reactor coolant loops	:	NA	Number of on-site safety related diesel generators	:	8
Coolant type	:	CO2	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4307.53 GW(e).h	Forced Loss Rate (FLR)	:	2.42 %
Energy Availability Factor (EAF)	:	79.4 %	Unplanned Capability Loss Factor (UCL)	:	3.42 %
Unit Capability Factor (UCF)	:	79.55 %	Planned Unavailability Factor (PUF)	:	17.03 %
Load Factor (LF)	:	79.09 %	Externally cause unavailability (XUF)	:	0.14 %
Operating Factor (OF)	:	84.52 %	Total off-line time	:	1360 hours

Annual Summary



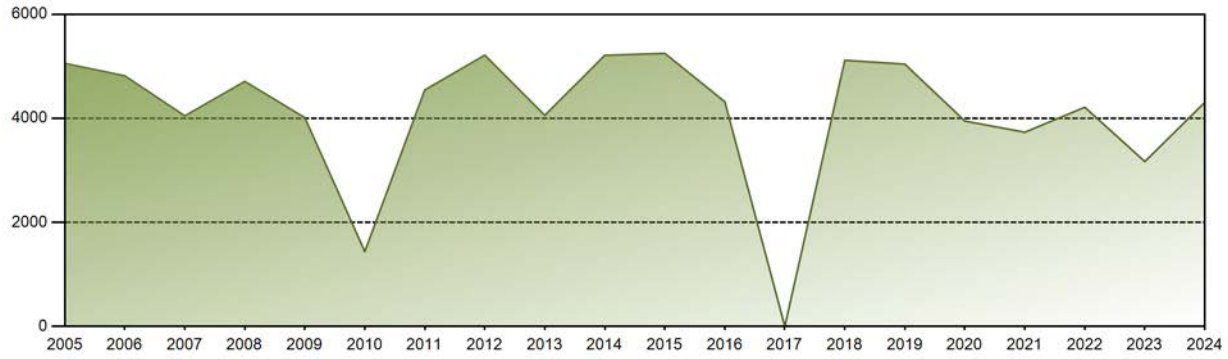
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	457.91	429.40	200.26	448.08	458.72	376.88	226.28	357.41	440.48	456.34	250.78	205.00	4307.53
EAF [%]	99.27	99.49	44.67	99.78	99.43	84.43	50.00	77.88	98.67	98.80	56.79	45.56	79.40
UCF [%]	99.27	99.50	44.67	99.78	99.69	84.63	50.00	77.88	99.33	99.03	57.17	45.56	79.55
LF [%]	99.27	99.51	43.47	100.38	99.45	84.43	49.05	77.48	98.67	98.80	56.18	44.44	79.09
OF [%]	100.00	100.00	49.93	100.00	100.00	100.00	61.29	92.74	100.00	100.00	58.61	53.23	84.52
FLR [%]	0.00	0.28	0.00	0.22	0.00	13.75	0.00	11.07	0.10	0.00	0.00	0.00	2.42
UCL [%]	0.00	0.28	0.00	0.22	0.00	13.49	0.00	9.69	0.10	0.00	0.00	17.10	3.42
PUF [%]	0.73	0.22	55.33	0.00	0.31	1.89	50.00	12.43	0.58	0.97	42.83	37.34	17.03
XUF [%]	0.00	0.00	0.00	0.00	0.27	0.20	0.00	0.00	0.65	0.23	0.38	0.00	0.14

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Historical Summary

Lifetime energy generation	:	146615.24 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.11 %
Cumulative Energy Availability Factor (EAF)	:	77.55 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.42 %
Cumulative Unit Capability Factor (UCF)	:	78.35 %	Cumulative Planned Unavailability Factor (PUF)	:	14.24 %
Cumulative Load Factor (LF)	:	76.89 %	Cumulative Externally cause unavailability (XUF)	:	0.8 %
Cumulative Operating Factor (OF)	:	82.03 %			

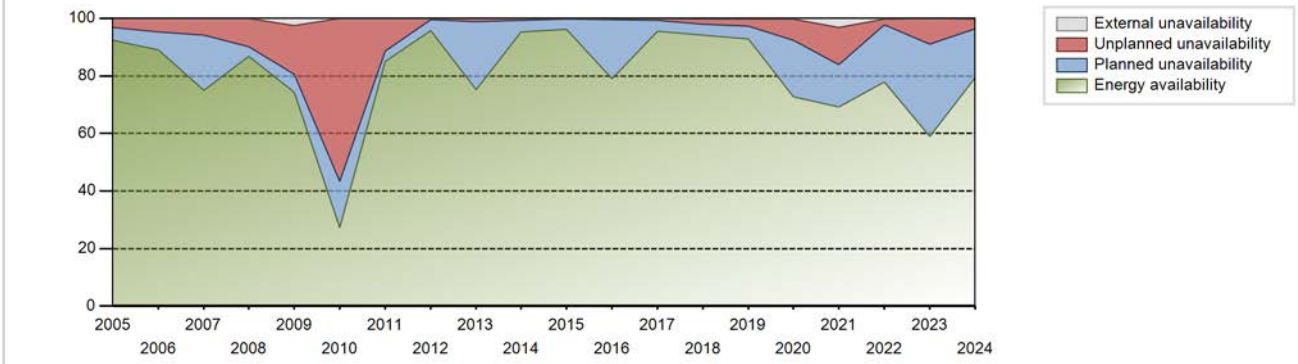
Electricity Production (net) [GWh]



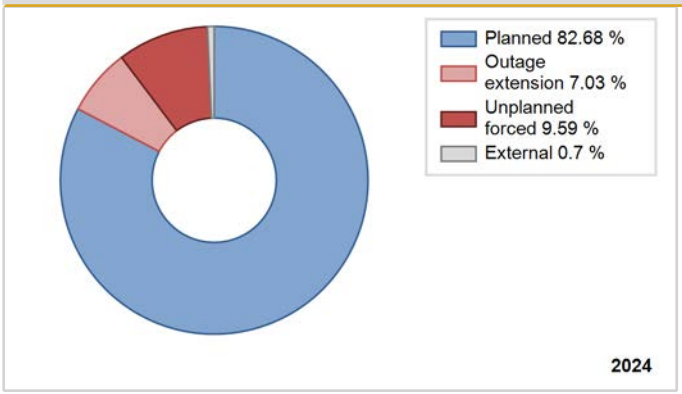
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	3825.57	6989	615	74.41	74.41	63.81	73.90	0.00	0.00	25.59	0.00
1990	783.97	1901	615	14.92	14.92	14.59	21.76	0.00	0.00	85.08	0.00
1991	2423.97	4453	615	53.43	53.66	45.12	50.97	3.43	1.91	44.43	0.23
1992	3486.52	6198	615	64.72	66.40	63.67	69.61	1.13	0.76	32.84	1.68
1993	4384.85	7125	622	79.59	91.61	80.62	81.56	1.63	1.52	6.88	12.02
1994	4435.32	7723	625	80.75	83.96	81.23	88.40	7.89	7.19	8.85	3.21
1995	4498.83	7249	625	82.30	82.22	81.95	82.53	7.24	6.41	11.37	-0.08
1996	4265.35	7103	625	78.39	78.58	77.69	80.86	13.73	12.50	8.92	0.19
1997	4780.70	8021	625	85.46	87.35	87.08	91.31	1.26	1.12	11.53	1.89
1998	4209.73	7574	625	76.15	76.95	76.68	86.22	6.77	5.59	17.46	0.80
1999	2987.21	4987	625	54.59	54.69	54.41	56.77	44.43	43.72	1.59	0.09
2000	5001.88	8660	625	90.49	91.11	91.11	98.59	3.12	2.94	5.95	0.62
2001	4234.22	7103	625	90.80	91.44	77.13	80.86	4.46	4.27	4.29	0.63
2002	5010.34	8521	625	91.53	91.53	91.51	97.27	3.78	3.87	4.60	0.00
2003	4582.83	7712	625	83.75	83.91	83.70	88.04	14.27	14.06	2.04	0.15
2004	4244.16	7383	625	77.48	77.48	77.31	84.05	7.02	7.63	14.89	0.00
2005	5056.80	8564	625	92.32	92.32	92.36	97.76	3.29	3.21	4.47	0.00
2006	4816.70	8293	625	89.08	89.08	89.05	94.67	4.91	4.79	6.14	0.00
2007	4046.74	7104	615	74.92	74.92	75.11	81.10	3.81	5.74	19.34	0.00
2008	4709.31	8252	620	86.70	86.71	86.65	93.94	9.64	9.82	3.47	0.01
2009	4012.10	7268	620	74.22	76.77	73.87	82.97	15.69	16.80	6.43	2.55
2010	1437.40	2719	620	27.24	27.24	26.47	31.04	12.02	56.55	16.21	0.00
2011	4545.68	7968	605	84.99	84.99	85.77	90.96	11.75	11.39	3.62	0.00
2012	5214.03	8784	610	95.80	95.86	97.31	100.00	0.15	0.42	3.72	0.06
2013	4057.17	6945	610	75.17	75.17	75.93	79.28	1.42	1.20	23.63	0.00
2014	5211.77	8713	610	95.26	95.26	97.53	99.46	0.80	0.77	3.97	0.00
2015	5249.04	8760	615	96.20	96.27	97.43	100.00	0.07	0.07	3.65	0.07
2016	4319.05	7214		79.08	79.09	79.95	82.13	0.58	0.46	20.45	0.01
2017	0.00			95.49	95.56	96.19	100.00	0.24	0.56	3.88	0.07
2018	5116.17	8624	620	94.20	94.50	94.20	98.45	1.79	1.80	3.70	0.30
2019	5042.29	8635	620	92.82	93.07	92.84	98.57	2.28	2.57	4.37	0.25
2020	3948.62	6782	620	72.85	73.05	72.50	77.21	3.60	7.35	19.61	0.20
2021	3733.11	7143	620	69.21	72.26	68.73	81.54	8.52	13.01	14.73	3.05
2022	4213.26	7249	620	77.88	78.14	77.58	82.75	2.42	1.94	19.92	0.26
2023	3168.39	5437	620	59.04	59.08	58.34	62.07	1.60	9.01	31.91	0.04
2024	4307.53	7424	620	79.40	79.55	79.09	84.52	2.42	3.42	17.03	0.14

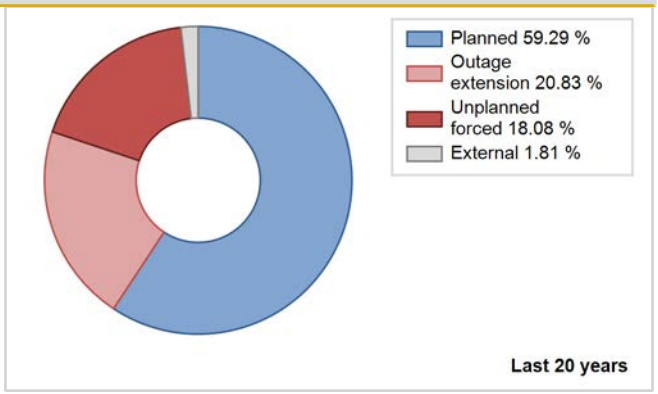
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					463	
B. Refuelling without maintenance	1290			123	4	
C. Inspection, maintenance or repair combined with refuelling				624	14	
D. Inspection, maintenance or repair without refuelling				205		
E. Testing of plant systems or components					6	
J. Grid limitation, failure or grid unavailability						33
L. Human factor related					5	
P. Fire					1	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				14	36	
Z. Other		71			24	30
Subtotal	1290	71		966	553	63
Total		**1361**			**1582**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1989 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		17
12. Reactor I&C Systems		10
15. Reactor Cooling Systems		0
16. Steam generation systems		13
17. Safety I&C Systems (excluding reactor I&C)		2
21. Fuel Handling and Storage Facilities	71	57
31. Turbine and auxiliaries		196
32. Feedwater and Main Steam System		29
33. Circulating Water System		124
41. Main Generator Systems		74
42. Electrical Power Supply Systems		9
Total	**71**	**531**

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2024 Operating Experience

GB-24 SIZEWELL B UNITED KINGDOM

Status at end of year	:	**Operational**
Operator	:	EDF UK (EDF Energy)
Owner	:	EDF UK (EDF Energy)
Reactor Supplier	:	PPC (PWR POWER PROJECTS, Ltd.)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	PWR / SNUPPS
Thermal power	:	3425 MWth
Gross electrical power	:	1250 MWe
Reference unit power (net)	:	1198 MWe

Key Dates

Construction Date	:	1988-07-18
Grid Date	:	1995-02-14
Commercial Date	:	1995-09-22
Age at end of year	:	29 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	43
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

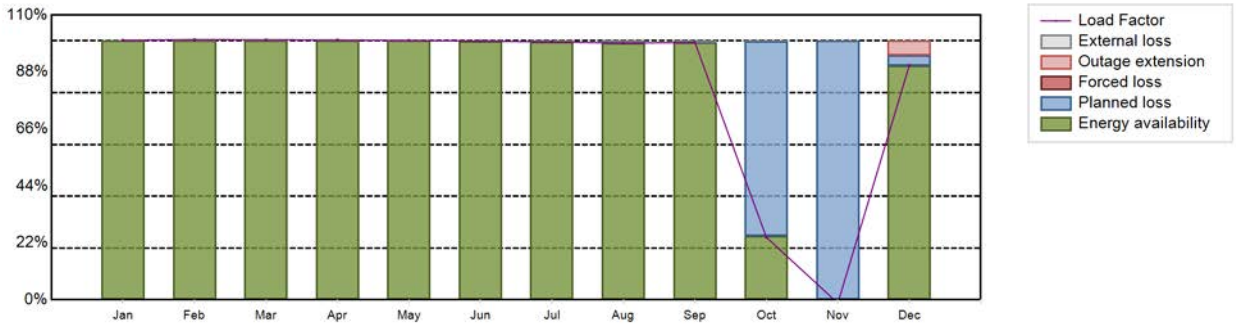
Operating coolant pressure [MPa]	:	15.01
Reactor outlet temperature [°C]	:	323.4
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	0.35
Secondary systems		
Number of turbine-generators per unit/reactor	:	2
Turbine speed [rpm]	:	3000
Number of LP cylinders per turbine	:	3
HP cylinder inlet steam pressure [MPa]	:	6.71
Output voltage [kV]	:	23.5
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	4
Number of FW pumps for full power operation	:	4
Number of on-site safety related diesel generators	:	6
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8887.22 GW(e).h
Energy Availability Factor (EAF)	:	84.43 %
Unit Capability Factor (UCF)	:	84.6 %
Load Factor (LF)	:	84.45 %
Operating Factor (OF)	:	86.09 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0.48 %
Planned Unavailability Factor (PUF)	:	14.92 %
Externally cause unavailability (XUF)	:	0.17 %
Total off-line time	:	1222 hours

Annual Summary



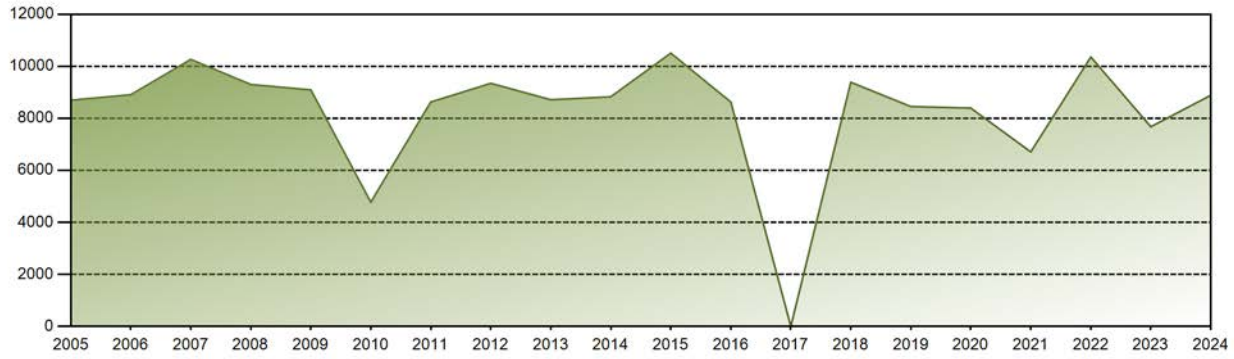
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	893.92	838.10	894.15	865.80	892.90	861.56	887.89	883.54	857.44	215.65	-10.93	807.19	8887.22
EAF [%]	100.00	100.00	100.00	100.00	100.00	99.86	99.62	99.13	99.41	24.71	0.00	90.34	84.43
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98	99.99	24.76	0.00	90.34	84.60
LF [%]	100.29	100.51	100.45	100.38	100.18	99.88	99.62	99.13	99.41	24.16	-1.27	90.56	84.45
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	33.42	0.00	99.19	86.09
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.65	0.48
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	75.24	100.00	4.01	14.92
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.14	0.38	0.86	0.58	0.05	0.00	0.00	0.17

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Historical Summary

Lifetime energy generation	:	233217.95 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.02 %
Cumulative Energy Availability Factor (EAF)	:	83.8 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.73 %
Cumulative Unit Capability Factor (UCF)	:	84.57 %	Cumulative Planned Unavailability Factor (PUF)	:	8.7 %
Cumulative Load Factor (LF)	:	83.19 %	Cumulative Externally cause unavailability (XUF)	:	0.77 %
Cumulative Operating Factor (OF)	:	85.92 %			

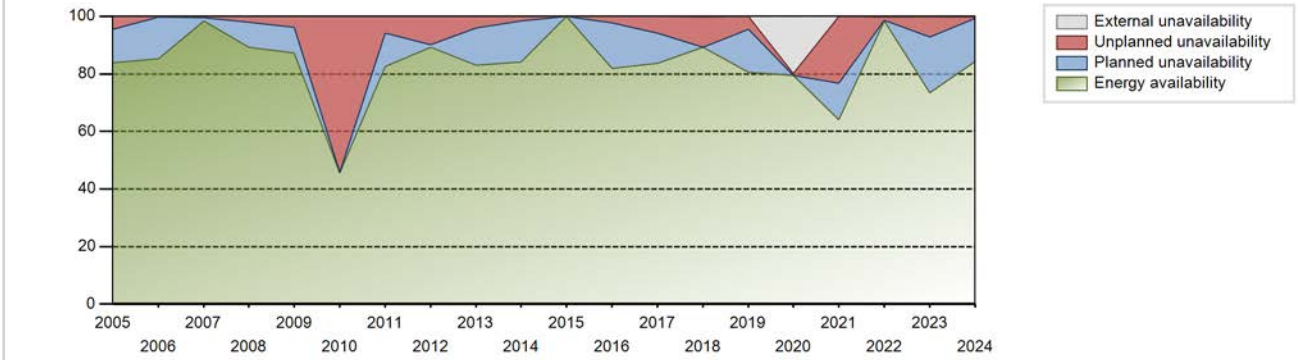
Electricity Production (net) [GWh]



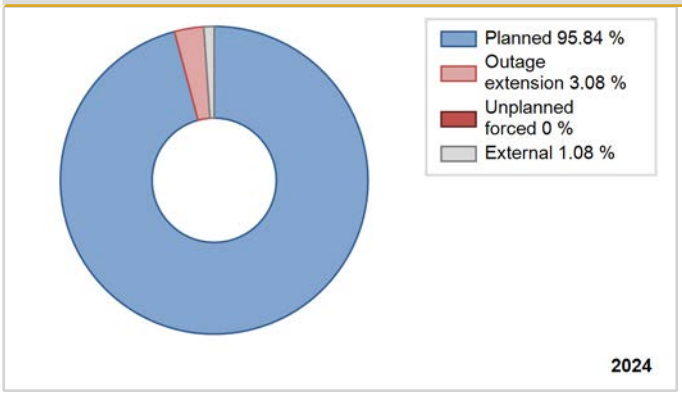
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1995	0.00	0	1188	99.79	100.00	0.00	0.00	0.00	0.00	0.00	0.21
1996	8488.47	7367	1188	81.38	81.34	81.34	83.87	5.51	4.74	13.91	-0.04
1997	8469.81	6992	1188	81.51	81.44	81.16	79.60	5.68	4.91	13.65	-0.07
1998	10123.09	8705	1188	97.38	97.28	97.01	99.10	2.71	2.71	0.01	-0.10
1999	7959.01	7134	1188	76.53	76.54	76.27	81.22	11.22	9.68	13.78	0.01
2000	8527.18	7612	1188	81.62	81.71	81.71	86.66	9.10	8.18	10.10	0.09
2001	9197.96	7784	1188	77.17	77.44	88.14	88.62	12.71	11.28	11.28	0.27
2002	9195.04	7862	1188	88.48	88.90	88.36	89.75	2.36	2.15	8.95	0.42
2003	8854.19	7613	1188	88.74	89.26	85.08	86.91	2.36	2.16	8.58	0.52
2004	9329.11	8685	1188	89.42	89.42	89.40	98.87	9.72	9.63	0.94	0.00
2005	8696.25	7476	1188	83.93	83.93	83.56	85.34	0.00	4.53	11.54	0.00
2006	8908.26	7570	1196	85.25	85.25	85.17	86.42	0.33	0.28	14.47	0.00
2007	10264.31	8760	1188	98.46	98.46	98.47	100.00	0.38	0.38	1.16	0.00
2008	9301.23	8097	1188	89.23	89.23	89.13	92.18	2.05	2.06	8.71	0.00
2009	9094.88	7863	1188	87.35	87.35	87.39	89.76	0.92	3.80	8.85	0.00
2010	4774.80	4032	1188	45.63	45.63	45.88	46.03	54.31	54.24	0.13	0.00
2011	8627.40	7463	1191	82.54	82.54	82.69	85.19	3.43	5.77	11.69	0.00
2012	9346.24	8348	1191	89.20	89.20	89.34	95.04	9.95	9.86	0.95	0.00
2013	8714.72	7612	1198	83.03	83.03	83.04	86.89	0.23	3.97	13.00	0.00
2014	8828.14	7589	1198	84.08	84.08	84.12	86.63	0.69	1.58	14.34	0.00
2015	10507.34	8760	1198	99.91	99.98	100.12	100.00	0.02	0.02	0.00	0.06
2016	8626.70	7280	1198	81.89	82.00	81.98	82.88	0.14	2.13	15.87	0.11
2017	0.00		1198	83.72	83.82	83.90	83.94	0.01	5.84	10.35	0.10
2018	9388.12	8039	1198	89.22	89.37	89.46	91.77	2.20	10.63	0.00	0.15
2019	8452.10	7175	1198	80.54	80.64	80.54	81.91	0.18	4.32	15.04	0.10
2020	8393.47	8743	1198	79.54	99.43	79.76	99.53	0.57	0.57	0.00	19.89
2021	6709.39	5689	1198	64.18	64.23	63.93	64.94	0.00	23.07	12.69	0.06
2022	10357.17	8676	1198	98.50	98.70	98.69	99.04	1.27	1.27	0.02	0.21
2023	7676.68	6566	1198	73.39	73.67	73.15	74.95	0.60	6.90	19.43	0.28
2024	8887.22	7562	1198	84.43	84.60	84.45	86.09	0.00	0.48	14.92	0.17

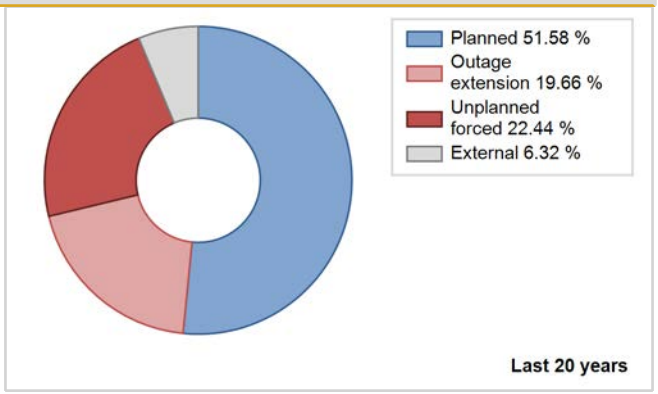
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1995 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					441	
C. Inspection, maintenance or repair combined with refuelling	1222			723	49	
D. Inspection, maintenance or repair without refuelling				1		
E. Testing of plant systems or components					2	
L. Human factor related					3	
Z. Other					3	
Subtotal	1222			724	498	
Total	**1222**			**1222**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1995 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		66
12. Reactor I&C Systems		19
13. Reactor Auxiliary Systems		13
14. Safety Systems		49
15. Reactor Cooling Systems		165
16. Steam generation systems		46
31. Turbine and auxiliaries		2
32. Feedwater and Main Steam System		12
34. Miscellaneous Systems		0
41. Main Generator Systems		52
42. Electrical Power Supply Systems		12
Total		**436**

Highlights (2024)

Carried out a statutory outage

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2024 Operating Experience

GB-23A TORNESS-1 UNITED KINGDOM

Status at end of year	:	**Operational**
Operator	:	EDF UK (EDF Energy)
Owner	:	EDF UK (EDF Energy)
Reactor Supplier	:	NNC (NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	GCR / AGR
Thermal power	:	1623 MWth
Gross electrical power	:	682 MWe
Reference unit power (net)	:	595 MWe

Key Dates

Construction Date	:	1980-08-01
Grid Date	:	1988-05-25
Commercial Date	:	1988-05-25
Age at end of year	:	36 years

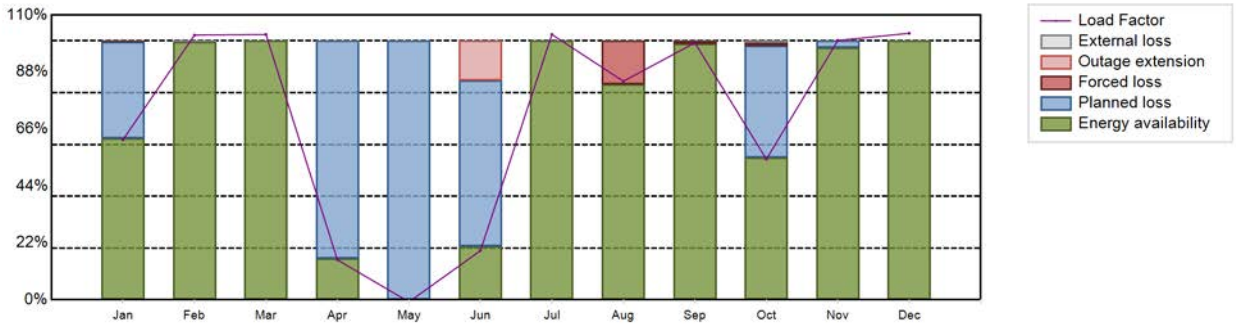
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	4.3
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	635
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	NA
Moderator material	:	GRAPHITE	Containment design pressure [MPa]	:	NA
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	2	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	3	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	27000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	9.46	HP cylinder inlet steam pressure [MPa]	:	15.9
Active core height/length [m]	:	8.31	Output voltage [kV]	:	23.5
Number of fissile fuel assemblies/bundles	:	332	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.8	Number of main condensate pumps	:	2
Number of control rod assemblies	:	89	Number of FW pumps for full power operation	:	1
Number of external reactor coolant loops	:	NA	Number of on-site safety related diesel generators	:	-
Coolant type	:	CO2	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	3672.53 GW(e).h	Forced Loss Rate (FLR)	:	2.33 %
Energy Availability Factor (EAF)	:	69.36 %	Unplanned Capability Loss Factor (UCL)	:	2.9 %
Unit Capability Factor (UCF)	:	69.44 %	Planned Unavailability Factor (PUF)	:	27.65 %
Load Factor (LF)	:	70.27 %	Externally cause unavailability (XUF)	:	0.08 %
Operating Factor (OF)	:	72.23 %	Total off-line time	:	2439 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	273.66	423.45	453.05	66.13	-3.45	81.33	453.71	373.72	425.25	240.80	429.16	455.73	3672.53
EAF [%]	62.41	99.57	100.00	15.93	0.00	20.66	100.00	83.29	98.89	54.87	97.30	100.00	69.36
UCF [%]	62.41	100.00	100.00	15.93	0.00	20.66	100.00	83.29	98.89	55.41	97.30	100.00	69.44
LF [%]	61.82	102.25	102.48	15.44	-0.78	18.98	102.49	84.42	99.26	54.32	100.18	102.95	70.27
OF [%]	66.53	100.00	100.00	16.53	0.00	25.14	100.00	100.00	100.00	58.93	100.00	100.00	72.23
FLR [%]	0.57	0.00	0.00	0.00	0.00	0.00	0.00	16.71	1.11	2.53	0.00	0.00	2.33
UCL [%]	0.36	0.00	0.00	0.00	0.00	15.18	0.00	16.71	1.11	1.44	0.00	0.00	2.90
PUF [%]	37.24	0.00	0.00	84.07	100.00	64.15	0.00	0.00	0.00	43.15	2.70	0.00	27.65
XUF [%]	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.00	0.00	0.08

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Historical Summary

Lifetime energy generation	:	144003.07 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.07 %
Cumulative Energy Availability Factor (EAF)	:	77.28 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.15 %
Cumulative Unit Capability Factor (UCF)	:	78.73 %	Cumulative Planned Unavailability Factor (PUF)	:	15.12 %
Cumulative Load Factor (LF)	:	74.95 %	Cumulative Externally cause unavailability (XUF)	:	1.45 %
Cumulative Operating Factor (OF)	:	82.39 %			

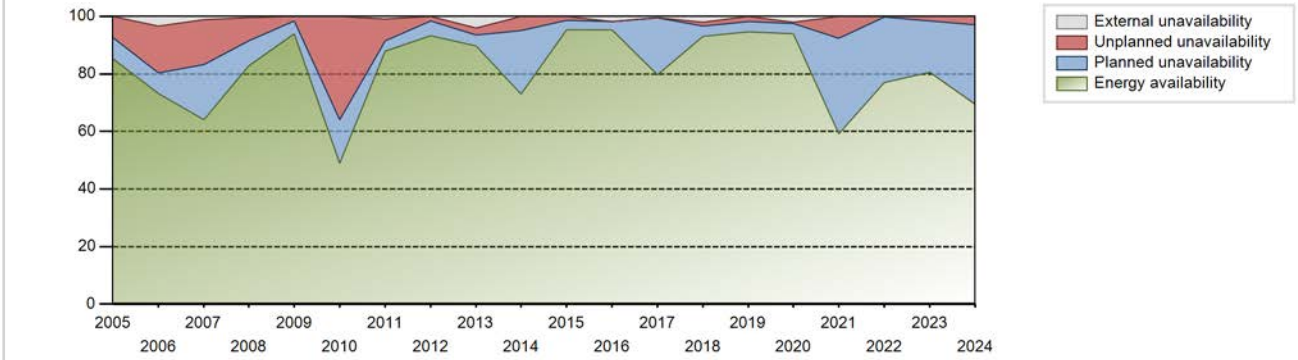
Electricity Production (net) [GWh]



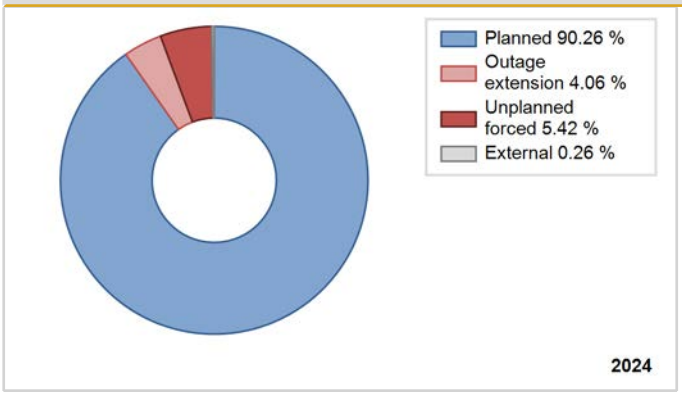
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	2287.10	4330	638	69.41	92.32	68.07	82.99	7.68	7.68	0.00	22.91
1989	2162.10	4582	625	39.47	53.23	39.60	52.45	4.16	2.31	44.46	13.76
1990	1938.35	3943	625	35.66	35.66	35.50	45.14	10.53	4.20	60.14	0.00
1991	2513.60	5011	625	45.97	45.97	46.04	57.36	6.72	3.31	50.72	0.00
1992	4532.90	7792	632	81.66	81.66	80.55	87.51	4.22	3.60	14.74	0.00
1993	3603.10	6358	632	67.68	67.89	62.91	70.15	10.75	8.18	23.93	0.21
1994	4329.90	7716	632	79.51	86.73	78.42	88.32	0.00	0.00	13.27	7.22
1995	4058.60	6867	632	75.19	75.19	71.54	76.50	0.48	0.36	24.44	0.00
1996	1178.10	2043	632	96.64	96.64	21.22	23.26	0.38	0.37	2.99	0.00
1997	4909.44	8050	625	89.70	89.70	89.43	91.64	0.09	0.08	10.22	0.00
1998	4297.87	7153	625	78.56	78.56	78.29	81.43	2.61	2.11	19.33	0.00
1999	5157.76	8737	625	94.22	94.22	93.95	99.46	0.22	0.21	5.57	0.00
2000	4376.80	8769	625	79.72	79.72	79.72	99.83	16.50	15.76	4.52	0.00
2001	3968.48	7613	625	70.24	70.24	72.29	86.67	18.14	15.57	14.19	0.00
2002	3761.93	6719	625	68.71	69.64	68.71	76.70	24.65	24.01	6.35	0.93
2003	4681.94	8347	625	85.61	85.76	85.51	95.29	7.20	8.00	6.24	0.15
2004	3921.80	6993	625	71.68	71.68	71.44	79.61	12.51	12.74	15.58	0.00
2005	4667.73	8372	625	85.34	85.34	85.26	95.57	6.95	7.34	7.32	0.00
2006	4000.87	7939	625	73.31	76.74	73.08	90.63	14.29	16.15	7.11	3.43
2007	3500.94	6234	625	64.16	65.32	63.94	71.16	14.34	15.57	19.11	1.16
2008	4488.12	8110	615	82.89	83.47	82.75	92.33	8.62	7.88	8.65	0.59
2009	4963.55	8760	600	93.86	93.86	93.86	100.00	1.42	1.55	4.59	0.00
2010	2565.36	5302	600	48.82	48.82	48.81	60.53	34.51	35.95	15.23	0.00
2011	4582.85	8393	600	87.99	88.91	87.19	95.81	5.98	7.56	3.53	0.92
2012	4878.05	8784	595	93.33	93.35	93.33	100.00	1.12	1.57	5.08	0.01
2013	4637.66	8451	590	89.80	93.80	89.73	96.47	1.96	2.40	3.79	4.01
2014	3758.73	6823	590	73.02	73.05	72.73	77.89	4.81	4.82	22.14	0.03
2015	4954.38	8760	590	95.37	95.45	95.86	100.00	1.44	1.39	3.15	0.08
2016	4968.15	8678	590	95.29	97.07	95.86	98.79	0.00	0.00	2.92	1.78
2017	4056.96	7235		79.60	80.02	78.50	82.59	0.01	0.16	19.82	0.42
2018	4908.39	8610	595	93.14	95.08	94.17	98.29	1.45	1.43	3.49	1.94
2019	5006.74	8760	595	94.66	94.75	96.06	100.00	1.12	1.67	3.58	0.09
2020	4946.16	8784	595	94.00	95.95	94.64	100.00	0.48	0.54	3.51	1.96
2021	3090.34	5372	595	59.23	59.27	59.29	61.32	0.38	7.53	33.20	0.04
2022	4079.44	6890	595	77.04	77.04	78.27	78.65	0.36	0.28	22.68	0.00
2023	4225.69	7192	595	80.53	80.57	81.07	82.10	0.42	1.61	17.82	0.03
2024	3672.53	6345	595	69.36	69.44	70.27	72.23	2.33	2.90	27.65	0.08

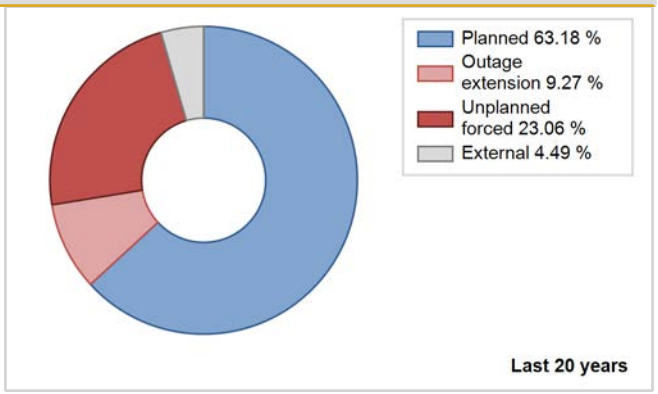
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					208	
B.	Refuelling without maintenance	555			154		
C.	Inspection, maintenance or repair combined with refuelling	1807			597	19	
D.	Inspection, maintenance or repair without refuelling				137		
E.	Testing of plant systems or components					1	
J.	Grid limitation, failure or grid unavailability						2
L.	Human factor related					27	
M.	Governmental requirements or court decisions						9
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						16
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					10	
Z.	Other		77		69	39	40
Subtotal		2362	77		957	304	67
Total		**2439**			**1328**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1988 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		11
12. Reactor I&C Systems		18
14. Safety Systems		4
15. Reactor Cooling Systems		48
16. Steam generation systems		6
21. Fuel Handling and Storage Facilities		27
31. Turbine and auxiliaries		14
32. Feedwater and Main Steam System		7
33. Circulating Water System		24
41. Main Generator Systems		50
42. Electrical Power Supply Systems		53
Total		**262**

Highlights (2024)

Carried out a statutory outage

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2024 Operating Experience

GB-23B TORNESS-2 UNITED KINGDOM

Status at end of year	:	**Operational**
Operator	:	EDF UK (EDF Energy)
Owner	:	EDF UK (EDF Energy)
Reactor Supplier	:	NNC (NATIONAL NUCLEAR CORPORATION)
Turbine Supplier	:	GEC (GENERAL ELECTRIC COMPANY (UK))

Reactor Unit Details

Reactor type and model	:	GCR / AGR
Thermal power	:	1623 MWth
Gross electrical power	:	682 MWe
Reference unit power (net)	:	605 MWe

Key Dates

Construction Date	:	1980-08-01
Grid Date	:	1989-02-03
Commercial Date	:	1989-02-04
Age at end of year	:	35 years

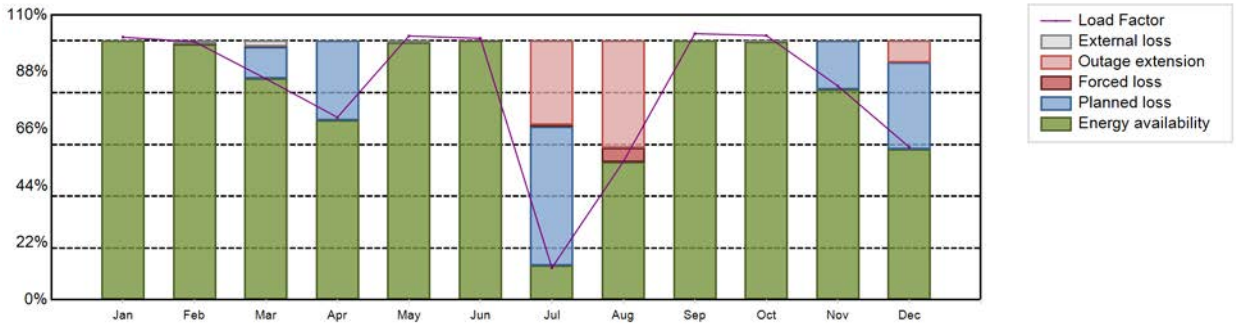
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	4.3
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	635
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	ON-line	Containment type	:	NA
Moderator material	:	GRAPHITE	Containment design pressure [MPa]	:	NA
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	2	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	3	Turbine speed [rpm]	:	3000
Average discharge burnup [MWd/t]	:	27000	Number of LP cylinders per turbine	:	3
Active core diameter [m]	:	9.46	HP cylinder inlet steam pressure [MPa]	:	15.9
Active core height/length [m]	:	8.31	Output voltage [kV]	:	23.5
Number of fissile fuel assemblies/bundles	:	332	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	16.8	Number of main condensate pumps	:	2
Number of control rod assemblies	:	89	Number of FW pumps for full power operation	:	1
Number of external reactor coolant loops	:	NA	Number of on-site safety related diesel generators	:	-
Coolant type	:	CO2	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	4294.99 GW(e).h	Forced Loss Rate (FLR)	:	0.68 %
Energy Availability Factor (EAF)	:	79.68 %	Unplanned Capability Loss Factor (UCL)	:	7.48 %
Unit Capability Factor (UCF)	:	80.04 %	Planned Unavailability Factor (PUF)	:	12.48 %
Load Factor (LF)	:	80.82 %	Externally cause unavailability (XUF)	:	0.36 %
Operating Factor (OF)	:	82.3 %	Total off-line time	:	1555 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	456.54	419.87	383.79	307.09	458.65	439.95	55.77	240.51	447.72	460.04	359.75	265.32	4294.99
EAF [%]	100.00	98.74	85.44	69.25	99.38	100.00	13.30	53.24	100.00	99.54	81.26	58.26	79.68
UCF [%]	100.00	99.98	87.47	69.25	100.00	100.00	13.30	53.24	100.00	100.00	81.26	58.26	80.04
LF [%]	101.43	99.71	85.38	70.50	101.89	101.00	12.39	53.43	102.78	102.07	82.59	58.94	80.82
OF [%]	100.00	100.00	88.56	73.33	100.00	100.00	14.25	65.32	100.00	100.00	81.39	66.67	82.30
FLR [%]	0.00	0.02	0.25	0.00	0.00	0.00	5.36	9.31	0.00	0.00	0.00	0.00	0.68
UCL [%]	0.00	0.02	0.22	0.00	0.00	0.00	33.08	46.76	0.00	0.00	0.00	8.25	7.48
PUF [%]	0.00	0.00	12.30	30.75	0.00	0.00	53.62	0.00	0.00	0.00	18.74	33.49	12.48
XUF [%]	0.00	1.24	2.04	0.00	0.62	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.36

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Historical Summary

Lifetime energy generation	:	141197.88 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.9 %
Cumulative Energy Availability Factor (EAF)	:	76.56 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.04 %
Cumulative Unit Capability Factor (UCF)	:	77.53 %	Cumulative Planned Unavailability Factor (PUF)	:	14.43 %
Cumulative Load Factor (LF)	:	74.38 %	Cumulative Externally cause unavailability (XUF)	:	0.98 %
Cumulative Operating Factor (OF)	:	82.47 %			

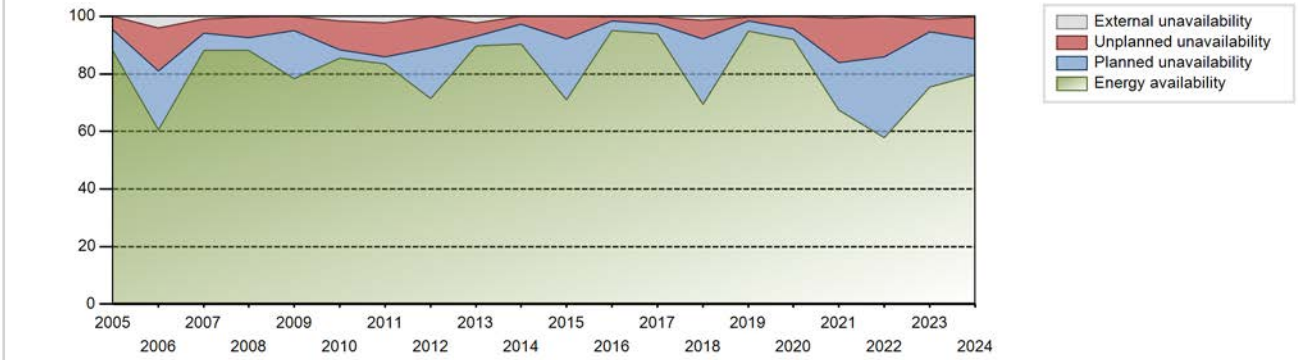
Electricity Production (net) [GWh]



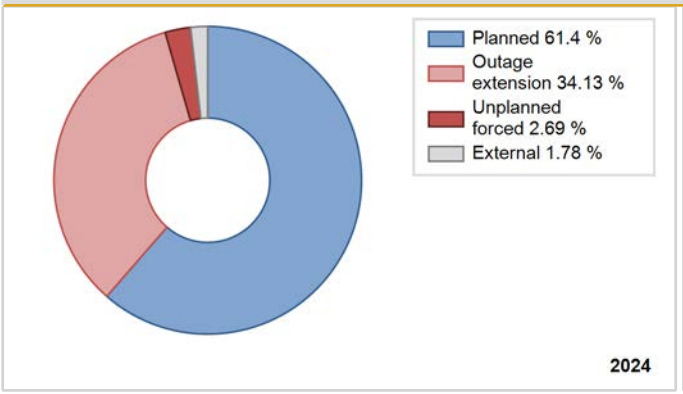
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	3633.80	7068	625	74.21	87.39	73.28	89.08	4.32	3.94	8.67	13.18
1990	1948.30	4211	625	36.08	36.08	35.68	48.20	6.46	2.49	61.43	0.00
1991	2651.30	5068	625	48.37	48.37	48.56	58.01	4.70	2.38	49.25	0.00
1992	3732.70	6560	625	67.02	67.02	67.07	73.67	5.42	3.84	29.14	0.00
1993	4038.00	7168	632	74.35	74.35	73.14	82.05	3.86	2.99	22.66	0.00
1994	3478.09	6264	632	65.46	71.21	62.82	71.51	1.36	0.98	27.81	5.74
1995	4651.90	7909	632	85.88	85.88	81.31	87.37	1.10	0.95	13.17	0.00
1996	1571.30	2409	632	96.20	96.20	28.30	27.42	0.00	0.00	3.80	0.00
1997	4217.98	7181	625	77.72	77.72	76.83	81.75	1.33	1.04	21.24	0.00
1998	5094.36	8713	625	93.68	93.68	92.79	99.19	0.63	0.60	5.72	0.00
1999	4983.97	8588	625	91.06	91.06	90.78	97.77	4.07	3.86	5.08	0.00
2000	3936.12	7686	625	71.70	71.70	71.70	87.50	17.72	15.45	12.86	0.00
2001	4293.57	8476	625	76.57	77.15	78.21	96.49	19.60	18.81	4.03	0.58
2002	1945.61	3751	625	35.73	36.99	35.54	42.82	61.93	60.74	2.27	1.26
2003	3782.85	6874	625	69.44	69.44	69.09	78.47	14.58	14.03	16.53	0.00
2004	4082.96	7682	625	74.61	74.61	74.37	87.45	10.63	14.69	10.69	0.00
2005	4821.85	8570	625	87.85	87.85	88.07	97.83	4.80	4.64	7.51	0.00
2006	3297.00	6456	625	60.46	64.44	60.22	73.70	12.00	14.99	20.57	3.98
2007	4829.04	8480	625	88.26	89.19	88.20	96.80	5.15	4.87	5.94	0.93
2008	4780.78	8494	615	88.23	88.40	88.14	96.70	7.06	7.23	4.37	0.17
2009	4151.18	7303	605	78.30	78.30	78.01	83.37	3.43	5.01	16.70	0.00
2010	4531.25	8345	605	85.50	87.13	85.50	95.26	9.83	9.97	2.91	1.63
2011	4417.91	8235	605	83.48	85.67	83.36	94.01	12.08	11.95	2.39	2.18
2012	3717.79	6632	595	71.43	71.43	71.13	75.50	3.31	10.85	17.72	0.00
2013	4672.85	8287	595	89.68	91.85	89.65	94.60	4.83	4.74	3.41	2.16
2014	4718.74	8274	595	90.41	90.50	90.53	94.45	2.71	2.52	6.98	0.09
2015	3711.61	6684	595	70.90	70.91	71.21	76.30	4.29	7.83	21.25	0.02
2016	4982.13	8746	595	95.11	95.32	95.32	99.57	0.96	1.44	3.23	0.21
2017	4853.06	8710		94.02	94.35	93.11	99.43	0.80	2.36	3.29	0.33
2018	3680.98	6602	605	69.34	70.78	69.46	75.37	8.41	6.49	22.73	1.44
2019	5059.93	8760	605	94.81	95.01	95.47	100.00	0.91	1.48	3.52	0.20
2020	4904.72	8615	605	92.01	92.04	92.29	98.08	4.03	4.26	3.70	0.03
2021	3589.01	7005	605	67.51	68.23	67.72	79.97	12.88	15.32	16.45	0.72
2022	3076.41	6048	605	57.80	57.80	58.05	69.04	19.56	14.05	28.15	0.00
2023	4055.74	6839	605	75.46	76.35	76.53	78.07	0.83	4.43	19.23	0.88
2024	4294.99	7229	605	79.68	80.04	80.82	82.30	0.68	7.48	12.48	0.36

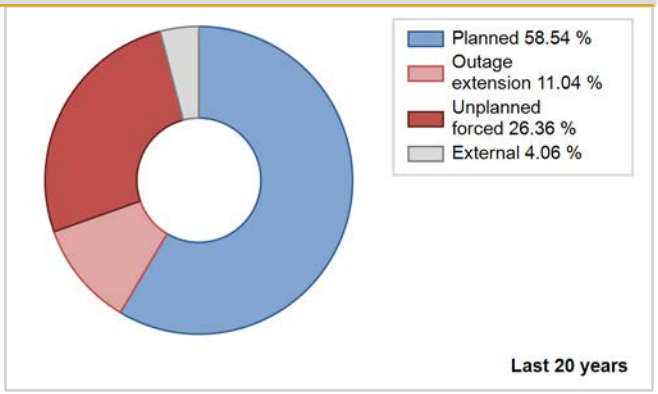
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		498			291	
B. Refuelling without maintenance	1057			122		
C. Inspection, maintenance or repair combined with refuelling				569	35	
D. Inspection, maintenance or repair without refuelling				151		
E. Testing of plant systems or components					5	
G. Major backfitting, refurbishment or upgrading activities without refuelling				13	13	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					3	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						23
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				5	84	
Z. Other					23	16
Subtotal	1057	498		860	454	40
Total		**1555**			**1354**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1989 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		21
12. Reactor I&C Systems		15
13. Reactor Auxiliary Systems		5
15. Reactor Cooling Systems		158
16. Steam generation systems		33
17. Safety I&C Systems (excluding reactor I&C)		12
21. Fuel Handling and Storage Facilities	498	115
31. Turbine and auxiliaries		16
32. Feedwater and Main Steam System		13
33. Circulating Water System		23
34. Miscellaneous Systems		2
41. Main Generator Systems		5
42. Electrical Power Supply Systems		16
Total	**498**	**434**

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2024 Operating Experience

US-313 ANO-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	ENTERGY (Entergy Nuclear Operations, Inc.)
Owner	:	ENTARK (ENTERGY ARKANSAS, INC.)
Reactor Supplier	:	B&W (BABCOCK & WILCOX CO.)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / B&W LLP (DRYAMB)
Thermal power	:	2568 MWth
Gross electrical power	:	903 MWe
Reference unit power (net)	:	836 MWe

Key Dates

Construction Date	:	1968-10-01
Grid Date	:	1974-08-17
Commercial Date	:	1974-12-19
Age at end of year	:	50 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	35000
Active core diameter [m]	:	3.27
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	18
Number of control rod assemblies	:	60
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

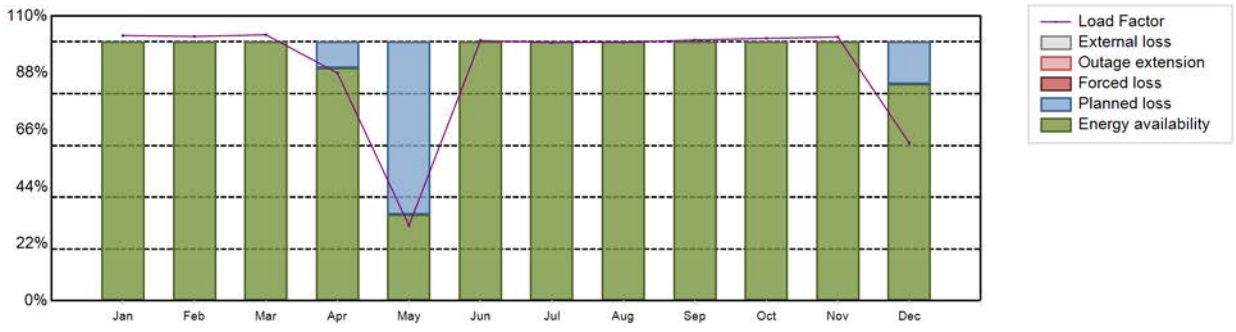
Operating coolant pressure [MPa]	:	15.3
Reactor outlet temperature [°C]	:	318
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.415
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.3
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6657.17 GW(e).h
Energy Availability Factor (EAF)	:	92.15 %
Unit Capability Factor (UCF)	:	92.15 %
Load Factor (LF)	:	90.65 %
Operating Factor (OF)	:	92.13 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	7.85 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	691 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	637.28	594.20	638.27	529.54	180.97	605.24	620.28	621.50	606.27	630.63	614.12	378.87	6657.17
EAF [%]	100.00	100.00	100.00	90.03	33.24	100.00	100.00	100.00	100.00	100.00	100.00	83.78	92.15
UCF [%]	100.00	100.00	100.00	90.03	33.24	100.00	100.00	100.00	100.00	100.00	100.00	83.78	92.15
LF [%]	102.46	102.12	102.76	87.98	29.10	100.55	99.73	99.92	100.72	101.39	101.88	60.91	90.65
OF [%]	100.00	100.00	100.00	86.67	36.29	100.00	100.00	100.00	100.00	100.00	100.00	83.74	92.13
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	9.97	66.76	0.00	0.00	0.00	0.00	0.00	0.00	16.22	7.85
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	289721.87 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.38 %
Cumulative Energy Availability Factor (EAF)	:	82.08 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.69 %
Cumulative Unit Capability Factor (UCF)	:	82.42 %	Cumulative Planned Unavailability Factor (PUF)	:	12.88 %
Cumulative Load Factor (LF)	:	79.03 %	Cumulative Externally cause unavailability (XUF)	:	0.34 %
Cumulative Operating Factor (OF)	:	82.53 %			

Electricity Production (net) [GWh]

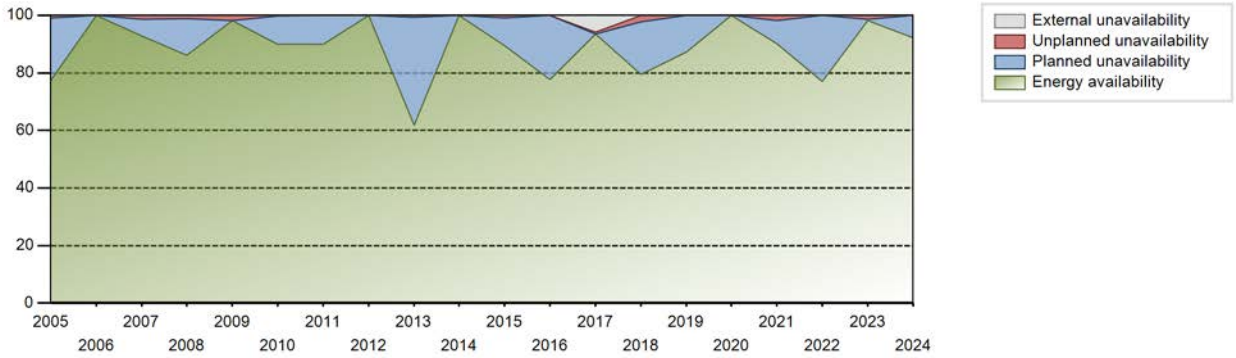


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1974	Data not provided										
1975	4898.40	6661	797	67.71	67.71	70.16	76.04	10.27	7.75	24.54	0.00
1976	3888.00	4966	836	53.00	53.00	52.95	56.53	25.47	18.11	28.89	0.00
1977	5103.10	6688	836	69.67	69.67	69.68	76.35	6.76	5.05	25.28	0.00
1978	5249.80	6676	836	71.72	71.72	71.69	76.21	12.66	10.40	17.88	0.00
1979	3323.40	4253	836	45.38	45.38	45.38	48.55	38.62	28.55	26.07	0.00
1980	3781.20	5570	836	63.70	74.77	51.49	63.41	21.95	21.03	4.20	11.06
1981	4900.80	6336	836	72.55	72.55	66.92	72.33	8.69	6.90	20.55	0.00
1982	3721.40	5671	836	64.79	64.79	50.82	64.74	12.50	9.26	25.96	0.00
1983	3220.60	4191	836	48.26	48.26	43.98	47.84	33.32	24.12	27.63	0.00
1984	4604.13	6150	836	70.06	70.06	62.70	70.01	1.20	0.85	29.09	0.00
1985	5190.35	6852	836	78.25	78.25	70.87	78.22	16.02	14.92	6.82	0.00
1986	3589.93	5446	836	62.20	62.20	49.02	62.17	8.05	5.45	32.35	0.00
1987	4763.34	7720	836	88.17	88.17	65.04	88.13	4.45	4.11	7.73	0.00
1988	3963.24	5996	836	68.28	68.28	53.97	68.26	3.24	2.28	29.44	0.00
1989	3377.00	5871	836	67.07	67.07	46.11	67.02	27.55	25.50	7.43	0.00
1990	4145.80	6437	836	75.88	75.88	56.61	73.48	1.60	1.23	22.89	0.00
1991	6540.51	7991	836	91.27	91.27	89.31	91.22	3.54	3.34	5.39	0.00
1992	5833.14	7088	836	80.69	80.69	79.43	80.69	0.07	0.06	19.25	0.00
1993	6126.55	7520	836	85.86	85.86	83.66	85.84	2.74	2.42	11.72	0.00
1994	7198.56	8643	836	98.69	98.69	98.30	98.66	1.31	1.31	0.00	0.00
1995	5978.22	7493	836	85.59	85.59	81.63	85.54	1.83	1.60	12.81	0.00
1996	6287.02	7613	836	86.70	86.70	85.61	86.67	4.59	4.17	9.13	0.00
1997	7251.10	8723	836	99.59	99.59	99.01	99.58	0.41	0.41	0.00	0.00
1998	6216.85	7364	836	84.11	84.11	84.89	84.06	4.45	3.92	11.98	0.00
1999	6714.72	7907	836	90.30	90.30	91.69	90.26	1.49	1.36	8.34	0.00
2000	6410.14	7748	836	88.22	88.22	87.29	88.21	8.37	8.06	3.71	0.00
2001	6875.47	8100	836	91.81	91.81	93.88	92.47	1.39	1.29	6.90	0.00
2002	6568.63	7820	836	89.15	89.15	89.69	89.27	0.00	0.00	10.85	0.00
2003	6794.30	8050	836	91.82	91.82	92.78	91.89	8.18	8.18	0.00	0.00
2004	6827.58	8045	836	91.57	91.57	92.98	91.59	0.00	0.00	8.43	0.00
2005	5743.24	6778	840	77.38	77.38	78.05	77.37	1.29	1.01	21.61	0.00
2006	7474.87	8760	836	100.00	100.00	102.06	99.99	0.00	0.00	0.00	0.00
2007	6882.81	8122	843	92.80	92.80	93.20	92.72	1.54	1.45	5.75	0.00
2008	6124.05	7558	843	86.06	86.06	82.70	86.04	1.29	1.12	12.82	0.00
2009	7302.10	8595	842	98.12	98.12	99.00	98.12	1.88	1.88	0.00	0.00
2010	6607.09	7883	842	90.00	90.00	89.58	89.99	0.31	0.28	9.71	0.00

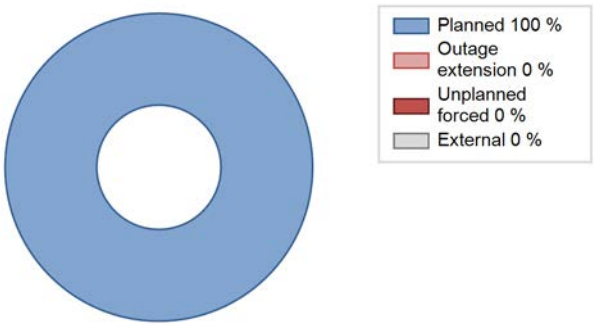
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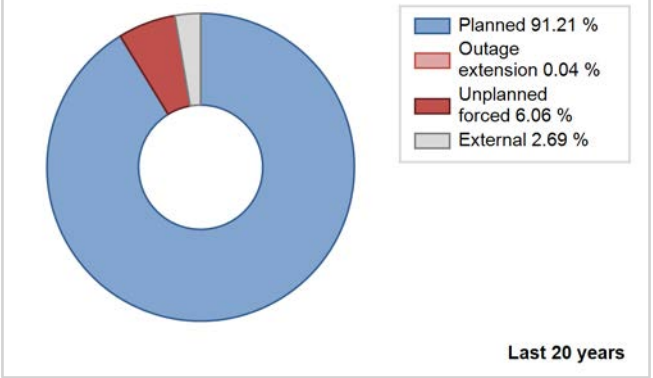
2011	6395.49	7872	842	89.87	89.87	86.71	89.86	0.00	0.00	10.13	0.00
2012	7436.06	8784	842	100.00	100.00	100.54	100.00	0.00	0.00	0.00	0.00
2013	4448.74	5415	836	61.79	61.79	60.74	61.81	1.22	0.76	37.45	0.00
2014	7180.53	8760	836	100.00	100.00	98.05	100.00	0.00	0.00	0.00	0.00
2015	6528.76	7832	836	89.40	89.40	89.15	89.41	0.96	0.87	9.73	0.00
2016	5681.14	6821	836	77.65	77.65	77.36	77.65	0.00	0.00	22.35	0.00
2017	6883.54	8193	836	93.53	99.44	93.99	93.53	0.56	0.56	0.00	5.91
2018	5647.03	6966	836	79.53	79.53	77.11	79.52	2.67	2.18	18.29	0.00
2019	6447.65	7644	836	87.26	87.26	88.04	87.26	0.00	0.00	12.74	0.00
2020	7436.38	8783	836	100.00	100.00	101.27	99.99	0.00	0.00	0.00	0.00
2021	6553.94	7897	836	90.15	90.15	89.49	90.15	1.91	1.76	8.09	0.00
2022	5552.65	6753	836	77.10	77.10	75.82	77.09	0.00	0.00	22.90	0.00
2023	7274.18	8659	836	98.27	98.27	99.33	98.85	1.37	1.46	0.26	0.00
2024	6657.17	8093	836	92.15	92.15	90.65	92.13	0.00	0.00	7.85	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1974 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					430	
B. Refuelling without maintenance				54		
C. Inspection, maintenance or repair combined with refuelling	570			788		
D. Inspection, maintenance or repair without refuelling	121			97		
E. Testing of plant systems or components				2	2	
F. Major backfitting, refurbishment or upgrading activities with refuelling				38		
H. Nuclear regulatory requirements					33	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					4	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						13
P. Fire					3	
Z. Other				41	4	
Subtotal	691			1020	476	14
Total	**691**			**1510**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1974 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		60
12. Reactor I&C Systems		26
13. Reactor Auxiliary Systems		10
14. Safety Systems		24
15. Reactor Cooling Systems		34
16. Steam generation systems		37
17. Safety I&C Systems (excluding reactor I&C)		14
31. Turbine and auxiliaries		95
32. Feedwater and Main Steam System		48
33. Circulating Water System		7
34. Miscellaneous Systems		3
35. All other I&C Systems		1
41. Main Generator Systems		60
42. Electrical Power Supply Systems		27
Total		**446**

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2024 Operating Experience

US-368 ANO-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	ENTERGY (Entergy Nuclear Operations, Inc.)
Owner	:	ENTARK (ENTERGY ARKANSAS, INC.)
Reactor Supplier	:	CE (COMBUSTION ENGINEERING CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / CE 2LP (DRYAMB)
Thermal power	:	3026 MWth
Gross electrical power	:	1065 MWe
Reference unit power (net)	:	988 MWe

Key Dates

Construction Date	:	1968-12-06
Grid Date	:	1978-12-26
Commercial Date	:	1980-03-26
Age at end of year	:	46 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	35000
Active core diameter [m]	:	3.12
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	18
Number of control rod assemblies	:	73
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

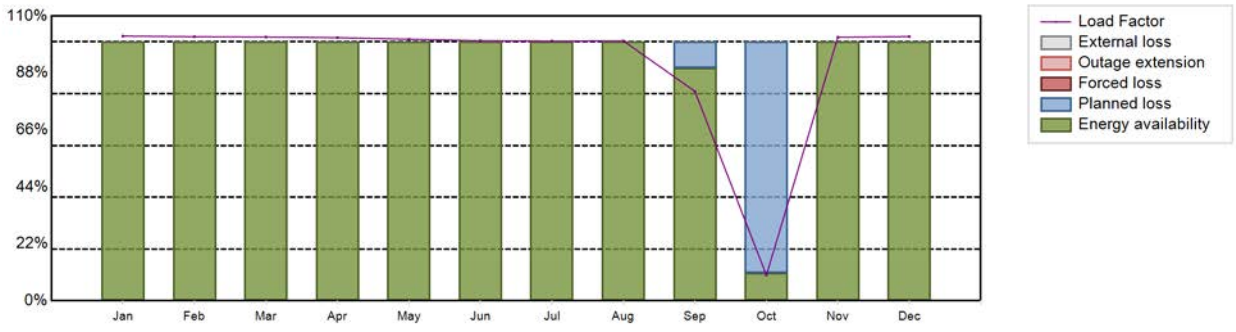
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	323
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.38
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.08
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7980.84 GW(e).h
Energy Availability Factor (EAF)	:	91.62 %
Unit Capability Factor (UCF)	:	91.62 %
Load Factor (LF)	:	91.96 %
Operating Factor (OF)	:	91.61 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	8.38 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	737 hours

Annual Summary



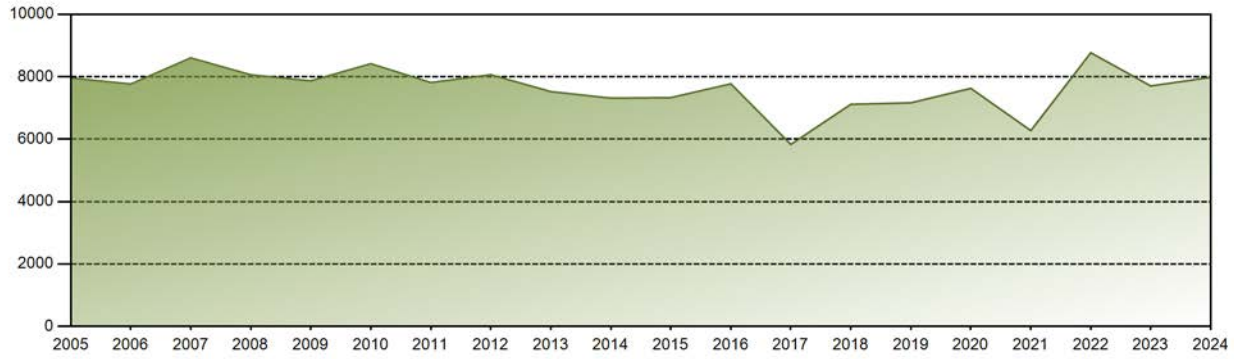
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	751.72	701.47	747.83	722.99	742.61	714.57	737.61	737.91	575.67	73.01	725.13	750.31	7980.84
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.01	10.69	100.00	100.00	91.62
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.01	10.69	100.00	100.00	91.62
LF [%]	102.26	102.01	101.87	101.63	101.03	100.45	100.35	100.39	80.93	9.93	101.79	102.07	91.96
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.00	10.62	100.00	100.00	91.61
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.99	89.31	0.00	0.00	8.38
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	305712.8 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.97 %
Cumulative Energy Availability Factor (EAF)	:	84.77 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.7 %
Cumulative Unit Capability Factor (UCF)	:	84.89 %	Cumulative Planned Unavailability Factor (PUF)	:	10.42 %
Cumulative Load Factor (LF)	:	84.54 %	Cumulative Externally cause unavailability (XUF)	:	0.11 %
Cumulative Operating Factor (OF)	:	84.48 %			

Electricity Production (net) [GWh]

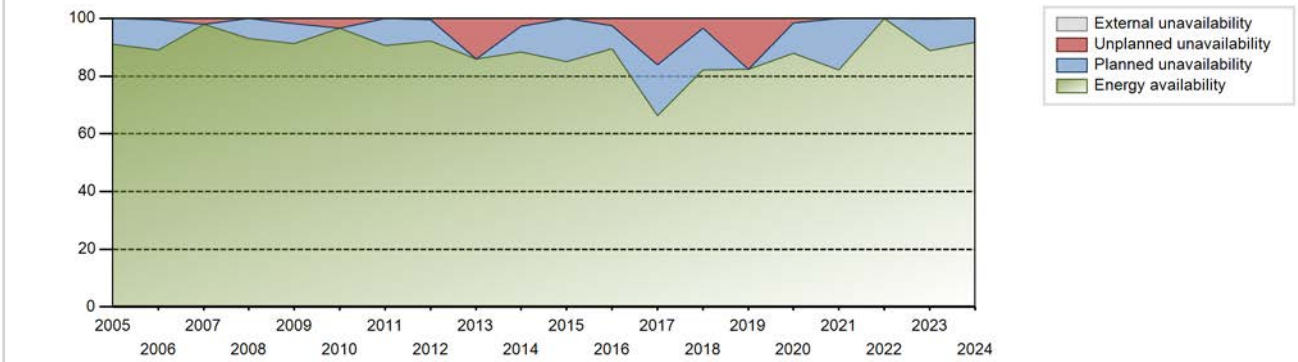


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	3646.60	4913	884	73.39	80.25	60.50	72.74	19.75	19.75	0.00	6.85
1981	4323.60	5622	858	65.23	65.23	57.52	64.18	10.27	7.47	27.31	0.00
1982	3807.50	5023	858	57.88	57.88	50.66	57.34	22.77	17.07	25.05	0.00
1983	4427.90	5380	858	61.45	61.45	58.91	61.42	19.19	14.60	23.95	0.00
1984	6203.57	7439	858	84.74	84.74	82.31	84.69	7.34	6.71	8.55	0.00
1985	4701.15	6040	858	68.99	69.16	62.55	68.95	13.85	11.12	19.73	0.17
1986	5314.34	6274	858	71.65	71.65	70.71	71.62	4.57	3.43	24.92	0.00
1987	6605.17	7678	858	87.69	87.69	87.88	87.65	12.31	12.31	0.00	0.00
1988	4952.90	5867	858	66.82	66.82	65.72	66.79	8.13	5.91	27.27	0.00
1989	5472.22	6514	858	74.42	74.42	72.81	74.36	11.75	9.91	15.67	0.00
1990	7129.57	8211	858	93.76	93.76	94.86	93.73	3.76	3.66	2.58	0.00
1991	6123.35	7187	858	82.05	82.05	81.47	82.04	2.60	2.19	15.75	0.00
1992	5504.76	6390	858	72.76	72.76	73.04	72.75	16.96	14.86	12.39	0.00
1993	7344.72	8346	858	95.27	95.27	97.72	95.27	0.44	0.42	4.30	0.00
1994	6724.88	7707	858	88.00	88.00	89.47	87.98	0.00	0.00	12.00	0.00
1995	5694.52	6644	858	75.92	75.92	75.76	75.84	6.02	4.86	19.21	0.00
1996	7063.90	8049	858	91.64	91.64	93.73	91.63	8.36	8.36	0.00	0.00
1997	6957.03	8013	858	91.50	91.50	92.56	91.47	0.00	0.00	8.50	0.00
1998	6877.28	7995	858	91.28	91.28	91.50	91.27	2.01	1.87	6.84	0.00
1999	6226.87	7219	858	82.43	82.43	82.85	82.41	0.00	0.00	17.57	0.00
2000	5265.35	6077	858	69.20	69.20	69.86	69.18	3.82	2.75	28.05	0.00
2001	7917.02	8498	858	96.84	96.84	105.33	97.01	3.16	3.16	0.00	0.00
2002	8002.15	8203	858	93.10	93.10	106.47	93.64	0.42	0.39	6.51	0.00
2003	7925.72	8156	858	92.55	92.55	105.45	93.11	1.44	1.35	6.10	0.00
2004	8627.56	8580	1000	97.71	97.71	98.22	97.68	1.41	1.40	0.89	0.00
2005	7959.45	7966	1000	90.95	90.95	90.85	90.93	0.00	0.00	9.05	0.00
2006	7765.40	7793	998	88.99	88.99	88.82	88.96	0.43	0.38	10.63	0.00
2007	8603.30	8584	995	98.02	98.02	98.70	97.99	1.98	1.98	0.00	0.00
2008	8060.45	8166	995	92.98	92.98	92.22	92.96	0.01	0.01	7.01	0.00
2009	7867.87	7986	997	91.21	91.21	90.09	91.16	1.85	1.72	7.06	0.00
2010	8415.59	8472	993	96.72	96.72	96.75	96.71	3.28	3.28	0.00	0.00
2011	7812.57	7944	993	90.70	90.70	89.81	90.68	0.00	0.00	9.30	0.00
2012	8063.57	8090	993	92.13	92.13	92.45	92.10	0.48	0.45	7.43	0.00
2013	7522.80	7537	992	86.02	86.02	86.56	86.03	13.98	13.98	0.00	0.00
2014	7313.90	7382	993	88.39	88.39	84.08	84.27	2.94	2.68	8.93	0.00
2015	7329.68	7441	993	84.94	84.94	84.26	84.94	0.00	0.00	15.06	0.00
2016	7771.44	7854	993	89.41	89.41	89.10	89.41	2.82	2.59	8.00	0.00

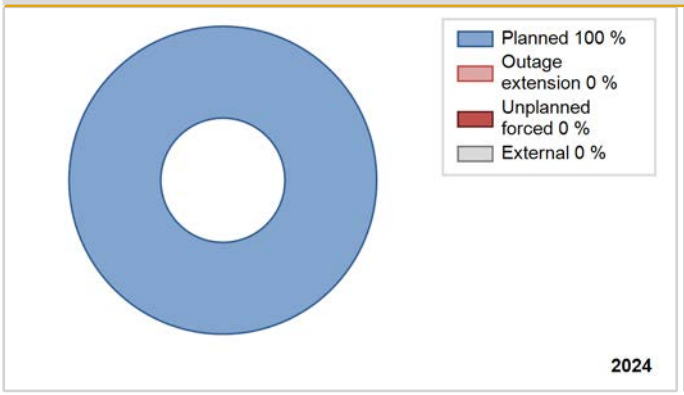
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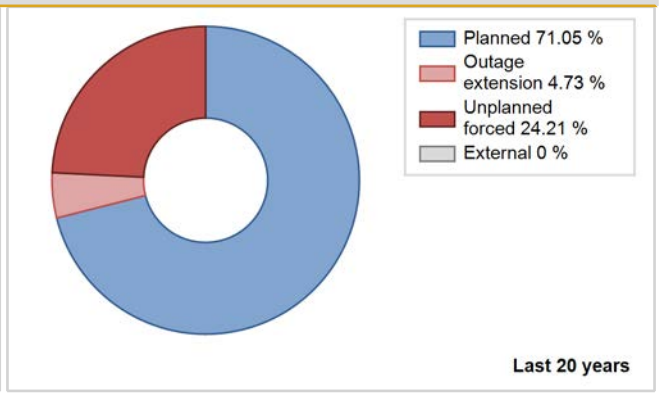
2017	5831.07	6325	993	66.37	66.37	67.03	72.20	7.51	16.19	17.45	0.00
2018	7114.93	7196	988	82.14	82.14	82.21	82.15	3.98	3.41	14.45	0.00
2019	7163.64	7216	988	82.39	82.39	82.77	82.37	17.61	17.61	0.00	0.00
2020	7626.67	7715	988	87.84	87.84	87.88	87.83	1.84	1.64	10.52	0.00
2021	6272.92	7199	988	82.18	82.18	72.48	82.18	0.00	0.00	17.82	0.00
2022	8767.06	8760	988	100.00	100.00	101.30	100.00	0.00	0.00	0.00	0.00
2023	7703.81	7847	988	88.79	88.79	89.01	89.58	0.23	0.21	11.00	0.00
2024	7980.84	8047	988	91.62	91.62	91.96	91.61	0.00	0.00	8.38	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1980 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					430	
B. Refuelling without maintenance				56		
C. Inspection, maintenance or repair combined with refuelling	737			793		
D. Inspection, maintenance or repair without refuelling				91		
E. Testing of plant systems or components				9	16	
H. Nuclear regulatory requirements				16	22	
J. Grid limitation, failure or grid unavailability						19
L. Human factor related					9	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
P. Fire					17	
Z. Other					4	
Subtotal	737			965	498	19
Total	**737**			**1482**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		48
13. Reactor Auxiliary Systems		14
14. Safety Systems		66
15. Reactor Cooling Systems		134
16. Steam generation systems		53
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		33
32. Feedwater and Main Steam System		41
33. Circulating Water System		2
34. Miscellaneous Systems		24
41. Main Generator Systems		7
42. Electrical Power Supply Systems		45
Total		**472**

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2024 Operating Experience

US-334 BEAVER VALLEY-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	FENOC (FIRST ENERGY NUCLEAR OPERATING CO.)
Owner	:	PPL_SUSQ (PPL Susquehanna, LLC)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYSUB)
Thermal power	:	2900 MWth
Gross electrical power	:	959 MWe
Reference unit power (net)	:	908 MWe

Key Dates

Construction Date	:	1970-06-26
Grid Date	:	1976-06-14
Commercial Date	:	1976-10-01
Age at end of year	:	48 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	43727
Active core diameter [m]	:	3.05
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.06
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

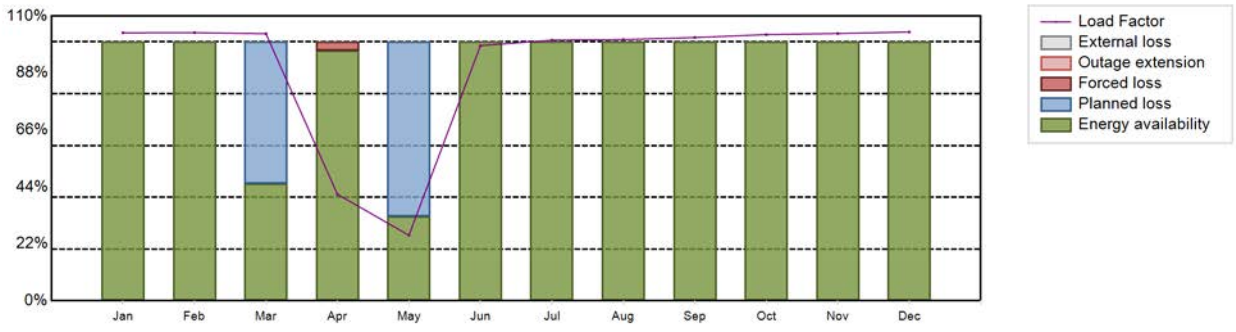
Operating coolant pressure [MPa]	:	15.82
Reactor outlet temperature [°C]	:	322
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.38
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.3
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7232.66 GW(e).h
Energy Availability Factor (EAF)	:	89.39 %
Unit Capability Factor (UCF)	:	89.39 %
Load Factor (LF)	:	90.68 %
Operating Factor (OF)	:	89.38 %

Forced Loss Rate (FLR)	:	0.3 %
Unplanned Capability Loss Factor (UCL)	:	0.27 %
Planned Unavailability Factor (PUF)	:	10.35 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	933 hours

Annual Summary



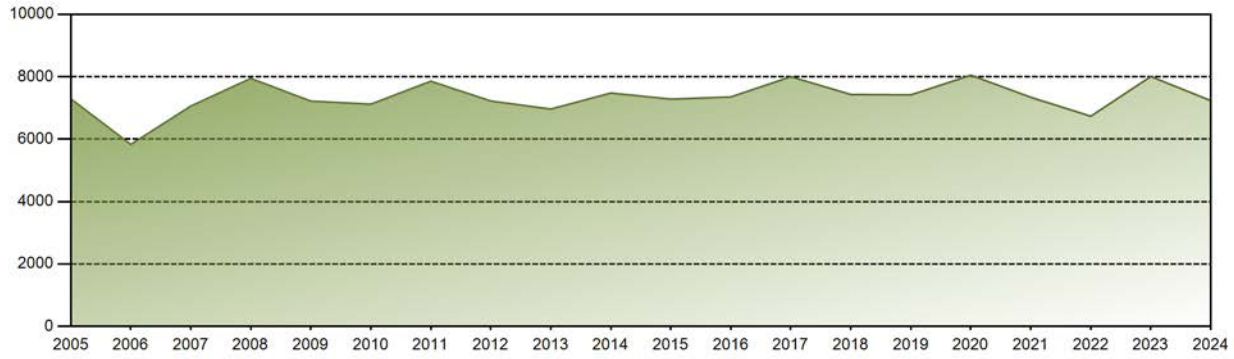
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	699.35	654.51	695.92	269.12	171.06	644.25	680.14	681.58	664.74	694.67	675.91	701.41	7232.66
EAF [%]	100.00	100.00	45.15	96.75	32.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.39
UCF [%]	100.00	100.00	45.15	96.75	32.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.39
LF [%]	103.52	103.57	103.15	41.16	25.32	98.54	100.68	100.89	101.68	102.83	103.25	103.83	90.68
OF [%]	100.00	100.00	100.00	40.14	32.53	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.38
FLR [%]	0.00	0.00	0.00	3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30
UCL [%]	0.00	0.00	0.00	3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
PUF [%]	0.00	0.00	54.85	0.00	67.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.35
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	278176.78 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.98 %
Cumulative Energy Availability Factor (EAF)	:	79.63 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.85 %
Cumulative Unit Capability Factor (UCF)	:	79.63 %	Cumulative Planned Unavailability Factor (PUF)	:	12.52 %
Cumulative Load Factor (LF)	:	77.55 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	79.33 %			

Electricity Production (net) [GWh]

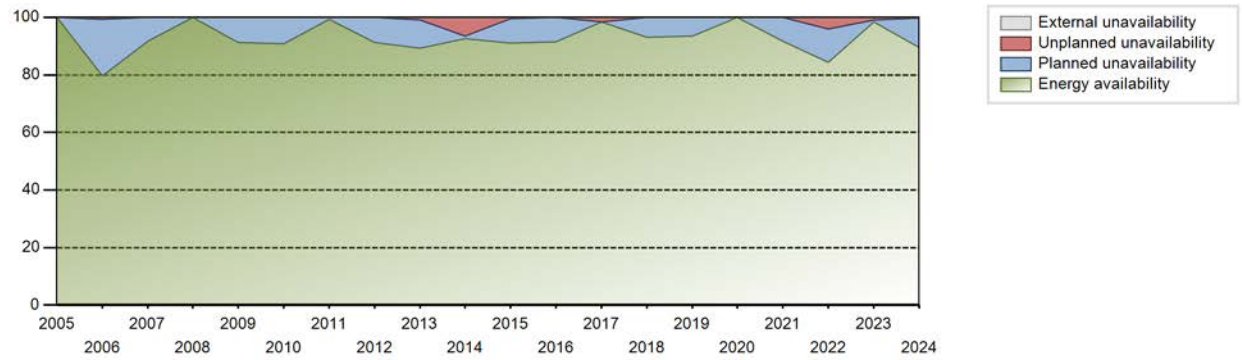


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1976	504.50	821	834	100.00	100.00	16.12	37.18	0.00	0.00	0.00	0.00
1977	2870.30	4312	843	39.24	39.24	38.87	49.22	49.37	38.27	22.49	0.00
1978	2481.40	3569	800	35.43	35.43	35.41	40.74	56.65	46.30	18.27	0.00
1979	1778.40	3498	815	24.85	24.85	24.91	39.93	72.84	66.64	8.51	0.00
1980	300.70	600	811	6.92	6.92	4.22	6.83	38.56	4.34	88.74	0.00
1981	4674.70	6444	810	73.88	73.88	65.88	73.56	26.11	26.11	0.01	0.00
1982	2717.40	3644	810	41.73	41.73	38.30	41.60	5.02	2.21	56.06	0.00
1983	4682.20	5976	810	68.55	68.55	65.99	68.22	3.54	2.51	28.94	0.00
1984	4756.84	6301	810	71.77	71.77	66.86	71.73	3.00	2.22	26.01	0.00
1985	5901.46	8046	810	91.92	91.92	83.17	91.85	7.12	7.05	1.03	0.00
1986	4784.15	6195	810	70.74	70.74	67.42	70.72	4.47	3.31	25.95	0.00
1987	5620.94	7320	810	84.03	84.03	79.22	83.56	2.95	2.55	13.42	0.00
1988	4993.62	6989	810	79.59	79.59	70.18	79.57	4.41	3.67	16.73	0.00
1989	3794.29	5822	810	66.49	66.49	53.47	66.46	9.22	6.75	26.76	0.00
1990	6167.05	8074	810	92.20	92.20	86.91	92.17	4.10	3.94	3.86	0.00
1991	3710.88	4883	810	55.76	55.76	52.30	55.74	22.93	16.59	27.65	0.00
1992	6298.39	8218	810	93.58	93.58	88.52	93.56	6.42	6.42	0.00	0.00
1993	4359.75	5891	810	67.26	67.26	61.44	67.25	13.44	10.45	22.29	0.00
1994	5504.38	6991	810	79.87	79.87	77.57	79.81	20.13	20.13	0.00	0.00
1995	5449.22	6813	810	77.83	77.83	76.80	77.77	5.69	4.69	17.48	0.00
1996	5698.05	7132	810	81.25	81.25	80.08	81.19	5.94	5.13	13.62	0.00
1997	4025.78	4972	810	56.77	56.77	56.74	56.76	32.90	27.83	15.40	0.00
1998	2829.29	3557	810	40.43	40.43	39.87	40.61	59.09	58.39	1.18	0.00
1999	6106.21	7746	810	88.47	88.47	86.06	88.42	7.39	7.06	4.47	0.00
2000	5883.02	7430	810	84.60	84.60	82.68	84.59	1.64	1.41	14.00	0.00
2001	5991.02	7407	821	84.64	84.64	84.14	84.55	2.80	2.44	12.92	0.00
2002	6989.86	8490	821	96.96	96.96	97.19	96.92	0.62	0.61	2.43	0.00
2003	5985.36	7359	821	84.13	84.13	83.22	84.01	1.14	0.97	14.90	0.00
2004	6678.55	8119	821	92.44	92.44	92.61	92.43	0.00	0.00	7.56	0.00
2005	7290.28	8760	821	100.00	100.00	101.37	100.00	0.00	0.00	0.00	0.00
2006	5828.55	6973	851	79.63	79.63	78.18	79.59	0.96	0.78	19.59	0.00
2007	7057.66	8017	892	91.62	91.62	90.32	91.52	0.00	0.00	8.38	0.00
2008	7945.03	8784	892	100.00	100.00	101.40	100.00	0.00	0.00	0.00	0.00
2009	7217.48	7999	892	91.32	91.32	92.37	91.31	0.00	0.00	8.68	0.00
2010	7119.41	7963	892	90.91	90.91	91.11	90.90	0.00	0.00	9.09	0.00
2011	7854.57	8702	892	99.34	99.34	100.52	99.34	0.00	0.00	0.66	0.00
2012	7220.58	8010	892	91.20	91.20	92.15	91.19	0.00	0.00	8.80	0.00

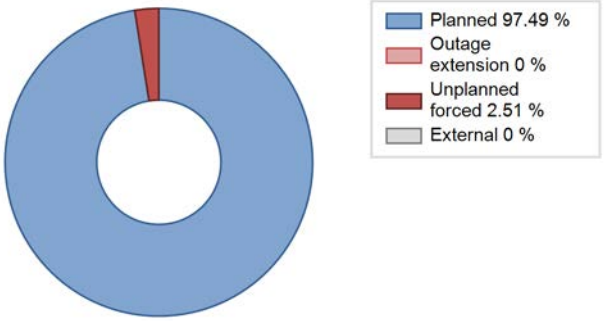
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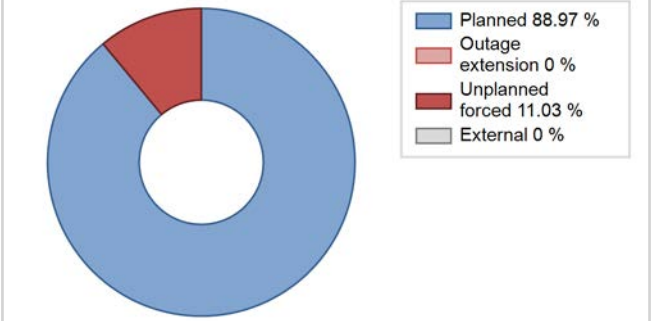
2013	6963.06	7825	921	89.35	89.35	88.86	89.32	0.91	0.82	9.83	0.00
2014	7477.39	8116	921	92.65	92.65	92.68	92.65	6.56	6.51	0.84	0.00
2015	7282.19	7971	921	91.00	91.00	90.26	90.99	0.47	0.43	8.57	0.00
2016	7351.14	8031	921	91.43	91.43	90.87	91.43	0.00	0.00	8.57	0.00
2017	7999.17	8624	921	98.44	98.44	99.15	98.45	1.56	1.56	0.00	0.00
2018	7430.72	8156	908	93.11	93.11	93.42	93.11	0.00	0.00	6.89	0.00
2019	7416.90	8193	908	93.53	93.53	93.25	93.53	0.00	0.00	6.47	0.00
2020	8047.73	8783	908	100.00	100.00	100.90	99.99	0.00	0.00	0.00	0.00
2021	7339.79	8028	908	91.65	91.65	92.28	91.64	0.00	0.00	8.35	0.00
2022	6734.41	7394	908	84.41	84.41	84.67	84.41	4.66	4.12	11.47	0.00
2023	8006.89	8760	908	98.44	98.44	100.66	100.00	1.00	1.00	0.56	0.00
2024	7232.66	7851	908	89.39	89.39	90.68	89.38	0.30	0.27	10.35	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1976 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		23			478	
B. Refuelling without maintenance				49		
C. Inspection, maintenance or repair combined with refuelling	910			929	4	
D. Inspection, maintenance or repair without refuelling				78		
E. Testing of plant systems or components				7	14	
H. Nuclear regulatory requirements					87	
L. Human factor related					10	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
Z. Other				14	128	
Subtotal	910	23		1077	721	2
Total	**933**			**1800**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1976 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	23	42
12. Reactor I&C Systems		5
13. Reactor Auxiliary Systems		23
14. Safety Systems		28
15. Reactor Cooling Systems		257
16. Steam generation systems		2
17. Safety I&C Systems (excluding reactor I&C)		4
31. Turbine and auxiliaries		16
32. Feedwater and Main Steam System		102
34. Miscellaneous Systems		40
35. All other I&C Systems		1
41. Main Generator Systems		15
42. Electrical Power Supply Systems		118
Total	**23**	**653**

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2024 Operating Experience

US-412 BEAVER VALLEY-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	FENOC (FIRST ENERGY NUCLEAR OPERATING CO.)
Owner	:	OHIO ED (OHIO EDISON CO.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYSUB)
Thermal power	:	2900 MWth
Gross electrical power	:	958 MWe
Reference unit power (net)	:	905 MWe

Key Dates

Construction Date	:	1974-05-03
Grid Date	:	1987-08-17
Commercial Date	:	1987-11-17
Age at end of year	:	37 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	36351
Active core diameter [m]	:	3.05
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.06
Number of control rod assemblies	:	48
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

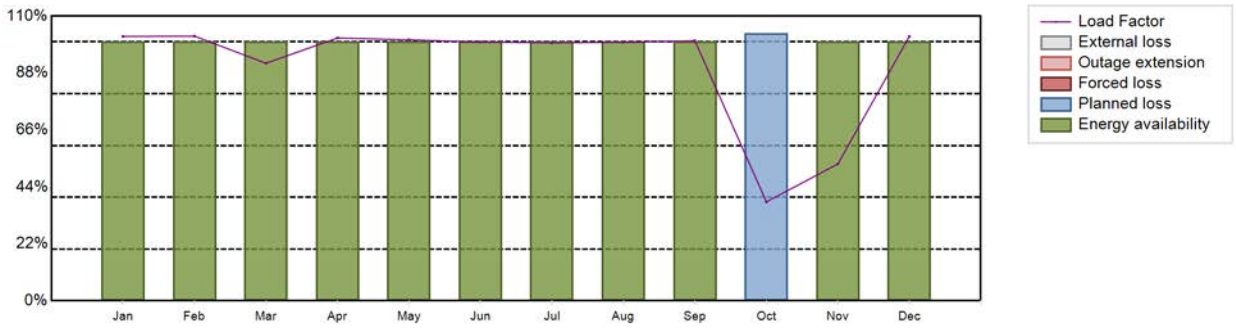
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	322
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.38
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.3
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7228.16 GW(e).h
Energy Availability Factor (EAF)	:	91.24 %
Unit Capability Factor (UCF)	:	91.24 %
Load Factor (LF)	:	90.93 %
Operating Factor (OF)	:	91.2 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	8.76 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	773 hours

Annual Summary



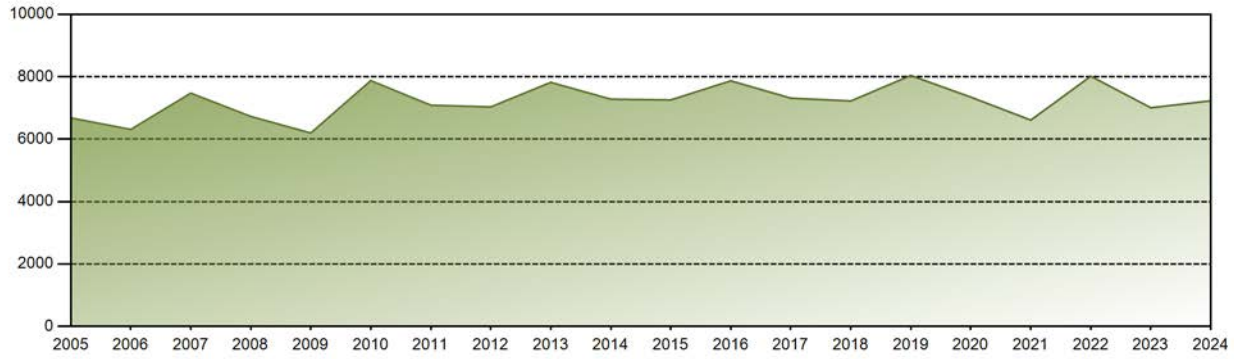
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	687.55	643.93	616.98	661.52	678.69	651.37	670.98	672.49	654.63	257.44	344.95	687.63	7228.16
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-3.45	100.00	100.00	91.24
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-3.45	100.00	100.00	91.24
LF [%]	102.11	102.23	91.76	101.52	100.80	99.97	99.65	99.88	100.46	38.23	52.86	102.13	90.93
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	38.71	56.03	100.00	91.20
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	103.45	0.00	0.00	8.76
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	244139.84 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.94 %
Cumulative Energy Availability Factor (EAF)	:	89.13 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.66 %
Cumulative Unit Capability Factor (UCF)	:	89.13 %	Cumulative Planned Unavailability Factor (PUF)	:	7.21 %
Cumulative Load Factor (LF)	:	87.28 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	88.64 %			

Electricity Production (net) [GWh]

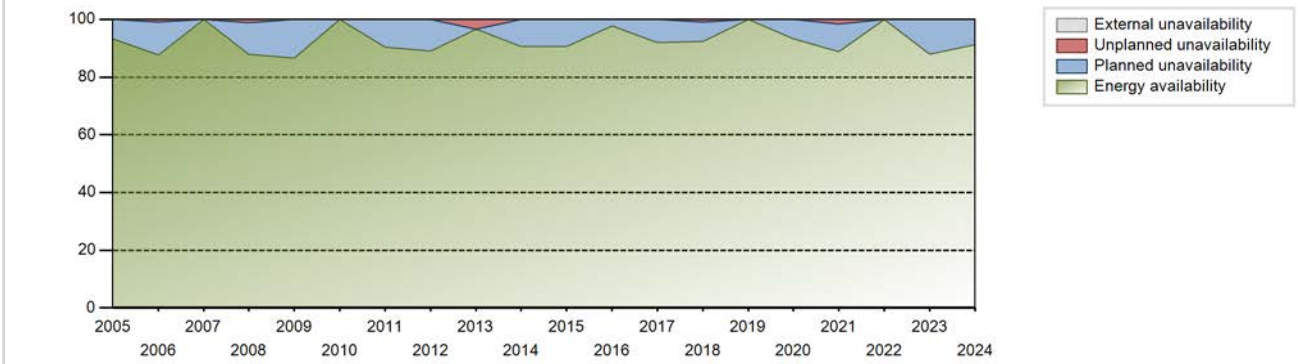


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	738.10	950	822	100.00	100.00	93.42	100.00	0.00	0.00	0.00	0.00
1988	6477.06	8224	833	93.78	93.78	88.52	93.62	2.42	2.33	3.89	0.00
1989	4557.14	6245	833	71.68	71.68	62.45	71.29	11.01	8.87	19.45	0.00
1990	4291.55	6734	827	77.09	77.09	59.20	76.87	1.66	1.30	21.60	0.00
1991	6762.16	8720	820	99.54	99.54	94.14	99.54	0.46	0.46	0.00	0.00
1992	5647.13	7342	820	94.83	94.83	78.40	83.58	0.18	0.17	5.00	0.00
1993	5212.68	6770	820	77.29	77.29	72.57	77.28	1.57	1.23	21.47	0.00
1994	7024.73	8481	820	96.83	96.83	97.79	96.82	3.17	3.17	0.00	0.00
1995	6047.02	7616	820	86.97	86.97	84.18	86.94	0.50	0.43	12.59	0.00
1996	4788.59	6169	820	70.30	70.30	66.48	70.23	18.40	15.85	13.85	0.00
1997	6158.70	7583	820	86.62	86.62	85.74	86.56	13.38	13.38	0.00	0.00
1998	1808.72	2179	820	25.12	25.12	25.18	24.87	74.87	74.86	0.02	0.00
1999	5752.52	7155	820	81.70	81.70	80.08	81.68	8.23	7.33	10.97	0.00
2000	6227.85	7804	820	88.86	88.86	86.46	88.84	2.45	2.23	8.91	0.00
2001	7191.65	8702	831	99.35	99.35	99.78	99.34	0.65	0.65	0.00	0.00
2002	6604.31	8133	831	92.95	92.95	90.72	92.84	0.22	0.20	6.85	0.00
2003	6636.99	8037	831	91.76	91.76	91.17	91.75	0.34	0.32	7.92	0.00
2004	7314.83	8784	831	100.00	100.00	100.21	100.00	0.00	0.00	0.00	0.00
2005	6680.03	8169	831	93.26	93.26	91.76	93.25	0.00	0.00	6.74	0.00
2006	6309.51	7673	851	87.61	87.61	84.64	87.59	1.10	0.98	11.42	0.00
2007	7473.20	8760	846	100.00	100.00	100.84	100.00	0.00	0.00	0.00	0.00
2008	6726.20	7744	890	87.93	87.93	87.84	88.16	1.34	1.20	10.88	0.00
2009	6193.96	7651	846	86.69	86.69	83.58	87.34	0.00	0.00	13.31	0.00
2010	7874.15	8760	885	100.00	100.00	101.57	100.00	0.00	0.00	0.00	0.00
2011	7085.78	7920	885	90.42	90.42	91.40	90.41	0.00	0.00	9.58	0.00
2012	7032.52	7828	885	89.13	89.13	90.46	89.12	0.00	0.00	10.87	0.00
2013	7818.59	8458	885	96.55	96.55	100.84	96.54	3.45	3.45	0.00	0.00
2014	7279.91	7929	904	90.71	90.71	91.93	90.51	0.00	0.00	9.29	0.00
2015	7255.59	7931	904	90.53	90.53	91.62	90.54	0.00	0.00	9.47	0.00
2016	7868.44	8579	904	97.67	97.67	99.09	97.67	0.00	0.00	2.33	0.00
2017	7312.33	8058	905	91.99	91.99	92.24	91.99	0.00	0.00	8.01	0.00
2018	7222.74	8085	905	92.29	92.29	91.11	92.29	1.08	1.01	6.70	0.00
2019	8039.57	8760	905	100.00	100.00	101.41	100.00	0.00	0.00	0.00	0.00
2020	7345.66	8190	905	93.25	93.25	92.40	93.24	0.00	0.00	6.75	0.00
2021	6610.08	7784	905	88.85	88.85	83.38	88.86	1.81	1.64	9.51	0.00
2022	8015.62	8760	905	100.00	100.00	101.11	100.00	0.00	0.00	0.00	0.00
2023	7005.57	7708	905	87.94	87.94	88.37	87.99	0.00	0.05	12.01	0.00

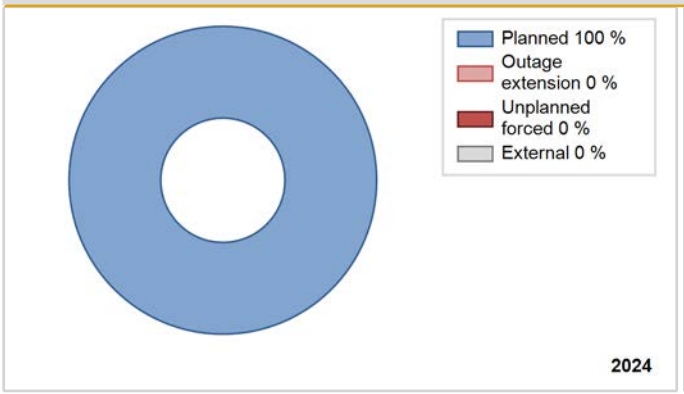
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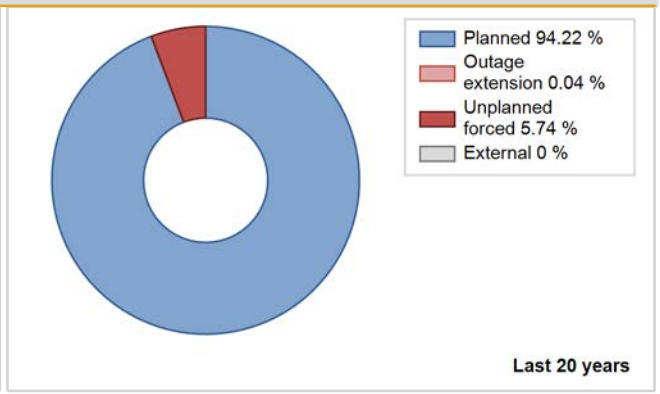
2024	7228.16	8011	905	91.24	91.24	90.93	91.20	0.00	0.00	8.76	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					276	
B. Refuelling without maintenance				39		
C. Inspection, maintenance or repair combined with refuelling	773			579	2	
D. Inspection, maintenance or repair without refuelling				16		
E. Testing of plant systems or components				1	12	
L. Human factor related					4	
Z. Other					42	
Subtotal	773			635	336	
Total	**773**			**971**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1987 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		11
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		27
14. Safety Systems		10
15. Reactor Cooling Systems		150
16. Steam generation systems		15
17. Safety I&C Systems (excluding reactor I&C)		4
31. Turbine and auxiliaries		14
32. Feedwater and Main Steam System		5
34. Miscellaneous Systems		17
35. All other I&C Systems		3
41. Main Generator Systems		13
42. Electrical Power Supply Systems		20
Total		**296**

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2024 Operating Experience

US-456 BRAIDWOOD-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3645 MWth
Gross electrical power	:	1270 MWe
Reference unit power (net)	:	1194 MWe

Key Dates

Construction Date	:	1975-08-01
Grid Date	:	1987-07-12
Commercial Date	:	1988-07-29
Age at end of year	:	37 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	43
Average discharge burnup [MWd/t]	:	49000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.65
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	18.3
Number of control rod assemblies	:	25
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

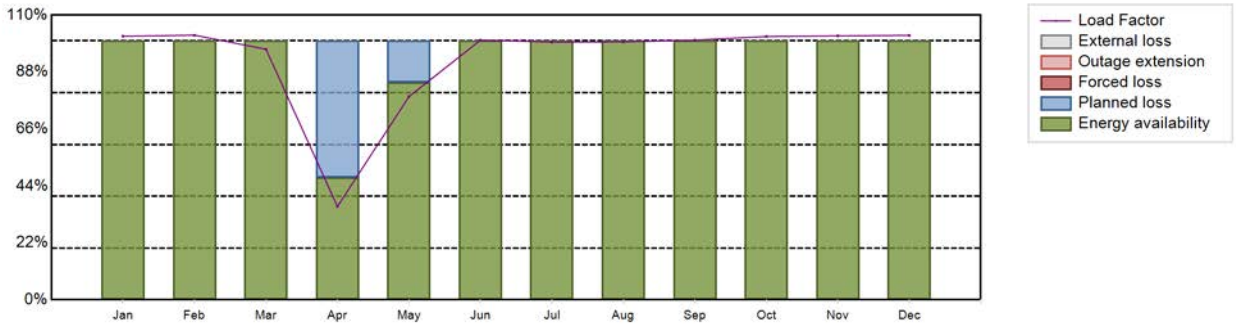
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	326
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.42
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.63
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Pond (closed-cycle)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9801.78 GW(e).h
Energy Availability Factor (EAF)	:	94.31 %
Unit Capability Factor (UCF)	:	94.31 %
Load Factor (LF)	:	93.46 %
Operating Factor (OF)	:	94.26 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	5.69 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	504 hours

Annual Summary



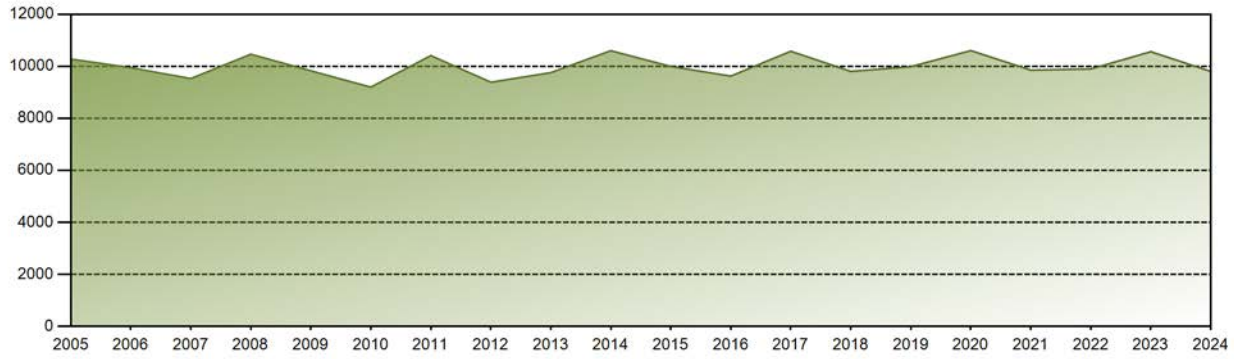
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	904.23	849.45	858.65	309.92	697.10	862.09	884.50	885.06	862.27	903.37	877.70	907.44	9801.78
EAF [%]	100.00	100.00	100.00	47.16	83.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.31
UCF [%]	100.00	100.00	100.00	47.16	83.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.31
LF [%]	101.79	102.22	96.79	36.05	78.47	100.28	99.57	99.63	100.30	101.69	101.95	102.15	93.46
OF [%]	100.00	100.00	100.00	46.81	83.74	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.26
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	52.84	16.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.69
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	333088.34 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.29 %
Cumulative Energy Availability Factor (EAF)	:	91.06 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.14 %
Cumulative Unit Capability Factor (UCF)	:	91.08 %	Cumulative Planned Unavailability Factor (PUF)	:	6.79 %
Cumulative Load Factor (LF)	:	90.17 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	90.79 %			

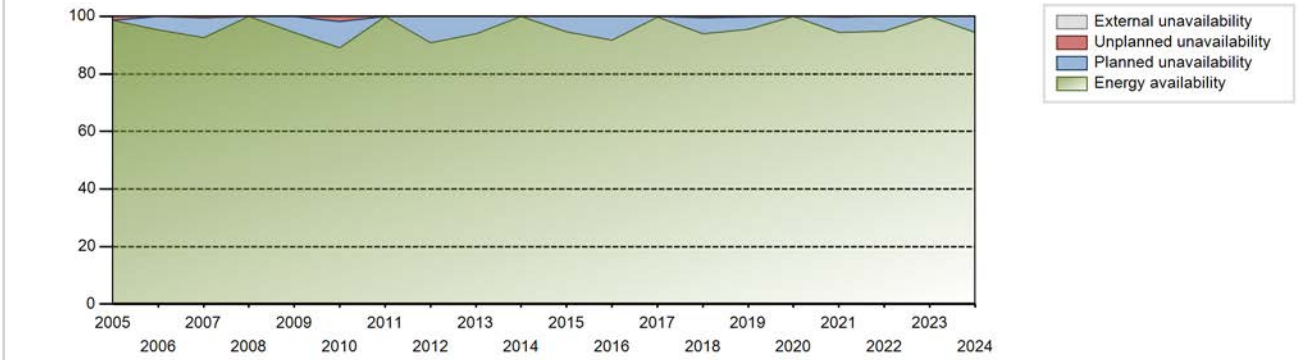
Electricity Production (net) [GWh]



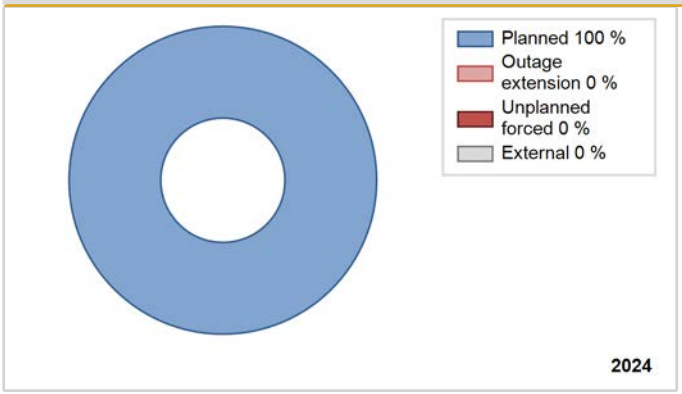
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	3424.22	3409	1105	91.55	91.55	81.78	91.29	8.45	8.45	0.00	0.00
1989	4649.10	5435	1120	62.25	62.25	47.39	62.04	2.74	1.76	35.99	0.00
1990	8264.58	7778	1120	89.11	89.11	84.24	88.79	10.89	10.89	0.00	0.00
1991	5018.62	5198	1120	59.37	59.37	51.15	59.34	40.63	40.63	0.00	0.00
1992	7157.93	7142	1120	81.36	81.36	72.76	81.31	1.13	0.93	17.71	0.00
1993	8693.12	8048	1120	92.10	92.10	88.60	91.87	7.48	7.44	0.46	0.00
1994	7398.15	6940	1120	79.81	79.81	75.41	79.22	1.70	1.38	18.81	0.00
1995	6614.28	6214	1120	71.75	71.75	67.42	70.94	2.77	2.04	26.21	0.00
1996	7618.88	7021	1120	80.50	80.50	77.44	79.93	6.43	5.53	13.97	0.00
1997	8096.33	7339	1120	84.03	84.03	82.52	83.78	0.00	0.00	15.97	0.00
1998	7578.79	6976	1118	79.93	79.93	77.36	79.63	1.20	0.97	19.10	0.00
1999	9904.81	8680	1120	99.11	99.11	100.95	99.09	0.89	0.89	0.00	0.00
2000	9311.32	8335	1100	94.95	94.95	96.08	94.89	0.00	0.00	5.05	0.00
2001	9557.87	8247	1168	94.05	94.05	97.70	94.14	0.00	0.00	5.95	0.00
2002	10612.24	8760	1161	100.00	100.00	104.08	100.00	0.00	0.00	0.00	0.00
2003	10094.77	8353	1161	95.26	95.26	99.26	95.35	0.00	0.00	4.74	0.00
2004	9807.19	8310	1161	94.49	94.49	96.17	94.60	0.00	0.00	5.51	0.00
2005	10276.96	8630	1185	98.53	98.53	98.99	98.50	1.47	1.47	0.00	0.00
2006	9945.95	8352	1178	95.35	95.35	96.38	95.34	0.00	0.00	4.65	0.00
2007	9526.68	8119	1178	92.70	93.13	92.32	92.68	0.00	0.00	6.87	0.43
2008	10462.94	8784	1178	100.00	100.00	101.12	100.00	0.00	0.00	0.00	0.00
2009	9826.25	8259	1178	94.29	94.29	95.22	94.28	0.00	0.00	5.71	0.00
2010	9196.69	7806	1178	89.13	89.13	89.12	89.11	1.99	1.81	9.06	0.00
2011	10411.70	8760	1178	100.00	100.00	100.90	100.00	0.00	0.00	0.00	0.00
2012	9388.44	7969	1178	90.73	90.73	90.73	90.72	0.00	0.00	9.27	0.00
2013	9754.57	8238	1178	94.04	94.04	94.52	94.03	0.00	0.00	5.96	0.00
2014	10599.62	8760	1194	100.00	100.00	101.34	100.00	0.00	0.00	0.00	0.00
2015	9994.36	8298	1194	94.72	94.72	95.55	94.73	0.00	0.00	5.28	0.00
2016	9622.74	8058	1194	91.73	91.73	91.75	91.73	0.00	0.00	8.27	0.00
2017	10579.19	8737	1194	99.73	99.73	101.14	99.74	0.00	0.00	0.27	0.00
2018	9803.97	8208	1194	93.84	93.84	93.73	93.70	0.58	0.54	5.61	0.00
2019	9986.33	8360	1194	95.45	95.45	95.48	95.43	0.27	0.26	4.29	0.00
2020	10604.45	8783	1194	100.00	100.00	101.11	99.99	0.00	0.00	0.00	0.00
2021	9853.70	8264	1194	94.33	94.33	94.21	94.34	0.37	0.35	5.31	0.00
2022	9898.29	8308	1194	94.84	94.84	94.63	94.84	0.00	0.00	5.16	0.00
2023	10562.93	8760	1194	100.00	100.00	100.99	100.00	0.00	0.00	0.00	0.00
2024	9801.78	8280	1194	94.31	94.31	93.46	94.26	0.00	0.00	5.69	0.00

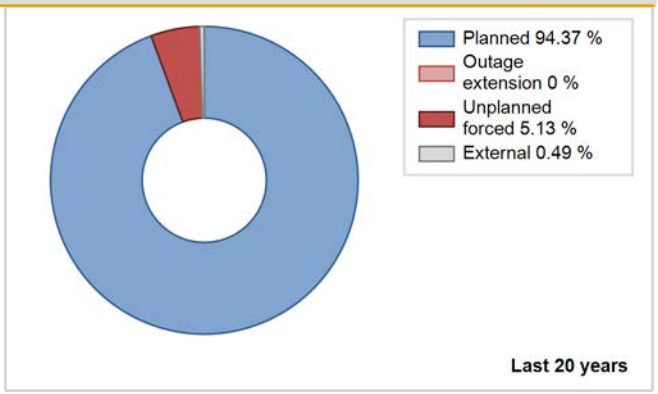
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					173	
B. Refuelling without maintenance				25		
C. Inspection, maintenance or repair combined with refuelling	504			511		
D. Inspection, maintenance or repair without refuelling				72		
E. Testing of plant systems or components				1		
H. Nuclear regulatory requirements					12	
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					5	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z. Other				0	3	
Subtotal	504			609	193	3
Total	**504**			**805**		

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1988 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		3
13. Reactor Auxiliary Systems		2
14. Safety Systems		3
15. Reactor Cooling Systems		4
16. Steam generation systems		13
17. Safety I&C Systems (excluding reactor I&C)		20
31. Turbine and auxiliaries		1
32. Feedwater and Main Steam System		18
34. Miscellaneous Systems		12
41. Main Generator Systems		91
42. Electrical Power Supply Systems		7
Total		**174**

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2024 Operating Experience

US-457 BRAIDWOOD-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3645 MWth
Gross electrical power	:	1230 MWe
Reference unit power (net)	:	1160 MWe

Key Dates

Construction Date	:	1975-08-01
Grid Date	:	1988-05-25
Commercial Date	:	1988-10-17
Age at end of year	:	36 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	43
Average discharge burnup [MWd/t]	:	49000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.65
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	20.8
Number of control rod assemblies	:	25
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

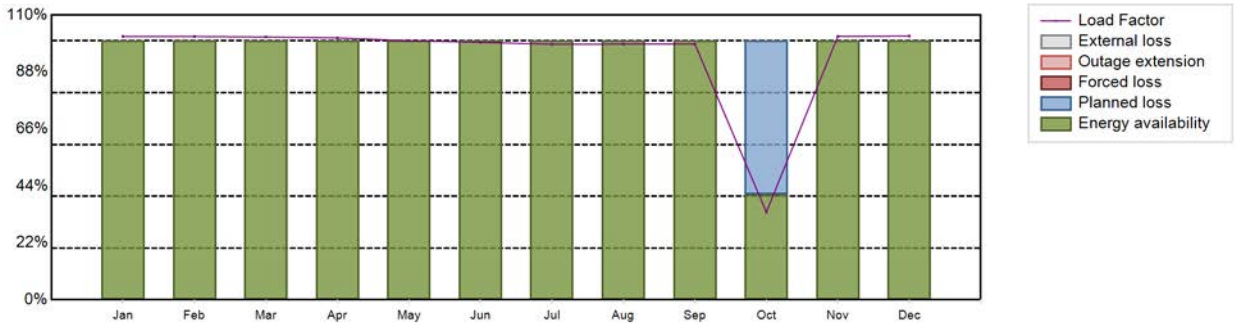
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	326
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.42
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.63
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Pond (closed-cycle)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9665.02 GW(e).h
Energy Availability Factor (EAF)	:	94.98 %
Unit Capability Factor (UCF)	:	94.98 %
Load Factor (LF)	:	94.85 %
Operating Factor (OF)	:	94.93 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	5.02 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	445 hours

Annual Summary



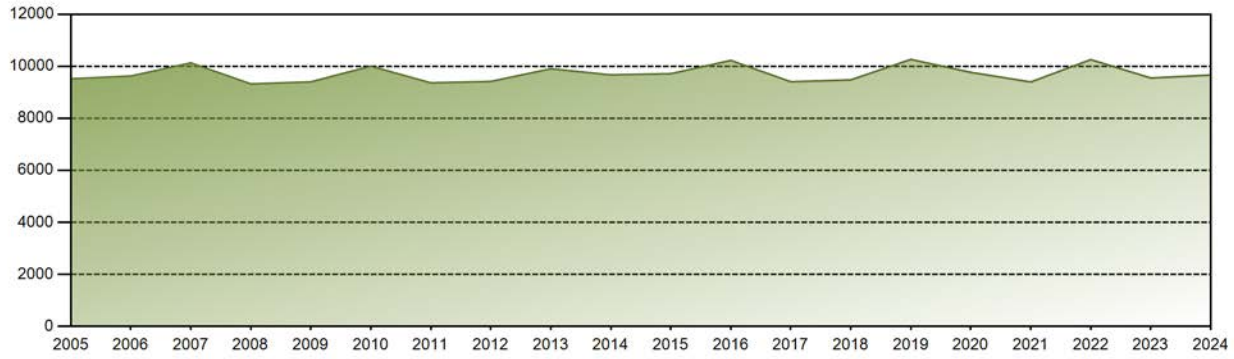
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	878.04	820.94	874.98	844.90	863.60	830.88	851.68	852.34	824.99	292.29	850.87	879.50	9665.02
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	40.69	100.00	100.00	94.98
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	40.69	100.00	100.00	94.98
LF [%]	101.74	101.68	101.52	101.16	100.06	99.48	98.68	98.76	98.78	33.87	101.73	101.91	94.85
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	40.19	100.00	100.00	94.93
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.31	0.00	0.00	5.02
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	331431.68 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.22 %
Cumulative Energy Availability Factor (EAF)	:	92.85 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.15 %
Cumulative Unit Capability Factor (UCF)	:	92.86 %	Cumulative Planned Unavailability Factor (PUF)	:	5.99 %
Cumulative Load Factor (LF)	:	91.51 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	92.7 %			

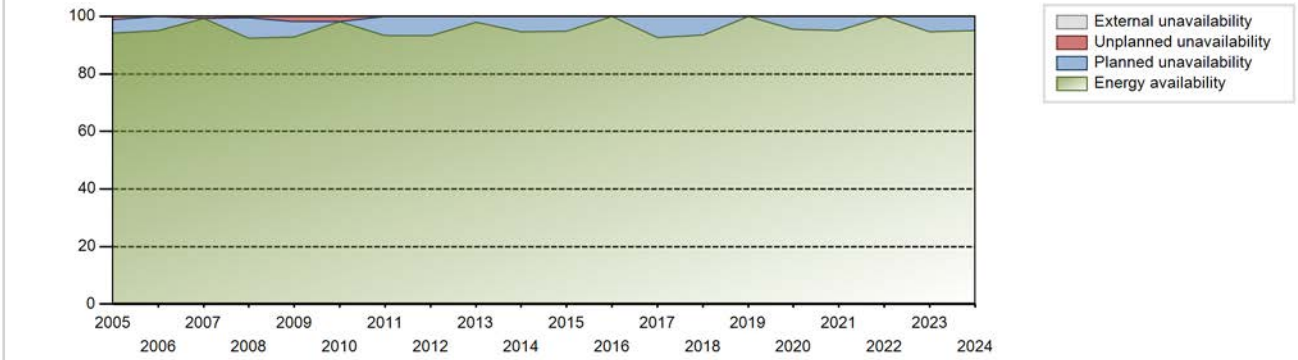
Electricity Production (net) [GWh]



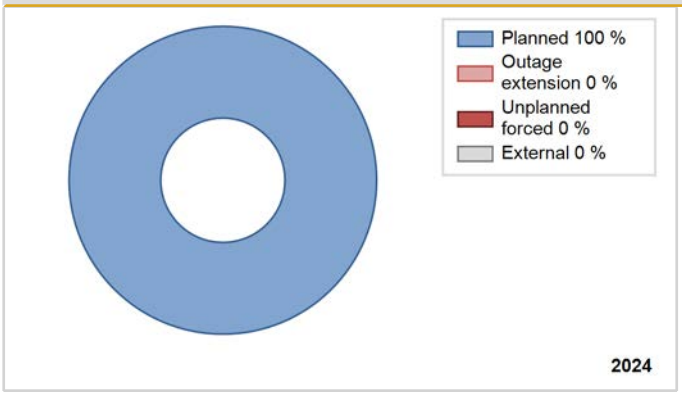
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	1350.94	1476	1097	87.43	87.43	72.73	87.30	12.57	12.57	0.00	0.00
1989	7142.04	7581	1120	86.89	86.89	72.79	86.54	1.71	1.51	11.60	0.00
1990	6353.59	6849	1120	78.79	78.79	64.76	78.18	2.04	1.64	19.56	0.00
1991	6545.52	6626	1120	75.72	75.72	66.71	75.64	4.73	3.76	20.51	0.00
1992	8751.14	8346	1120	95.06	95.06	88.95	95.01	2.20	2.14	2.80	0.00
1993	7362.34	7098	1120	81.46	81.46	75.04	81.03	3.37	2.84	15.70	0.00
1994	6636.15	6454	1120	74.13	74.13	67.64	73.68	16.56	14.71	11.16	0.00
1995	9533.04	8583	1120	98.06	98.06	97.16	97.98	1.94	1.94	0.00	0.00
1996	8011.80	7349	1120	84.12	84.12	81.44	83.66	0.00	0.00	15.88	0.00
1997	8234.75	7563	1120	86.46	86.46	83.93	86.34	0.00	0.00	13.54	0.00
1998	9694.64	8552	1118	97.71	97.71	98.96	97.63	2.29	2.29	0.00	0.00
1999	9030.88	8070	1120	92.35	92.35	92.05	92.12	0.91	0.84	6.81	0.00
2000	9510.95	8303	1100	94.60	94.60	98.14	94.52	1.23	1.18	4.23	0.00
2001	9647.86	8481	1122	96.74	96.74	98.96	96.82	0.49	0.48	2.78	0.00
2002	9449.48	8099	1154	92.48	92.48	94.28	92.45	0.54	0.50	7.02	0.00
2003	9932.17	8337	1154	95.08	95.08	98.25	95.17	0.61	0.58	4.34	0.00
2004	10200.98	8757	1129	99.68	99.68	102.67	99.69	0.32	0.32	0.00	0.00
2005	9519.42	8244	1177	94.11	94.11	92.32	94.10	1.27	1.21	4.68	0.00
2006	9624.59	8335	1152	95.16	95.16	95.37	95.15	0.00	0.00	4.84	0.00
2007	10131.17	8706	1152	99.39	100.00	100.39	99.38	0.00	0.00	0.00	0.61
2008	9323.22	8106	1152	92.29	92.29	92.13	92.28	0.57	0.53	7.18	0.00
2009	9401.72	8121	1152	92.74	92.74	93.16	92.71	1.91	1.80	5.46	0.00
2010	10003.25	8599	1152	98.17	98.17	99.13	98.16	1.83	1.83	0.00	0.00
2011	9364.17	8177	1152	93.36	93.36	92.79	93.34	0.00	0.00	6.64	0.00
2012	9417.92	8188	1152	93.23	93.23	93.07	93.21	0.00	0.00	6.77	0.00
2013	9905.03	8580	1152	97.95	97.95	98.14	97.93	0.00	0.00	2.05	0.00
2014	9670.45	8276	1160	94.52	94.52	95.17	94.47	0.06	0.06	5.43	0.00
2015	9715.53	8312	1160	94.88	94.88	95.61	94.89	0.00	0.00	5.12	0.00
2016	10226.53	8784	1160	100.00	100.00	100.36	100.00	0.00	0.00	0.00	0.00
2017	9406.23	8117	1160	92.67	92.67	92.57	92.66	0.00	0.00	7.33	0.00
2018	9479.35	8175	1160	93.42	93.42	93.29	93.32	0.00	0.00	6.58	0.00
2019	10264.82	8760	1160	100.00	100.00	101.02	100.00	0.00	0.00	0.00	0.00
2020	9767.22	8394	1160	95.57	95.57	95.86	95.56	0.00	0.00	4.43	0.00
2021	9398.28	8319	1160	94.96	94.96	92.49	94.97	0.00	0.00	5.04	0.00
2022	10257.34	8760	1160	100.00	100.00	100.94	100.00	0.00	0.00	0.00	0.00
2023	9550.66	8290	1160	94.71	94.71	93.99	94.63	0.00	0.00	5.29	0.00
2024	9665.02	8339	1160	94.98	94.98	94.85	94.93	0.00	0.00	5.02	0.00

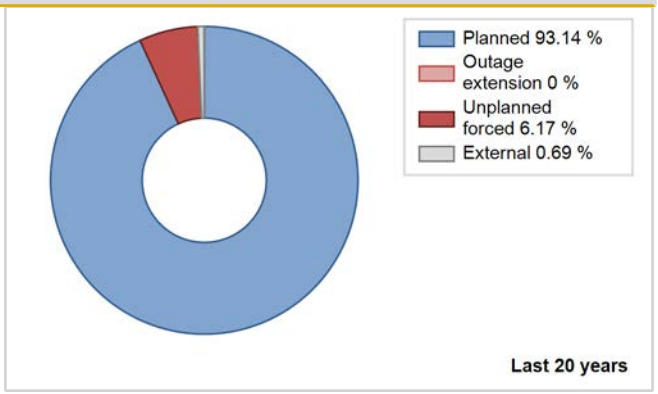
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					91	
B. Refuelling without maintenance				23		
C. Inspection, maintenance or repair combined with refuelling	445			461		
D. Inspection, maintenance or repair without refuelling				50		
L. Human factor related					7	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						3
Z. Other					8	
Subtotal	445			534	106	3
Total	**445**			**643**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1988 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		5
12. Reactor I&C Systems		8
13. Reactor Auxiliary Systems		1
14. Safety Systems		5
15. Reactor Cooling Systems		5
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		7
32. Feedwater and Main Steam System		10
34. Miscellaneous Systems		1
35. All other I&C Systems		3
41. Main Generator Systems		12
42. Electrical Power Supply Systems		36
Total		**94**

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2024 Operating Experience

US-259 BROWNS FERRY-1 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	TVA (Tennessee Valley Authority)
Owner	:	TVA (Tennessee Valley Authority)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	3458 MWth
Gross electrical power	:	1256 MWe
Reference unit power (net)	:	1200 MWe

Key Dates

Construction Date	:	1967-05-01
Grid Date	:	1973-10-15
Commercial Date	:	1974-12-20
Age at end of year	:	51 years

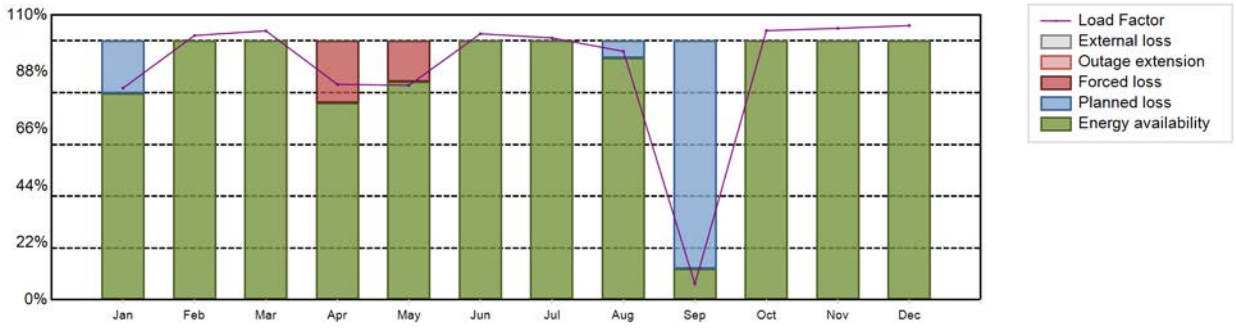
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.2
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	285
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.39
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	28	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	38000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.8	HP cylinder inlet steam pressure [MPa]	:	6.8
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	154	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	18.25	Number of main condensate pumps	:	-
Number of control rod assemblies	:	185	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9448.58 GW(e).h	Forced Loss Rate (FLR)	:	3.64 %
Energy Availability Factor (EAF)	:	87.22 %	Unplanned Capability Loss Factor (UCL)	:	3.29 %
Unit Capability Factor (UCF)	:	87.22 %	Planned Unavailability Factor (PUF)	:	9.49 %
Load Factor (LF)	:	89.64 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	87.51 %	Total off-line time	:	1097 hours

Annual Summary



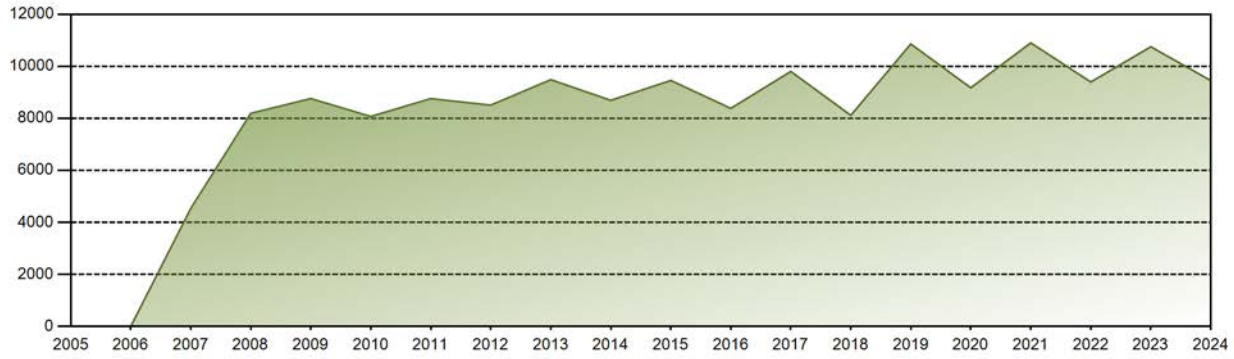
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	729.99	852.66	926.26	719.04	739.50	887.75	903.16	856.78	52.44	928.19	907.27	945.54	9448.58
EAF [%]	79.75	100.00	100.00	76.13	84.25	100.00	100.00	93.40	12.00	100.00	100.00	100.00	87.22
UCF [%]	79.75	100.00	100.00	76.13	84.25	100.00	100.00	93.40	12.00	100.00	100.00	100.00	87.22
LF [%]	81.76	102.09	103.89	83.22	82.83	102.75	101.16	95.97	6.07	103.96	104.86	105.91	89.64
OF [%]	80.24	100.00	100.00	79.72	81.59	100.00	100.00	96.37	11.11	100.00	100.00	100.00	87.51
FLR [%]	0.00	0.00	0.00	23.87	15.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.64
UCL [%]	0.00	0.00	0.00	23.87	15.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.29
PUF [%]	20.25	0.00	0.00	0.00	0.00	0.00	0.00	6.60	88.00	0.00	0.00	0.00	9.49
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	215051.76 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	9.68 %
Cumulative Energy Availability Factor (EAF)	:	79.64 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.56 %
Cumulative Unit Capability Factor (UCF)	:	79.87 %	Cumulative Planned Unavailability Factor (PUF)	:	11.57 %
Cumulative Load Factor (LF)	:	78.76 %	Cumulative Externally cause unavailability (XUF)	:	0.23 %
Cumulative Operating Factor (OF)	:	81.14 %			

Electricity Production (net) [GWh]

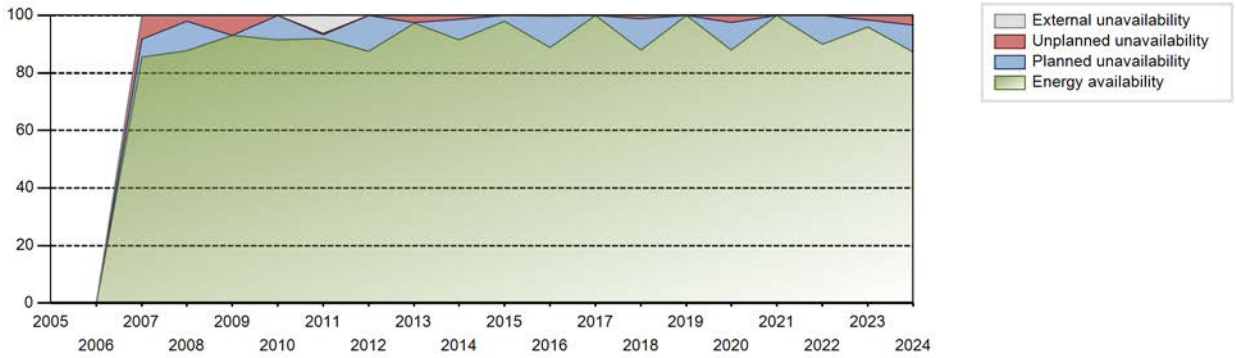


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1974	5168.70	6523	1065	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1975	1378.50	1535	1065	14.79	14.79	14.78	17.52	84.64	81.48	3.73	0.00
1976	1301.10	2174	1065	13.94	13.94	13.91	24.75	83.55	70.84	15.22	0.00
1977	5043.10	5817	1065	54.09	54.09	54.06	66.40	18.68	12.42	33.49	0.00
1978	5817.80	7042	1065	62.37	62.37	62.36	80.39	16.54	12.36	25.26	0.00
1979	7495.70	7918	1065	80.35	80.35	80.34	90.39	10.30	9.23	10.42	0.00
1980	6061.30	6376	1065	73.34	73.47	64.79	72.59	6.41	5.03	21.49	0.13
1981	4405.30	4435	1065	50.95	50.95	47.22	50.63	3.11	1.64	47.41	0.00
1982	7880.90	7967	1065	91.25	91.25	84.47	90.95	8.20	8.16	0.60	0.00
1983	2175.50	2316	1065	26.51	26.51	23.32	26.44	7.92	2.28	71.21	0.00
1984	7848.49	7930	1065	90.30	90.30	83.90	90.28	9.37	9.34	0.36	0.00
1985	1603.03	1626	1065	74.94	74.94	69.68	75.28	25.06	25.06	0.00	0.00
1986	Data not available - Suspended Operation										
1987	"										
1988	"										
1989	"										
1990	"										
1991	"										
1992	"										
1993	"										
1994	"										
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2005	"										
2006	"										
2007	4535.28	4452	1065	85.43	85.43	82.90	86.67	8.84	8.28	6.29	0.00
2008	8193.05	7693	1065	87.60	87.60	87.58	87.58	2.22	1.99	10.41	0.00
2009	8758.70	8147	1065	93.03	93.03	93.88	93.00	6.97	6.97	0.00	0.00
2010	8072.30	8007	1093	91.45	91.45	86.15	91.40	0.00	0.00	8.55	0.00

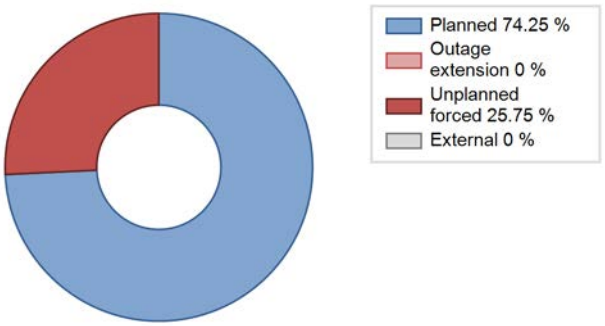
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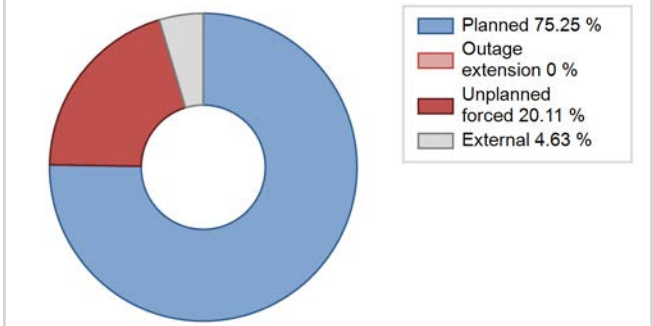
2011	8757.41	8048	1101	91.95	98.21	90.80	91.87	0.49	0.48	1.31	6.26
2012	8505.98	7691	1101	87.57	87.57	87.95	87.56	0.00	0.00	12.43	0.00
2013	9485.99	8516	1101	97.22	97.22	98.34	97.20	2.49	2.48	0.30	0.00
2014	8691.41	8021	1101	91.56	91.56	90.12	91.56	1.42	1.32	7.11	0.00
2015	9455.32	8575	1101	97.88	97.88	98.04	97.89	0.00	0.00	2.12	0.00
2016	8382.89	7799	1101	88.79	88.79	86.68	88.79	0.25	0.22	10.99	0.00
2017	9801.35	8760	1101	100.00	100.00	101.62	100.00	0.00	0.00	0.00	0.00
2018	8114.12	7702	1101	87.92	87.92	84.13	87.92	1.39	1.24	10.84	0.00
2019	10857.30	8760	1200	100.00	100.00	103.28	100.00	0.00	0.00	0.00	0.00
2020	9174.12	7718	1200	87.86	87.86	87.03	87.86	2.63	2.37	9.76	0.00
2021	10902.22	8760	1200	100.00	100.00	103.71	100.00	0.00	0.00	0.00	0.00
2022	9396.07	7886	1200	90.02	90.02	89.38	90.02	0.00	0.00	9.98	0.00
2023	10750.38	8627	1200	96.00	96.00	102.27	98.48	1.72	1.68	2.32	0.00
2024	9448.58	7687	1200	87.22	87.22	89.64	87.51	3.64	3.29	9.49	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1974 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		283			250	
B. Refuelling without maintenance				54		
C. Inspection, maintenance or repair combined with refuelling	667			984	78	
D. Inspection, maintenance or repair without refuelling	147			3257		
E. Testing of plant systems or components				10	15	
H. Nuclear regulatory requirements				316	2499	
J. Grid limitation, failure or grid unavailability						21
L. Human factor related					8	
P. Fire					474	
Z. Other					10	
Subtotal	814	283		4621	3334	21
Total	**1097**			**7976**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1974 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		8
12. Reactor I&C Systems		10
13. Reactor Auxiliary Systems		13
14. Safety Systems		15
15. Reactor Cooling Systems		68
31. Turbine and auxiliaries		54
32. Feedwater and Main Steam System		22
34. Miscellaneous Systems		22
41. Main Generator Systems		8
42. Electrical Power Supply Systems	283	34
Total	**283**	**254**

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2024 Operating Experience

US-260 BROWNS FERRY-2 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	TVA (Tennessee Valley Authority)
Owner	:	TVA (Tennessee Valley Authority)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	3458 MWth
Gross electrical power	:	1259 MWe
Reference unit power (net)	:	1200 MWe

Key Dates

Construction Date	:	1967-05-01
Grid Date	:	1974-08-28
Commercial Date	:	1975-03-01
Age at end of year	:	50 years

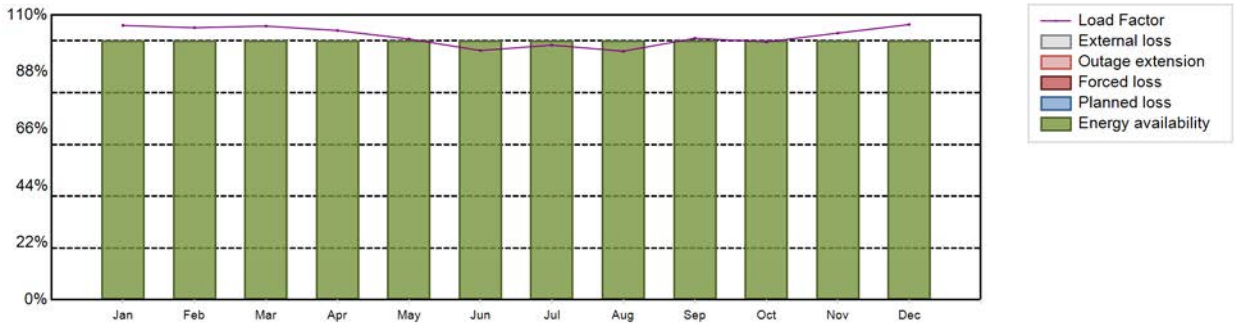
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.2
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	285
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.39
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	28	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	38000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.8	HP cylinder inlet steam pressure [MPa]	:	6.8
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	764	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	18.49	Number of main condensate pumps	:	-
Number of control rod assemblies	:	185	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	101.84 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



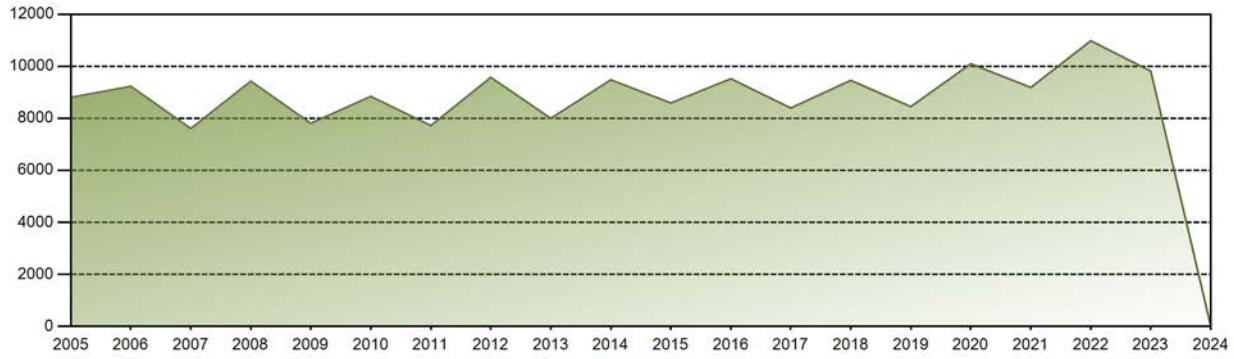
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	946.04	877.71	942.75	898.67	899.39	831.85	878.28	857.22	872.83	889.45	891.36	949.23	10734.79
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	105.96	105.09	105.74	104.01	100.74	96.28	98.37	96.02	101.02	99.62	103.02	106.32	101.84
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.01 %
Cumulative Energy Availability Factor (EAF)	:	84.18 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.45 %
Cumulative Unit Capability Factor (UCF)	:	84.36 %	Cumulative Planned Unavailability Factor (PUF)	:	10.19 %
Cumulative Load Factor (LF)	:	81.89 %	Cumulative Externally cause unavailability (XUF)	:	0.18 %
Cumulative Operating Factor (OF)	:	84.83 %			

Electricity Production (net) [GWh]

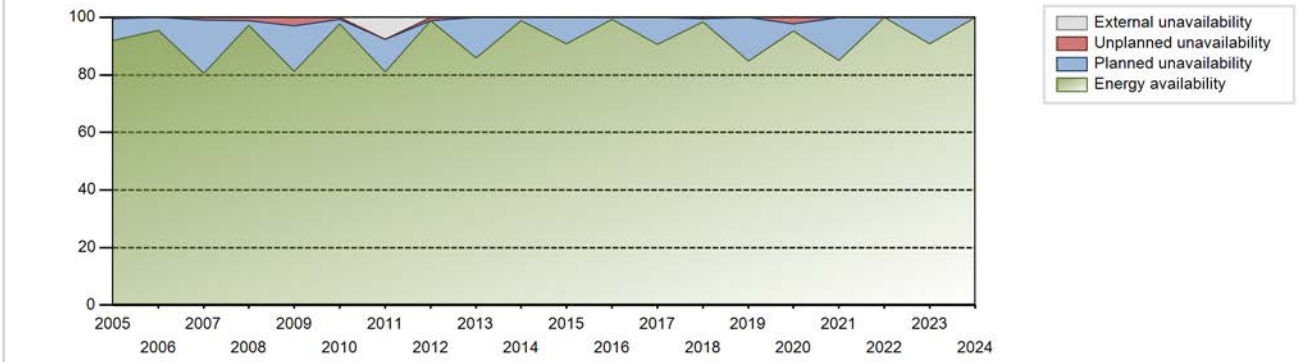


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	1425.70	1578	1065	7.04	7.04	7.04	7.04	92.96	92.96	0.00	0.00
1976	1567.20	2547	1065	16.78	16.78	16.75	29.00	78.21	60.26	22.96	0.00
1977	6225.00	6963	1065	66.78	66.78	66.72	79.49	31.21	30.29	2.93	0.00
1978	5547.50	6032	1065	59.45	59.45	59.46	68.86	12.86	8.77	31.78	0.00
1979	7441.40	7593	1065	79.76	79.76	79.76	86.68	8.98	7.87	12.37	0.00
1980	5618.40	6073	1065	69.46	69.78	60.06	69.14	10.06	7.81	22.42	0.32
1981	7471.90	7452	1065	85.24	85.24	80.09	85.07	9.56	9.01	5.74	0.00
1982	4450.90	4778	1065	54.92	54.92	47.71	54.54	4.91	2.84	42.25	0.00
1983	6385.60	6514	1065	74.81	74.81	68.45	74.36	4.85	3.81	21.38	0.00
1984	4044.37	5844	1065	66.55	66.55	43.23	66.53	4.09	2.84	30.61	0.00
1985	0.00	0	1065	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1986	Data not available - Suspended Operation										
1987	"										
1988	"										
1989	"										
1990	"										
1991	3804.01	4125	1065	80.36	80.36	69.53	80.30	15.46	14.70	4.94	0.00
1992	8388.77	8401	1065	95.69	95.69	89.67	95.64	2.05	2.00	2.31	0.00
1993	5776.84	5753	1065	65.68	65.68	61.92	65.67	0.00	0.00	34.32	0.00
1994	7345.17	7234	1065	82.58	82.58	78.73	82.58	2.24	1.89	15.53	0.00
1995	9197.03	8629	1065	98.50	98.50	98.58	98.50	1.50	1.50	0.00	0.00
1996	8046.29	7795	1065	88.74	88.74	86.01	88.74	2.76	2.52	8.74	0.00
1997	8372.93	8130	1065	92.82	92.82	89.75	92.81	1.29	1.21	5.97	0.00
1998	9301.04	8730	1065	99.66	99.66	99.70	99.66	0.34	0.34	0.00	0.00
1999	8586.32	7985	1100	91.02	91.02	89.06	91.15	1.28	1.18	7.80	0.00
2000	9733.46	8727	1118	99.36	99.36	99.11	99.35	0.64	0.64	0.00	0.00
2001	8414.56	7636	1118	87.18	87.18	85.92	87.17	0.49	0.43	12.39	0.00
2002	8911.26	8269	1118	94.40	94.40	90.99	94.39	0.78	0.75	4.85	0.00
2003	8369.22	7888	1118	90.06	90.06	85.46	90.05	1.82	1.67	8.28	0.00
2004	9785.98	8715	1118	99.21	99.21	99.65	99.21	0.79	0.79	0.00	0.00
2005	8802.16	8052	1118	91.94	91.94	89.88	91.92	0.62	0.57	7.49	0.00
2006	9232.64	8365	1118	95.50	95.50	94.27	95.49	0.00	0.00	4.50	0.00
2007	7606.63	7229	1104	80.66	80.66	78.65	82.52	1.12	0.91	18.43	0.00
2008	9429.92	8545	1104	97.29	97.29	97.24	97.28	1.17	1.15	1.56	0.00
2009	7808.51	7122	1103	81.31	81.31	80.81	81.30	3.37	2.84	15.85	0.00
2010	8842.51	8568	1104	97.82	97.82	91.43	97.81	0.66	0.65	1.53	0.00
2011	7720.39	7092	1104	80.98	88.55	79.83	80.96	0.05	0.04	11.40	7.57

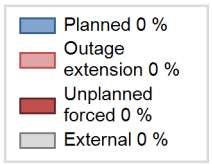
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2012	9576.00	8685	1104	98.88	98.88	98.75	98.87	1.12	1.12	0.00	0.00
2013	7997.82	7527	1104	85.93	85.93	82.69	85.91	0.00	0.00	14.07	0.00
2014	9481.43	8657	1104	98.83	98.83	98.04	98.82	0.00	0.00	1.17	0.00
2015	8591.32	7947	1104	90.72	90.72	88.84	90.72	0.00	0.00	9.28	0.00
2016	9523.24	8722	1104	99.29	99.29	98.20	99.29	0.00	0.00	0.71	0.00
2017	8395.47	7940	1104	90.64	90.64	86.81	90.64	0.00	0.00	9.36	0.00
2018	9460.54	8622	1104	98.42	98.42	97.82	98.42	0.50	0.49	1.09	0.00
2019	8448.74	7399	1200	84.84	84.84	83.12	84.46	0.00	0.00	15.16	0.00
2020	10098.92	8368	1200	95.27	95.27	95.81	95.26	0.00	2.22	2.50	0.00
2021	9186.32	7440	1200	84.93	84.93	87.39	84.93	0.00	0.00	15.07	0.00
2022	10981.47	8760	1200	100.00	100.00	104.47	100.00	0.00	0.00	0.00	0.00
2023	9813.14	7979	1200	90.75	90.75	93.35	91.08	0.00	0.00	9.25	0.00
2024	Data not provided										

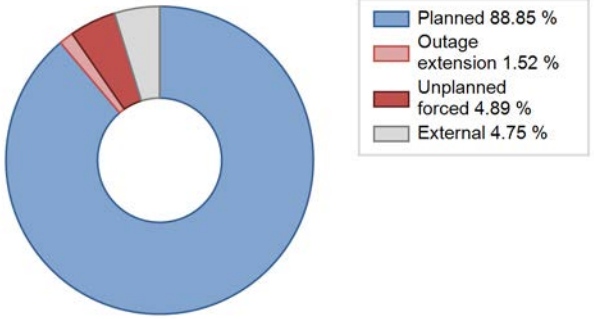
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024			1975 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					158	
B. Refuelling without maintenance				30		
C. Inspection, maintenance or repair combined with refuelling				884	50	
D. Inspection, maintenance or repair without refuelling				90		
E. Testing of plant systems or components				7	2	
H. Nuclear regulatory requirements					1054	
J. Grid limitation, failure or grid unavailability						15
L. Human factor related					18	
P. Fire					295	
Z. Other					2	4
Subtotal				1011	1579	19
Total	**0**			**2609**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		26
13. Reactor Auxiliary Systems		9
14. Safety Systems		8
15. Reactor Cooling Systems		23
31. Turbine and auxiliaries		41
32. Feedwater and Main Steam System		8
34. Miscellaneous Systems		5
35. All other I&C Systems		1
41. Main Generator Systems		14
42. Electrical Power Supply Systems		20
Total		**159**

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2024 Operating Experience

US-296 BROWNS FERRY-3 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	TVA (Tennessee Valley Authority)
Owner	:	TVA (Tennessee Valley Authority)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	3458 MWth
Gross electrical power	:	1260 MWe
Reference unit power (net)	:	1210 MWe

Key Dates

Construction Date	:	1968-07-01
Grid Date	:	1976-09-12
Commercial Date	:	1977-03-01
Age at end of year	:	48 years

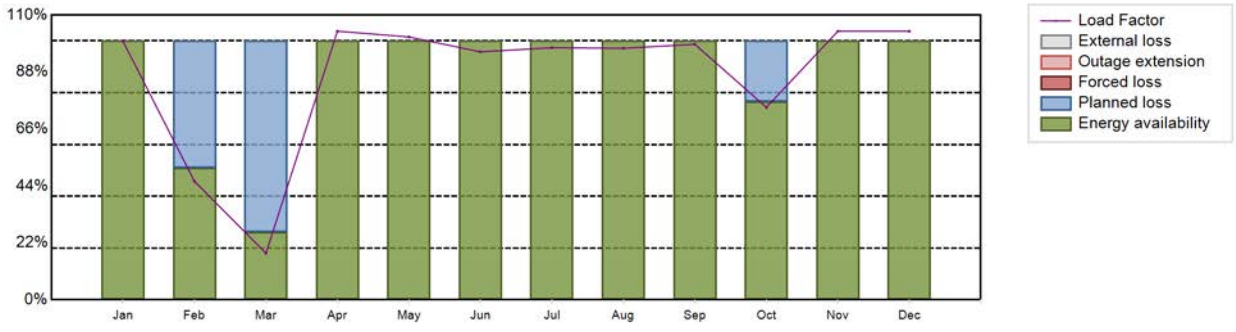
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	32
Average discharge burnup [MWd/t]	:	38000
Active core diameter [m]	:	4.8
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	149
Fuel linear heat generation rate [kW/m]	:	17.5
Number of control rod assemblies	:	185
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7.2
Reactor outlet temperature [°C]	:	285
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.39
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.8
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9218.13 GW(e).h
Energy Availability Factor (EAF)	:	87.89 %
Unit Capability Factor (UCF)	:	87.89 %
Load Factor (LF)	:	86.73 %
Operating Factor (OF)	:	88.05 %
Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	12.11 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1050 hours

Annual Summary



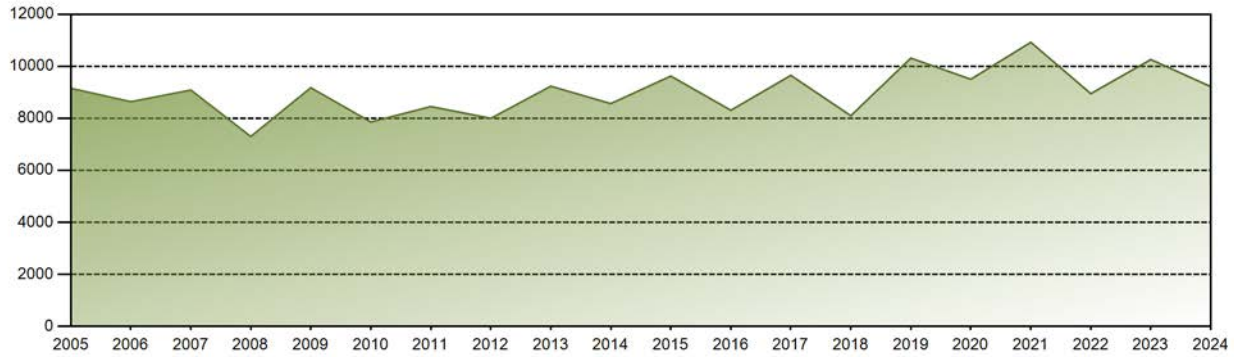
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	899.36	385.27	161.89	903.93	913.99	834.34	876.51	874.63	859.78	669.30	905.03	934.09	9218.13
EAF [%]	100.00	51.06	26.24	100.00	100.00	100.00	100.00	100.00	100.00	76.48	100.00	100.00	87.89
UCF [%]	100.00	51.06	26.24	100.00	100.00	100.00	100.00	100.00	100.00	76.48	100.00	100.00	87.89
LF [%]	99.90	45.75	18.01	103.76	101.53	95.77	97.36	97.16	98.69	74.35	103.74	103.76	86.73
OF [%]	100.00	54.74	24.36	100.00	100.00	100.00	100.00	100.00	100.00	76.75	100.00	100.00	88.05
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	48.94	73.76	0.00	0.00	0.00	0.00	0.00	0.00	23.52	0.00	0.00	12.11
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	307235 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.02 %
Cumulative Energy Availability Factor (EAF)	:	85.78 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.51 %
Cumulative Unit Capability Factor (UCF)	:	86.06 %	Cumulative Planned Unavailability Factor (PUF)	:	8.42 %
Cumulative Load Factor (LF)	:	84 %	Cumulative Externally cause unavailability (XUF)	:	0.28 %
Cumulative Operating Factor (OF)	:	86.3 %			

Electricity Production (net) [GWh]

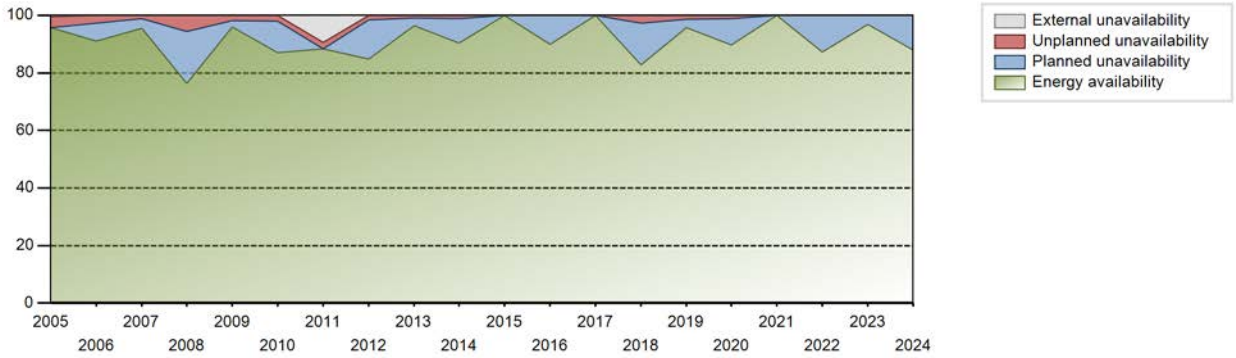


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1977	7247.50	7857	1065	74.81	74.81	74.81	88.49	25.19	25.19	0.00	0.00
1978	5554.30	6225	1065	59.52	59.52	59.54	71.06	20.60	15.45	25.03	0.00
1979	5482.50	5704	1065	58.77	58.77	58.77	65.11	12.99	8.77	32.46	0.00
1980	6936.10	6949	1065	79.26	79.89	74.14	79.11	10.83	9.71	10.41	0.63
1981	6264.80	6358	1065	72.62	72.62	67.15	72.58	7.11	5.56	21.82	0.00
1982	4892.80	5022	1065	57.43	57.43	52.44	57.33	20.46	14.77	27.80	0.00
1983	5394.30	5417	1065	61.87	61.87	57.82	61.84	9.33	6.37	31.76	0.00
1984	290.50	503	1065	5.75	5.75	3.11	5.73	94.19	93.15	1.10	0.00
1985	1526.47	1496	1065	90.78	90.78	86.95	90.75	9.22	9.22	0.00	0.00
1986	Data not available - Suspended Operation										
1987	"										
1988	"										
1989	"										
1990	"										
1991	"										
1992	"										
1993	"										
1994	"										
1995	764.62	810	1065	79.51	79.51	70.39	79.41	0.98	0.78	19.71	0.00
1996	8803.50	8412	1065	95.81	95.81	94.11	95.77	2.65	2.61	1.58	0.00
1997	8523.36	8302	1065	94.78	94.78	91.36	94.77	0.00	0.00	5.22	0.00
1998	7884.88	7863	1078	89.90	89.90	83.46	89.76	3.56	3.32	6.79	0.00
1999	9730.59	8760	1118	100.00	100.00	99.36	100.00	0.00	0.00	0.00	0.00
2000	9097.37	8311	1118	94.62	94.62	92.64	94.62	0.65	0.62	4.76	0.00
2001	9803.36	8760	1118	100.00	100.00	100.10	100.00	0.00	0.00	0.00	0.00
2002	9260.08	8407	1118	95.99	95.99	94.55	95.97	0.00	0.00	4.01	0.00
2003	9325.73	8463	1118	96.62	96.62	95.22	96.61	0.00	0.00	3.38	0.00
2004	8701.83	8000	1118	91.12	91.12	88.61	91.07	0.68	0.62	8.26	0.00
2005	9153.72	8384	1114	95.73	96.18	93.80	95.71	3.82	3.82	0.00	0.45
2006	8638.83	7974	1114	91.08	91.08	88.29	91.03	2.94	2.76	6.16	0.00
2007	9086.06	8372	1105	95.57	95.57	93.87	95.57	1.14	1.10	3.33	0.00
2008	7300.59	6794	1104	76.35	76.35	75.27	77.35	6.87	5.63	18.02	0.00
2009	9175.41	8433	1104	95.86	95.86	94.88	96.27	1.96	1.92	2.22	0.00
2010	7858.11	7625	1105	87.08	87.08	81.18	87.04	2.22	1.97	10.95	0.00
2011	8451.13	7731	1105	88.27	97.64	87.31	88.25	2.36	2.36	0.00	9.37
2012	7999.54	7455	1105	84.89	84.89	82.42	84.87	1.77	1.53	13.58	0.00
2013	9234.30	8443	1105	96.38	96.38	95.39	96.37	0.90	0.87	2.75	0.00

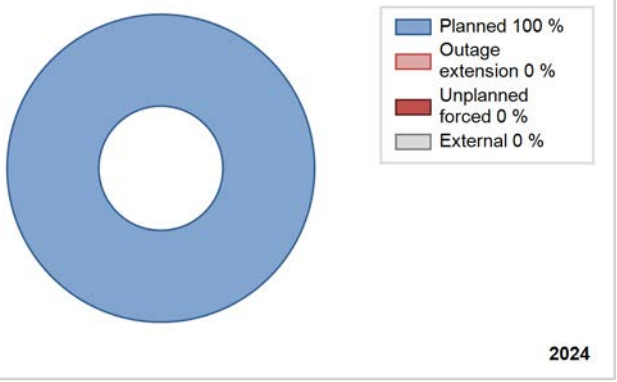
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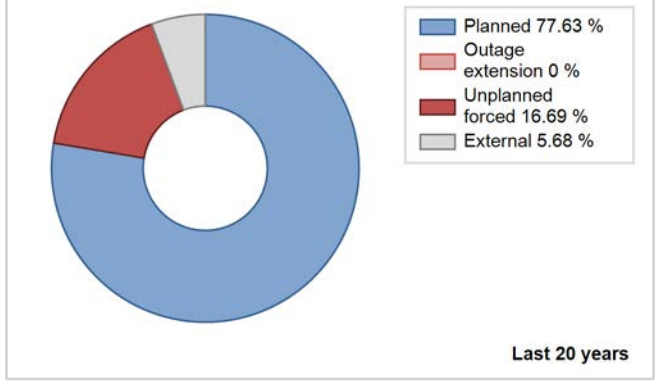
2014	8565.45	7911	1105	90.31	90.31	88.49	90.31	1.22	1.11	8.58	0.00
2015	9623.05	8760	1105	100.00	100.00	99.41	100.00	0.00	0.00	0.00	0.00
2016	8308.77	7906	1105	90.01	90.01	85.60	90.00	0.00	0.00	9.99	0.00
2017	9651.06	8760	1105	100.00	100.00	99.70	100.00	0.00	0.00	0.00	0.00
2018	8099.12	7243	1105	82.69	82.69	83.67	82.68	3.26	2.79	14.52	0.00
2019	10313.85	8390	1210	95.79	95.79	97.30	95.78	1.48	1.43	2.78	0.00
2020	9501.81	7870	1210	89.61	89.61	89.40	89.59	1.31	1.19	9.21	0.00
2021	10922.05	8760	1210	100.00	100.00	103.04	100.00	0.00	0.00	0.00	0.00
2022	8947.91	7645	1210	87.29	87.29	84.42	87.27	0.00	0.00	12.71	0.00
2023	10261.99	8573	1210	96.75	96.75	96.81	97.87	0.01	0.02	3.23	0.00
2024	9218.13	7734	1210	87.89	87.89	86.73	88.05	0.00	0.00	12.11	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1977 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					212	
B.	Refuelling without maintenance				46		
C.	Inspection, maintenance or repair combined with refuelling	877			634	210	
D.	Inspection, maintenance or repair without refuelling	173			480		
E.	Testing of plant systems or components				6	1	
H.	Nuclear regulatory requirements					2055	
J.	Grid limitation, failure or grid unavailability						22
L.	Human factor related					11	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						5
S.	Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				3		
Z.	Other					12	
Subtotal		1050			1169	2501	27
Total		**1050**			**3697**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1977 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		15
13. Reactor Auxiliary Systems		13
14. Safety Systems		13
15. Reactor Cooling Systems		36
31. Turbine and auxiliaries		64
32. Feedwater and Main Steam System		24
33. Circulating Water System		1
34. Miscellaneous Systems		241
41. Main Generator Systems		15
42. Electrical Power Supply Systems		24
Total		**449**

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2024 Operating Experience

US-325 BRUNSWICK-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	PROGRESS (Progress Energy)
Owner	:	PROG_E_C (PROGRESS ENERGY Carolinas, Inc.)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	2923 MWth
Gross electrical power	:	990 MWe
Reference unit power (net)	:	938 MWe

Key Dates

Construction Date	:	1970-02-07
Grid Date	:	1976-12-04
Commercial Date	:	1977-03-18
Age at end of year	:	48 years

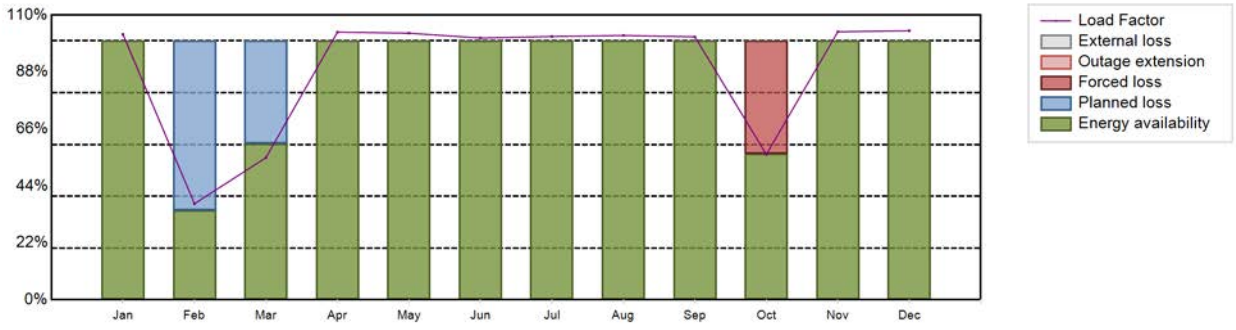
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.07
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	285
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.44
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	27800	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.1	HP cylinder inlet steam pressure [MPa]	:	6.8
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	560	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	18.42	Number of main condensate pumps	:	-
Number of control rod assemblies	:	137	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7366.13 GW(e).h	Forced Loss Rate (FLR)	:	4.02 %
Energy Availability Factor (EAF)	:	87.77 %	Unplanned Capability Loss Factor (UCL)	:	3.68 %
Unit Capability Factor (UCF)	:	87.77 %	Planned Unavailability Factor (PUF)	:	8.55 %
Load Factor (LF)	:	89.4 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	87.77 %	Total off-line time	:	1074 hours

Annual Summary



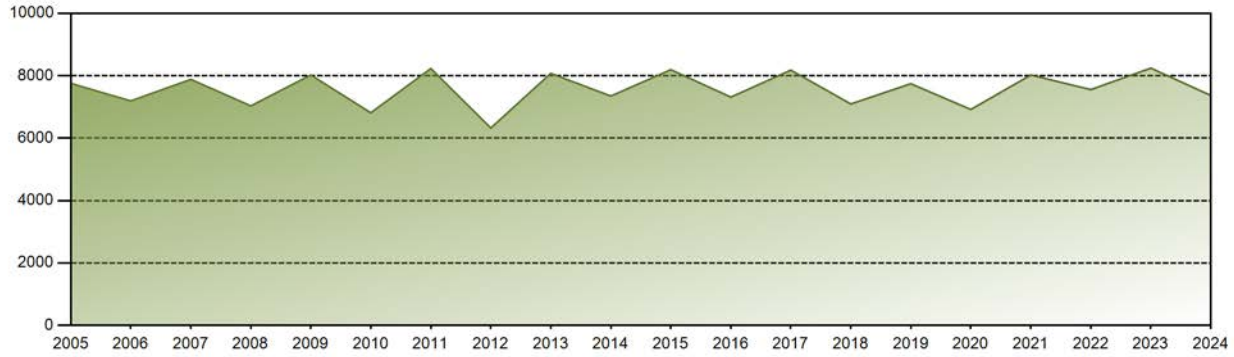
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	715.33	242.37	382.73	698.29	718.70	682.86	709.77	712.60	686.05	392.07	700.16	725.20	7366.13
EAF [%]	100.00	34.48	60.34	100.00	100.00	100.00	100.00	100.00	100.00	56.55	100.00	100.00	87.77
UCF [%]	100.00	34.48	60.34	100.00	100.00	100.00	100.00	100.00	100.00	56.55	100.00	100.00	87.77
LF [%]	102.50	37.13	54.92	103.39	102.98	101.11	101.71	102.11	101.58	56.18	103.53	103.92	89.40
OF [%]	100.00	37.21	57.74	100.00	100.00	100.00	100.00	100.00	100.00	56.59	100.00	100.00	87.77
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.45	0.00	0.00	4.02
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.45	0.00	0.00	3.68
PUF [%]	0.00	65.52	39.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.55
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	282140.73 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.29 %
Cumulative Energy Availability Factor (EAF)	:	80.26 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.49 %
Cumulative Unit Capability Factor (UCF)	:	80.53 %	Cumulative Planned Unavailability Factor (PUF)	:	14.97 %
Cumulative Load Factor (LF)	:	78.93 %	Cumulative Externally cause unavailability (XUF)	:	0.27 %
Cumulative Operating Factor (OF)	:	79.58 %			

Electricity Production (net) [GWh]

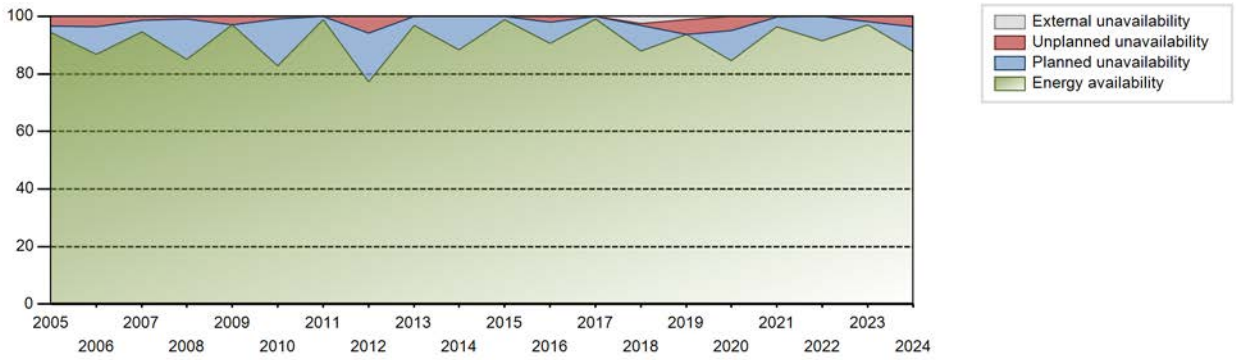


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1977	2984.50	4949	790	43.63	43.63	43.63	54.61	56.37	56.37	0.00	0.00
1978	5122.90	7624	790	74.11	74.11	74.03	87.03	16.75	14.91	10.99	0.00
1979	3169.20	4778	790	45.79	45.79	45.80	54.54	25.42	15.61	38.59	0.00
1980	3939.20	6045	790	69.75	69.75	56.77	68.82	7.13	5.36	24.90	0.00
1981	2574.80	4155	790	48.98	48.98	37.21	47.43	12.80	7.19	43.83	0.00
1982	2935.40	5428	790	62.93	62.93	42.42	61.96	31.61	29.09	7.98	0.00
1983	1419.10	2116	790	26.40	26.40	20.51	24.16	5.51	1.54	72.06	0.00
1984	5037.71	6797	790	79.77	81.45	72.60	77.38	5.30	4.56	13.99	1.68
1985	1942.51	3247	790	38.92	38.92	28.07	37.07	3.99	1.62	59.46	0.00
1986	5973.81	8068	790	92.23	92.23	86.32	92.10	7.77	7.77	0.00	0.00
1987	4057.95	5651	790	65.57	65.57	58.64	64.51	3.78	2.57	31.86	0.00
1988	4458.42	6514	790	74.45	74.45	64.25	74.16	3.73	2.89	22.66	0.00
1989	4193.76	5568	790	64.63	64.63	60.60	63.56	10.52	7.60	27.77	0.00
1990	4340.35	5909	790	68.40	68.40	62.72	67.45	8.16	6.07	25.52	0.00
1991	4400.35	5849	780	67.35	67.35	64.37	66.77	20.44	17.30	15.35	0.00
1992	1874.55	2486	767	28.31	28.31	27.82	28.30	31.05	12.75	58.94	0.00
1993	0.00	0	767	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1994	5956.34	7755	767	88.56	88.56	88.65	88.53	0.22	0.19	11.24	0.00
1995	5780.71	7391	767	84.42	84.42	86.04	84.37	2.04	1.76	13.82	0.00
1996	5708.15	7490	767	85.33	88.57	84.72	85.27	2.52	2.29	9.14	3.24
1997	6857.03	8558	767	97.71	97.71	102.06	97.69	2.29	2.29	0.00	0.00
1998	6360.44	7811	820	89.89	91.39	88.55	89.17	0.10	0.10	8.51	1.51
1999	6998.16	8481	820	96.82	98.97	97.42	96.82	1.03	1.03	0.00	2.16
2000	6746.48	8122	820	92.46	92.46	93.66	92.46	0.00	0.00	7.54	0.00
2001	7303.12	8760	820	100.00	100.00	101.67	100.00	0.00	0.00	0.00	0.00
2002	6697.34	7874	820	89.89	89.89	93.24	89.89	0.03	0.03	10.08	0.00
2003	7701.83	8653	872	98.85	98.85	100.83	98.78	1.15	1.15	0.00	0.00
2004	7093.38	7853	872	89.42	90.53	92.61	89.40	0.00	0.00	9.47	1.11
2005	7755.05	8275	872	94.47	94.47	101.51	94.45	3.37	3.29	2.24	0.00
2006	7190.78	7601	938	86.80	86.80	87.51	86.77	3.94	3.56	9.63	0.00
2007	7881.91	8290	938	94.64	94.64	95.92	94.63	1.45	1.39	3.97	0.00
2008	7030.63	7458	938	84.92	84.92	85.33	84.90	0.99	0.85	14.22	0.00
2009	8022.67	8493	938	96.96	96.96	97.64	96.95	3.04	3.04	0.00	0.00
2010	6810.87	7255	938	82.84	82.84	82.89	82.82	1.16	0.98	16.19	0.00
2011	8228.37	8663	938	98.90	98.90	100.14	98.89	0.00	0.00	1.10	0.00
2012	6323.87	6778	938	77.20	77.20	76.75	77.16	7.03	5.83	16.97	0.00
2013	8074.21	8483	938	96.83	96.83	98.25	96.83	0.00	0.00	3.17	0.00

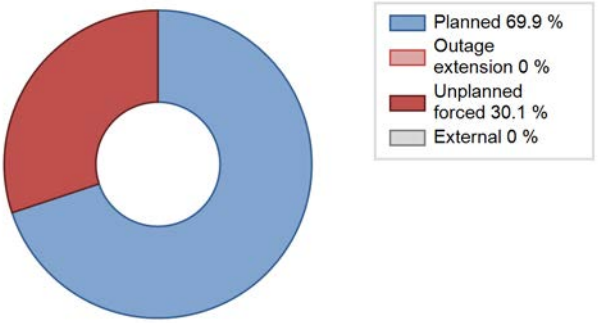
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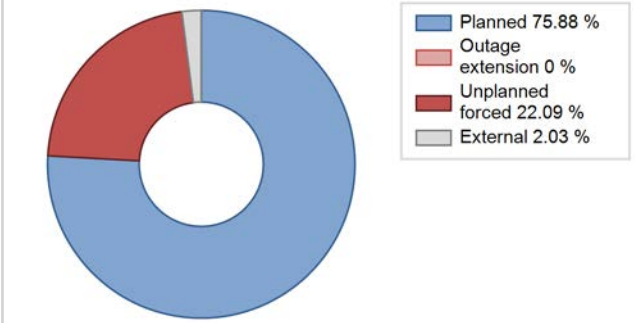
2014	7347.75	7751	938	88.48	88.48	89.42	88.48	0.00	0.00	11.52	0.00
2015	8192.60	8653	938	98.78	98.78	99.70	98.78	0.00	0.00	1.22	0.00
2016	7313.54	7959	938	90.60	90.60	88.76	90.61	2.18	2.01	7.39	0.00
2017	8179.12	8685	938	99.14	99.14	99.54	99.14	0.00	0.00	0.86	0.00
2018	7094.07	7700	938	87.90	90.31	86.34	87.90	0.78	0.71	8.98	2.41
2019	7744.25	8211	938	93.75	94.79	94.25	93.73	5.21	5.21	0.00	1.04
2020	6917.77	7432	938	84.62	84.62	83.96	84.61	5.57	4.99	10.39	0.00
2021	8022.51	8447	938	96.43	96.43	97.63	96.43	0.29	0.29	3.28	0.00
2022	7555.39	8023	938	91.59	91.59	91.95	91.59	0.00	0.00	8.41	0.00
2023	8243.54	8658	938	97.14	97.14	100.32	98.84	1.94	1.92	0.94	0.00
2024	7366.13	7710	938	87.77	87.77	89.40	87.77	4.02	3.68	8.55	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1977 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		323			287	
B. Refuelling without maintenance				29		
C. Inspection, maintenance or repair combined with refuelling	751			999		
D. Inspection, maintenance or repair without refuelling				344		
E. Testing of plant systems or components				4	45	
H. Nuclear regulatory requirements					9	
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					26	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						24
Z. Other					15	
Subtotal	751	323		1376	382	27
Total	**1074**			**1785**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1977 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		11
12. Reactor I&C Systems		19
13. Reactor Auxiliary Systems		7
14. Safety Systems		24
15. Reactor Cooling Systems		44
31. Turbine and auxiliaries		25
32. Feedwater and Main Steam System	323	17
33. Circulating Water System		4
34. Miscellaneous Systems		58
41. Main Generator Systems		84
42. Electrical Power Supply Systems		40
Total	**323**	**333**

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2024 Operating Experience

US-324 BRUNSWICK-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	PROGRESS (Progress Energy)
Owner	:	PROG_E_C (PROGRESS ENERGY Carolinas, Inc.)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	2923 MWth
Gross electrical power	:	960 MWe
Reference unit power (net)	:	932 MWe

Key Dates

Construction Date	:	1970-02-07
Grid Date	:	1975-04-29
Commercial Date	:	1975-11-03
Age at end of year	:	49 years

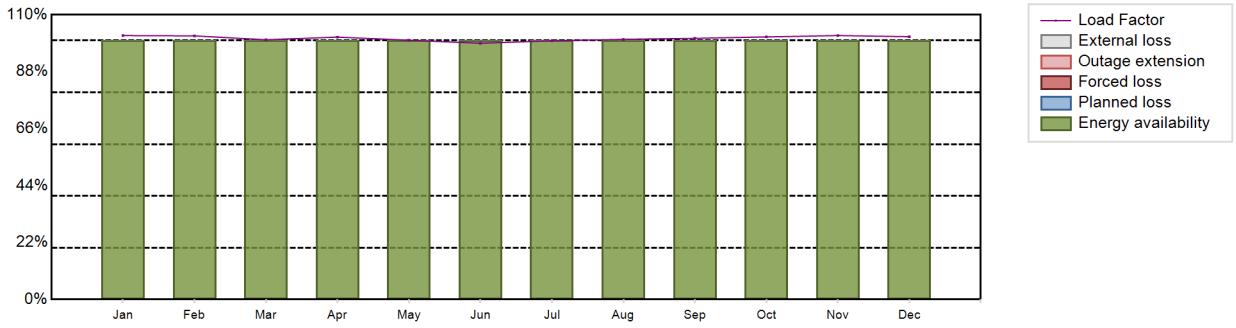
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.07
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	285
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.44
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	27800	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.1	HP cylinder inlet steam pressure [MPa]	:	6.8
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	560	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	18.61	Number of main condensate pumps	:	-
Number of control rod assemblies	:	137	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	100.89 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



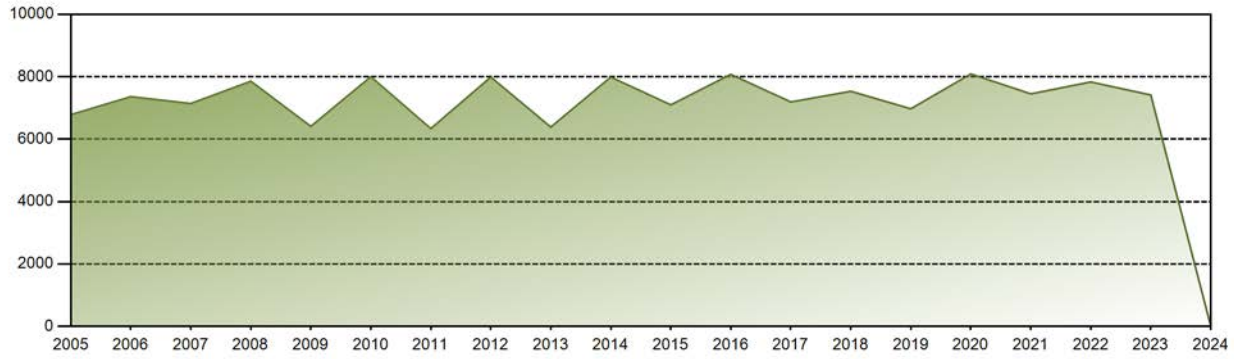
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	706.77	660.51	694.68	680.09	694.48	664.10	692.91	696.67	676.92	703.28	685.06	703.95	8259.42
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	101.93	101.83	100.32	101.35	100.15	98.97	99.93	100.47	100.88	101.42	101.95	101.52	100.89
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.05 %
Cumulative Energy Availability Factor (EAF)	:	79.67 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.15 %
Cumulative Unit Capability Factor (UCF)	:	79.95 %	Cumulative Planned Unavailability Factor (PUF)	:	14.9 %
Cumulative Load Factor (LF)	:	77.09 %	Cumulative Externally cause unavailability (XUF)	:	0.28 %
Cumulative Operating Factor (OF)	:	79.53 %			

Electricity Production (net) [GWh]

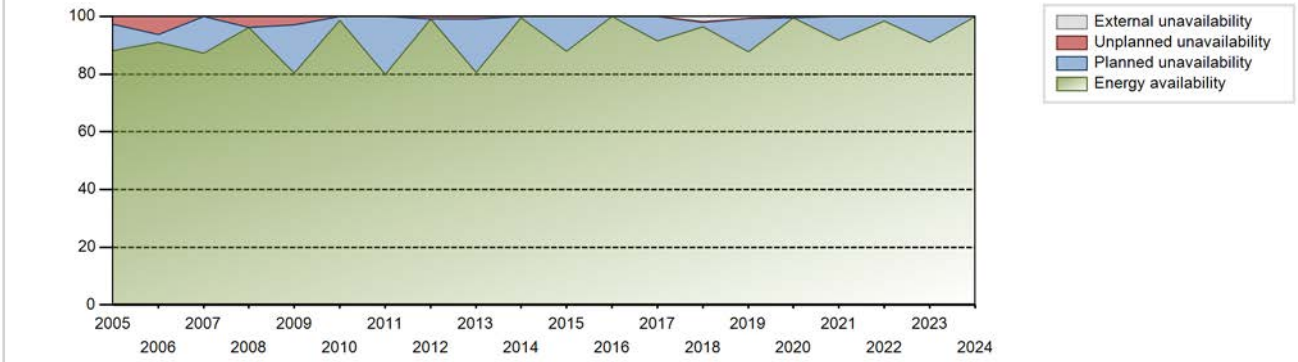


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	1423.80	3254	804	93.19	93.19	58.80	93.17	6.81	6.81	0.00	0.00
1976	2486.60	4911	789	35.81	35.81	35.88	55.91	48.62	33.89	30.30	0.00
1977	2436.60	4872	790	35.26	35.26	35.21	55.62	38.79	22.35	42.39	0.00
1978	4794.60	7018	790	69.26	69.26	69.28	80.11	25.55	23.77	6.97	0.00
1979	3652.10	5741	790	52.78	52.78	52.77	65.54	16.97	10.79	36.44	0.00
1980	1864.60	3086	790	38.13	38.13	26.87	35.13	21.96	10.73	51.14	0.00
1981	3283.90	5800	790	67.96	67.96	47.45	66.21	29.31	28.17	3.86	0.00
1982	1942.10	3378	790	41.42	41.42	28.06	38.56	27.98	16.09	42.48	0.00
1983	3941.70	5630	790	65.29	65.29	56.96	64.27	28.98	26.64	8.07	0.00
1984	1429.01	2236	790	28.90	28.90	20.59	25.46	28.94	11.77	59.33	0.00
1985	5021.91	6983	790	80.01	84.09	72.57	79.71	4.59	4.05	11.86	4.08
1986	2933.07	4027	790	48.47	48.47	42.38	45.97	2.96	1.48	50.05	0.00
1987	5694.10	8203	790	93.96	93.96	82.28	93.64	5.00	4.94	1.10	0.00
1988	3929.22	5361	790	62.80	62.80	56.62	61.03	6.30	4.22	32.98	0.00
1989	4195.43	5763	790	67.36	67.36	60.62	65.79	4.03	2.83	29.81	0.00
1990	4067.43	5616	790	66.07	66.07	58.77	64.11	16.62	13.17	20.76	0.00
1991	3664.18	4959	775	57.79	57.79	53.98	56.61	17.90	12.60	29.61	0.00
1992	1315.10	2200	754	25.06	25.06	19.86	25.05	18.45	5.67	69.27	0.00
1993	4000.88	5525	754	63.07	63.07	60.57	63.07	0.00	0.00	36.93	0.00
1994	4823.21	6436	754	73.49	73.49	73.02	73.47	0.00	0.00	26.51	0.00
1995	6215.96	8760	754	100.00	100.00	94.11	100.00	0.00	0.00	0.00	0.00
1996	5188.12	7277	754	82.90	86.90	78.33	82.84	2.68	2.39	10.71	4.00
1997	6055.38	7816	754	89.25	89.25	91.68	89.22	0.00	0.00	10.75	0.00
1998	6963.48	8539	811	97.66	98.93	98.02	97.48	1.07	1.07	0.00	1.26
1999	6095.17	7577	811	86.50	89.24	85.79	86.50	7.18	6.90	3.86	2.74
2000	7055.01	8616	811	98.09	98.09	99.03	98.09	1.91	1.91	0.00	0.00
2001	6540.43	7996	811	91.29	91.29	92.06	91.28	0.00	0.00	8.71	0.00
2002	7078.62	8609	811	98.28	98.28	99.64	98.28	0.00	0.00	1.72	0.00
2003	7028.09	7966	811	90.97	90.97	98.93	90.94	1.60	1.47	7.56	0.00
2004	7756.76	8639	900	98.53	98.53	98.12	98.35	0.86	0.85	0.62	0.00
2005	6781.70	7724	811	88.19	88.19	95.45	88.16	3.10	2.82	8.99	0.00
2006	7361.27	7972	937	91.02	91.02	89.68	91.00	6.35	6.17	2.81	0.00
2007	7140.26	7645	937	87.28	87.28	86.99	87.27	0.00	0.00	12.72	0.00
2008	7854.24	8448	937	96.18	96.18	95.43	96.17	3.82	3.82	0.00	0.00
2009	6410.20	7060	920	80.27	80.27	79.54	80.59	3.43	2.85	16.88	0.00
2010	8000.04	8639	920	98.63	98.63	99.27	98.62	0.09	0.09	1.28	0.00
2011	6336.69	6995	920	79.88	79.88	78.63	79.85	0.00	0.00	20.12	0.00

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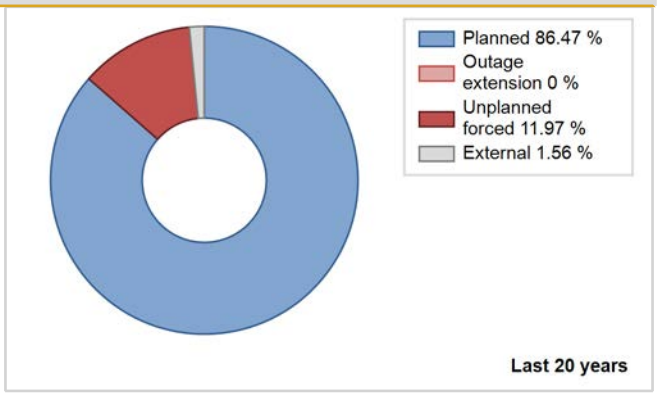
2012	7987.81	8704	920	99.10	99.10	98.84	99.09	0.90	0.90	0.00	0.00
2013	6385.33	7059	920	80.58	80.58	79.22	80.57	1.25	1.02	18.40	0.00
2014	7987.55	8715	920	99.48	99.48	99.11	99.49	0.00	0.00	0.52	0.00
2015	7098.43	7704	920	87.92	87.92	88.08	87.95	0.00	0.00	12.08	0.00
2016	8075.19	8784	920	100.00	100.00	99.92	100.00	0.00	0.00	0.00	0.00
2017	7191.04	8010	920	91.44	91.44	89.23	91.44	0.00	0.00	8.56	0.00
2018	7532.90	8453	932	96.50	98.23	92.27	96.50	0.41	0.41	1.36	1.74
2019	6972.51	7689	932	87.79	88.42	85.40	87.77	0.00	0.00	11.58	0.64
2020	8088.45	8740	932	99.51	99.51	98.80	99.50	0.49	0.49	0.00	0.00
2021	7450.71	8035	932	91.73	91.73	91.26	91.72	0.00	0.00	8.27	0.00
2022	7831.71	8625	932	98.46	98.46	95.93	98.46	0.00	0.00	1.54	0.00
2023	7414.54	8079	932	91.10	91.10	90.82	92.23	0.05	0.05	8.85	0.00
2024	Data not provided										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1975 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					472	
B. Refuelling without maintenance				15		
C. Inspection, maintenance or repair combined with refuelling				973		
D. Inspection, maintenance or repair without refuelling				291		
E. Testing of plant systems or components				9	3	
F. Major backfitting, refurbishment or upgrading activities with refuelling				0		
H. Nuclear regulatory requirements					5	
L. Human factor related					36	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						25
Z. Other					5	1
Subtotal				1288	521	26
Total	**0**			**1835**		

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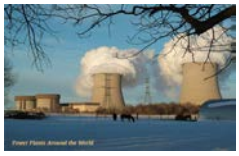
Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		12
12. Reactor I&C Systems		17
13. Reactor Auxiliary Systems		10
14. Safety Systems		27
15. Reactor Cooling Systems		179
17. Safety I&C Systems (excluding reactor I&C)		5
21. Fuel Handling and Storage Facilities		22
31. Turbine and auxiliaries		63
32. Feedwater and Main Steam System		38
33. Circulating Water System		1
34. Miscellaneous Systems		13
41. Main Generator Systems		30
42. Electrical Power Supply Systems		56
Total		**473**

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2024 Operating Experience

US-454 BYRON-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3645 MWth
Gross electrical power	:	1242 MWe
Reference unit power (net)	:	1164 MWe

Key Dates

Construction Date	:	1975-04-01
Grid Date	:	1985-03-01
Commercial Date	:	1985-09-16
Age at end of year	:	39 years

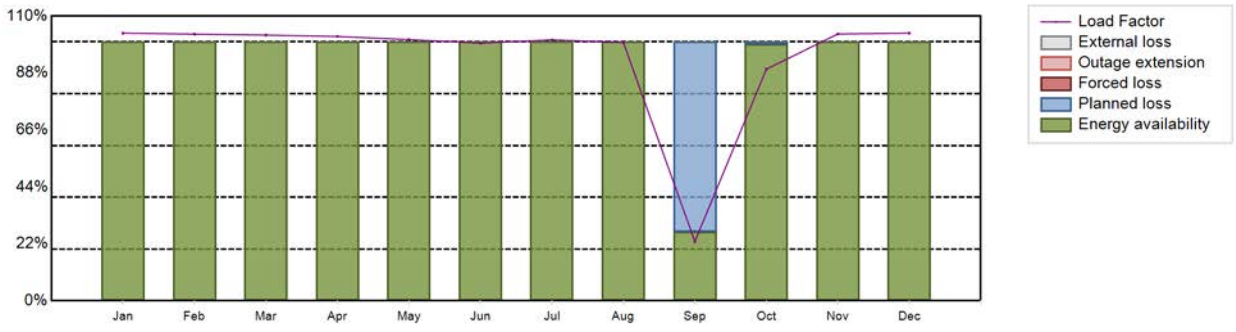
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	326
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.42
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	43	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	49000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.63
Active core height/length [m]	:	3.65	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	18.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	25	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9644.43 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	93.92 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	93.92 %	Planned Unavailability Factor (PUF)	:	6.08 %
Load Factor (LF)	:	94.33 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	93.92 %	Total off-line time	:	534 hours

Annual Summary



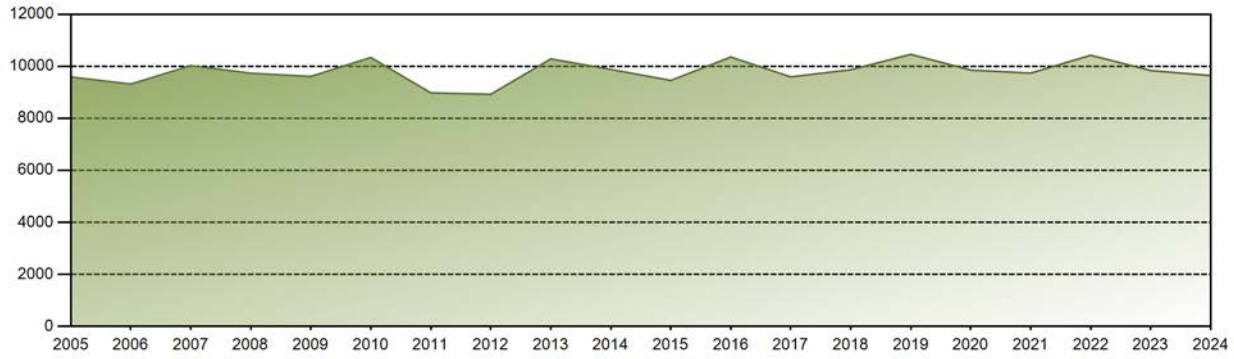
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	895.36	834.52	887.57	855.77	873.60	833.98	872.78	863.74	192.11	774.75	864.99	895.27	9644.43
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	26.67	99.21	100.00	100.00	93.92
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	26.67	99.21	100.00	100.00	93.92
LF [%]	103.39	103.01	102.63	102.11	100.88	99.51	100.78	99.74	22.92	89.46	103.07	103.38	94.33
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	26.81	99.06	100.00	100.00	93.92
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.33	0.79	0.00	0.00	6.08
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	349423.05 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.72 %
Cumulative Energy Availability Factor (EAF)	:	90.68 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.66 %
Cumulative Unit Capability Factor (UCF)	:	90.74 %	Cumulative Planned Unavailability Factor (PUF)	:	8.59 %
Cumulative Load Factor (LF)	:	88.86 %	Cumulative Externally cause unavailability (XUF)	:	0.07 %
Cumulative Operating Factor (OF)	:	90.57 %			

Electricity Production (net) [GWh]

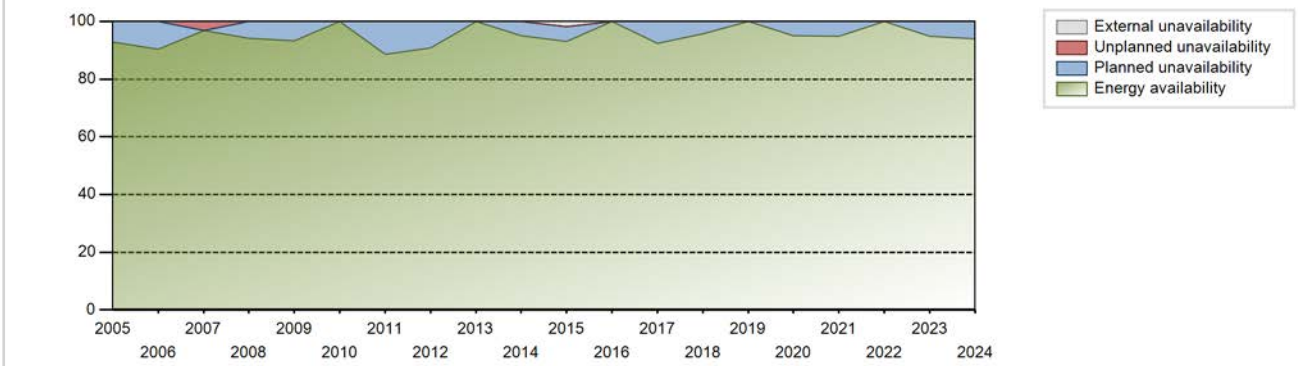


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	1696.12	2025	1124	41.27	41.27	31.22	40.74	3.54	1.51	57.21	0.00
1986	7396.00	7760	1129	89.09	89.09	74.78	88.58	7.52	7.24	3.67	0.00
1987	5355.66	6005	1125	68.74	69.62	54.33	68.55	0.92	0.64	29.74	0.89
1988	6303.67	6393	1112	72.90	72.90	64.51	72.78	1.88	1.40	25.71	0.00
1989	8945.52	8737	1105	99.74	99.74	92.41	99.74	0.26	0.26	0.00	0.00
1990	6951.66	7059	1105	80.33	80.33	71.82	80.58	2.95	2.44	17.23	0.00
1991	6318.07	7148	1105	81.35	81.35	65.27	81.60	1.07	0.88	17.77	0.00
1992	8986.36	8723	1105	99.30	99.30	92.58	99.31	0.70	0.70	0.00	0.00
1993	7366.86	7104	1105	80.85	80.85	76.11	81.10	1.34	1.10	18.05	0.00
1994	6801.55	7136	1105	81.24	81.24	70.27	81.46	4.04	3.42	15.33	0.00
1995	7706.54	7228	1105	82.30	82.30	79.61	82.51	0.00	0.00	17.70	0.00
1996	6871.06	6588	1105	74.70	74.70	70.79	75.00	0.58	0.44	24.87	0.00
1997	7161.73	6737	1105	76.78	76.78	73.99	76.91	2.97	2.35	20.87	0.00
1998	7804.60	7145	1105	81.54	81.54	80.63	81.56	0.00	0.00	18.46	0.00
1999	8908.49	7944	1105	90.59	90.59	92.03	90.68	1.47	1.35	8.06	0.00
2000	9291.86	8284	1105	94.24	94.24	95.73	94.31	0.00	0.00	5.76	0.00
2001	10389.90	8760	1163	100.00	100.00	104.13	100.00	0.00	0.00	0.00	0.00
2002	9827.85	8256	1163	94.08	94.08	96.47	94.25	0.76	0.72	5.20	0.00
2003	9858.83	8248	1163	94.01	94.01	96.77	94.16	0.00	0.00	5.99	0.00
2004	10381.33	8784	1152	100.00	100.00	102.19	100.00	0.00	0.00	0.00	0.00
2005	9589.71	8135	1194	92.88	92.88	91.67	92.85	0.00	0.00	7.12	0.00
2006	9317.03	7914	1164	90.35	90.35	91.37	90.34	0.00	0.00	9.65	0.00
2007	10024.16	8482	1164	96.83	96.83	98.31	96.83	3.17	3.17	0.00	0.00
2008	9733.36	8266	1164	94.11	94.11	95.20	94.10	0.00	0.00	5.89	0.00
2009	9609.39	8169	1164	93.26	93.26	94.24	93.25	0.00	0.00	6.74	0.00
2010	10337.29	8760	1164	100.00	100.00	101.38	100.00	0.00	0.00	0.00	0.00
2011	8978.80	7759	1164	88.58	88.58	88.06	88.57	0.00	0.00	11.42	0.00
2012	8925.08	7984	1164	90.91	90.91	87.29	90.89	0.00	0.00	9.09	0.00
2013	10283.27	8760	1164	100.00	100.00	100.84	99.99	0.00	0.00	0.00	0.00
2014	9879.89	8328	1164	95.06	95.06	96.89	95.07	0.00	0.00	4.94	0.00
2015	9456.59	8158	1164	93.12	94.88	92.74	93.13	0.00	0.00	5.12	1.76
2016	10356.72	8784	1164	100.00	100.00	101.29	100.00	0.00	0.00	0.00	0.00
2017	9593.03	8098	1164	92.45	92.45	94.08	92.44	0.00	0.00	7.55	0.00
2018	9868.77	8385	1164	95.74	95.74	96.78	95.72	0.00	0.00	4.26	0.00
2019	10459.12	8760	1164	100.00	100.00	102.57	100.00	0.00	0.00	0.00	0.00
2020	9853.74	8339	1164	94.95	94.95	96.37	94.93	0.00	0.00	5.05	0.00
2021	9739.71	8315	1164	94.92	94.92	95.52	94.92	0.00	0.00	5.08	0.00

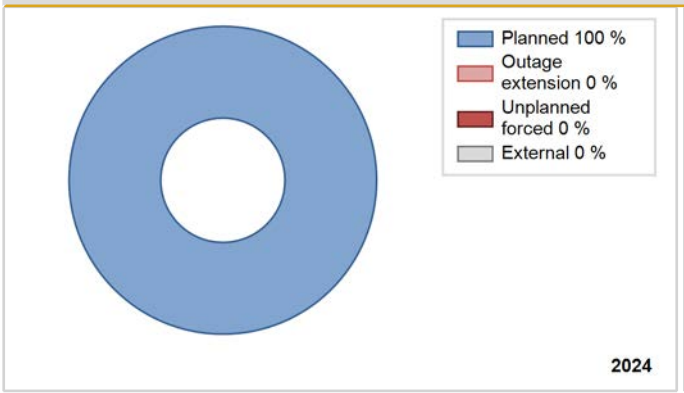
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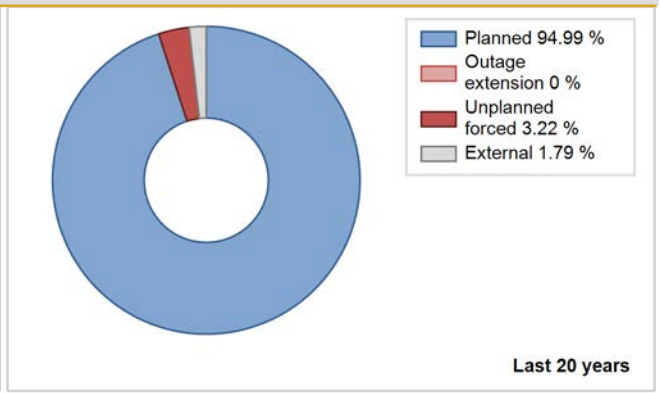
2022	10425.57	8760	1164	100.00	100.00	102.25	100.00	0.00	0.00	0.00	0.00
2023	9835.73	8315	1164	94.89	94.89	96.46	94.92	0.00	0.00	5.11	0.00
2024	9644.43	8250	1164	93.92	93.92	94.33	93.92	0.00	0.00	6.08	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					42	
B. Refuelling without maintenance				32		
C. Inspection, maintenance or repair combined with refuelling	534			613		
D. Inspection, maintenance or repair without refuelling				112		
E. Testing of plant systems or components					0	
H. Nuclear regulatory requirements					9	
L. Human factor related					6	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						7
Z. Other				2	2	
Subtotal	534			759	59	7
Total	**534**			**825**		

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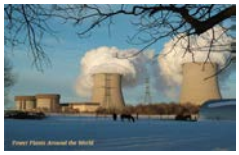
Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		13
12. Reactor I&C Systems		2
13. Reactor Auxiliary Systems		2
15. Reactor Cooling Systems		4
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		7
34. Miscellaneous Systems		3
41. Main Generator Systems		0
42. Electrical Power Supply Systems		4
Total		**45**

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2024 Operating Experience

US-455 BYRON-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3645 MWth
Gross electrical power	:	1210 MWe
Reference unit power (net)	:	1136 MWe

Key Dates

Construction Date	:	1975-04-01
Grid Date	:	1987-02-06
Commercial Date	:	1987-08-02
Age at end of year	:	37 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	43
Average discharge burnup [MWd/t]	:	49000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.65
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	18.3
Number of control rod assemblies	:	25
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

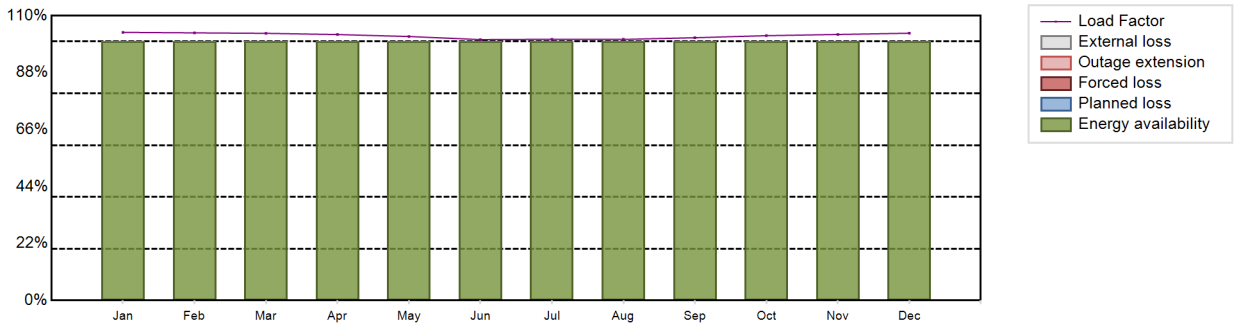
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	326
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.42
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.63
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	102.26 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



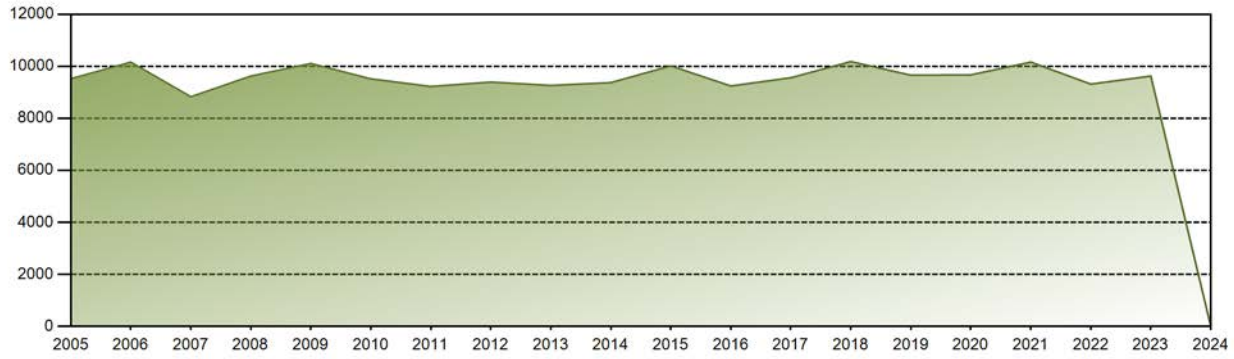
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	875.39	817.34	870.98	840.20	861.75	824.37	852.93	852.48	830.20	864.48	841.61	872.55	10204.28
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	103.57	103.38	103.19	102.72	101.96	100.79	100.92	100.86	101.50	102.28	102.75	103.24	102.26
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	0.75 %
Cumulative Energy Availability Factor (EAF)	:	93.53 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	0.71 %
Cumulative Unit Capability Factor (UCF)	:	93.53 %	Cumulative Planned Unavailability Factor (PUF)	:	5.76 %
Cumulative Load Factor (LF)	:	91.63 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	93.13 %			

Electricity Production (net) [GWh]

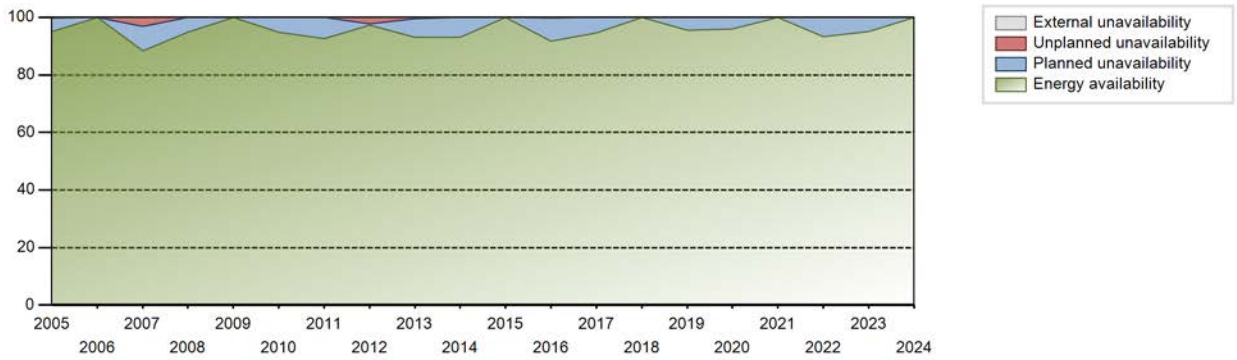


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	3876.06	5071	1128	100.00	100.00	47.54	62.91	0.00	0.00	0.00	0.00
1988	6357.92	8419	1112	95.86	95.86	65.06	95.84	2.04	1.99	2.14	0.00
1989	6069.54	6981	1105	79.46	79.46	62.70	79.69	4.88	4.08	16.46	0.00
1990	6052.68	6598	1105	75.00	75.00	62.53	75.32	1.02	0.78	24.23	0.00
1991	8772.68	8489	1105	96.89	96.89	90.63	96.91	3.11	3.11	0.00	0.00
1992	7000.34	7027	1105	79.76	79.76	72.12	80.00	1.27	1.03	19.21	0.00
1993	7622.47	7399	1105	84.26	84.26	78.75	84.46	1.35	1.16	14.58	0.00
1994	9504.17	8704	1105	99.36	99.36	98.19	99.36	0.64	0.64	0.00	0.00
1995	8183.77	7710	1105	87.87	87.87	84.54	88.01	0.00	0.00	12.13	0.00
1996	7830.62	7225	1105	82.05	82.05	80.68	82.25	5.51	4.79	13.17	0.00
1997	9102.89	8344	1105	95.21	95.21	94.04	95.25	0.44	0.42	4.37	0.00
1998	8592.83	7855	1105	89.54	89.54	88.76	89.66	0.00	0.00	10.46	0.00
1999	9174.10	8182	1105	93.32	93.32	94.78	93.40	0.00	0.00	6.68	0.00
2000	10005.38	8724	1105	99.32	99.32	103.08	99.32	0.68	0.68	0.00	0.00
2001	9826.73	8353	1131	95.30	95.30	100.14	95.35	0.33	0.31	4.38	0.00
2002	9537.62	8119	1131	92.31	92.31	96.27	92.68	1.72	1.62	6.07	0.00
2003	10298.69	8760	1131	100.00	100.00	103.95	100.00	0.00	0.00	0.00	0.00
2004	9623.24	8360	1125	95.04	95.04	97.17	95.17	0.00	0.00	4.96	0.00
2005	9521.05	8328	1162	95.08	95.08	93.54	95.07	0.35	0.33	4.59	0.00
2006	10158.74	8760	1136	100.00	100.00	102.08	100.00	0.00	0.00	0.00	0.00
2007	8828.60	7736	1136	88.33	88.33	88.72	88.31	3.34	3.05	8.62	0.00
2008	9624.16	8339	1136	94.94	94.94	96.45	94.93	0.00	0.00	5.06	0.00
2009	10108.89	8760	1136	100.00	100.00	101.58	100.00	0.00	0.00	0.00	0.00
2010	9518.42	8300	1136	94.76	94.76	95.65	94.75	0.00	0.00	5.24	0.00
2011	9223.94	8115	1136	92.65	92.65	92.69	92.64	0.00	0.00	7.35	0.00
2012	9393.22	8536	1136	97.19	97.19	94.13	97.18	2.19	2.17	0.64	0.00
2013	9263.79	8160	1136	93.15	93.15	93.08	93.14	0.52	0.49	6.36	0.00
2014	9372.50	8158	1136	93.13	93.13	94.18	93.13	0.00	0.00	6.87	0.00
2015	10015.44	8760	1136	100.00	100.00	100.64	100.00	0.00	0.00	0.00	0.00
2016	9243.53	8064	1136	91.80	91.80	92.63	91.80	0.23	0.21	7.99	0.00
2017	9560.01	8295	1136	94.69	94.69	96.07	94.69	0.00	0.00	5.31	0.00
2018	10182.25	8760	1136	100.00	100.00	102.32	100.00	0.00	0.00	0.00	0.00
2019	9658.86	8372	1136	95.58	95.58	97.06	95.57	0.00	0.00	4.42	0.00
2020	9671.16	8430	1136	95.98	95.98	96.92	95.97	0.00	0.00	4.02	0.00
2021	10162.04	8760	1136	100.00	100.00	102.12	100.00	0.00	0.00	0.00	0.00
2022	9316.18	8178	1136	93.36	93.36	93.62	93.36	0.00	0.00	6.64	0.00
2023	9623.79	8337	1136	95.11	95.11	96.71	95.17	0.00	0.08	4.81	0.00

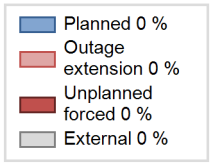
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2024	Data not provided

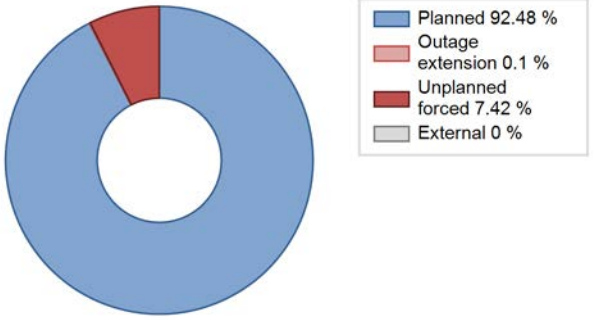
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					51	
B. Refuelling without maintenance				25		
C. Inspection, maintenance or repair combined with refuelling				455		
D. Inspection, maintenance or repair without refuelling				28		
H. Nuclear regulatory requirements					7	
Z. Other					4	
Subtotal				508	62	
Total	**0**			**570**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1987 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		1
12. Reactor I&C Systems		3
15. Reactor Cooling Systems		6
16. Steam generation systems		12
17. Safety I&C Systems (excluding reactor I&C)		2
32. Feedwater and Main Steam System		5
34. Miscellaneous Systems		9
35. All other I&C Systems		1
41. Main Generator Systems		7
42. Electrical Power Supply Systems		5
Total		**51**

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2024 Operating Experience

US-483 CALLAWAY-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	AmerenUE (AMEREN UE, Union Electric Company)
Owner	:	AmerenUE (AMEREN UE, Union Electric Company)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3565 MWth
Gross electrical power	:	1275 MWe
Reference unit power (net)	:	1215 MWe

Key Dates

Construction Date	:	1975-09-01
Grid Date	:	1984-10-24
Commercial Date	:	1984-12-19
Age at end of year	:	40 years

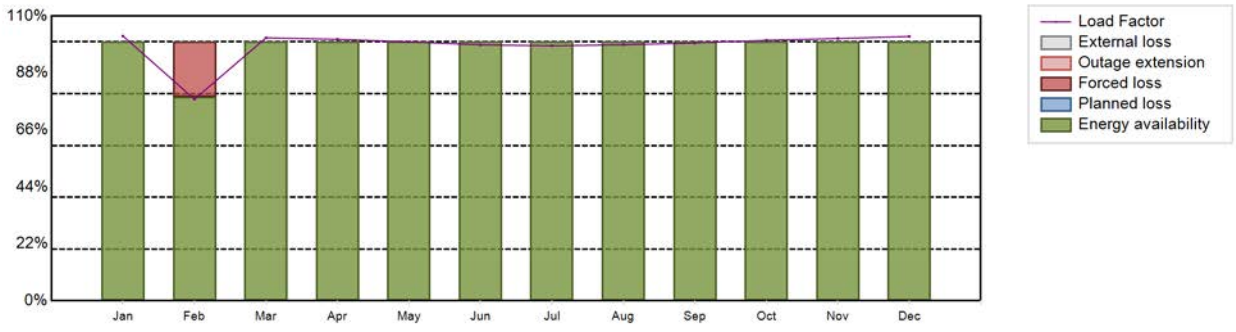
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	329
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.34
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	42000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.78
Active core height/length [m]	:	3.65	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	19.13	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10528.42 GW(e).h	Forced Loss Rate (FLR)	:	1.67 %
Energy Availability Factor (EAF)	:	98.33 %	Unplanned Capability Loss Factor (UCL)	:	1.67 %
Unit Capability Factor (UCF)	:	98.33 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	98.65 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	98.29 %	Total off-line time	:	150 hours

Annual Summary



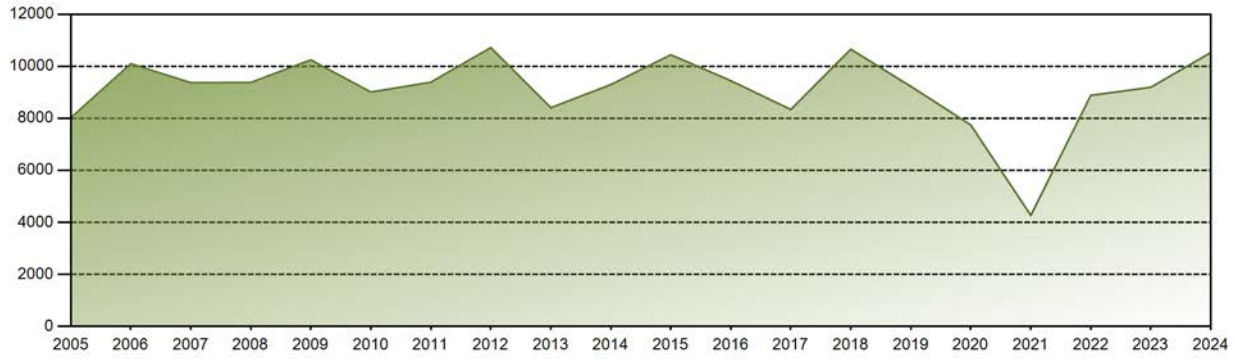
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	924.53	658.38	917.04	883.38	904.39	864.87	890.37	893.97	871.40	909.56	887.34	923.18	10528.42
EAF [%]	100.00	78.87	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.33
UCF [%]	100.00	78.87	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.33
LF [%]	102.28	77.86	101.58	100.98	100.05	98.86	98.50	98.90	99.61	100.62	101.29	102.13	98.65
OF [%]	100.00	78.45	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.29
FLR [%]	0.00	21.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67
UCL [%]	0.00	21.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	353768.06 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.66 %
Cumulative Energy Availability Factor (EAF)	:	87.24 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.32 %
Cumulative Unit Capability Factor (UCF)	:	87.24 %	Cumulative Planned Unavailability Factor (PUF)	:	9.44 %
Cumulative Load Factor (LF)	:	86.47 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	87.04 %			

Electricity Production (net) [GWh]

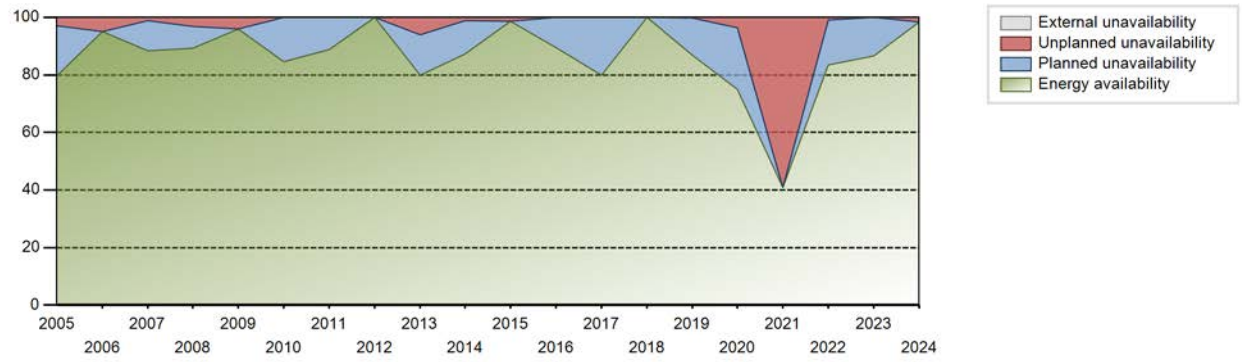


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	577.21	863	1140	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1985	8045.76	7882	1120	89.99	89.99	82.01	89.98	6.38	6.14	3.87	0.00
1986	7199.11	7121	1120	81.57	81.57	73.38	81.29	3.29	2.78	15.65	0.00
1987	6321.78	6141	1120	70.02	70.02	64.43	70.10	1.98	1.42	28.56	0.00
1988	8144.18	7413	1120	92.53	92.53	82.75	84.39	3.18	3.03	4.44	0.00
1989	8350.92	7368	1118	84.04	84.04	85.27	84.11	1.04	0.89	15.08	0.00
1990	8005.06	7167	1125	81.84	81.84	81.23	81.82	3.49	2.96	15.21	0.00
1991	9979.37	8726	1125	99.61	99.61	101.26	99.61	0.39	0.39	0.00	0.00
1992	8094.55	7204	1125	82.04	82.04	81.91	82.01	1.95	1.63	16.34	0.00
1993	8389.95	7498	1120	85.53	85.53	85.51	85.59	0.00	0.00	14.47	0.00
1994	10006.49	8726	1115	99.62	99.62	102.45	99.61	0.00	0.00	0.38	0.00
1995	8252.83	7356	1125	83.98	83.98	83.74	83.97	3.29	2.85	13.16	0.00
1996	8890.38	7864	1125	89.56	89.56	89.97	89.53	2.01	1.83	8.61	0.00
1997	8954.60	8760	1125	100.00	100.00	90.86	100.00	0.00	0.00	0.00	0.00
1998	8516.77	7913	1125	90.36	90.36	86.42	90.33	1.19	1.09	8.55	0.00
1999	8596.43	7707	1125	87.79	87.79	87.23	87.98	2.75	2.48	9.73	0.00
2000	9991.84	8762	1125	99.75	100.00	101.11	99.75	0.00	0.00	0.00	0.25
2001	8384.12	7500	1125	85.39	85.39	85.07	85.62	2.48	2.17	12.44	0.00
2002	8386.58	7484	1125	85.20	85.20	85.10	85.43	5.84	5.29	9.51	0.00
2003	9699.74	8397	1125	95.81	95.81	98.42	95.86	0.98	0.95	3.25	0.00
2004	7842.38	6856	1125	77.93	77.93	79.36	78.05	5.38	4.43	17.64	0.00
2005	8021.18	6966	1137	79.57	79.57	80.53	79.52	3.65	3.01	17.42	0.00
2006	10098.88	8324	1190	95.04	95.04	96.88	95.02	4.96	4.96	0.00	0.00
2007	9371.96	7742	1190	88.40	88.40	89.90	88.38	1.25	1.12	10.48	0.00
2008	9378.23	7834	1190	89.20	89.20	89.72	89.18	3.43	3.16	7.64	0.00
2009	10247.12	8408	1190	96.01	96.01	98.30	95.98	3.99	3.99	0.00	0.00
2010	9011.04	7412	1190	84.63	84.63	86.44	84.61	0.00	0.00	15.37	0.00
2011	9387.87	7771	1215	88.74	88.74	89.90	88.71	0.00	0.00	11.26	0.00
2012	10718.32	8784	1215	100.00	100.00	100.43	100.00	0.00	0.00	0.00	0.00
2013	8408.87	7008	1215	79.99	79.99	79.00	79.99	7.13	6.14	13.87	0.00
2014	9297.34	7649	1215	87.31	87.31	87.35	87.32	1.19	1.05	11.64	0.00
2015	10443.55	8648	1215	98.73	98.73	98.12	98.72	1.27	1.27	0.00	0.00
2016	9445.58	7859	1215	89.48	89.48	88.50	89.47	0.00	0.00	10.52	0.00
2017	8338.45	6995	1215	79.85	79.85	78.34	79.85	0.00	0.00	20.15	0.00
2018	10657.75	8760	1215	100.00	100.00	100.13	100.00	0.00	0.00	0.00	0.00
2019	9227.76	7603	1215	86.81	86.81	86.70	86.79	0.18	0.15	13.04	0.00
2020	7742.12	6477	1215	74.93	74.93	72.54	73.74	4.68	3.68	21.39	0.00

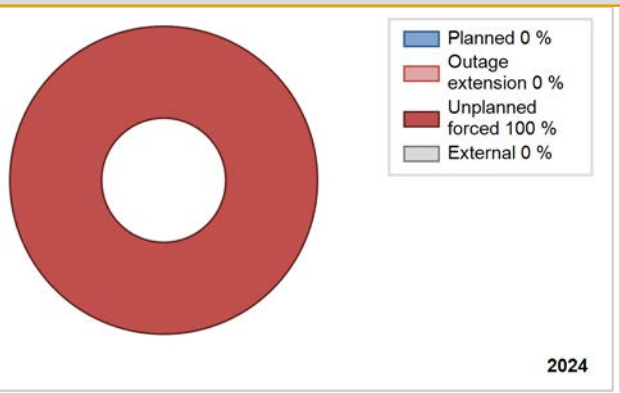
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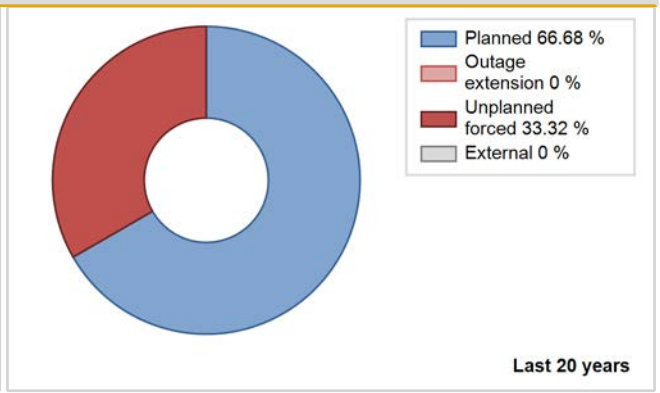
2021	4265.82	3584	1215	40.91	40.91	40.08	40.91	59.09	59.09	0.00	0.00
2022	8882.15	7312	1215	83.47	83.47	83.45	83.47	1.16	0.98	15.55	0.00
2023	9195.58	7573	1215	86.64	86.64	86.40	86.45	0.00	0.00	13.36	0.00
2024	10528.42	8634	1215	98.33	98.33	98.65	98.29	1.67	1.67	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		150			137	
B. Refuelling without maintenance				81		
C. Inspection, maintenance or repair combined with refuelling				684		
D. Inspection, maintenance or repair without refuelling				63		
E. Testing of plant systems or components				0	1	
H. Nuclear regulatory requirements					0	
L. Human factor related					6	
Z. Other					126	1
Subtotal		150		828	270	1
Total		**150**			**1099**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		5
12. Reactor I&C Systems		6
13. Reactor Auxiliary Systems		1
14. Safety Systems		1
15. Reactor Cooling Systems		12
16. Steam generation systems		3
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries	42	23
32. Feedwater and Main Steam System		26
33. Circulating Water System		9
34. Miscellaneous Systems		5
35. All other I&C Systems		2
41. Main Generator Systems		9
42. Electrical Power Supply Systems	108	37
Total	**150**	**140**

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2024 Operating Experience

US-317 CALVERT CLIFFS-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	CE (COMBUSTION ENGINEERING CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / CE 2LP (DRYAMB)
Thermal power	:	2737 MWth
Gross electrical power	:	918 MWe
Reference unit power (net)	:	877 MWe

Key Dates

Construction Date	:	1968-06-01
Grid Date	:	1975-01-03
Commercial Date	:	1975-05-08
Age at end of year	:	49 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	3.45
Active core height/length [m]	:	3.47
Number of fissile fuel assemblies/bundles	:	217
Fuel linear heat generation rate [kW/m]	:	20.62
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

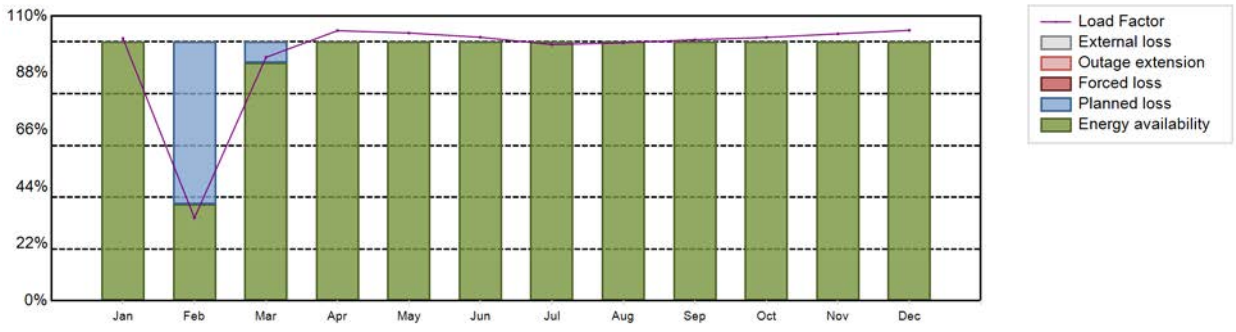
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	314
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.352
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7376.08 GW(e).h
Energy Availability Factor (EAF)	:	94.36 %
Unit Capability Factor (UCF)	:	94.36 %
Load Factor (LF)	:	95.75 %
Operating Factor (OF)	:	94.41 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	5.64 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	491 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	661.10	195.50	612.73	658.87	674.92	642.72	645.86	650.18	636.76	663.79	652.04	681.62	7376.08
EAF [%]	100.00	37.42	91.95	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.36
UCF [%]	100.00	37.42	91.95	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.36
LF [%]	101.32	32.03	94.03	104.34	103.44	101.79	98.98	99.65	100.84	101.73	103.12	104.47	95.75
OF [%]	100.00	37.93	92.06	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.41
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	62.58	8.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.64
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	309546.23 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.75 %
Cumulative Energy Availability Factor (EAF)	:	83.13 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.25 %
Cumulative Unit Capability Factor (UCF)	:	83.35 %	Cumulative Planned Unavailability Factor (PUF)	:	13.4 %
Cumulative Load Factor (LF)	:	84.22 %	Cumulative Externally cause unavailability (XUF)	:	0.23 %
Cumulative Operating Factor (OF)	:	83.45 %			

Electricity Production (net) [GWh]

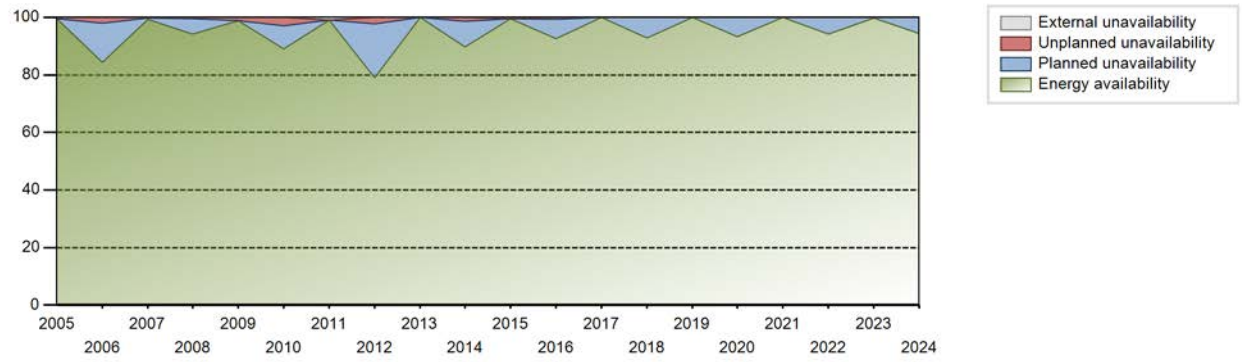


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	4381.60	6667	800	77.16	77.16	77.40	81.75	15.38	14.02	8.82	0.00
1976	6303.90	8356	800	89.70	89.70	89.71	95.13	2.27	2.08	8.22	0.00
1977	4882.00	6313	807	68.62	68.62	69.06	72.07	8.77	6.60	24.78	0.00
1978	4676.10	6150	810	65.91	65.91	65.90	70.21	16.09	12.64	21.45	0.00
1979	4194.10	6154	810	59.11	59.11	59.11	70.25	23.95	18.62	22.27	0.00
1980	4542.50	6349	810	72.20	77.03	63.84	72.28	4.97	4.03	18.94	4.84
1981	6109.60	7544	821	86.43	86.43	84.95	86.12	10.53	10.17	3.40	0.00
1982	5362.10	6419	825	73.86	73.86	74.20	73.28	0.64	0.48	25.66	0.00
1983	5570.70	6719	825	77.04	77.04	77.08	76.70	2.67	2.11	20.84	0.00
1984	6221.60	7422	825	84.35	86.67	85.85	84.49	13.33	13.33	0.00	2.32
1985	4359.73	5186	825	58.76	58.76	60.33	59.20	5.79	3.61	37.63	0.00
1986	5830.74	6855	825	78.24	78.24	80.68	78.25	1.66	1.32	20.44	0.00
1987	5268.48	6233	825	70.91	70.91	72.90	71.15	26.14	25.09	4.00	0.00
1988	5164.23	6263	825	71.01	71.01	71.26	71.30	2.39	1.74	27.25	0.00
1989	1345.62	1727	825	18.77	18.77	18.62	19.71	3.06	0.59	80.64	0.00
1990	1344.37	1840	825	20.06	20.06	18.60	21.00	1.87	0.38	79.56	0.00
1991	5465.33	6638	825	75.52	75.52	75.62	75.78	12.00	10.29	14.19	0.00
1992	4113.88	4927	825	55.58	55.58	56.77	56.09	3.87	2.24	42.18	0.00
1993	7334.90	8599	827	98.16	98.16	101.18	98.16	1.84	1.84	0.00	0.00
1994	4686.43	5656	832	64.56	64.56	64.23	64.57	11.21	8.15	27.29	0.00
1995	7030.23	8487	835	96.89	96.89	96.11	96.88	3.11	3.11	0.00	0.00
1996	4846.90	5762	835	65.65	65.65	66.08	65.60	13.65	10.38	23.96	0.00
1997	7158.40	8400	835	95.95	95.95	97.86	95.89	1.76	1.72	2.33	0.00
1998	6116.77	7184	835	82.01	82.01	83.62	82.01	0.00	0.00	17.99	0.00
1999	6994.34	8231	835	93.99	96.81	95.62	93.96	1.09	1.07	2.12	2.82
2000	6449.61	7580	825	86.18	86.18	88.73	86.29	1.01	0.88	12.94	0.00
2001	7454.78	8727	825	99.63	99.63	103.15	99.62	0.00	0.00	0.37	0.00
2002	4645.18	5506	825	62.76	62.76	64.28	62.85	2.08	1.33	35.91	0.00
2003	7532.45	8760	825	100.00	100.00	104.23	100.00	0.00	0.00	0.00	0.00
2004	6973.98	8034	870	91.55	91.55	93.26	91.46	0.44	0.40	8.05	0.00
2005	7626.32	8726	845	99.62	99.62	103.02	99.60	0.38	0.38	0.00	0.00
2006	6449.83	7386	873	84.34	84.34	84.34	84.32	2.28	1.96	13.70	0.00
2007	7545.36	8701	873	99.35	99.35	98.66	99.33	0.31	0.31	0.35	0.00
2008	7161.09	8275	873	94.22	94.22	93.38	94.21	0.44	0.42	5.37	0.00
2009	7528.57	8661	873	98.87	98.87	98.45	98.87	1.13	1.13	0.00	0.00
2010	6755.04	7814	855	88.99	88.99	90.19	89.20	3.09	2.83	8.17	0.00
2011	7542.52	8676	855	99.05	100.00	100.70	99.04	0.00	0.00	0.00	0.95

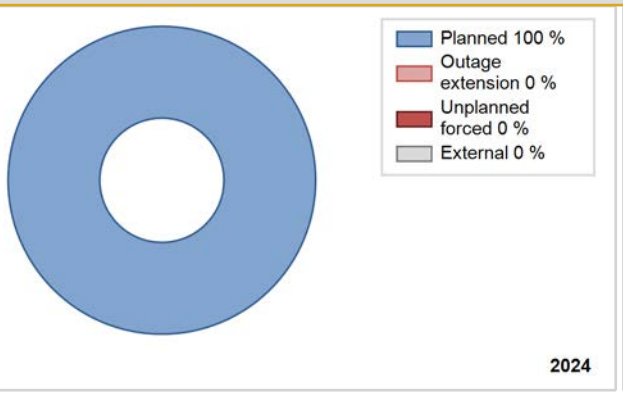
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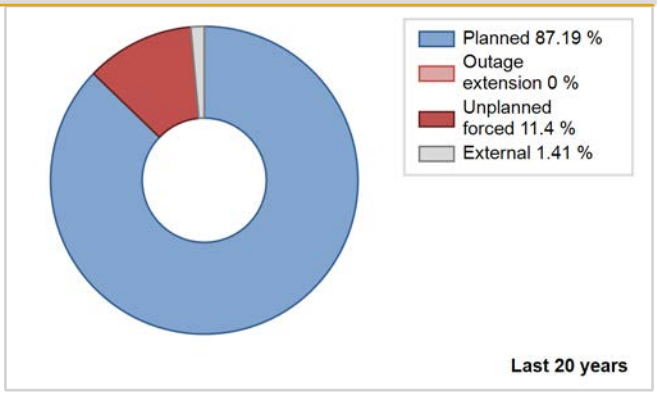
2012	6070.18	6930	866	79.08	79.08	80.13	78.89	2.84	2.31	18.61	0.00
2013	7815.24	8760	866	100.00	100.00	103.01	99.99	0.00	0.00	0.00	0.00
2014	6928.82	7868	866	89.82	89.82	91.34	89.82	1.60	1.46	8.72	0.00
2015	7772.62	8718	866	99.52	100.00	102.46	99.52	0.00	0.00	0.00	0.48
2016	7191.74	8132	866	92.58	92.58	94.54	92.58	0.73	0.68	6.74	0.00
2017	7832.43	8760	863	100.00	100.00	103.49	100.00	0.00	0.00	0.00	0.00
2018	7289.37	8128	877	92.83	92.83	95.90	92.79	0.00	0.00	7.17	0.00
2019	7913.33	8760	877	100.00	100.00	103.00	100.00	0.00	0.00	0.00	0.00
2020	7371.35	8185	877	93.20	93.20	95.69	93.18	0.00	0.00	6.80	0.00
2021	7869.30	8760	877	100.00	100.00	102.43	100.00	0.00	0.00	0.00	0.00
2022	7319.64	8257	877	94.26	94.26	95.28	94.26	0.00	0.00	5.74	0.00
2023	7828.41	8760	877	99.68	99.68	101.90	100.00	0.00	0.00	0.32	0.00
2024	7376.08	8293	877	94.36	94.36	95.75	94.41	0.00	0.00	5.64	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1975 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					244	
B. Refuelling without maintenance				22		
C. Inspection, maintenance or repair combined with refuelling	491			767		
D. Inspection, maintenance or repair without refuelling				341		
E. Testing of plant systems or components				32		
H. Nuclear regulatory requirements					18	
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					6	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						9
Z. Other					17	
Subtotal	491			1162	285	12
Total	**491**			**1459**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		9
12. Reactor I&C Systems		10
13. Reactor Auxiliary Systems		45
14. Safety Systems		27
15. Reactor Cooling Systems		47
16. Steam generation systems		1
17. Safety I&C Systems (excluding reactor I&C)		2
21. Fuel Handling and Storage Facilities		5
31. Turbine and auxiliaries		45
32. Feedwater and Main Steam System		37
33. Circulating Water System		5
34. Miscellaneous Systems		3
35. All other I&C Systems		1
41. Main Generator Systems		5
42. Electrical Power Supply Systems		23
Total		**265**

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2024 Operating Experience

US-318 CALVERT CLIFFS-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	CE (COMBUSTION ENGINEERING CO.)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / CE 2LP (DRYAMB)
Thermal power	:	2737 MWth
Gross electrical power	:	911 MWe
Reference unit power (net)	:	855 MWe

Key Dates

Construction Date	:	1968-06-01
Grid Date	:	1976-12-07
Commercial Date	:	1977-04-01
Age at end of year	:	48 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	3.45
Active core height/length [m]	:	3.47
Number of fissile fuel assemblies/bundles	:	217
Fuel linear heat generation rate [kW/m]	:	20.56
Number of control rod assemblies	:	37
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

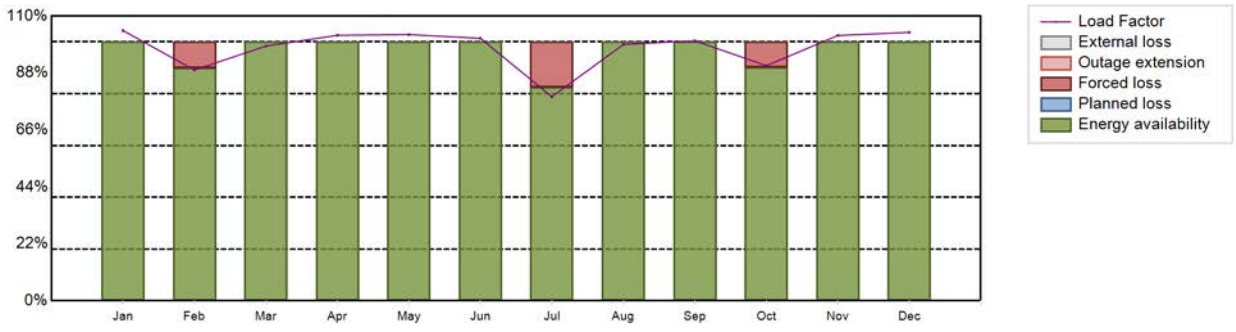
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	314
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.352
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7347.99 GW(e).h
Energy Availability Factor (EAF)	:	96.89 %
Unit Capability Factor (UCF)	:	96.89 %
Load Factor (LF)	:	97.84 %
Operating Factor (OF)	:	96.91 %

Forced Loss Rate (FLR)	:	3.11 %
Unplanned Capability Loss Factor (UCL)	:	3.11 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	271 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	664.03	530.55	625.07	631.30	654.18	624.14	501.45	629.91	618.33	577.70	631.75	659.59	7347.99
EAF [%]	100.00	89.82	100.00	100.00	100.00	100.00	82.55	100.00	100.00	90.20	100.00	100.00	96.89
UCF [%]	100.00	89.82	100.00	100.00	100.00	100.00	82.55	100.00	100.00	90.20	100.00	100.00	96.89
LF [%]	104.39	89.16	98.39	102.55	102.84	101.39	78.83	99.02	100.44	90.82	102.48	103.69	97.84
OF [%]	100.00	89.94	100.00	100.00	100.00	100.00	82.66	100.00	100.00	90.32	100.00	100.00	96.91
FLR [%]	0.00	10.18	0.00	0.00	0.00	0.00	17.45	0.00	0.00	9.80	0.00	0.00	3.11
UCL [%]	0.00	10.18	0.00	0.00	0.00	0.00	17.45	0.00	0.00	9.80	0.00	0.00	3.11
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	302778.13 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.62 %
Cumulative Energy Availability Factor (EAF)	:	86.02 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.32 %
Cumulative Unit Capability Factor (UCF)	:	86.09 %	Cumulative Planned Unavailability Factor (PUF)	:	11.59 %
Cumulative Load Factor (LF)	:	86.15 %	Cumulative Externally cause unavailability (XUF)	:	0.07 %
Cumulative Operating Factor (OF)	:	85.76 %			

Electricity Production (net) [GWh]

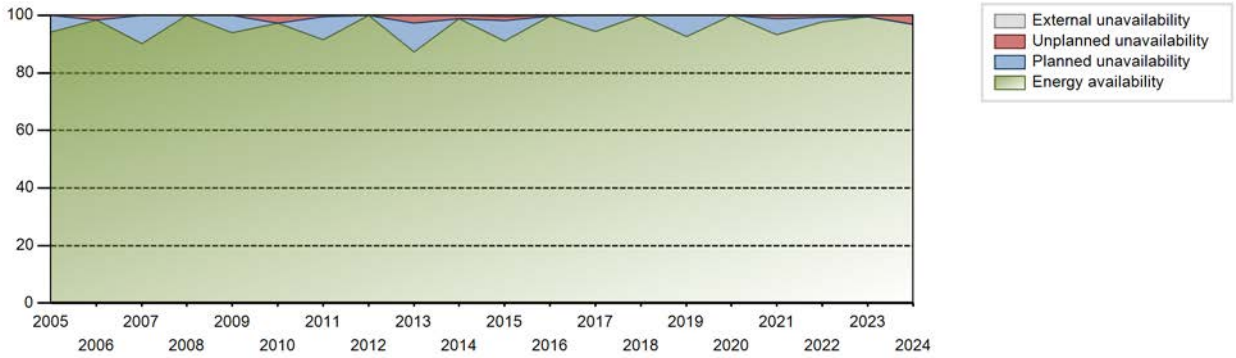


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1977	6009.80	7608	810	100.00	100.00	84.95	86.00	0.00	0.00	0.00	0.00
1978	5226.60	7129	810	72.85	72.85	73.66	81.38	15.43	13.29	13.86	0.00
1979	5489.00	6792	812	76.60	76.60	77.17	77.53	10.07	8.58	14.82	0.00
1980	6412.30	8425	825	96.25	98.88	88.48	95.91	0.73	0.72	0.39	2.63
1981	5416.00	7005	825	80.08	80.08	74.94	79.97	5.48	4.65	15.27	0.00
1982	5005.20	6496	825	74.21	74.21	69.26	74.16	5.97	4.71	21.08	0.00
1983	6113.10	7567	825	86.39	86.39	84.59	86.38	7.89	7.40	6.21	0.00
1984	5338.45	6502	825	73.68	73.68	73.67	74.02	7.99	6.39	19.93	0.00
1985	5608.05	6789	825	77.41	77.41	77.60	77.50	5.72	4.70	17.89	0.00
1986	7006.67	8405	825	95.98	95.98	96.95	95.95	4.02	4.02	0.00	0.00
1987	4831.98	5859	825	66.35	66.35	66.86	66.88	4.10	2.84	30.81	0.00
1988	6602.69	7813	825	88.78	88.78	91.11	88.95	1.73	1.56	9.66	0.00
1989	1448.46	1731	825	18.32	18.32	20.04	19.76	12.14	2.53	79.15	0.00
1990	0.00	0	825	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1991	3635.58	4515	825	51.29	51.29	50.31	51.54	9.70	5.51	43.21	0.00
1992	6590.28	7855	825	89.30	89.30	90.94	89.42	10.70	10.70	0.00	0.00
1993	4975.19	5939	827	67.36	67.36	68.63	67.80	0.99	0.67	31.97	0.00
1994	6576.52	7925	835	90.56	90.56	89.82	90.47	7.88	7.74	1.70	0.00
1995	5911.11	7121	840	81.36	81.36	80.33	81.29	2.52	2.10	16.54	0.00
1996	7247.74	8561	840	97.50	97.50	98.23	97.46	2.50	2.50	0.00	0.00
1997	5979.88	7100	840	81.10	81.10	81.27	81.05	0.00	0.00	18.90	0.00
1998	7225.49	8393	840	95.83	95.83	98.19	95.81	4.17	4.17	0.00	0.00
1999	6332.72	7400	840	84.50	84.50	86.06	84.47	0.00	0.00	15.50	0.00
2000	7391.04	8614	835	98.05	98.05	100.72	98.06	0.00	0.00	1.95	0.00
2001	6201.52	7297	835	83.28	83.28	84.78	83.30	0.76	0.64	16.09	0.00
2002	7480.55	8760	835	100.00	100.00	102.27	100.00	0.00	0.00	0.00	0.00
2003	6156.86	7124	835	81.37	81.37	84.17	81.32	0.44	0.36	18.27	0.00
2004	7552.20	8729	858	99.37	99.37	101.33	99.37	0.63	0.63	0.00	0.00
2005	7114.31	8249	858	94.18	94.18	94.64	94.16	0.00	0.00	5.82	0.00
2006	7406.34	8621	862	98.43	98.43	98.08	98.41	1.57	1.57	0.00	0.00
2007	6807.83	7902	862	90.22	90.22	90.16	90.21	0.00	0.00	9.78	0.00
2008	7514.73	8784	862	100.00	100.00	99.25	100.00	0.00	0.00	0.00	0.00
2009	7021.55	8227	862	93.93	93.93	92.99	93.92	0.00	0.00	6.07	0.00
2010	7238.91	8528	850	97.32	97.32	97.22	97.35	2.68	2.68	0.00	0.00
2011	6787.88	8005	850	91.41	91.41	91.16	91.38	0.55	0.51	8.08	0.00
2012	7506.54	8784	850	100.00	100.00	100.54	100.00	0.00	0.00	0.00	0.00
2013	6486.75	7652	850	87.35	87.35	87.11	87.34	3.02	2.72	9.93	0.00

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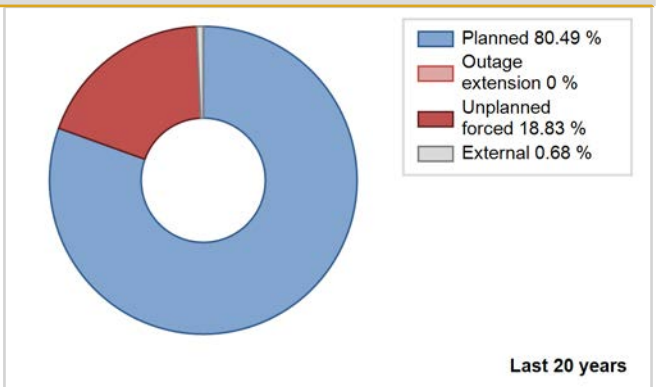
2014	7422.54	8662	850	98.88	98.88	99.68	98.88	1.12	1.12	0.00	0.00
2015	6877.67	7969	850	90.98	91.55	92.37	90.97	1.46	1.36	7.10	0.57
2016	7574.55	8753	850	99.64	99.64	101.45	99.65	0.36	0.36	0.00	0.00
2017	7278.30	8257	855	94.28	94.28	97.36	94.26	0.00	0.00	5.72	0.00
2018	7698.56	8760	855	100.00	100.00	102.79	100.00	0.00	0.00	0.00	0.00
2019	7099.58	8107	855	92.56	92.56	94.79	92.55	0.00	0.00	7.44	0.00
2020	7709.21	8783	855	100.00	100.00	102.65	99.99	0.00	0.00	0.00	0.00
2021	7035.82	8178	855	93.35	93.35	93.94	93.36	1.10	1.04	5.61	0.00
2022	7472.48	8554	855	97.65	97.65	99.77	97.65	0.73	0.72	1.63	0.00
2023	7155.35	8189	855	99.45	99.45	95.53	93.48	0.55	0.55	0.00	0.00
2024	7347.99	8513	855	96.89	96.89	97.84	96.91	3.11	3.11	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1977 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		272			185	
B. Refuelling without maintenance				10		
C. Inspection, maintenance or repair combined with refuelling				928		
D. Inspection, maintenance or repair without refuelling				60		
E. Testing of plant systems or components				7	1	
H. Nuclear regulatory requirements					6	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					12	
Z. Other					2	
Subtotal		272		1005	206	1
Total		**272**			**1212**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1977 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		13
13. Reactor Auxiliary Systems		18
14. Safety Systems		1
15. Reactor Cooling Systems		56
16. Steam generation systems		7
31. Turbine and auxiliaries	199	23
32. Feedwater and Main Steam System		30
34. Miscellaneous Systems		0
35. All other I&C Systems		2
41. Main Generator Systems	72	12
42. Electrical Power Supply Systems		25
Total	**271**	**191**

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2024 Operating Experience

US-413 CATAWBA-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	DUKEENER (Duke Energy Corp.)
Owner	:	NCEMCO (North Carolina Electric Membership Corp.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (ICECND)
Thermal power	:	3411 MWth
Gross electrical power	:	1188 MWe
Reference unit power (net)	:	1160 MWe

Key Dates

Construction Date	:	1974-05-01
Grid Date	:	1985-01-22
Commercial Date	:	1985-06-29
Age at end of year	:	39 years

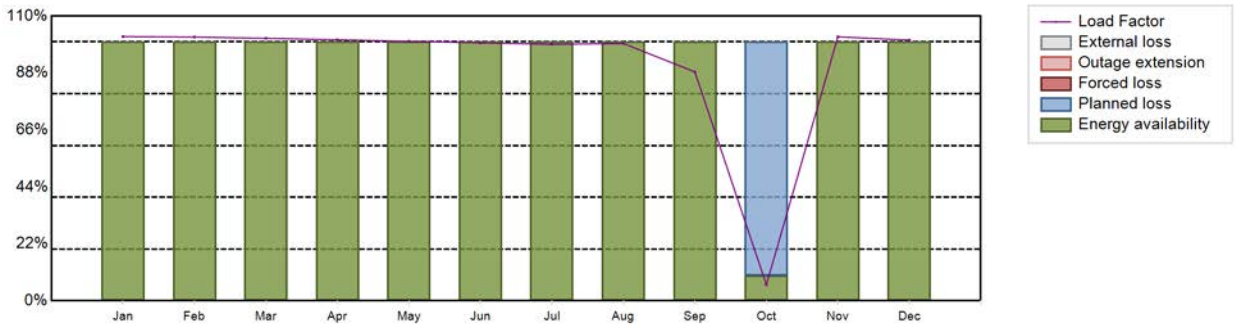
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	325
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.204
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	39	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	40200	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.83
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	18.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	25	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9343.38 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	92.35 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	92.35 %	Planned Unavailability Factor (PUF)	:	7.65 %
Load Factor (LF)	:	91.7 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	92.35 %	Total off-line time	:	672 hours

Annual Summary



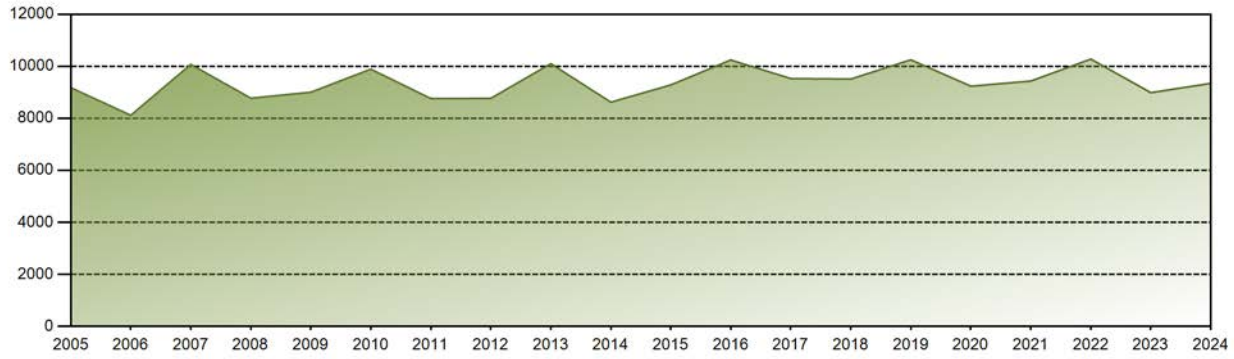
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	880.89	822.49	873.91	841.99	865.17	832.20	855.07	857.80	738.48	53.61	852.77	869.00	9343.38
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	9.68	100.00	100.00	92.35
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	9.68	100.00	100.00	92.35
LF [%]	102.07	101.87	101.40	100.81	100.25	99.64	99.08	99.39	88.42	6.21	101.96	100.69	91.70
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	9.68	100.00	100.00	92.35
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	90.32	0.00	0.00	7.65
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	344152.85 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.87 %
Cumulative Energy Availability Factor (EAF)	:	87.75 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.59 %
Cumulative Unit Capability Factor (UCF)	:	87.75 %	Cumulative Planned Unavailability Factor (PUF)	:	9.65 %
Cumulative Load Factor (LF)	:	87.34 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	87.67 %			

Electricity Production (net) [GWh]

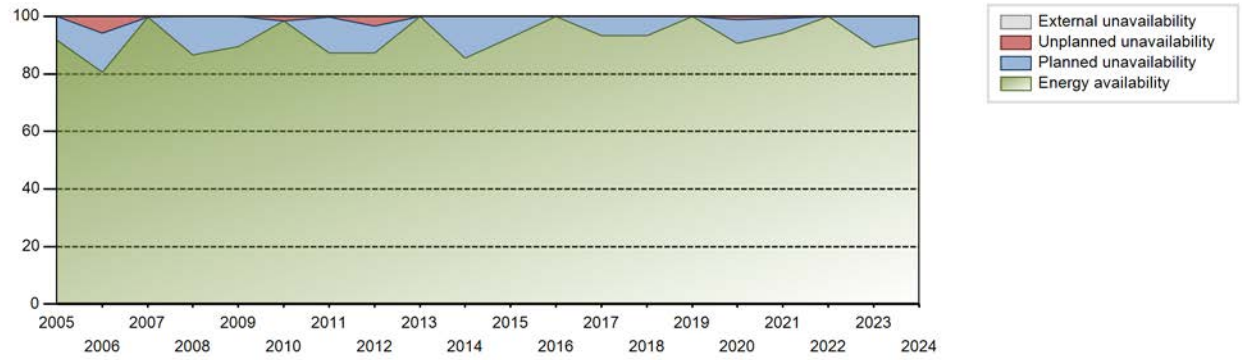


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	3440.51	3513	1138	78.55	78.55	66.98	78.45	21.45	21.45	0.00	0.00
1986	5199.12	5151	1145	58.88	58.88	51.83	58.80	18.75	13.59	27.53	0.00
1987	6405.97	5924	1145	68.00	68.00	63.87	67.63	15.46	12.43	19.57	0.00
1988	7639.97	7003	1129	79.75	79.75	77.04	79.72	8.32	7.24	13.00	0.00
1989	7775.42	7278	1129	84.67	84.67	78.62	83.08	4.00	3.52	11.81	0.00
1990	6900.50	6277	1129	71.67	71.67	69.77	71.66	9.05	7.13	21.20	0.00
1991	6681.05	6227	1129	71.11	71.11	67.55	71.08	4.10	3.04	25.86	0.00
1992	7050.94	6338	1129	72.14	72.14	71.10	72.15	7.46	5.82	22.04	0.00
1993	7597.13	6916	1129	78.97	78.97	76.82	78.95	4.65	3.85	17.18	0.00
1994	9778.83	8722	1129	99.58	99.58	98.88	99.57	0.41	0.41	0.01	0.00
1995	8721.63	7712	1129	88.07	88.07	88.19	88.04	0.53	0.47	11.46	0.00
1996	6341.10	5806	1129	66.17	66.17	63.94	66.10	4.16	2.87	30.97	0.00
1997	9192.55	7966	1129	90.68	90.68	92.95	90.94	0.00	0.00	9.32	0.00
1998	8903.65	7923	1129	90.47	90.47	90.03	90.45	8.31	8.20	1.34	0.00
1999	9073.74	7987	1129	91.20	91.20	91.75	91.18	0.00	0.00	8.80	0.00
2000	8923.00	7844	1129	89.32	89.32	89.98	89.30	0.45	0.41	10.28	0.00
2001	9976.97	8722	1129	99.57	99.57	100.88	99.57	0.43	0.43	0.00	0.00
2002	9481.61	8250	1129	94.20	94.20	95.87	94.18	0.00	0.00	5.80	0.00
2003	8198.52	7157	1129	81.72	81.72	82.90	81.70	8.02	7.12	11.15	0.00
2004	9711.07	8608	1129	98.01	98.01	97.92	98.00	1.98	1.98	0.02	0.00
2005	9177.33	8027	1129	91.66	91.66	92.78	91.62	0.00	0.00	8.34	0.00
2006	8114.96	7066	1129	80.68	80.68	82.05	80.66	6.75	5.84	13.47	0.00
2007	10070.89	8728	1129	99.65	99.65	101.83	99.63	0.35	0.35	0.00	0.00
2008	8773.30	7610	1129	86.64	86.64	88.47	86.63	0.00	0.00	13.36	0.00
2009	9002.04	7834	1129	89.45	89.45	91.02	89.43	0.00	0.00	10.55	0.00
2010	9889.07	8629	1129	98.51	98.51	99.99	98.50	1.49	1.49	0.00	0.00
2011	8758.04	7630	1146	87.23	87.23	87.78	87.10	0.32	0.28	12.49	0.00
2012	8767.33	7657	1146	87.19	87.19	87.09	87.17	3.73	3.38	9.43	0.00
2013	10100.41	8760	1146	100.00	100.00	100.60	99.99	0.00	0.00	0.00	0.00
2014	8619.61	7493	1146	85.54	85.54	85.86	85.54	0.00	0.00	14.46	0.00
2015	9283.45	8104	1146	92.52	92.52	92.47	92.51	0.11	0.10	7.38	0.00
2016	10242.36	8784	1146	100.00	100.00	101.75	100.00	0.00	0.00	0.00	0.00
2017	9529.31	8179	1146	93.36	93.36	94.92	93.37	0.00	0.00	6.64	0.00
2018	9510.49	8171	1160	93.28	93.28	93.59	93.28	0.00	0.00	6.72	0.00
2019	10249.75	8760	1160	100.00	100.00	100.87	100.00	0.00	0.00	0.00	0.00
2020	9235.52	7955	1160	90.58	90.58	90.64	90.56	1.28	1.17	8.25	0.00
2021	9433.23	8241	1160	94.08	94.08	92.83	94.08	0.81	0.77	5.15	0.00

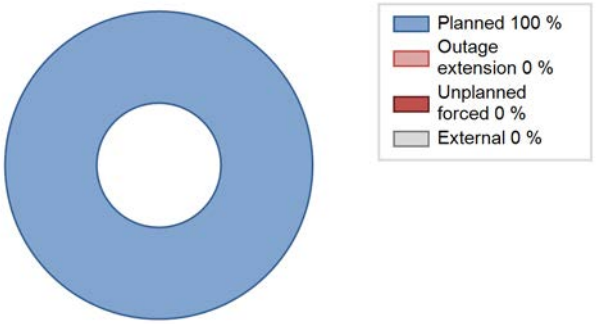
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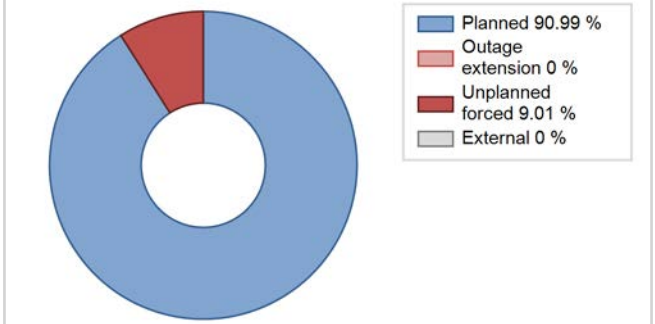
2022	10277.59	8760	1160	100.00	100.00	101.14	100.00	0.00	0.00	0.00	0.00
2023	8988.09	7820	1160	89.23	89.23	88.45	89.27	0.01	0.01	10.76	0.00
2024	9343.38	8112	1160	92.35	92.35	91.70	92.35	0.00	0.00	7.65	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					208	
B. Refuelling without maintenance				30		
C. Inspection, maintenance or repair combined with refuelling	672			777		
D. Inspection, maintenance or repair without refuelling				36		
E. Testing of plant systems or components				2	3	
H. Nuclear regulatory requirements					4	
L. Human factor related					4	
Z. Other				2	8	
Subtotal	672			847	227	
Total	**672**			**1074**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		23
13. Reactor Auxiliary Systems		9
14. Safety Systems		15
15. Reactor Cooling Systems		77
16. Steam generation systems		2
31. Turbine and auxiliaries		9
32. Feedwater and Main Steam System		37
33. Circulating Water System		8
34. Miscellaneous Systems		6
41. Main Generator Systems		10
42. Electrical Power Supply Systems		19
Total		**219**

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2024 Operating Experience

US-414 CATAWBA-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	DUKEENER (Duke Energy Corp.)
Owner	:	NCMPA1 (North Carolina Municipal Power Agency No.1)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (ICECND)
Thermal power	:	3411 MWth
Gross electrical power	:	1188 MWe
Reference unit power (net)	:	1150 MWe

Key Dates

Construction Date	:	1974-05-01
Grid Date	:	1986-05-18
Commercial Date	:	1986-08-19
Age at end of year	:	38 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	46
Average discharge burnup [MWd/t]	:	40200
Active core diameter [m]	:	3.4
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	18.3
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

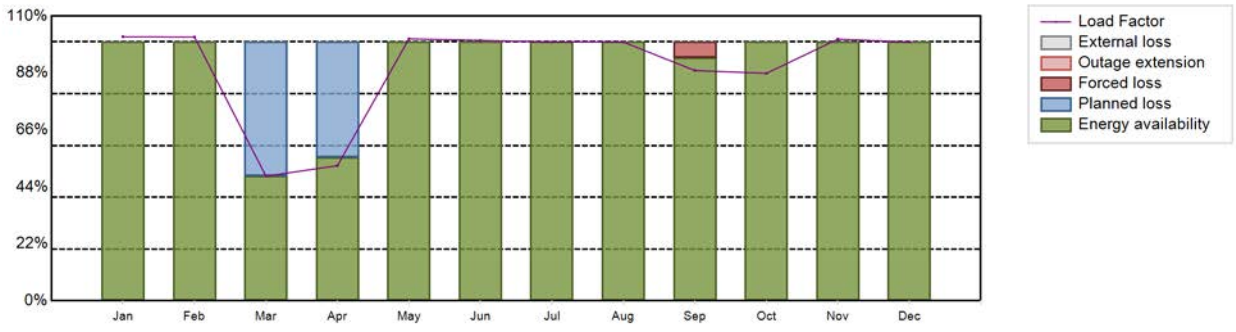
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	326
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.204
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.83
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9122.21 GW(e).h
Energy Availability Factor (EAF)	:	91.49 %
Unit Capability Factor (UCF)	:	91.49 %
Load Factor (LF)	:	90.3 %
Operating Factor (OF)	:	91.48 %

Forced Loss Rate (FLR)	:	0.54 %
Unplanned Capability Loss Factor (UCL)	:	0.5 %
Planned Unavailability Factor (PUF)	:	8.02 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	748 hours

Annual Summary



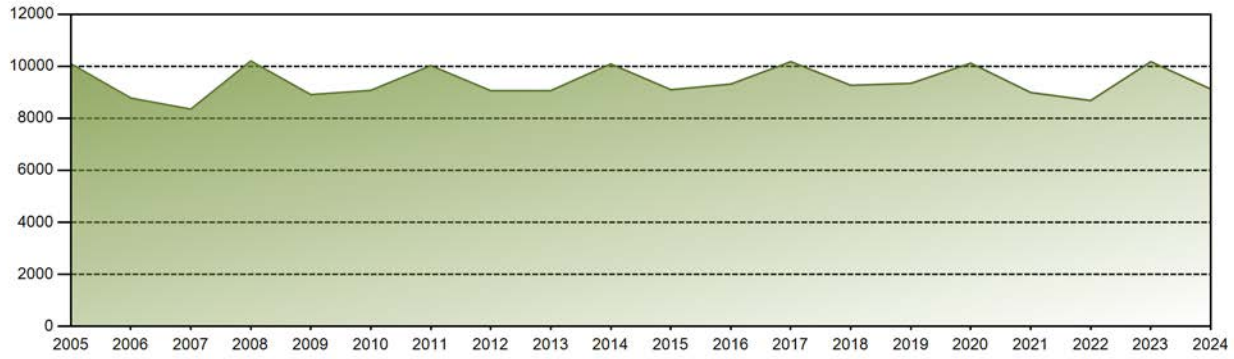
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	872.60	815.38	411.39	432.42	865.79	832.94	855.32	855.08	736.50	751.78	837.91	855.11	9122.21
EAF [%]	100.00	100.00	48.31	55.51	100.00	100.00	100.00	100.00	93.94	100.00	100.00	100.00	91.49
UCF [%]	100.00	100.00	48.31	55.51	100.00	100.00	100.00	100.00	93.94	100.00	100.00	100.00	91.49
LF [%]	101.99	101.87	48.15	52.23	101.19	100.60	99.97	99.94	88.95	87.87	101.06	99.94	90.30
OF [%]	100.00	100.00	48.86	55.00	100.00	100.00	100.00	100.00	93.89	100.00	100.00	100.00	91.48
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.06	0.00	0.00	0.00	0.54
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.06	0.00	0.00	0.00	0.50
PUF [%]	0.00	0.00	51.69	44.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.02
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	337100.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.34 %
Cumulative Energy Availability Factor (EAF)	:	88.5 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.06 %
Cumulative Unit Capability Factor (UCF)	:	88.5 %	Cumulative Planned Unavailability Factor (PUF)	:	8.44 %
Cumulative Load Factor (LF)	:	88.06 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	88.21 %			

Electricity Production (net) [GWh]

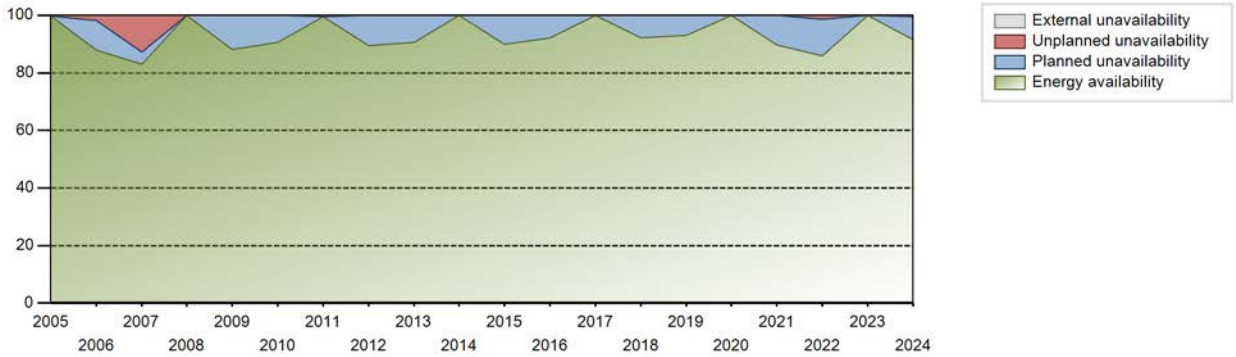


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	1324.22	1325	1135	35.55	35.55	29.10	34.59	64.45	64.45	0.00	0.00
1987	7169.49	7014	1145	80.16	80.16	71.48	80.07	18.04	17.64	2.19	0.00
1988	5434.95	5571	1129	71.80	71.80	54.80	63.42	11.82	9.62	18.58	0.00
1989	6527.10	6302	1129	71.97	71.97	66.00	71.94	4.01	3.00	25.03	0.00
1990	6502.99	5984	1129	69.00	69.00	65.75	68.31	0.59	0.41	30.59	0.00
1991	7274.89	6621	1129	75.59	75.59	73.56	75.58	6.64	5.38	19.03	0.00
1992	9273.46	8281	1129	94.29	94.29	93.51	94.27	1.62	1.55	4.17	0.00
1993	8177.41	7233	1129	82.57	82.57	82.68	82.57	0.60	0.50	16.93	0.00
1994	7691.73	6978	1129	79.75	79.75	77.77	79.66	2.70	2.21	18.04	0.00
1995	7960.18	7074	1129	80.83	80.83	80.49	80.75	9.08	8.07	11.10	0.00
1996	9233.63	8107	1129	92.33	92.33	93.11	92.29	7.67	7.67	0.00	0.00
1997	8593.36	7623	1129	87.09	87.09	86.89	87.02	1.47	1.30	11.61	0.00
1998	8672.30	7580	1129	86.55	86.55	87.69	86.53	2.16	1.91	11.54	0.00
1999	8855.38	7727	1129	88.23	88.23	89.54	88.21	11.77	11.77	0.00	0.00
2000	8981.37	7928	1129	90.29	90.29	90.56	90.26	2.00	1.85	7.86	0.00
2001	8574.14	7507	1129	85.72	85.72	86.69	85.70	5.44	4.93	9.35	0.00
2002	10172.30	8760	1129	100.00	100.00	102.85	100.00	0.00	0.00	0.00	0.00
2003	9318.16	8117	1129	92.66	92.66	94.22	92.66	0.14	0.13	7.21	0.00
2004	8835.74	7672	1129	87.36	87.36	89.10	87.34	0.81	0.71	11.93	0.00
2005	10099.11	8737	1129	99.74	99.74	102.10	99.73	0.26	0.26	0.00	0.00
2006	8779.22	7696	1129	87.88	87.88	88.77	87.85	2.00	1.80	10.32	0.00
2007	8351.56	7262	1129	82.92	82.92	84.44	82.90	13.33	12.75	4.33	0.00
2008	10203.16	8784	1129	100.00	100.00	102.88	100.00	0.00	0.00	0.00	0.00
2009	8910.22	7727	1129	88.22	88.22	90.09	88.21	0.00	0.00	11.78	0.00
2010	9075.00	7934	1129	90.58	90.58	91.76	90.57	0.00	0.00	9.42	0.00
2011	10025.54	8716	1129	99.50	99.50	101.37	99.50	0.50	0.50	0.00	0.00
2012	9061.97	7849	1146	89.49	89.49	90.35	89.36	0.00	0.00	10.51	0.00
2013	9065.55	7942	1146	90.67	90.67	90.29	90.65	0.00	0.00	9.33	0.00
2014	10091.90	8760	1146	100.00	100.00	100.53	100.00	0.00	0.00	0.00	0.00
2015	9100.43	7886	1146	90.01	90.01	90.65	90.02	0.00	0.00	9.99	0.00
2016	9315.90	8090	1146	92.10	92.10	92.54	92.10	0.00	0.00	7.90	0.00
2017	10177.38	8760	1150	100.00	100.00	101.03	100.00	0.00	0.00	0.00	0.00
2018	9269.23	8080	1150	92.23	92.23	92.01	92.24	0.00	0.00	7.77	0.00
2019	9343.86	8155	1150	93.10	93.10	92.75	93.09	0.00	0.00	6.90	0.00
2020	10121.15	8783	1150	100.00	100.00	100.19	99.99	0.00	0.00	0.00	0.00
2021	8989.38	7864	1150	89.77	89.77	89.23	89.77	0.00	0.00	10.23	0.00
2022	8685.27	7526	1150	85.92	85.92	86.21	85.91	1.59	1.39	12.69	0.00

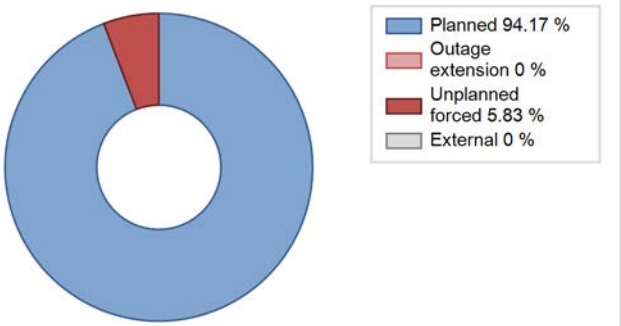
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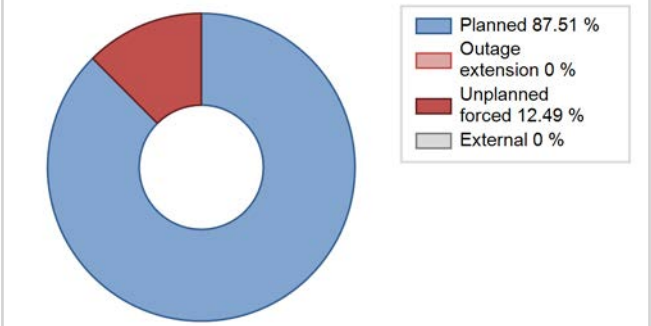
2023	10177.43	8760	1150	99.99	99.99	101.03	100.00	0.00	0.00	0.01	0.00
2024	9122.21	8036	1150	91.49	91.49	90.30	91.48	0.54	0.50	8.02	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		44			254	
B. Refuelling without maintenance				52		
C. Inspection, maintenance or repair combined with refuelling	704			641		
D. Inspection, maintenance or repair without refuelling				46		
E. Testing of plant systems or components				2	3	
H. Nuclear regulatory requirements					4	
L. Human factor related					1	
Z. Other				0	6	
Subtotal	704	44		741	268	
Total	**748**			**1009**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		2
13. Reactor Auxiliary Systems		21
14. Safety Systems		5
15. Reactor Cooling Systems		21
16. Steam generation systems		3
17. Safety I&C Systems (excluding reactor I&C)		9
31. Turbine and auxiliaries	44	40
32. Feedwater and Main Steam System		58
33. Circulating Water System		0
34. Miscellaneous Systems		1
41. Main Generator Systems		75
42. Electrical Power Supply Systems		23
Total	**44**	**262**

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2024 Operating Experience

US-461 CLINTON-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-6 (Mark 3)
Thermal power	:	3473 MWth
Gross electrical power	:	1098 MWe
Reference unit power (net)	:	1062 MWe

Key Dates

Construction Date	:	1975-10-01
Grid Date	:	1987-04-24
Commercial Date	:	1987-11-24
Age at end of year	:	37 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	45
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	4.3
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	624
Fuel linear heat generation rate [kW/m]	:	18.85
Number of control rod assemblies	:	145
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

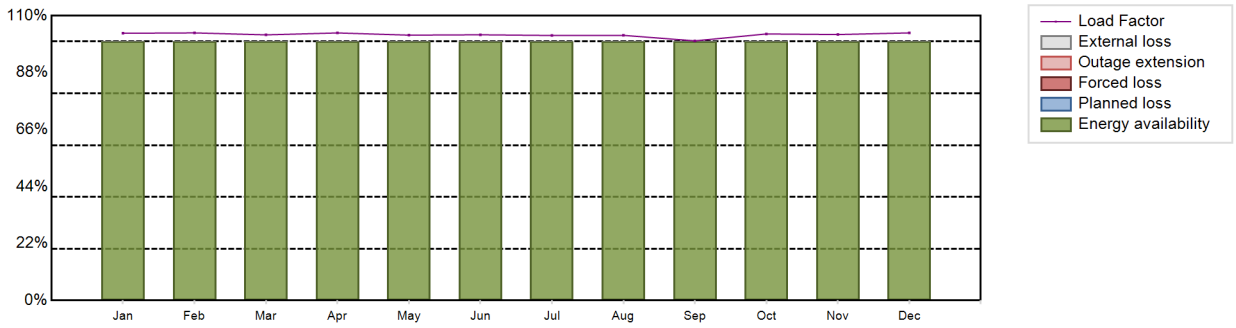
Operating coolant pressure [MPa]	:	7.3
Reactor outlet temperature [°C]	:	288.3
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.10
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.66
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Pond (closed-cycle)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	102.65 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	815.58	763.95	809.61	790.20	809.78	784.74	808.82	809.17	766.84	813.47	786.57	816.64	9575.38
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	103.22	103.36	102.60	103.34	102.49	102.63	102.37	102.41	100.29	102.95	102.73	103.36	102.65
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.57 %
Cumulative Energy Availability Factor (EAF)	:	83.46 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.1 %
Cumulative Unit Capability Factor (UCF)	:	83.51 %	Cumulative Planned Unavailability Factor (PUF)	:	13.4 %
Cumulative Load Factor (LF)	:	81.63 %	Cumulative Externally cause unavailability (XUF)	:	0.04 %
Cumulative Operating Factor (OF)	:	82.63 %			

Electricity Production (net) [GWh]

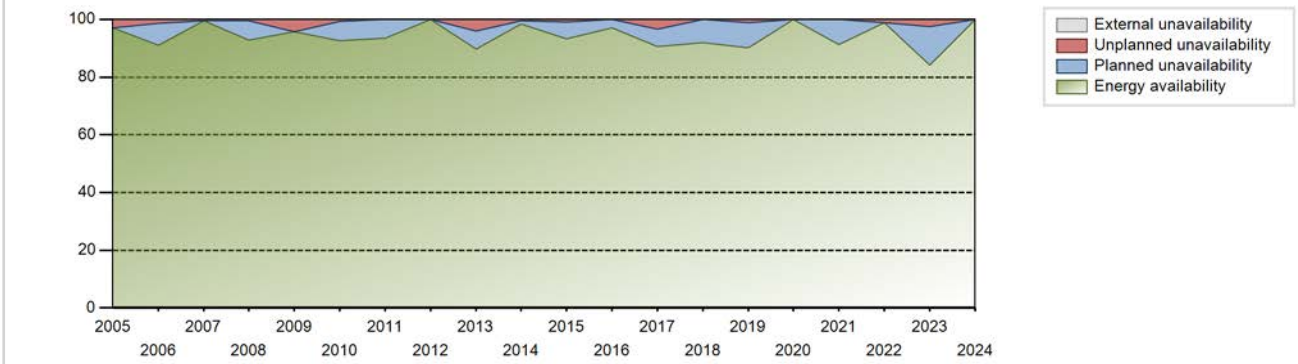


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	1628.83	3264	932	100.00	100.00	80.98	100.00	0.00	0.00	0.00	0.00
1988	5860.74	7244	930	82.50	82.50	71.73	82.46	6.52	5.75	11.75	0.00
1989	2861.90	3947	931	45.13	45.13	35.08	45.06	31.57	20.83	34.04	0.00
1990	3596.62	4604	930	52.57	52.57	44.15	52.56	19.21	12.50	34.93	0.00
1991	6048.01	6927	930	79.10	79.10	74.24	79.08	3.02	2.47	18.44	0.00
1992	4935.26	5824	930	66.31	66.31	60.41	66.30	31.03	29.84	3.85	0.00
1993	5879.18	6750	930	77.05	77.10	72.17	77.05	3.64	2.91	19.99	0.05
1994	7410.34	8217	930	93.85	93.85	90.96	93.80	0.18	0.17	5.98	0.00
1995	6109.18	7140	930	81.60	81.60	74.99	81.51	3.05	2.57	15.83	0.00
1996	5312.93	5833	930	66.46	66.46	65.02	66.40	14.96	11.69	21.85	0.00
1997	0.00	0	930	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1998	0.00	0	930	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1999	4704.21	5270	930	60.17	60.17	57.74	60.16	0.00	0.00	39.83	0.00
2000	6888.84	7542	930	85.89	85.89	84.33	85.86	3.31	2.94	11.16	0.00
2001	7877.25	8565	930	97.80	97.80	96.69	97.77	1.53	1.52	0.69	0.00
2002	7657.46	7805	1022	89.77	89.77	88.84	89.10	1.35	1.22	9.00	0.00
2003	8700.78	8634	1022	98.62	98.62	97.19	98.56	0.76	0.75	0.63	0.00
2004	8000.42	7911	1022	90.04	91.50	89.12	90.06	1.94	1.81	6.69	1.46
2005	8688.67	8497	1026	97.01	97.01	96.66	96.99	2.99	2.99	0.00	0.00
2006	8233.30	7974	1052	91.06	91.06	89.34	91.03	1.44	1.33	7.60	0.00
2007	9250.44	8714	1043	99.48	99.48	101.25	99.47	0.52	0.52	0.00	0.00
2008	8546.55	8160	1043	92.90	92.90	93.29	92.90	0.40	0.37	6.72	0.00
2009	8887.91	8390	1043	95.80	95.80	97.28	95.78	4.20	4.20	0.00	0.00
2010	8612.00	8089	1065	92.51	92.51	92.31	92.34	0.77	0.72	6.76	0.00
2011	8671.47	8184	1065	93.45	93.45	92.95	93.42	0.00	0.00	6.55	0.00
2012	9373.73	8784	1065	100.00	100.00	100.20	100.00	0.00	0.00	0.00	0.00
2013	8323.86	7861	1065	89.74	89.74	89.21	89.73	4.21	3.95	6.32	0.00
2014	9098.05	8615	1065	98.34	98.34	97.52	98.34	0.47	0.47	1.19	0.00
2015	8084.74	8167	1065	93.24	93.24	86.66	93.23	1.04	0.98	5.78	0.00
2016	8915.50	8520	1065	96.99	96.99	95.30	96.99	0.00	0.00	3.01	0.00
2017	8357.89	7934	1062	90.55	90.55	89.84	90.57	3.62	3.40	6.05	0.00
2018	8398.48	8027	1062	91.95	91.95	90.28	91.63	0.00	0.00	8.05	0.00
2019	8388.42	7899	1062	90.19	90.19	90.17	90.17	1.32	1.21	8.61	0.00
2020	9462.48	8783	1062	100.00	100.00	101.44	99.99	0.00	0.00	0.00	0.00
2021	8286.14	7998	1062	91.30	91.30	89.07	91.30	0.00	0.00	8.70	0.00
2022	9224.08	8665	1062	98.92	98.92	99.15	98.92	1.08	1.08	0.00	0.00
2023	8050.49	7645	1062	84.04	84.04	86.54	87.27	2.75	2.47	13.49	0.00

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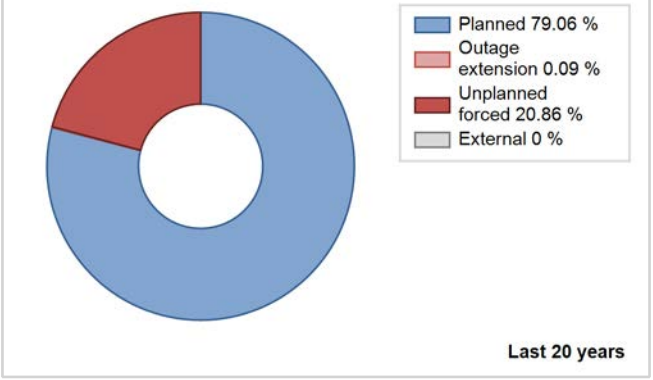
2024	Data not provided

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1987 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					234	
B. Refuelling without maintenance				21		
C. Inspection, maintenance or repair combined with refuelling				1091		
D. Inspection, maintenance or repair without refuelling				130		
E. Testing of plant systems or components				2		
H. Nuclear regulatory requirements					8	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L. Human factor related					11	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						3
Z. Other					32	
Subtotal				1244	285	3
Total		**0**			**1532**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		8
12. Reactor I&C Systems		16
14. Safety Systems		8
15. Reactor Cooling Systems		54
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		29
32. Feedwater and Main Steam System		84
34. Miscellaneous Systems		3
41. Main Generator Systems		11
42. Electrical Power Supply Systems		27
Total		**241**

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2024 Operating Experience

US-397 COLUMBIA — UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	ENERGYNW (Energy Northwest)
Owner	:	ENERGYNW (Energy Northwest)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-5 (Mark 2)
Thermal power	:	3486 MWth
Gross electrical power	:	1190 MWe
Reference unit power (net)	:	1131 MWe

Key Dates

Construction Date	:	1972-08-01
Grid Date	:	1984-05-27
Commercial Date	:	1984-12-13
Age at end of year	:	40 years

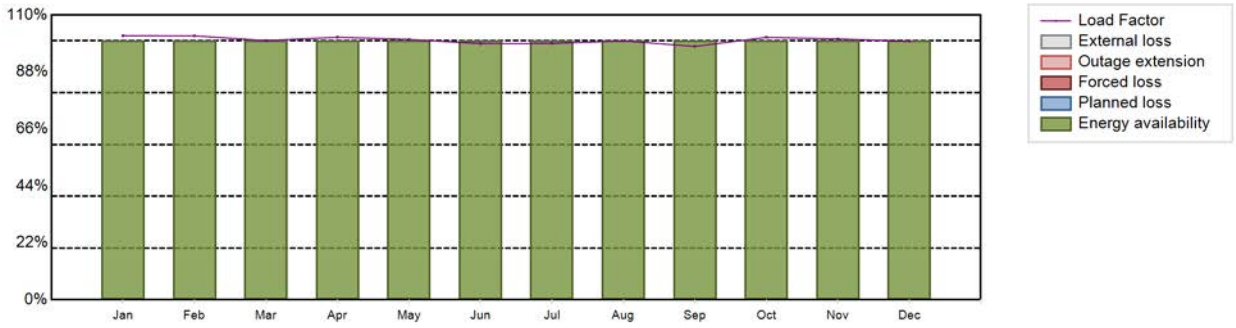
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.17
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	287
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.316
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	20	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	42000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.75	HP cylinder inlet steam pressure [MPa]	:	6.82
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	764	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	43	Number of main condensate pumps	:	-
Number of control rod assemblies	:	185	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	100.33 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	858.42	802.50	841.43	825.82	846.37	805.76	833.13	841.57	797.04	853.09	821.62	840.39	9967.14
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	102.02	101.95	100.13	101.41	100.58	98.95	99.01	100.01	97.88	101.38	100.76	99.87	100.33
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.56 %
Cumulative Energy Availability Factor (EAF)	:	82.7 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.97 %
Cumulative Unit Capability Factor (UCF)	:	83.2 %	Cumulative Planned Unavailability Factor (PUF)	:	12.82 %
Cumulative Load Factor (LF)	:	78.39 %	Cumulative Externally cause unavailability (XUF)	:	0.5 %
Cumulative Operating Factor (OF)	:	82.58 %			

Electricity Production (net) [GWh]

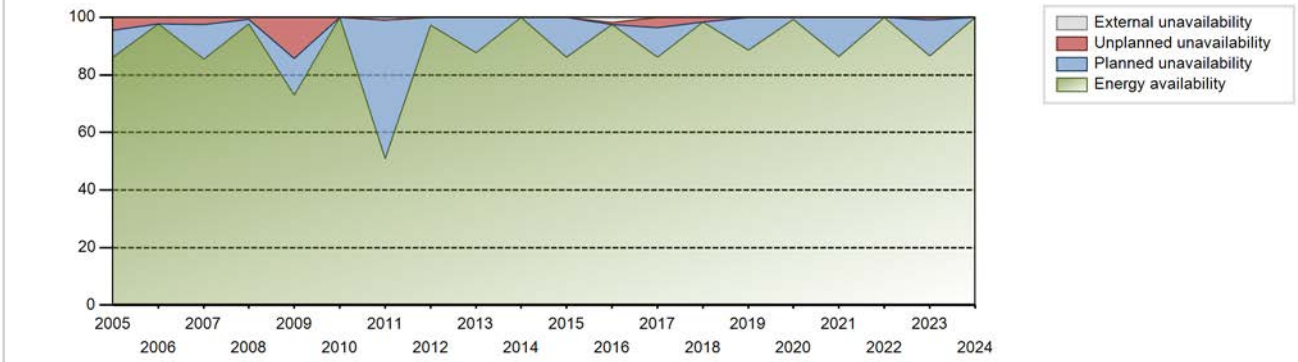


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	1458.42	2393	1104	90.49	90.49	84.56	90.68	9.51	9.51	0.00	0.00
1985	5176.39	6624	1100	77.10	77.10	53.70	75.62	8.28	6.96	15.94	0.00
1986	5183.20	6133	1095	74.11	74.11	54.04	70.01	4.33	3.35	22.54	0.00
1987	5397.98	5979	1095	67.93	67.93	56.27	68.25	8.83	6.58	25.49	0.00
1988	6000.36	6020	1095	68.24	68.24	62.38	68.53	15.00	12.04	19.72	0.00
1989	6127.94	6680	1095	76.05	76.05	63.88	76.26	4.41	3.51	20.43	0.00
1990	5791.26	5752	1095	65.31	65.31	60.37	65.66	6.68	4.67	30.02	0.00
1991	4272.55	4194	1090	47.10	47.10	44.75	47.88	42.75	35.16	17.74	0.00
1992	5705.42	5505	1085	61.96	61.96	59.86	62.67	15.37	11.26	26.78	0.00
1993	7141.96	6757	1107	77.16	77.16	73.61	77.13	8.30	6.98	15.86	0.00
1994	6753.81	6500	1086	73.73	73.73	70.99	74.20	1.32	0.99	25.29	0.00
1995	6947.98	6680	1091	75.98	75.98	72.67	76.26	5.02	4.02	20.01	0.00
1996	5562.63	5999	1106	68.30	79.66	57.24	68.29	1.73	1.40	18.94	11.36
1997	6129.89	6248	1107	71.35	77.36	63.21	71.32	0.21	0.16	22.48	6.02
1998	6922.83	6373	1107	72.78	72.78	71.39	72.75	13.97	11.82	15.40	0.00
1999	6099.69	6018	1107	68.51	68.51	62.90	68.70	0.00	0.00	31.49	0.00
2000	8605.23	8385	1107	95.41	95.41	88.50	95.46	3.21	3.16	1.43	0.00
2001	8257.71	7553	1107	86.14	86.14	85.15	86.22	2.28	2.01	11.85	0.00
2002	8981.29	8528	1107	97.35	97.35	92.62	97.35	2.65	2.65	0.00	0.00
2003	7614.87	7039	1107	80.39	80.39	78.53	80.35	6.92	5.98	13.63	0.00
2004	8981.58	8222	1107	93.61	93.61	92.37	93.60	6.39	6.39	0.00	0.00
2005	8242.27	7537	1108	86.05	86.05	84.91	86.03	4.92	4.45	9.50	0.00
2006	9328.28	8568	1131	97.82	97.82	94.15	97.81	2.18	2.18	0.00	0.00
2007	8108.56	7481	1131	85.43	85.43	81.84	85.40	2.86	2.52	12.05	0.00
2008	9269.64	8592	1131	97.83	97.83	93.31	97.81	0.71	0.70	1.47	0.00
2009	6634.01	6382	1131	72.93	72.93	66.96	72.85	16.39	14.30	12.77	0.00
2010	9241.13	8760	1131	100.00	100.00	93.27	100.00	0.00	0.00	0.00	0.00
2011	4806.28	4466	1131	51.01	51.96	48.51	50.98	0.00	0.00	48.04	0.95
2012	9333.71	8545	1107	97.28	97.28	95.99	97.28	0.00	0.00	2.72	0.00
2013	8460.89	7678	1107	87.65	87.65	87.24	87.64	0.00	0.00	12.35	0.00
2014	9497.32	8760	1107	100.00	100.00	97.94	100.00	0.00	0.00	0.00	0.00
2015	8160.91	7550	1107	86.19	86.19	84.16	86.19	0.00	0.00	13.81	0.00
2016	9625.62	8565	1107	97.51	99.28	98.99	97.51	0.72	0.72	0.00	1.78
2017	8128.26	7548	1116	86.22	86.22	83.48	86.16	3.93	3.53	10.25	0.00
2018	9708.44	8612	1131	98.31	98.31	97.99	98.31	1.69	1.69	0.00	0.00
2019	8866.50	7770	1131	88.70	88.70	89.49	88.70	0.00	0.00	11.30	0.00
2020	9427.05	8720	1131	99.28	99.28	94.89	99.27	0.00	0.00	0.72	0.00

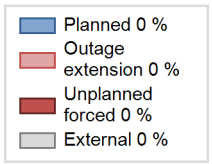
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2021	8716.73	7569	1131	86.40	86.40	87.98	86.40	0.00	0.00	13.60	0.00
2022	9851.53	8760	1131	100.00	100.00	99.43	100.00	0.00	0.00	0.00	0.00
2023	8408.02	7696	1131	86.49	86.49	84.86	87.85	1.00	0.88	12.63	0.00
2024	Data not provided										

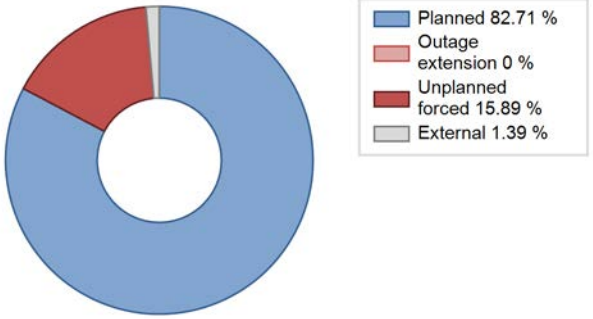
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					223	
B. Refuelling without maintenance				30		
C. Inspection, maintenance or repair combined with refuelling				944		
D. Inspection, maintenance or repair without refuelling				85		
E. Testing of plant systems or components				16	1	
H. Nuclear regulatory requirements					89	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						38
L. Human factor related					15	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				47		2
Z. Other				2	19	
Subtotal				1124	347	44
Total	**0**			**1515**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		9
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		2
14. Safety Systems		24
15. Reactor Cooling Systems		26
17. Safety I&C Systems (excluding reactor I&C)		18
31. Turbine and auxiliaries		70
32. Feedwater and Main Steam System		26
33. Circulating Water System		0
35. All other I&C Systems		4
41. Main Generator Systems		1
42. Electrical Power Supply Systems		56
Total		**243**

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2024 Operating Experience

US-445 COMANCHE PEAK-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	LUMINANT (Luminant Generation Company, LLC)
Owner	:	LUMINANT (Luminant Generation Company, LLC)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	AC (ALLIS CHALMERS)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3612 MWth
Gross electrical power	:	1259 MWe
Reference unit power (net)	:	1205 MWe

Key Dates

Construction Date	:	1974-12-19
Grid Date	:	1990-04-24
Commercial Date	:	1990-08-13
Age at end of year	:	34 years

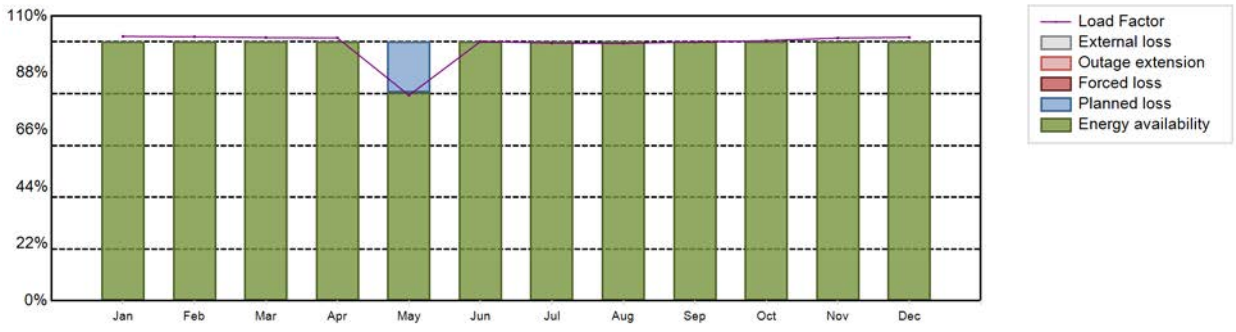
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.7
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	325
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.103
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	40000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.75
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	17.81	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10489.3 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	98.35 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	98.35 %	Planned Unavailability Factor (PUF)	:	1.65 %
Load Factor (LF)	:	99.1 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	98.35 %	Total off-line time	:	145 hours

Annual Summary



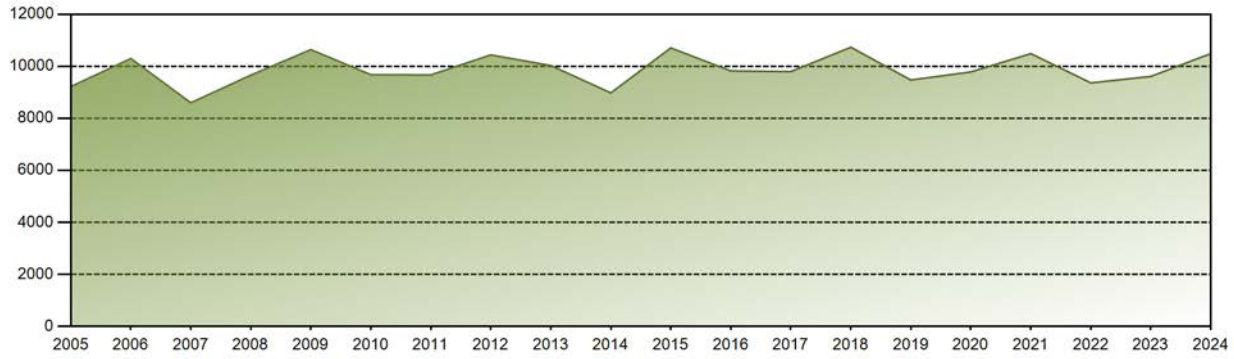
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	915.67	855.24	910.19	880.96	711.68	868.72	892.69	891.59	867.34	900.82	881.88	912.52	10489.30
EAF [%]	100.00	100.00	100.00	100.00	80.47	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.35
UCF [%]	100.00	100.00	100.00	100.00	80.47	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.35
LF [%]	102.14	101.97	101.66	101.54	79.38	100.13	99.57	99.45	99.97	100.48	101.51	101.78	99.10
OF [%]	100.00	100.00	100.00	100.00	80.51	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.35
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	19.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.65
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	315499.78 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.53 %
Cumulative Energy Availability Factor (EAF)	:	90.98 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.41 %
Cumulative Unit Capability Factor (UCF)	:	90.99 %	Cumulative Planned Unavailability Factor (PUF)	:	7.6 %
Cumulative Load Factor (LF)	:	88.91 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	90.99 %			

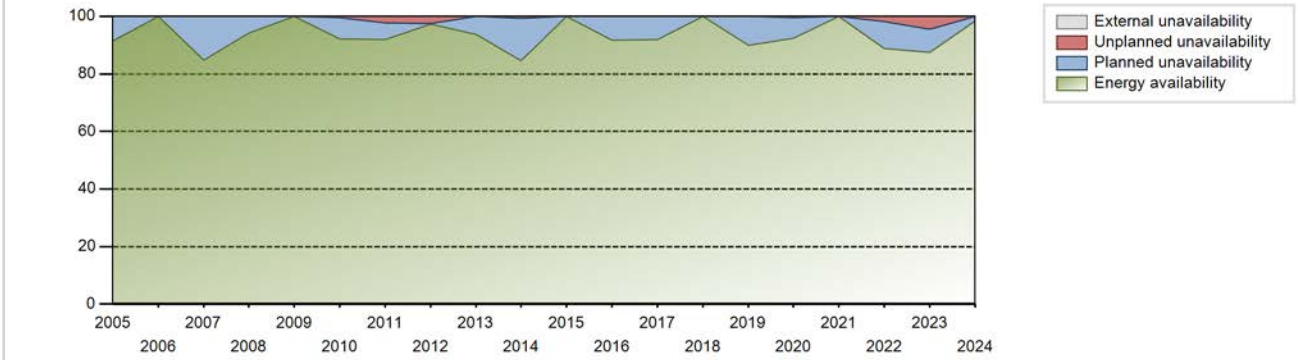
Electricity Production (net) [GWh]



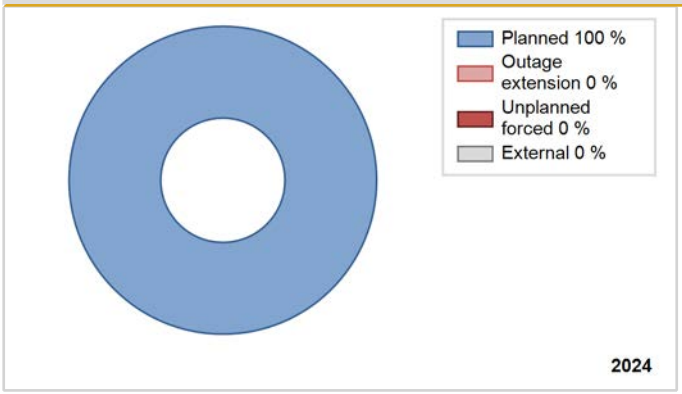
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1990	3335.18	4399	1140	80.61	80.61	60.19	78.00	8.53	7.52	11.87	0.00
1991	5360.52	5341	1150	60.51	60.51	53.21	60.97	12.05	8.29	31.20	0.00
1992	6937.48	6947	1150	79.11	79.11	68.68	79.09	3.93	3.23	17.66	0.00
1993	7150.44	6932	1150	79.14	79.14	70.98	79.13	1.92	1.55	19.30	0.00
1994	9367.60	8653	1150	98.78	98.78	92.99	98.78	1.22	1.22	0.00	0.00
1995	7803.75	7444	1150	84.98	84.98	77.46	84.98	3.11	2.73	12.29	0.00
1996	7756.24	7265	1150	82.73	83.00	76.78	82.71	6.01	5.31	11.69	0.27
1997	9478.88	8656	1150	98.81	98.81	94.09	98.81	1.19	1.19	0.00	0.00
1998	8505.96	7848	1150	89.59	89.59	84.43	89.59	0.00	0.00	10.41	0.00
1999	8601.51	7922	1150	90.44	90.44	85.38	90.43	0.01	0.01	9.54	0.00
2000	9619.80	8784	1150	100.00	100.00	95.23	100.00	0.00	0.00	0.00	0.00
2001	8444.32	7781	1150	88.86	88.86	83.82	88.82	3.47	3.20	7.95	0.00
2002	7785.26	7213	1150	82.97	82.97	77.28	82.34	5.99	5.29	11.74	0.00
2003	9625.95	8653	1150	98.85	98.85	95.55	98.78	1.15	1.15	0.00	0.00
2004	9018.13	7877	1150	89.82	89.82	89.27	89.67	0.00	0.00	10.18	0.00
2005	9217.83	8004	1084	91.39	91.39	97.07	91.37	0.00	0.00	8.61	0.00
2006	10297.95	8760	1150	100.00	100.00	102.22	100.00	0.00	0.00	0.00	0.00
2007	8596.75	7437	1150	84.91	84.91	85.34	84.90	0.00	0.00	15.09	0.00
2008	9658.71	8262	1209	94.11	94.11	94.80	94.06	0.00	0.00	5.89	0.00
2009	10640.87	8760	1209	100.00	100.00	100.47	100.00	0.00	0.00	0.00	0.00
2010	9676.72	8074	1209	92.19	92.19	91.37	92.17	0.46	0.43	7.38	0.00
2011	9667.76	8056	1209	91.99	91.99	91.28	91.96	2.51	2.37	5.64	0.00
2012	10438.08	8537	1209	97.20	97.20	98.29	97.19	2.60	2.59	0.21	0.00
2013	10028.69	8211	1205	93.71	93.71	95.00	93.72	0.00	0.00	6.29	0.00
2014	8976.75	7401	1209	84.48	84.48	84.76	84.49	0.90	0.77	14.75	0.00
2015	10706.90	8760	1218	100.00	100.00	100.35	100.00	0.00	0.00	0.00	0.00
2016	9821.67	8061	1218	91.77	91.77	91.80	91.77	0.00	0.00	8.23	0.00
2017	9795.19	8053	1218	91.93	91.93	91.80	91.93	0.00	0.00	8.07	0.00
2018	10733.89	8760	1218	100.00	100.00	100.60	100.00	0.00	0.00	0.00	0.00
2019	9472.80	7895	1205	90.03	90.03	89.74	90.13	0.00	0.00	9.97	0.00
2020	9781.85	8131	1205	92.31	92.31	92.41	92.57	0.55	0.51	7.18	0.00
2021	10487.56	8760	1205	100.00	100.00	99.35	100.00	0.00	0.00	0.00	0.00
2022	9363.00	7771	1205	88.71	88.71	88.70	88.71	2.00	1.81	9.48	0.00
2023	9610.95	8020	1205	87.59	87.59	91.05	91.55	4.77	4.38	8.02	0.00
2024	10489.30	8639	1205	98.35	98.35	99.10	98.35	0.00	0.00	1.65	0.00

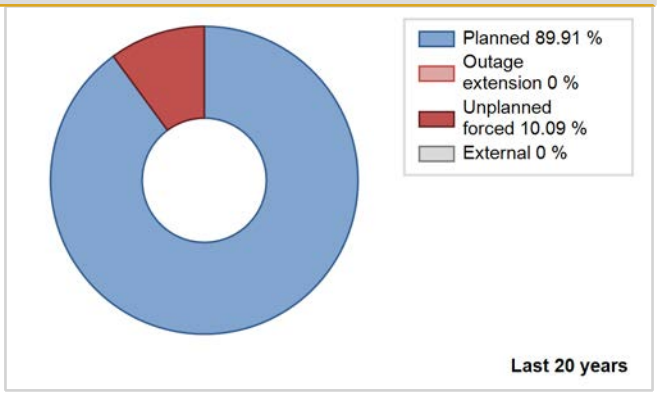
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1990 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					116	
B. Refuelling without maintenance				42		
C. Inspection, maintenance or repair combined with refuelling				576		
D. Inspection, maintenance or repair without refuelling	145			73		
L. Human factor related					10	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
Z. Other					1	
Subtotal	145			691	127	4
Total	**145**			**822**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1990 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		16
12. Reactor I&C Systems		11
13. Reactor Auxiliary Systems		0
15. Reactor Cooling Systems		11
16. Steam generation systems		6
31. Turbine and auxiliaries		23
32. Feedwater and Main Steam System		20
35. All other I&C Systems		5
41. Main Generator Systems		11
42. Electrical Power Supply Systems		15
Total		**118**

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2024 Operating Experience

US-446 COMANCHE PEAK-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	LUMINANT (Luminant Generation Company, LLC)
Owner	:	LUMINANT (Luminant Generation Company, LLC)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	AC (ALLIS CHALMERS)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3612 MWth
Gross electrical power	:	1250 MWe
Reference unit power (net)	:	1195 MWe

Key Dates

Construction Date	:	1974-12-19
Grid Date	:	1993-04-09
Commercial Date	:	1993-08-03
Age at end of year	:	31 years

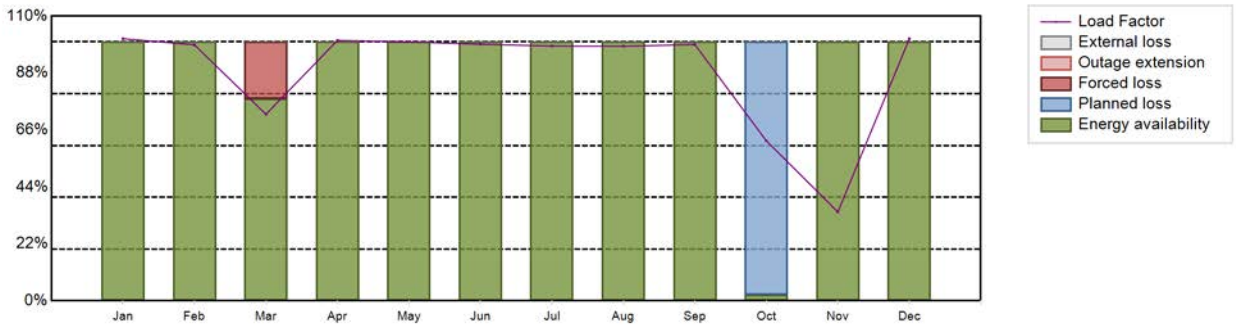
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.7
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	325
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.103
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	36000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.75
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	17.81	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9314.74 GW(e).h	Forced Loss Rate (FLR)	:	2.03 %
Energy Availability Factor (EAF)	:	89.86 %	Unplanned Capability Loss Factor (UCL)	:	1.86 %
Unit Capability Factor (UCF)	:	89.86 %	Planned Unavailability Factor (PUF)	:	8.28 %
Load Factor (LF)	:	88.74 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	89.87 %	Total off-line time	:	890 hours

Annual Summary



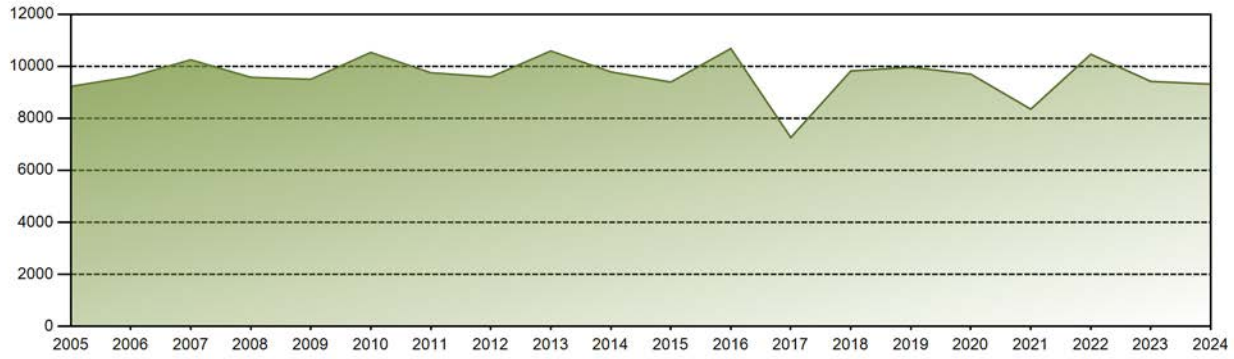
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	900.16	822.25	639.64	865.35	889.08	852.55	874.86	874.13	851.60	549.33	295.81	899.99	9314.74
EAF [%]	100.00	100.00	78.02	100.00	100.00	100.00	100.00	100.00	100.00	2.25	100.00	100.00	89.86
UCF [%]	100.00	100.00	78.02	100.00	100.00	100.00	100.00	100.00	100.00	2.25	100.00	100.00	89.86
LF [%]	101.25	98.86	72.04	100.58	100.00	99.09	98.40	98.32	98.98	61.79	34.33	101.23	88.74
OF [%]	100.00	100.00	78.06	100.00	100.00	100.00	100.00	100.00	100.00	62.90	37.45	100.00	89.87
FLR [%]	0.00	0.00	21.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.03
UCL [%]	0.00	0.00	21.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.86
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	97.75	0.00	0.00	8.28
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	289910.93 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.24 %
Cumulative Energy Availability Factor (EAF)	:	91.37 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.1 %
Cumulative Unit Capability Factor (UCF)	:	91.39 %	Cumulative Planned Unavailability Factor (PUF)	:	6.51 %
Cumulative Load Factor (LF)	:	89.86 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	91.34 %			

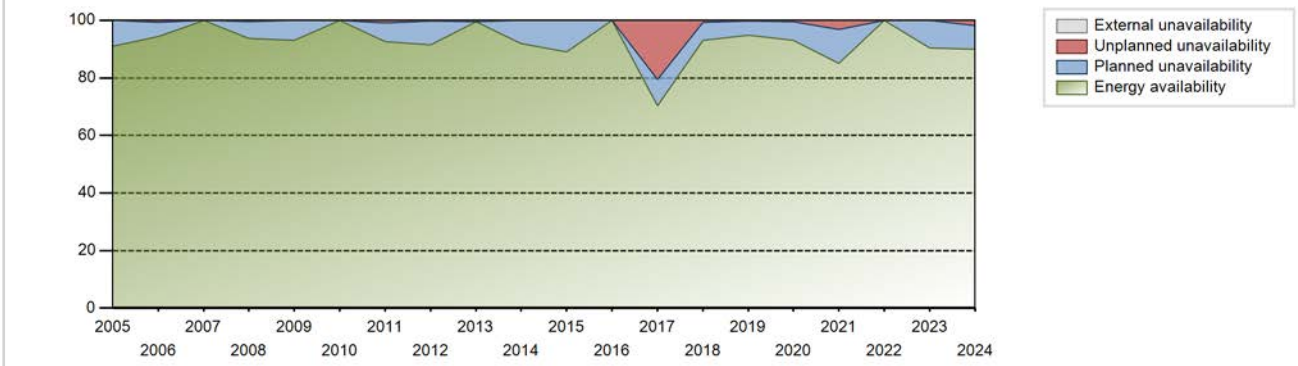
Electricity Production (net) [GWh]



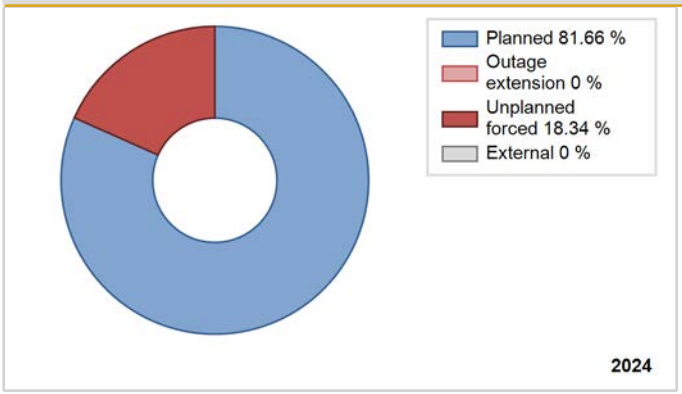
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1993	4131.71	4600	1150	89.74	89.74	82.77	89.74	10.26	10.26	0.00	0.00
1994	5263.15	5697	1150	65.07	65.07	52.24	65.03	17.02	13.34	21.59	0.00
1995	9166.58	8382	1150	95.68	95.68	90.99	95.68	1.60	1.55	2.76	0.00
1996	7370.37	6911	1150	78.68	79.42	72.96	78.68	7.06	6.03	14.55	0.74
1997	8062.05	7554	1150	86.23	86.23	80.03	86.23	0.00	0.00	13.77	0.00
1998	9345.30	8741	1150	99.78	99.78	92.77	99.78	0.22	0.22	0.00	0.00
1999	8756.02	7901	1150	90.19	90.19	86.92	90.19	0.65	0.59	9.21	0.00
2000	8868.05	7927	1150	90.24	90.24	87.79	90.24	0.00	0.00	9.76	0.00
2001	9877.95	8731	1150	99.67	99.67	98.05	99.67	0.33	0.33	0.00	0.00
2002	8793.82	7888	1150	90.11	90.11	87.29	90.05	0.36	0.33	9.56	0.00
2003	8123.39	7307	1150	83.80	83.80	80.64	83.41	10.11	9.43	6.77	0.00
2004	10038.85	8784	1150	100.00	100.00	99.38	100.00	0.00	0.00	0.00	0.00
2005	9225.37	7979	1124	91.10	91.10	93.68	91.07	0.00	0.00	8.90	0.00
2006	9598.20	8260	1150	94.30	94.30	95.28	94.29	0.63	0.60	5.10	0.00
2007	10249.00	8760	1150	100.00	100.00	101.74	100.00	0.00	0.00	0.00	0.00
2008	9575.91	8241	1150	93.83	93.83	94.80	93.82	0.41	0.39	5.78	0.00
2009	9500.60	8155	1158	93.15	93.15	93.66	93.09	0.00	0.00	6.85	0.00
2010	10531.75	8760	1158	100.00	100.00	103.82	100.00	0.00	0.00	0.00	0.00
2011	9751.59	8099	1197	92.71	92.71	93.00	92.45	1.00	0.94	6.36	0.00
2012	9588.68	8027	1197	91.41	91.41	91.20	91.38	0.33	0.30	8.29	0.00
2013	10588.12	8721	1195	99.55	99.55	101.13	99.54	0.45	0.45	0.00	0.00
2014	9784.63	8063	1197	92.04	92.04	93.31	92.04	0.00	0.00	7.96	0.00
2015	9393.65	7789	1207	89.01	89.01	88.84	88.92	0.03	0.02	10.97	0.00
2016	10682.62	8784	1207	100.00	100.00	100.76	100.00	0.00	0.00	0.00	0.00
2017	7262.76	6152	1207	70.23	70.23	68.69	70.23	22.57	20.48	9.29	0.00
2018	9820.04	8141	1207	93.01	93.01	92.88	92.93	0.66	0.62	6.37	0.00
2019	9965.35	8305	1195	94.76	94.76	95.20	94.81	0.30	0.29	4.95	0.00
2020	9698.10	8182	1195	93.15	93.15	92.39	93.15	0.58	0.54	6.31	0.00
2021	8351.29	7453	1195	85.09	85.09	79.78	85.08	3.64	3.22	11.70	0.00
2022	10462.06	8760	1195	100.00	100.00	99.94	100.00	0.00	0.00	0.00	0.00
2023	9419.27	7927	1195	90.46	90.46	89.98	90.49	0.03	0.03	9.51	0.00
2024	9314.74	7894	1195	89.86	89.86	88.74	89.87	2.03	1.86	8.28	0.00

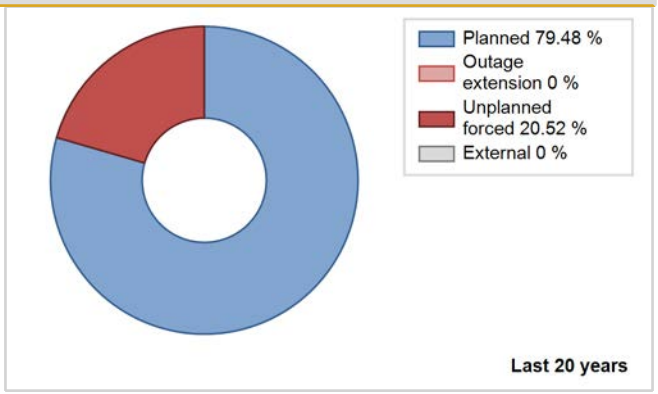
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1993 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		163			164	
B. Refuelling without maintenance				50		
C. Inspection, maintenance or repair combined with refuelling	727			484		
D. Inspection, maintenance or repair without refuelling				43		
E. Testing of plant systems or components				33		
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						14
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				7		
Z. Other					12	
Subtotal	727	163		617	177	14
Total	**890**			**808**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1993 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	77	2
12. Reactor I&C Systems		4
13. Reactor Auxiliary Systems		1
14. Safety Systems		22
15. Reactor Cooling Systems		29
16. Steam generation systems		5
17. Safety I&C Systems (excluding reactor I&C)		0
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		28
34. Miscellaneous Systems		2
41. Main Generator Systems		55
42. Electrical Power Supply Systems	87	16
Total	**164**	**174**

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2024 Operating Experience

US-315 COOK-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	AEP (American Electric Power Company, Inc.)
Owner	:	AEP (American Electric Power Company, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (ICECDN)
Thermal power	:	3304 MWth
Gross electrical power	:	1131 MWe
Reference unit power (net)	:	1030 MWe

Key Dates

Construction Date	:	1969-03-25
Grid Date	:	1975-02-10
Commercial Date	:	1975-08-28
Age at end of year	:	49 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	38000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	21.98
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

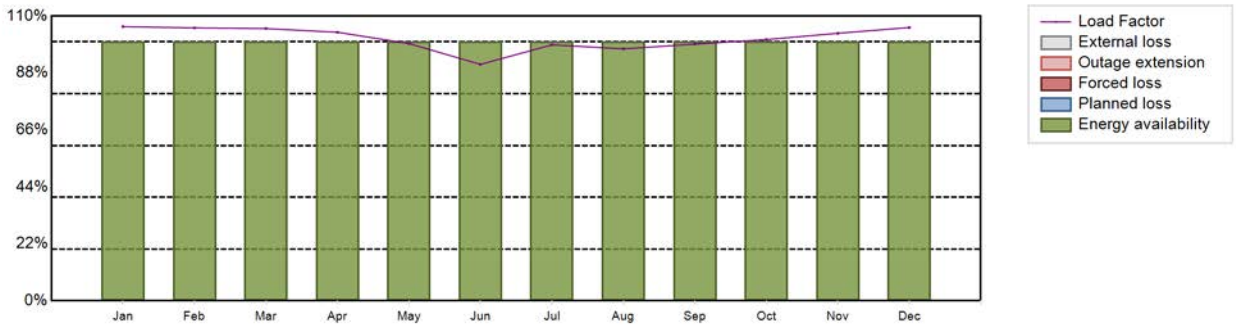
Operating coolant pressure [MPa]	:	14.76
Reactor outlet temperature [°C]	:	306
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.19
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.12
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	101.33 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



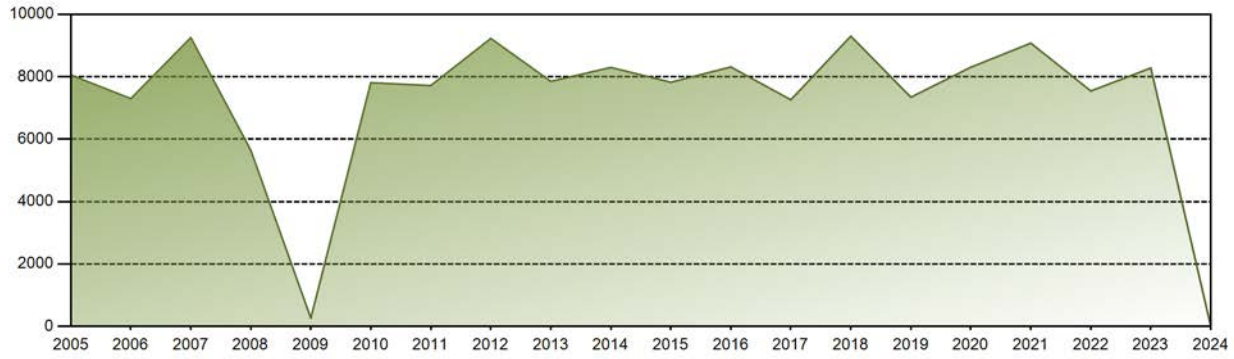
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	811.48	755.79	804.71	769.30	761.49	677.26	757.63	745.86	735.17	773.26	767.37	808.98	9168.30
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	105.89	105.43	105.15	103.73	99.37	91.32	98.87	97.33	99.13	100.91	103.33	105.57	101.33
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	13.91 %
Cumulative Energy Availability Factor (EAF)	:	74.5 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.06 %
Cumulative Unit Capability Factor (UCF)	:	74.62 %	Cumulative Planned Unavailability Factor (PUF)	:	13.32 %
Cumulative Load Factor (LF)	:	72.6 %	Cumulative Externally cause unavailability (XUF)	:	0.12 %
Cumulative Operating Factor (OF)	:	75 %			

Electricity Production (net) [GWh]

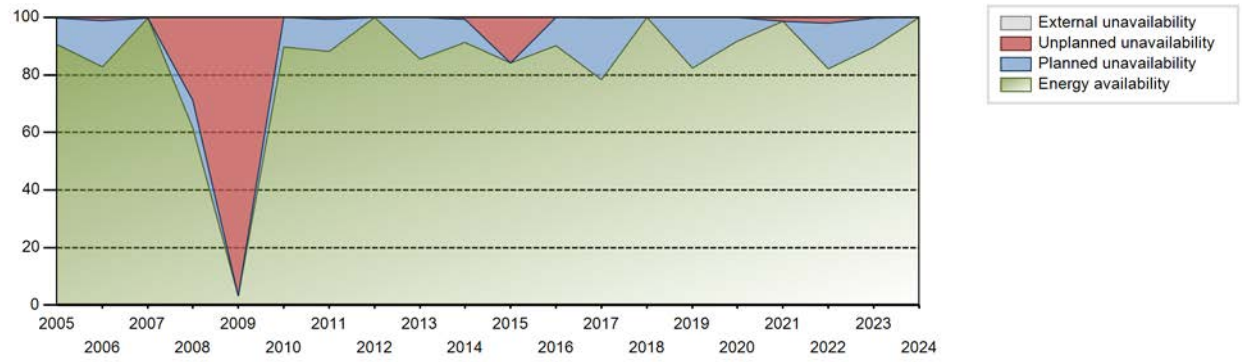


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	4450.80	5955	848	80.79	80.79	80.81	82.48	5.03	4.28	14.94	0.00
1976	6804.90	7298	983	79.21	79.21	78.81	83.08	3.86	3.18	17.61	0.00
1977	4785.80	6658	1044	52.38	52.38	52.33	76.00	29.20	21.61	26.02	0.00
1978	6286.90	6438	1044	68.75	68.75	68.74	73.49	6.67	4.91	26.34	0.00
1979	5660.20	5666	1044	61.89	61.89	61.89	64.68	11.37	7.94	30.17	0.00
1980	6461.30	6470	1044	74.77	79.48	70.46	73.66	0.99	0.79	19.73	4.71
1981	6781.50	6663	1044	77.13	77.13	74.15	76.06	5.09	4.14	18.73	0.00
1982	5352.70	5487	1044	64.17	64.17	58.53	62.64	15.78	12.02	23.80	0.00
1983	5286.70	5628	1030	64.33	64.33	58.59	64.25	0.87	0.57	35.11	0.00
1984	7550.76	8016	1020	91.33	91.33	84.27	91.26	4.92	4.72	3.95	0.00
1985	2116.06	2489	1020	29.85	29.85	23.68	28.41	14.24	4.96	65.19	0.00
1986	6650.07	7464	1020	85.53	85.53	74.43	85.21	14.46	14.46	0.01	0.00
1987	5033.77	5917	1020	68.21	68.21	56.34	67.55	5.90	4.28	27.52	0.00
1988	7467.79	8379	1020	95.51	95.51	83.35	95.39	1.79	1.74	2.75	0.00
1989	5433.04	6069	1020	69.90	69.90	60.80	69.28	0.41	0.29	29.81	0.00
1990	6301.64	6939	1020	79.24	79.24	70.53	79.21	0.00	0.00	20.76	0.00
1991	7338.24	7524	1013	85.96	85.96	82.67	85.89	2.91	2.58	11.46	0.00
1992	4990.66	5690	1008	65.09	65.09	56.35	64.78	0.36	0.24	34.67	0.00
1993	8759.43	8760	1006	100.00	100.00	99.34	100.00	0.00	0.00	0.00	0.00
1994	5759.52	6214	1000	70.96	70.96	65.75	70.94	0.00	0.00	29.04	0.00
1995	5396.79	5809	1000	66.37	66.37	61.61	66.31	14.56	11.31	22.32	0.00
1996	8373.26	8574	1000	97.62	97.62	95.32	97.61	2.38	2.38	0.00	0.00
1997	4545.86	4608	1000	52.41	52.41	51.89	52.60	37.55	31.51	16.07	0.00
1998	0.00	0	1000	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1999	0.00	0	1000	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
2000	129.80	242	1000	2.77	2.77	1.48	2.76	97.23	97.23	0.00	0.00
2001	7797.85	7840	1000	89.53	90.55	89.02	89.50	5.69	5.46	3.98	1.03
2002	7740.90	7782	1000	88.86	88.86	88.37	88.84	1.23	1.11	10.03	0.00
2003	6570.09	6489	1000	74.10	74.10	74.99	74.07	16.81	14.98	10.92	0.00
2004	8831.48	8588	1000	97.74	97.74	100.54	97.77	0.00	0.00	2.26	0.00
2005	8055.85	7940	1016	90.67	90.67	90.50	90.63	0.28	0.25	9.08	0.00
2006	7296.16	7256	1016	82.85	82.85	81.98	82.83	1.24	1.04	16.11	0.00
2007	9252.68	8728	1009	99.63	99.63	104.68	99.63	0.37	0.37	0.00	0.00
2008	5639.68	5407	1009	61.57	61.57	63.63	61.56	31.94	28.89	9.54	0.00
2009	263.43	289	1009	3.30	3.30	2.98	3.30	96.70	96.70	0.00	0.00
2010	7806.86	7859	1009	89.73	89.73	88.32	89.71	0.00	0.00	10.27	0.00
2011	7716.35	7716	1009	88.11	88.11	87.30	88.08	0.75	0.66	11.23	0.00

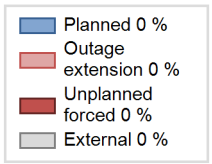
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2012	9224.63	8784	1045	100.00	100.00	100.49	100.00	0.00	0.00	0.00	0.00
2013	7850.11	7470	1045	85.49	85.49	85.74	85.26	0.00	0.00	14.51	0.00
2014	8296.79	7974	1045	91.16	91.16	90.63	91.03	0.71	0.65	8.19	0.00
2015	7822.53	7352	1045	84.15	84.15	85.45	83.93	15.85	15.85	0.00	0.00
2016	8311.75	7914	1045	90.09	90.09	90.55	90.10	0.00	0.00	9.91	0.00
2017	7260.08	6932	1045	78.29	78.29	79.31	79.13	0.03	0.16	21.55	0.00
2018	9299.54	8760	1030	100.00	100.00	103.07	100.00	0.00	0.00	0.00	0.00
2019	7343.23	7207	1030	82.28	82.28	81.39	82.27	0.00	0.00	17.72	0.00
2020	8303.66	8050	1030	91.65	91.65	91.78	91.64	0.06	0.06	8.29	0.00
2021	9074.88	8648	1030	98.72	98.72	100.58	98.72	1.28	1.28	0.00	0.00
2022	7542.17	7196	1030	82.14	82.14	83.59	82.15	2.30	1.93	15.92	0.00
2023	8279.91	7971	1030	89.71	89.71	91.77	90.99	0.27	0.25	10.04	0.00
2024	Data not provided										

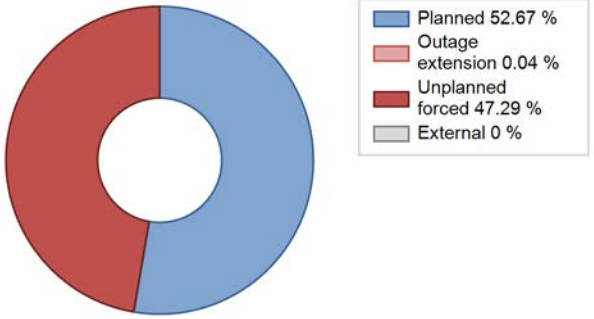
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1975 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					389	
B. Refuelling without maintenance				49		
C. Inspection, maintenance or repair combined with refuelling				989		
D. Inspection, maintenance or repair without refuelling				93		
E. Testing of plant systems or components				7	5	
F. Major backfitting, refurbishment or upgrading activities with refuelling				2		
H. Nuclear regulatory requirements					630	
L. Human factor related					8	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
P. Fire					10	
Z. Other					3	2
Subtotal				1140	1045	6
Total		**0**			**2191**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		14
14. Safety Systems		6
15. Reactor Cooling Systems		26
16. Steam generation systems		5
17. Safety I&C Systems (excluding reactor I&C)		3
31. Turbine and auxiliaries		265
32. Feedwater and Main Steam System		14
33. Circulating Water System		27
34. Miscellaneous Systems		579
35. All other I&C Systems		0
41. Main Generator Systems		20
42. Electrical Power Supply Systems		50
Total		**1012**

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2024 Operating Experience

US-316 COOK-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	AEP (American Electric Power Company, Inc.)
Owner	:	AEP (American Electric Power Company, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	BB&C (BROWN BOVERI & CIE)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (ICECDN)
Thermal power	:	3468 MWth
Gross electrical power	:	1231 MWe
Reference unit power (net)	:	1168 MWe

Key Dates

Construction Date	:	1969-03-25
Grid Date	:	1978-03-22
Commercial Date	:	1978-07-01
Age at end of year	:	46 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	48000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.81
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

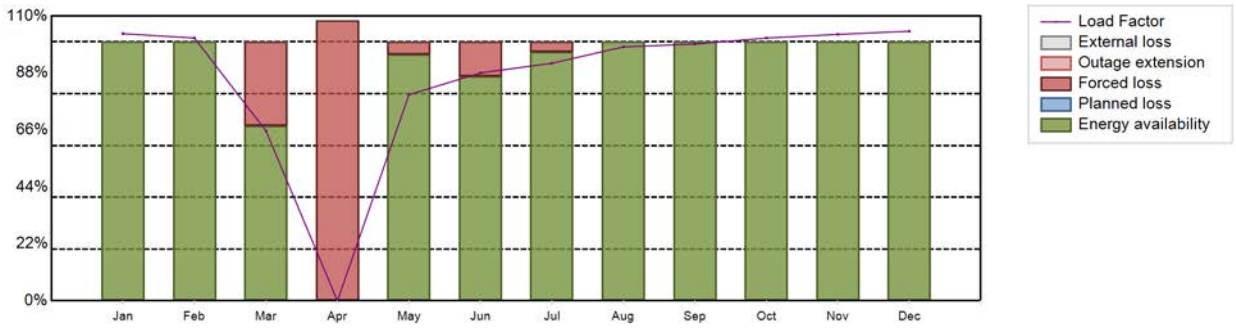
Operating coolant pressure [MPa]	:	15.82
Reactor outlet temperature [°C]	:	319
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.19
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.43
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8860.49 GW(e).h
Energy Availability Factor (EAF)	:	86.58 %
Unit Capability Factor (UCF)	:	86.58 %
Load Factor (LF)	:	86.36 %
Operating Factor (OF)	:	86.58 %

Forced Loss Rate (FLR)	:	13.42 %
Unplanned Capability Loss Factor (UCL)	:	13.42 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1179 hours

Annual Summary



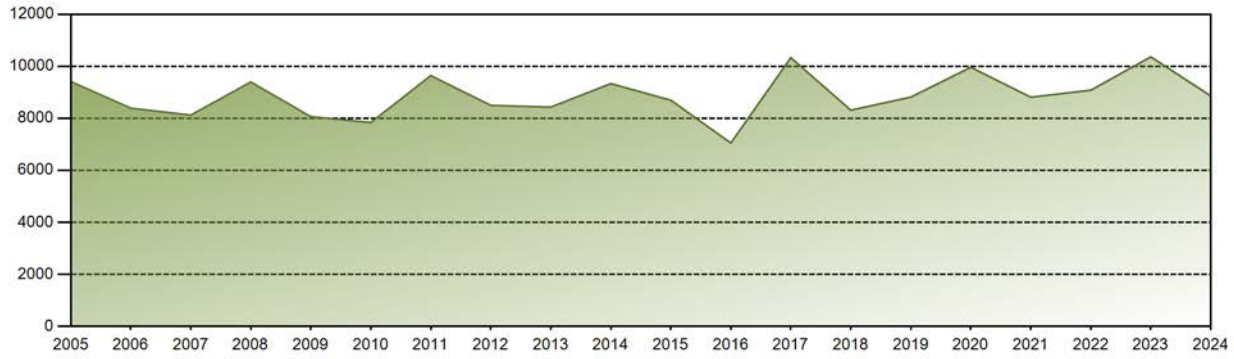
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	896.52	825.07	569.75	0.00	691.88	740.20	797.47	852.36	833.87	881.97	866.59	904.82	8860.49
EAF [%]	100.00	100.00	67.70	-8.19	95.14	86.67	96.25	100.00	100.00	100.00	100.00	100.00	86.58
UCF [%]	100.00	100.00	67.70	-8.19	95.14	86.67	96.25	100.00	100.00	100.00	100.00	100.00	86.58
LF [%]	103.17	101.49	65.65	0.00	79.62	88.02	91.77	98.09	99.16	101.49	102.90	104.12	86.36
OF [%]	100.00	100.00	68.91	0.00	86.02	87.78	95.16	100.00	100.00	100.00	100.00	100.00	86.58
FLR [%]	0.00	0.00	32.30	108.19	4.86	13.33	3.75	0.00	0.00	0.00	0.00	0.00	13.42
UCL [%]	0.00	0.00	32.30	108.19	4.86	13.33	3.75	0.00	0.00	0.00	0.00	0.00	13.42
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	327165.3 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	13.16 %
Cumulative Energy Availability Factor (EAF)	:	75.78 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	11.5 %
Cumulative Unit Capability Factor (UCF)	:	75.9 %	Cumulative Planned Unavailability Factor (PUF)	:	12.6 %
Cumulative Load Factor (LF)	:	73.76 %	Cumulative Externally cause unavailability (XUF)	:	0.13 %
Cumulative Operating Factor (OF)	:	75.62 %			

Electricity Production (net) [GWh]

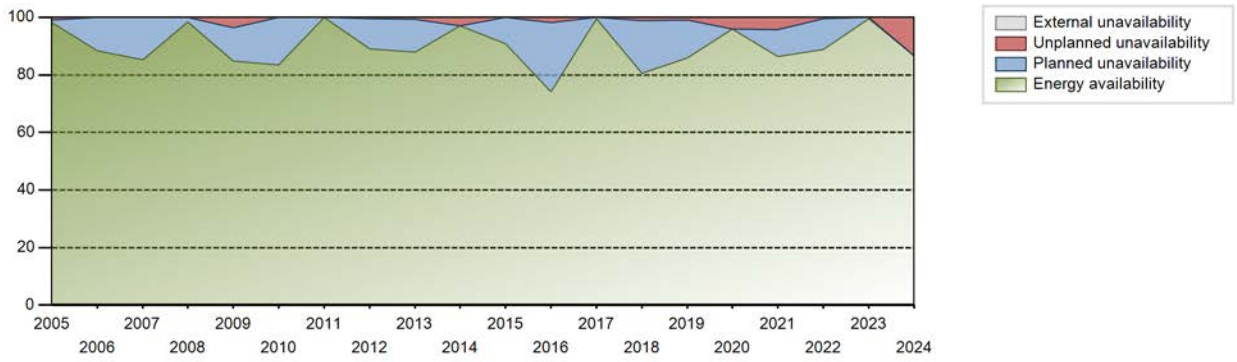


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1978	3814.00	4729	1078	65.36	65.36	65.34	77.22	21.39	17.78	16.86	0.00
1979	5953.50	5773	1082	62.81	62.81	62.81	65.90	19.38	15.10	22.08	0.00
1980	6691.20	6535	1082	74.81	80.15	70.40	74.40	16.26	15.56	4.29	5.34
1981	6384.80	6178	1082	71.21	71.21	67.36	70.53	10.24	8.12	20.67	0.00
1982	6995.60	6738	1082	77.17	77.17	73.81	76.92	13.09	11.62	11.21	0.00
1983	7013.60	6835	1071	78.32	78.32	74.76	78.03	12.60	11.29	10.39	0.00
1984	5364.36	5196	1060	59.19	59.19	57.61	59.15	10.64	7.05	33.77	0.00
1985	5683.63	5852	1060	66.85	66.85	61.21	66.80	33.15	33.15	0.00	0.00
1986	4335.57	5389	1060	61.54	61.54	46.69	61.52	3.41	2.17	36.29	0.00
1987	5026.56	6248	1060	71.38	71.38	54.13	71.32	17.65	15.30	13.32	0.00
1988	2323.26	2715	1060	30.92	30.92	24.95	30.91	0.00	0.00	69.08	0.00
1989	6660.99	6518	1060	74.43	74.43	71.73	74.41	1.50	1.14	24.43	0.00
1990	4813.31	4854	1060	55.42	55.42	51.84	55.41	10.79	6.70	37.88	0.00
1991	8185.91	8013	1065	91.51	92.17	87.74	91.47	7.83	7.83	0.00	0.66
1992	1427.30	1714	1072	20.47	20.47	15.15	19.51	68.47	44.45	35.08	0.00
1993	7553.81	8459	1070	96.60	96.60	80.60	96.56	3.40	3.40	0.00	0.00
1994	3531.45	4757	1060	54.38	54.38	38.03	54.30	26.08	19.19	26.43	0.00
1995	8602.53	8268	1060	94.45	94.45	92.64	94.38	5.55	5.55	0.00	0.00
1996	8022.60	7641	1060	87.01	87.01	86.16	86.99	0.13	0.11	12.88	0.00
1997	5875.21	5705	1060	64.87	64.87	63.27	65.12	14.76	11.23	23.90	0.00
1998	0.00	0	1060	0.00	0.00	0.00	0.00	100.00	98.15	1.85	0.00
1999	0.00	0	1060	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
2000	4789.85	4557	1060	51.88	51.88	51.44	51.88	48.12	48.12	0.00	0.00
2001	7963.43	7690	1060	87.81	87.81	85.76	87.79	12.19	12.19	0.00	0.00
2002	7687.69	7335	1060	83.80	83.80	82.79	83.73	5.84	5.20	11.00	0.00
2003	7112.17	6610	1060	75.46	75.46	76.59	75.46	13.38	11.66	12.88	0.00
2004	7938.51	7407	1060	84.33	84.33	85.26	84.32	5.68	5.08	10.59	0.00
2005	9415.54	8603	1077	98.22	98.22	99.79	98.20	0.97	0.96	0.81	0.00
2006	8388.76	7732	1077	88.28	88.28	88.91	88.25	0.00	0.00	11.72	0.00
2007	8124.48	7492	1060	85.30	85.30	87.50	85.53	0.00	0.00	14.70	0.00
2008	9396.64	8650	1060	98.48	98.48	100.92	98.47	0.00	0.00	1.52	0.00
2009	8062.96	7434	1060	84.88	84.88	86.83	84.86	3.98	3.52	11.60	0.00
2010	7839.20	7302	1060	83.37	83.37	84.42	83.36	0.00	0.00	16.63	0.00
2011	9641.90	8760	1077	100.00	100.00	102.20	100.00	0.00	0.00	0.00	0.00
2012	8497.17	7818	1077	89.03	89.03	89.82	89.00	0.46	0.41	10.56	0.00
2013	8430.45	7709	1077	88.00	88.00	89.35	87.99	0.75	0.66	11.34	0.00
2014	9334.04	8505	1077	97.09	97.09	98.93	97.09	2.91	2.91	0.00	0.00

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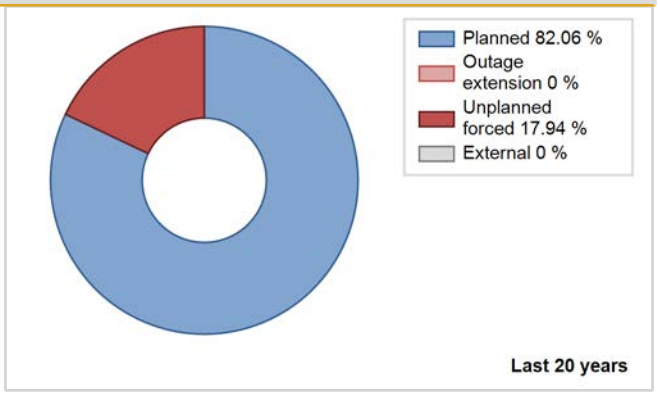
2015	8696.59	7942	1107	90.91	90.91	89.68	90.66	0.00	0.00	9.09	0.00
2016	7048.50	6510	1107	74.12	74.12	72.49	74.11	2.42	1.84	24.04	0.00
2017	10332.09	8717	1168	99.53	99.53	100.98	99.51	0.00	0.00	0.47	0.00
2018	8311.42	7056	1168	80.55	80.55	81.23	80.55	1.34	1.10	18.35	0.00
2019	8816.66	7525	1168	85.92	85.92	86.17	85.90	1.16	1.01	13.07	0.00
2020	9962.99	8423	1168	95.89	95.89	97.11	95.89	4.11	4.11	0.00	0.00
2021	8811.30	7575	1168	86.47	86.47	86.12	86.47	4.81	4.37	9.16	0.00
2022	9082.20	7783	1168	88.85	88.85	88.77	88.85	0.54	0.49	10.66	0.00
2023	10362.52	8760	1168	99.56	99.56	101.28	100.00	0.00	0.00	0.44	0.00
2024	8860.49	7605	1168	86.58	86.58	86.36	86.58	13.42	13.42	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1978 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		1179			486	
B. Refuelling without maintenance				37		
C. Inspection, maintenance or repair combined with refuelling				959		
D. Inspection, maintenance or repair without refuelling				83		
E. Testing of plant systems or components				0		
H. Nuclear regulatory requirements					499	
L. Human factor related					13	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z. Other					17	4
Subtotal		1179		1079	1015	5
Total		**1179**			**2099**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1978 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	160	5
12. Reactor I&C Systems		12
13. Reactor Auxiliary Systems		33
15. Reactor Cooling Systems		68
16. Steam generation systems		120
17. Safety I&C Systems (excluding reactor I&C)		6
31. Turbine and auxiliaries	1019	127
32. Feedwater and Main Steam System		16
33. Circulating Water System		35
34. Miscellaneous Systems		480
35. All other I&C Systems		9
41. Main Generator Systems		31
42. Electrical Power Supply Systems		30
Total	**1179**	**972**

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2024 Operating Experience

US-298 COOPER — UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	ENTERGY (Entergy Nuclear Operations, Inc.)
Owner	:	NPPD (NEBRASKA PUBLIC POWER DISTRICT)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	2419 MWth
Gross electrical power	:	801 MWe
Reference unit power (net)	:	769 MWe

Key Dates

Construction Date	:	1968-06-01
Grid Date	:	1974-05-10
Commercial Date	:	1974-07-01
Age at end of year	:	50 years

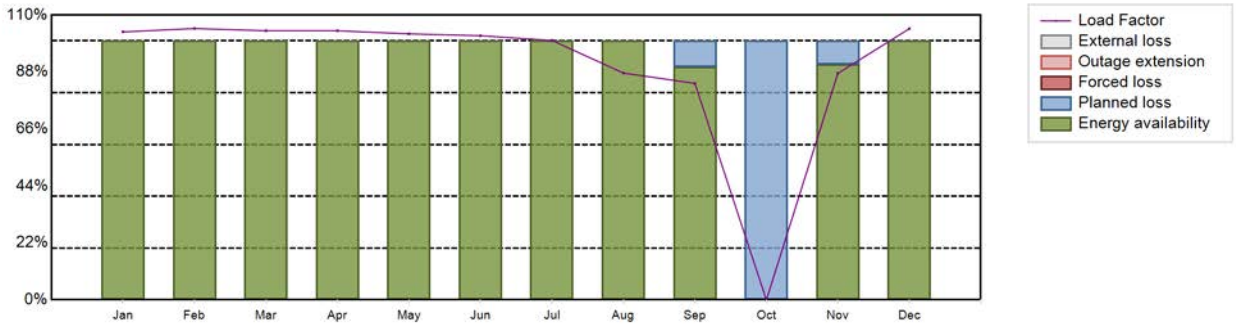
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.28
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	285
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.31
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	17349	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.03	HP cylinder inlet steam pressure [MPa]	:	6.83
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	548	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	43.6	Number of main condensate pumps	:	-
Number of control rod assemblies	:	137	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6095.73 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	89.97 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	89.97 %	Planned Unavailability Factor (PUF)	:	10.03 %
Load Factor (LF)	:	90.24 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	89.96 %	Total off-line time	:	882 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	591.94	560.83	593.83	575.35	587.67	564.80	573.17	501.20	462.86	0.00	484.99	599.09	6095.73
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.01	0.07	90.85	100.00	89.97
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.01	0.07	90.85	100.00	89.97
LF [%]	103.46	104.78	103.93	103.91	102.72	102.01	100.18	87.60	83.60	0.00	87.47	104.71	90.24
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.78	0.00	88.07	100.00	89.96
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.99	99.93	9.15	0.00	10.03
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	264477.66 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.14 %
Cumulative Energy Availability Factor (EAF)	:	80.83 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.39 %
Cumulative Unit Capability Factor (UCF)	:	80.86 %	Cumulative Planned Unavailability Factor (PUF)	:	14.75 %
Cumulative Load Factor (LF)	:	77.89 %	Cumulative Externally cause unavailability (XUF)	:	0.03 %
Cumulative Operating Factor (OF)	:	82.74 %			

Electricity Production (net) [GWh]

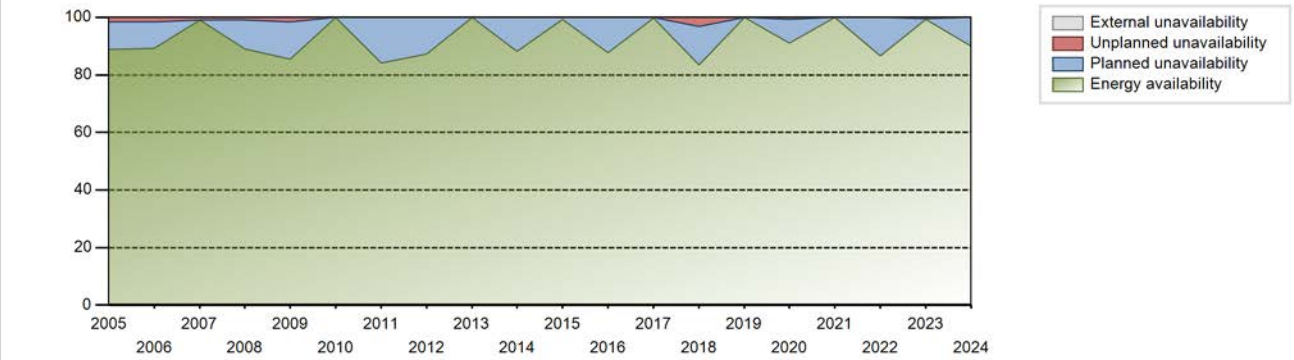


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1974	1885.60	3897	778	100.00	100.00	50.66	73.37	0.00	0.00	0.00	0.00
1975	3363.20	7320	764	50.30	50.30	50.25	83.56	30.39	21.96	27.73	0.00
1976	3642.60	6626	764	54.32	54.32	54.28	75.43	10.82	6.59	39.08	0.00
1977	4540.10	7546	764	67.89	67.89	67.84	86.14	11.41	8.74	23.36	0.00
1978	4886.80	7966	764	73.01	73.01	73.02	90.94	2.19	1.64	25.35	0.00
1979	4995.00	7670	764	74.63	74.63	74.63	87.56	8.86	7.26	18.11	0.00
1980	3787.50	6240	764	70.59	71.64	56.44	71.04	1.41	1.03	27.33	1.05
1981	3851.10	6239	764	71.00	71.00	57.54	71.22	2.02	1.47	27.54	0.00
1982	5276.10	7412	764	84.39	84.39	78.83	84.61	2.74	2.38	13.23	0.00
1983	3343.30	5544	764	62.68	62.68	49.95	63.29	3.08	1.99	35.33	0.00
1984	3469.95	5901	764	67.14	67.64	51.71	67.18	1.52	1.04	31.31	0.50
1985	1067.75	1884	764	20.09	20.09	15.95	21.51	40.65	13.76	66.14	0.00
1986	4052.14	6546	764	74.71	74.71	60.55	74.73	1.27	0.96	24.33	0.00
1987	5522.13	8291	764	94.61	94.61	82.51	94.65	3.93	3.87	1.52	0.00
1988	4200.61	5887	764	66.47	66.47	62.59	67.02	5.92	4.18	29.35	0.00
1989	4790.90	6594	764	74.91	74.91	71.58	75.27	6.64	5.33	19.76	0.00
1990	5111.39	6908	764	78.49	78.49	76.37	78.86	4.42	3.63	17.88	0.00
1991	4803.81	6830	764	77.93	77.93	71.78	77.97	0.00	0.00	22.07	0.00
1992	6227.93	8436	764	95.97	95.97	92.80	96.04	1.56	1.52	2.52	0.00
1993	3712.86	5041	764	56.77	56.77	55.48	57.55	3.13	1.84	41.40	0.00
1994	2227.26	3033	764	33.44	33.44	33.28	34.62	66.56	66.56	0.00	0.00
1995	4127.76	5663	764	64.03	64.03	61.68	64.65	18.35	14.39	21.58	0.00
1996	6338.90	8540	764	97.19	97.19	94.46	97.22	0.00	0.00	2.81	0.00
1997	5455.70	7336	764	83.64	83.64	81.52	83.74	1.76	1.50	14.86	0.00
1998	4869.91	6544	764	74.41	74.41	72.77	74.70	0.00	0.00	25.59	0.00
1999	6510.41	8563	764	97.74	97.74	97.28	97.75	2.26	2.26	0.00	0.00
2000	4735.94	6414	764	73.11	73.11	70.57	73.02	16.33	14.27	12.62	0.00
2001	5206.54	7009	764	79.95	79.95	77.80	80.01	0.00	0.00	20.05	0.00
2002	6318.15	8478	764	96.83	96.83	94.40	96.78	2.89	2.88	0.30	0.00
2003	4492.33	6236	764	71.29	71.29	67.12	71.19	17.41	15.03	13.68	0.00
2004	6171.77	8299	764	94.55	94.55	91.97	94.48	5.45	5.45	0.00	0.00
2005	5891.92	7774	757	88.77	88.77	88.84	88.73	1.84	1.67	9.57	0.00
2006	5910.48	7823	760	89.34	89.34	88.78	89.30	1.69	1.53	9.13	0.00
2007	6671.25	8685	758	99.14	99.14	100.47	99.14	0.86	0.86	0.00	0.00
2008	5964.14	7825	770	89.06	89.06	88.52	89.08	0.92	0.83	10.11	0.00
2009	5734.58	7494	769	85.54	85.54	85.13	85.55	1.75	1.52	12.94	0.00
2010	6792.88	8760	774	100.00	100.00	100.19	100.00	0.00	0.00	0.00	0.00

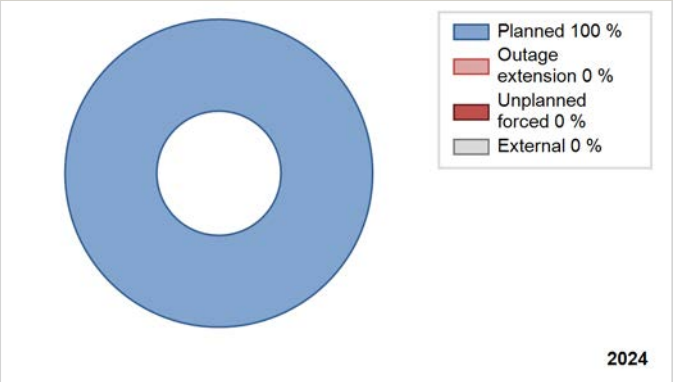
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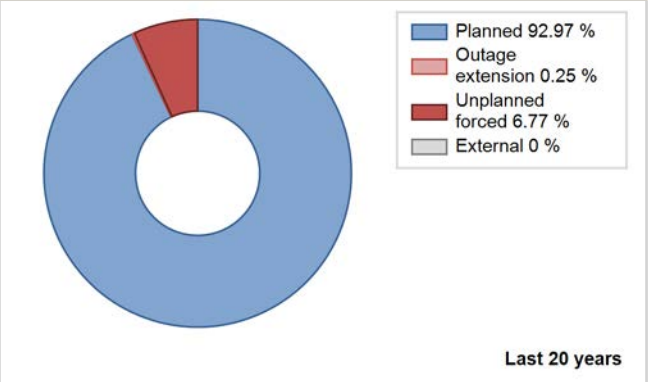
2011	5768.10	7376	774	84.21	84.21	85.07	84.20	0.00	0.00	15.79	0.00
2012	5822.50	7657	768	87.19	87.19	86.31	87.17	0.00	0.00	12.81	0.00
2013	6801.93	8760	766	100.00	100.00	101.36	99.99	0.00	0.00	0.00	0.00
2014	5915.35	7726	768	88.20	88.20	87.93	88.20	0.00	0.00	11.80	0.00
2015	6798.49	8692	768	99.23	99.23	101.05	99.22	0.00	0.00	0.77	0.00
2016	5922.80	7701	768	87.67	87.67	87.80	87.67	0.00	0.00	12.33	0.00
2017	6912.38	8741	769	99.79	99.79	102.61	99.78	0.00	0.00	0.21	0.00
2018	5632.14	7306	769	83.39	83.39	83.61	83.40	3.74	3.24	13.37	0.00
2019	6951.60	8760	769	100.00	100.00	103.19	100.00	0.00	0.00	0.00	0.00
2020	6188.55	7997	769	91.04	91.04	91.62	91.04	0.73	0.67	8.29	0.00
2021	6832.56	8760	769	100.00	100.00	101.43	100.00	0.00	0.00	0.00	0.00
2022	5618.50	7585	769	86.59	86.59	83.40	86.59	0.00	0.00	13.41	0.00
2023	6926.05	8760	769	99.20	99.20	102.81	100.00	0.00	0.38	0.42	0.00
2024	6095.73	7902	769	89.97	89.97	90.24	89.96	0.00	0.00	10.03	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1974 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					148	
B. Refuelling without maintenance				36		
C. Inspection, maintenance or repair combined with refuelling	882			1020		
D. Inspection, maintenance or repair without refuelling				110		
E. Testing of plant systems or components				1	130	
H. Nuclear regulatory requirements					8	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					6	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
P. Fire					3	
Z. Other					30	
Subtotal	882			1167	325	2
Total	**882**			**1494**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1974 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		5
13. Reactor Auxiliary Systems		19
14. Safety Systems		8
15. Reactor Cooling Systems		13
31. Turbine and auxiliaries		63
32. Feedwater and Main Steam System		9
34. Miscellaneous Systems		143
35. All other I&C Systems		4
41. Main Generator Systems		5
42. Electrical Power Supply Systems		12
Total		**284**

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2024 Operating Experience

US-346 DAVIS BESSE-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	FENOC (FIRST ENERGY NUCLEAR OPERATING CO.)
Owner	:	CEI (CLEVELAND ELECTRIC ILLUMINATING CO.)
Reactor Supplier	:	B&W (BABCOCK & WILCOX CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / B&W RLP (DRYAMB)
Thermal power	:	2817 MWth
Gross electrical power	:	925 MWe
Reference unit power (net)	:	894 MWe

Key Dates

Construction Date	:	1970-09-01
Grid Date	:	1977-08-28
Commercial Date	:	1978-07-31
Age at end of year	:	47 years

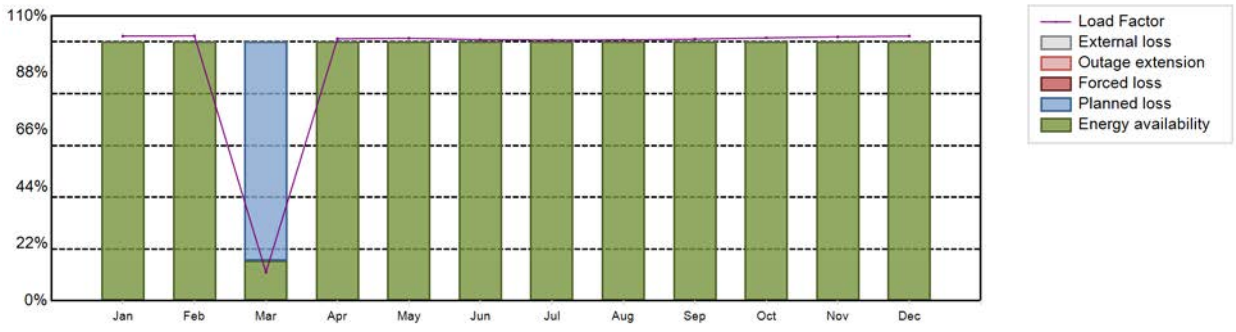
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.5
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.38
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	50000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	2.9	HP cylinder inlet steam pressure [MPa]	:	6.22
Active core height/length [m]	:	3.57	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	177	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	21.1	Number of main condensate pumps	:	-
Number of control rod assemblies	:	28	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7368.12 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	92.85 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	92.85 %	Planned Unavailability Factor (PUF)	:	7.15 %
Load Factor (LF)	:	93.83 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	92.85 %	Total off-line time	:	628 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	680.08	636.55	73.34	651.30	674.44	649.15	669.75	670.17	650.56	675.56	657.24	679.97	7368.12
EAF [%]	100.00	100.00	15.49	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.85
UCF [%]	100.00	100.00	15.49	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.85
LF [%]	102.25	102.30	11.04	101.18	101.40	100.85	100.69	100.76	101.07	101.57	101.97	102.23	93.83
OF [%]	100.00	100.00	15.48	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.85
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	84.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.15
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	267214.57 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.31 %
Cumulative Energy Availability Factor (EAF)	:	75.84 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.88 %
Cumulative Unit Capability Factor (UCF)	:	75.91 %	Cumulative Planned Unavailability Factor (PUF)	:	17.2 %
Cumulative Load Factor (LF)	:	74.43 %	Cumulative Externally cause unavailability (XUF)	:	0.07 %
Cumulative Operating Factor (OF)	:	76.16 %			

Electricity Production (net) [GWh]

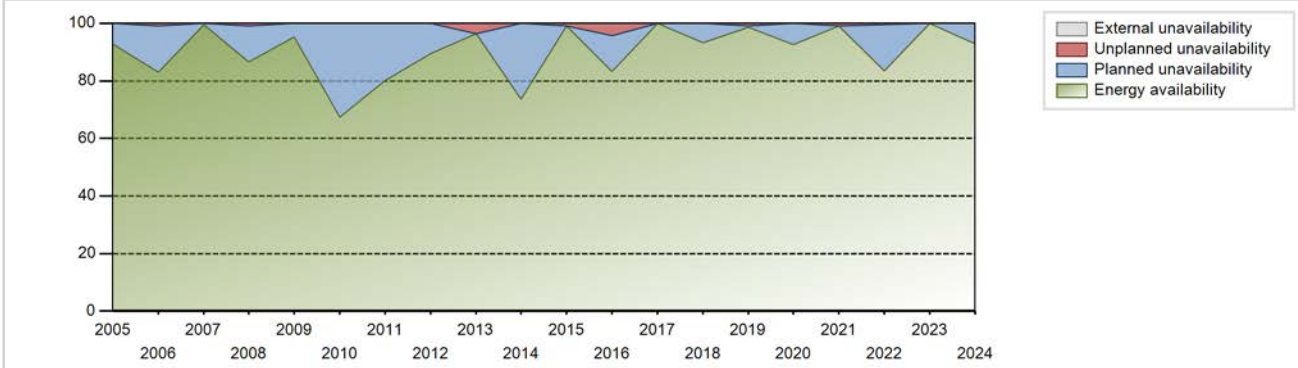


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1978	2614.50	4263	906	39.26	39.26	39.27	54.72	49.49	38.46	22.28	0.00
1979	3129.10	4139	906	39.43	39.43	39.43	47.25	36.36	22.52	38.05	0.00
1980	2093.60	3171	892	34.95	34.95	26.72	36.10	14.18	5.78	59.27	0.00
1981	4363.40	5902	888	67.39	67.39	56.09	67.37	28.77	27.22	5.39	0.00
1982	3218.10	4508	874	51.52	51.52	42.03	51.46	1.18	0.61	47.87	0.00
1983	4883.30	6389	874	72.26	72.26	63.78	72.93	10.53	8.51	19.23	0.00
1984	4291.56	5486	874	62.48	62.48	55.90	62.45	11.02	7.74	29.78	0.00
1985	1942.92	2729	862	30.92	30.92	25.72	31.15	64.96	57.33	11.75	0.00
1986	3.49	116	860	1.33	1.33	0.05	1.32	98.67	98.67	0.00	0.00
1987	5063.98	7308	860	82.82	82.82	67.22	83.42	6.91	6.14	11.04	0.00
1988	1164.40	1891	860	20.35	20.35	15.41	21.53	3.20	0.67	78.98	0.00
1989	7322.11	8506	870	97.08	97.08	96.02	97.10	1.84	1.82	1.10	0.00
1990	4161.47	4867	874	55.62	55.62	54.35	55.56	41.73	39.83	4.55	0.00
1991	5843.86	6962	874	78.62	78.62	76.33	79.47	2.16	1.74	19.64	0.00
1992	7650.49	8742	877	99.54	99.54	99.31	99.52	0.46	0.46	0.00	0.00
1993	6083.40	7246	871	82.70	82.70	79.66	82.72	0.83	0.69	16.61	0.00
1994	6385.00	7667	868	86.92	86.92	83.97	87.52	0.00	0.00	13.08	0.00
1995	7670.57	8760	869	100.00	100.00	100.76	100.00	0.00	0.00	0.00	0.00
1996	6456.29	7452	872	84.83	84.83	84.29	84.84	0.00	0.00	15.17	0.00
1997	7183.36	8184	873	93.45	93.45	93.93	93.42	6.55	6.55	0.00	0.00
1998	6130.68	7181	873	82.01	85.38	80.17	81.97	3.88	3.45	11.18	3.37
1999	7369.99	8311	873	94.89	94.89	96.37	94.87	0.00	0.00	5.11	0.00
2000	6770.53	7633	882	86.96	86.96	87.91	86.90	0.00	0.00	13.04	0.00
2001	7690.85	8738	882	99.75	99.75	99.54	99.75	0.00	0.00	0.25	0.00
2002	929.02	1081	882	12.36	12.36	12.02	12.34	2.21	0.28	87.36	0.00
2003	0.00	0	882	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2004	5778.43	6628	882	75.56	75.56	74.58	75.46	4.95	3.94	20.51	0.00
2005	7177.43	8125	873	92.77	92.77	93.85	92.75	0.00	0.00	7.23	0.00
2006	6375.42	7265	891	82.94	82.94	81.68	82.93	0.90	0.85	16.21	0.00
2007	7705.80	8712	879	99.45	99.45	100.07	99.45	0.00	0.00	0.55	0.00
2008	6829.44	7621	894	86.61	86.61	87.95	86.76	1.13	0.99	12.40	0.00
2009	7609.61	8361	879	95.38	95.38	98.83	95.45	0.00	0.00	4.62	0.00
2010	5188.16	5851	894	67.35	67.35	66.25	66.79	0.00	0.00	32.65	0.00
2011	6339.24	7012	894	80.07	80.07	80.95	80.05	0.00	0.00	19.93	0.00
2012	7101.70	7868	894	89.58	89.58	90.43	89.57	0.00	0.00	10.42	0.00
2013	7679.22	8451	894	96.48	96.48	98.05	96.46	3.52	3.52	0.00	0.00
2014	5972.42	6453	894	73.67	73.67	76.26	73.66	0.00	0.00	26.33	0.00

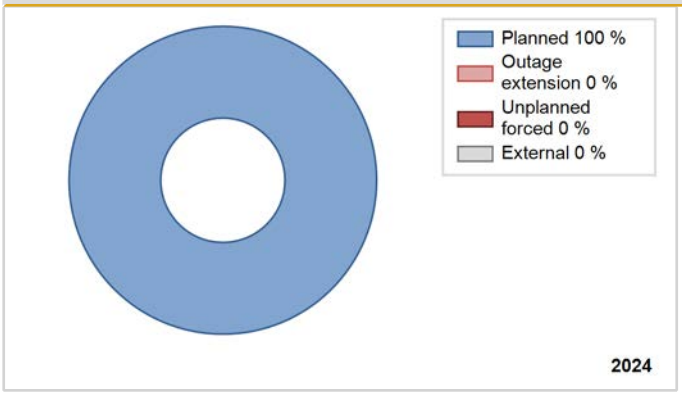
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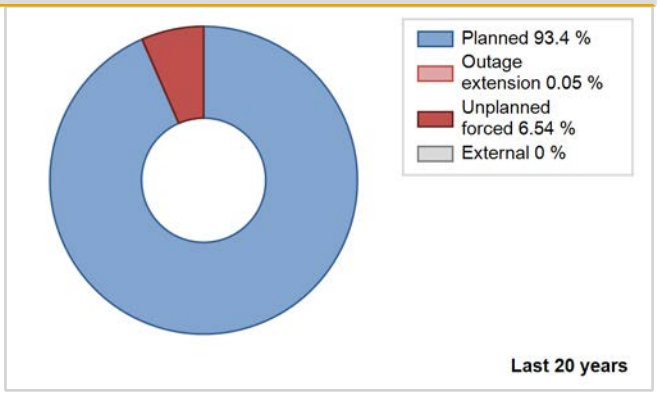
2015	7893.92	8684	894	99.13	99.13	100.80	99.13	0.87	0.87	0.00	0.00
2016	6394.93	7321	894	83.35	83.35	81.43	83.34	4.97	4.36	12.28	0.00
2017	7876.43	8760	894	100.00	100.00	100.57	100.00	0.00	0.00	0.00	0.00
2018	7380.27	8169	894	93.25	93.25	94.24	93.25	0.00	0.00	6.75	0.00
2019	7839.46	8632	894	98.55	98.55	100.10	98.54	0.84	0.84	0.61	0.00
2020	7228.06	8130	894	92.57	92.57	92.04	92.55	0.00	0.00	7.43	0.00
2021	7827.04	8682	894	99.10	99.10	99.94	99.11	0.90	0.90	0.00	0.00
2022	6486.64	7310	894	83.46	83.46	82.83	83.45	0.49	0.41	16.13	0.00
2023	7985.73	8760	894	99.99	99.99	101.97	100.00	0.00	0.00	0.01	0.00
2024	7368.12	8156	894	92.85	92.85	93.83	92.85	0.00	0.00	7.15	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1978 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					578	
B. Refuelling without maintenance				50		
C. Inspection, maintenance or repair combined with refuelling	628			838		
D. Inspection, maintenance or repair without refuelling				210		
E. Testing of plant systems or components				8	3	
F. Major backfitting, refurbishment or upgrading activities with refuelling				393		
H. Nuclear regulatory requirements					37	
L. Human factor related					10	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						6
Z. Other					14	
Subtotal	628			1499	642	6
Total	**628**			**2147**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1978 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		72
12. Reactor I&C Systems		47
13. Reactor Auxiliary Systems		5
14. Safety Systems		0
15. Reactor Cooling Systems		43
16. Steam generation systems		0
17. Safety I&C Systems (excluding reactor I&C)		3
31. Turbine and auxiliaries		15
32. Feedwater and Main Steam System		323
34. Miscellaneous Systems		1
35. All other I&C Systems		2
41. Main Generator Systems		7
42. Electrical Power Supply Systems		56
Total		**574**

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2024 Operating Experience

US-275 DIABLO CANYON-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	PG&E (Pacific Gas and Electric Company
Owner	:	PG&E COR (PG&E Corporation)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3411 MWth
Gross electrical power	:	1197 MWe
Reference unit power (net)	:	1138 MWe

Key Dates

Construction Date	:	1968-04-23
Grid Date	:	1984-11-11
Commercial Date	:	1985-05-07
Age at end of year	:	40 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.5
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

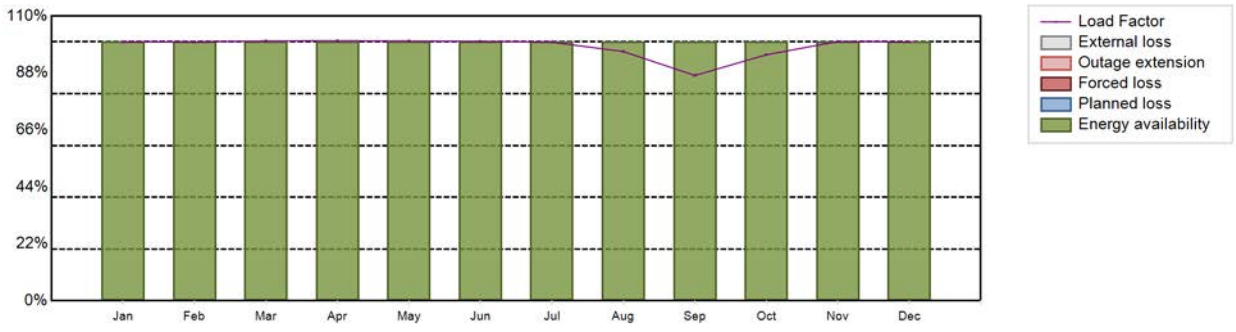
Operating coolant pressure [MPa]	:	15.83
Reactor outlet temperature [°C]	:	320
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.331
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.38
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	98.32 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	846.16	791.92	848.89	823.09	849.81	821.06	845.58	815.18	713.23	804.72	821.69	846.68	9828.01
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	99.94	99.98	100.40	100.46	100.37	100.21	99.87	96.28	87.05	95.05	100.15	100.00	98.32
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.01 %
Cumulative Energy Availability Factor (EAF)	:	88.75 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.83 %
Cumulative Unit Capability Factor (UCF)	:	88.79 %	Cumulative Planned Unavailability Factor (PUF)	:	9.38 %
Cumulative Load Factor (LF)	:	87.62 %	Cumulative Externally cause unavailability (XUF)	:	0.04 %
Cumulative Operating Factor (OF)	:	89.39 %			

Electricity Production (net) [GWh]

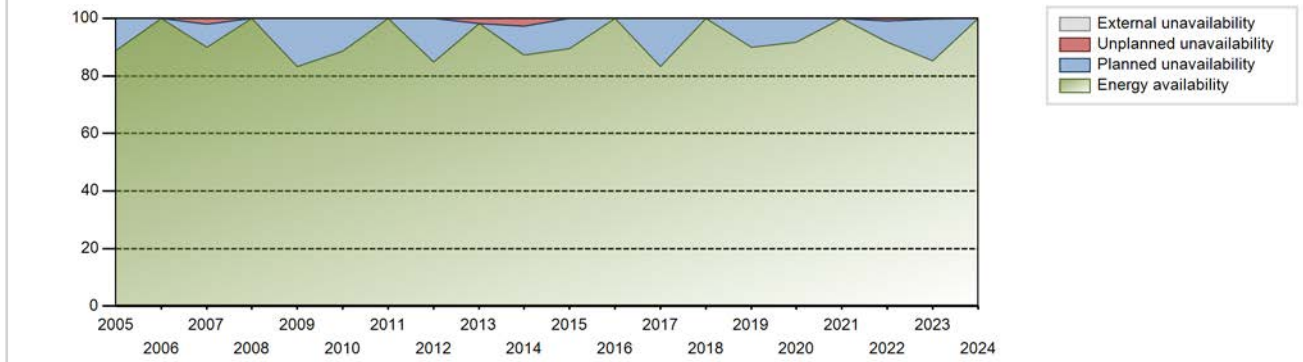


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	5234.23	5206	1073	90.81	90.81	85.07	90.79	4.54	4.31	4.87	0.00
1986	5316.22	5757	1073	65.74	65.74	56.56	65.72	1.98	1.33	32.93	0.00
1987	8284.20	8340	1073	95.26	95.26	88.13	95.21	4.74	4.74	0.00	0.00
1988	5276.12	5555	1073	34.58	34.58	55.98	63.24	46.37	29.90	35.52	0.00
1989	7199.90	7069	1073	80.70	80.70	76.60	80.70	0.04	0.03	19.27	0.00
1990	8713.52	8425	1073	96.20	96.20	92.70	96.18	3.80	3.80	0.00	0.00
1991	7366.28	7125	1073	80.42	80.42	78.37	81.34	1.76	1.44	18.14	0.00
1992	7454.72	7224	1073	82.27	82.27	79.09	82.24	1.85	1.55	16.18	0.00
1993	9028.01	8630	1073	98.52	98.52	96.05	98.52	1.48	1.48	0.00	0.00
1994	7371.98	6991	1073	79.85	79.85	78.43	79.81	5.35	4.51	15.64	0.00
1995	7451.75	7175	1073	81.94	81.94	79.28	81.91	2.80	2.36	15.70	0.00
1996	8786.81	8316	1073	94.72	94.72	93.23	94.67	4.21	4.17	1.12	0.00
1997	8195.01	7700	1073	87.92	87.92	87.19	87.90	0.00	0.00	12.08	0.00
1998	8967.83	8564	1073	97.77	97.77	95.41	97.76	2.23	2.23	0.00	0.00
1999	8224.84	7764	1073	88.67	90.31	87.50	88.63	0.00	0.00	9.69	1.64
2000	7853.51	7485	1073	85.23	85.23	83.32	85.21	4.20	3.73	11.04	0.00
2001	9504.59	8708	1087	99.42	99.42	100.02	99.41	0.09	0.09	0.49	0.00
2002	7048.21	6652	1087	75.97	75.97	74.02	75.94	1.71	1.32	22.71	0.00
2003	9585.43	8760	1087	100.00	100.00	100.66	100.00	0.00	0.00	0.00	0.00
2004	7233.89	6869	1087	78.23	78.23	75.76	78.20	0.79	0.63	21.14	0.00
2005	8323.35	7775	1087	88.77	88.77	87.41	88.76	0.00	0.00	11.23	0.00
2006	9944.98	8760	1122	100.00	100.00	101.18	100.00	0.00	0.00	0.00	0.00
2007	8868.35	7870	1122	89.87	89.87	90.23	89.84	2.14	1.97	8.16	0.00
2008	9884.24	8784	1122	100.00	100.00	100.29	100.00	0.00	0.00	0.00	0.00
2009	8237.57	7295	1122	83.29	83.29	83.81	83.28	0.00	0.00	16.71	0.00
2010	8677.45	7753	1122	88.53	88.53	88.29	88.50	0.00	0.00	11.47	0.00
2011	9916.75	8760	1122	100.00	100.00	100.90	100.00	0.00	0.00	0.00	0.00
2012	8295.66	7450	1122	84.84	84.84	84.17	84.81	0.00	0.00	15.16	0.00
2013	9653.45	8606	1122	98.24	98.24	98.21	98.23	1.76	1.76	0.00	0.00
2014	8556.89	7652	1122	87.35	87.35	87.06	87.35	3.13	2.82	9.83	0.00
2015	8793.72	7828	1138	89.50	89.50	88.21	89.36	0.00	0.00	10.50	0.00
2016	9974.63	8784	1138	100.00	100.00	99.78	100.00	0.00	0.00	0.00	0.00
2017	8204.54	7296	1138	83.29	83.29	82.30	83.29	0.00	0.00	16.71	0.00
2018	9733.67	8760	1138	100.00	100.00	97.64	100.00	0.00	0.00	0.00	0.00
2019	8871.17	7886	1138	90.03	90.03	88.99	90.02	0.00	0.00	9.97	0.00
2020	8910.58	8064	1138	91.81	91.81	89.14	91.80	0.00	0.00	8.19	0.00
2021	9827.85	8760	1138	100.00	100.00	98.59	100.00	0.00	0.00	0.00	0.00

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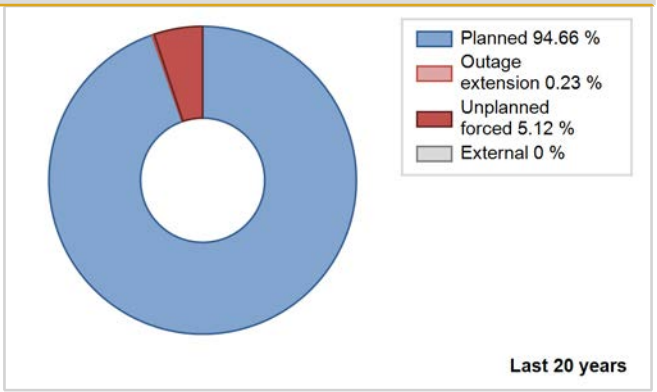
2022	8912.10	8040	1138	91.78	91.78	89.40	91.78	1.10	1.02	7.20	0.00
2023	8207.56	7502	1138	85.14	85.14	82.33	85.64	0.00	0.33	14.54	0.00
2024	Data not provided										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					148	
B. Refuelling without maintenance				34		
C. Inspection, maintenance or repair combined with refuelling				719		
D. Inspection, maintenance or repair without refuelling				83		
E. Testing of plant systems or components				0	1	
H. Nuclear regulatory requirements					4	
L. Human factor related					8	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
P. Fire					2	
Z. Other					3	
Subtotal				836	166	4
Total		**0**			**1006**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		2
13. Reactor Auxiliary Systems		5
14. Safety Systems		6
15. Reactor Cooling Systems		11
16. Steam generation systems		1
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		72
33. Circulating Water System		7
34. Miscellaneous Systems		1
35. All other I&C Systems		1
41. Main Generator Systems		2
42. Electrical Power Supply Systems		35
Total		**158**

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2024 Operating Experience

US-323 DIABLO CANYON-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	PG&E (Pacific Gas and Electric Company
Owner	:	PG&E COR (PG&E Corporation)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3411 MWth
Gross electrical power	:	1197 MWe
Reference unit power (net)	:	1118 MWe

Key Dates

Construction Date	:	1970-12-09
Grid Date	:	1985-10-20
Commercial Date	:	1986-03-13
Age at end of year	:	39 years

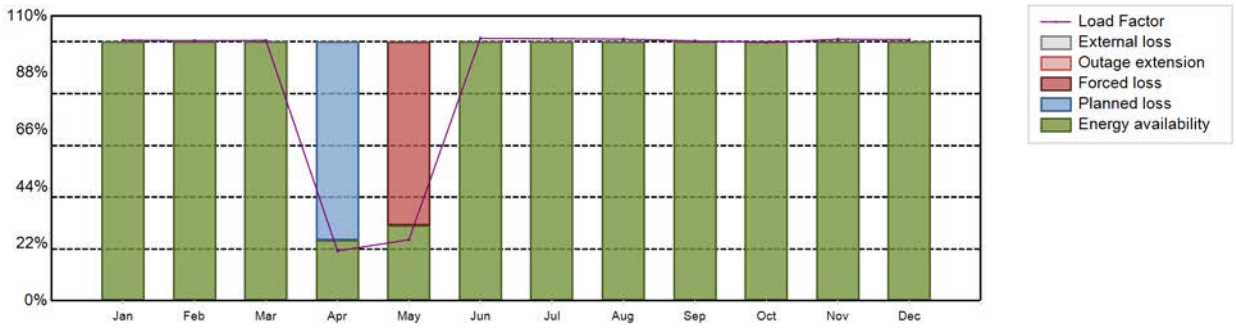
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.83
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	321
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.331
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	45000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	5.38
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	17.8	Number of main condensate pumps	:	-
Number of control rod assemblies	:	53	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8596.26 GW(e).h	Forced Loss Rate (FLR)	:	6.41 %
Energy Availability Factor (EAF)	:	87.7 %	Unplanned Capability Loss Factor (UCL)	:	6.01 %
Unit Capability Factor (UCF)	:	87.7 %	Planned Unavailability Factor (PUF)	:	6.28 %
Load Factor (LF)	:	87.53 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	87.69 %	Total off-line time	:	1081 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	837.30	781.90	835.45	155.29	196.31	816.08	841.92	840.78	807.98	830.26	814.22	838.78	8596.26
EAF [%]	100.00	100.00	100.00	23.33	29.03	100.00	100.00	100.00	100.00	100.00	100.00	100.00	87.70
UCF [%]	100.00	100.00	100.00	23.33	29.03	100.00	100.00	100.00	100.00	100.00	100.00	100.00	87.70
LF [%]	100.66	100.48	100.58	19.29	23.60	101.38	101.22	101.08	100.38	99.82	101.01	100.84	87.53
OF [%]	100.00	100.00	100.00	20.00	32.12	100.00	100.00	100.00	100.00	100.00	100.00	100.00	87.69
FLR [%]	0.00	0.00	0.00	0.00	70.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.41
UCL [%]	0.00	0.00	0.00	0.00	70.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.01
PUF [%]	0.00	0.00	0.00	76.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.28
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	325707.97 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.95 %
Cumulative Energy Availability Factor (EAF)	:	88.59 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.71 %
Cumulative Unit Capability Factor (UCF)	:	88.68 %	Cumulative Planned Unavailability Factor (PUF)	:	8.62 %
Cumulative Load Factor (LF)	:	86.88 %	Cumulative Externally cause unavailability (XUF)	:	0.08 %
Cumulative Operating Factor (OF)	:	88.59 %			

Electricity Production (net) [GWh]

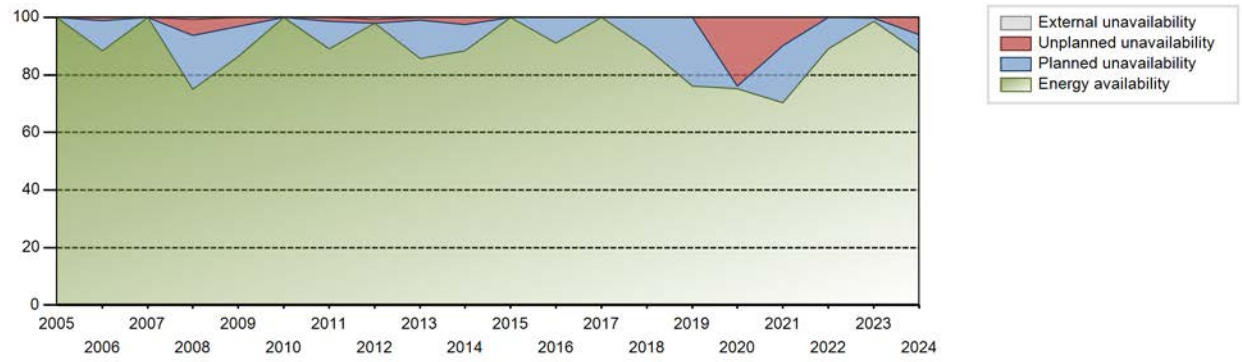


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	6757.71	7078	1080	95.39	95.39	86.22	95.41	4.21	4.19	0.42	0.00
1987	5728.78	5752	1079	65.44	65.44	60.61	65.66	9.03	6.50	28.06	0.00
1988	6243.35	6086	1087	69.33	69.33	65.39	69.29	10.10	7.79	22.88	0.00
1989	8615.97	8072	1087	92.18	92.18	90.48	92.15	5.91	5.79	2.03	0.00
1990	7578.08	7284	1087	83.15	83.15	79.58	83.15	0.29	0.24	16.61	0.00
1991	7718.47	7420	1087	84.70	84.70	81.06	84.70	0.00	0.00	15.30	0.00
1992	9247.73	8651	1087	98.50	98.50	96.85	98.49	1.50	1.50	0.00	0.00
1993	7796.19	7324	1087	83.64	83.64	81.87	83.61	1.00	0.84	15.51	0.00
1994	7896.10	7439	1087	84.98	84.98	82.92	84.92	6.18	5.59	9.43	0.00
1995	8820.98	8430	1087	96.28	96.28	92.64	96.23	3.72	3.72	0.00	0.00
1996	7932.91	7459	1087	84.96	84.96	83.08	84.92	2.12	1.84	13.19	0.00
1997	8883.55	8441	1087	96.39	96.39	93.29	96.36	3.61	3.61	0.00	0.00
1998	8158.97	7624	1087	87.06	87.06	85.68	87.03	1.67	1.48	11.46	0.00
1999	8443.69	7902	1087	90.22	91.31	88.67	90.21	0.00	0.00	8.69	1.09
2000	9188.54	8512	1087	96.91	96.91	96.23	96.90	2.67	2.66	0.43	0.00
2001	8658.37	8051	1087	91.93	91.93	90.93	91.91	0.00	0.00	8.07	0.00
2002	9286.06	8663	1087	98.90	99.58	97.52	98.89	0.42	0.42	0.00	0.67
2003	7725.23	7225	1087	82.50	82.50	81.13	82.48	4.07	3.50	14.01	0.00
2004	8017.93	7535	1087	85.79	85.79	83.97	85.78	0.00	0.00	14.21	0.00
2005	9441.73	8760	1087	100.00	100.00	99.14	99.99	0.00	0.00	0.00	0.00
2006	8529.60	7734	1087	88.30	88.30	89.58	88.29	1.20	1.07	10.63	0.00
2007	9720.14	8760	1118	100.00	100.00	99.25	100.00	0.00	0.00	0.00	0.00
2008	7263.10	6578	1118	74.93	75.65	73.96	74.89	6.79	5.51	18.83	0.72
2009	7998.16	7565	1118	86.41	86.41	81.67	86.36	3.62	3.25	10.34	0.00
2010	9752.48	8760	1118	100.00	100.00	99.58	100.00	0.00	0.00	0.00	0.00
2011	8751.61	7789	1118	88.94	88.94	89.36	88.92	1.41	1.27	9.79	0.00
2012	9474.76	8609	1118	98.02	98.79	96.48	98.01	1.21	1.21	0.00	0.77
2013	8428.27	7499	1118	85.61	85.61	86.05	85.60	1.16	1.00	13.39	0.00
2014	8499.41	7742	1118	88.38	88.38	86.78	88.38	2.84	2.58	9.03	0.00
2015	9749.16	8757	1118	99.96	99.96	99.55	99.97	0.00	0.00	0.04	0.00
2016	8966.24	8001	1118	91.09	91.09	91.30	91.09	0.00	0.00	8.91	0.00
2017	9765.30	8760	1118	100.00	100.00	99.71	100.00	0.00	0.00	0.00	0.00
2018	8560.44	7765	1118	89.29	89.29	87.41	88.64	0.00	0.00	10.71	0.00
2019	7350.12	6664	1118	76.08	76.08	75.05	76.07	0.00	0.00	23.92	0.00
2020	7348.12	6613	1118	75.28	75.28	74.82	75.28	24.17	24.00	0.72	0.00
2021	6411.51	6160	1118	70.32	70.32	65.47	70.32	12.24	9.81	19.88	0.00
2022	8743.28	7803	1118	89.07	89.07	89.27	89.08	0.00	0.00	10.93	0.00

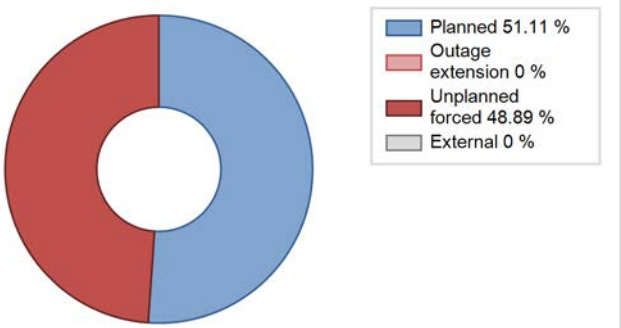
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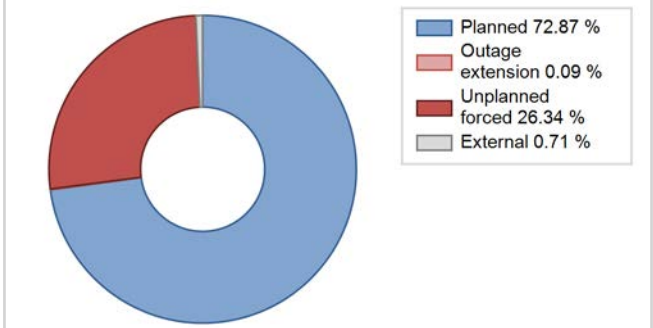
2023	9554.55	8736	1118	98.69	98.69	97.56	99.73	0.00	0.19	1.12	0.00
2024	8596.26	7703	1118	87.70	87.70	87.53	87.69	6.41	6.01	6.28	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		528			143	
B. Refuelling without maintenance				69		
C. Inspection, maintenance or repair combined with refuelling	552			673		
D. Inspection, maintenance or repair without refuelling				12		
E. Testing of plant systems or components				1		
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					8	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						16
Z. Other					105	
Subtotal	552	528		755	256	17
Total	**1080**			**1028**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	528	13
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		5
15. Reactor Cooling Systems		4
31. Turbine and auxiliaries		14
32. Feedwater and Main Steam System		26
33. Circulating Water System		6
34. Miscellaneous Systems		6
35. All other I&C Systems		6
41. Main Generator Systems		7
42. Electrical Power Supply Systems		61
Total	**528**	**155**

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2024 Operating Experience

US-237 DRESDEN-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-3 (Mark 1)
Thermal power	:	2957 MWth
Gross electrical power	:	950 MWe
Reference unit power (net)	:	894 MWe

Key Dates

Construction Date	:	1966-01-10
Grid Date	:	1970-04-13
Commercial Date	:	1970-06-09
Age at end of year	:	54 years

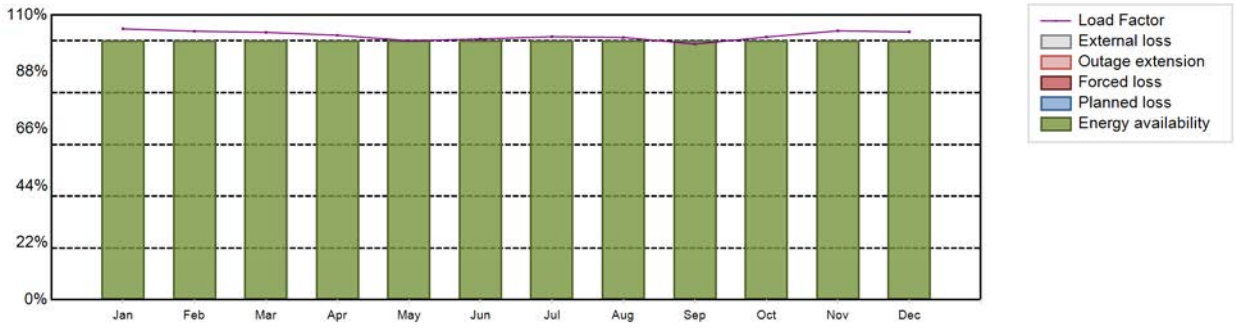
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.1
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	286
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.43
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	35	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	47000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.55	HP cylinder inlet steam pressure [MPa]	:	6.57
Active core height/length [m]	:	3.6	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	724	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	102.11 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



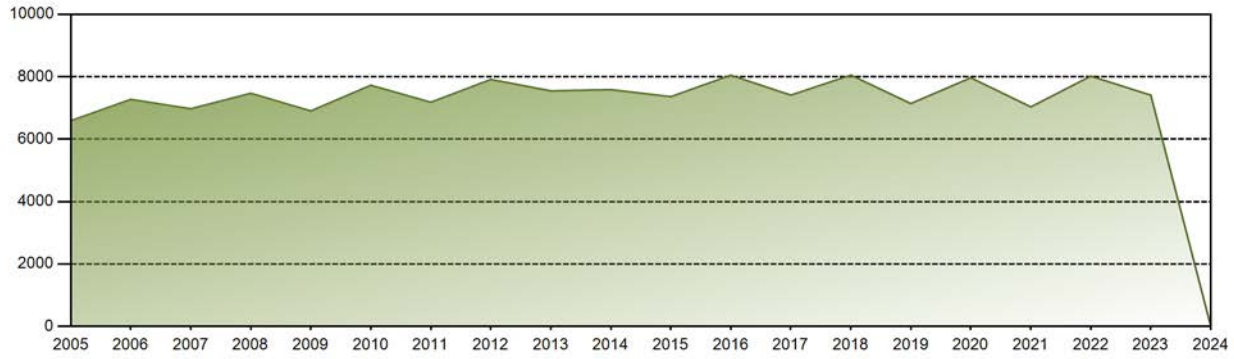
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	696.03	645.57	686.14	657.73	665.68	648.47	675.90	674.11	635.77	675.08	669.60	688.27	8018.36
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	104.65	103.75	103.30	102.18	100.08	100.74	101.62	101.35	98.77	101.49	103.88	103.48	102.11
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.6 %
Cumulative Energy Availability Factor (EAF)	:	83.33 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.89 %
Cumulative Unit Capability Factor (UCF)	:	83.35 %	Cumulative Planned Unavailability Factor (PUF)	:	10.76 %
Cumulative Load Factor (LF)	:	76.62 %	Cumulative Externally cause unavailability (XUF)	:	0.03 %
Cumulative Operating Factor (OF)	:	81.51 %			

Electricity Production (net) [GWh]

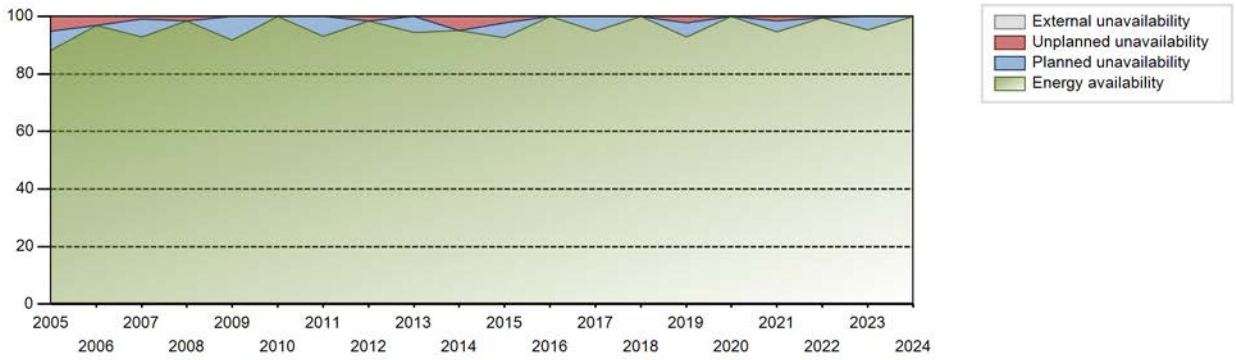


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1970	1253.00	2558	804	100.00	100.00	23.94	37.87	0.00	0.00	0.00	0.00
1971	2806.30	5694	815	100.00	100.00	39.31	65.00	0.00	0.00	0.00	0.00
1972	3370.50	5240	815	100.00	100.00	47.08	59.65	0.00	0.00	0.00	0.00
1973	5014.50	7672	800	90.77	90.77	71.55	87.58	3.23	3.03	6.20	0.00
1974	3376.00	5113	800	58.33	58.33	48.17	58.37	28.52	23.27	18.40	0.00
1975	2957.00	4826	800	42.24	42.24	42.19	55.09	21.18	11.35	46.42	0.00
1976	4374.40	6660	781	64.08	64.08	63.76	75.82	14.77	11.11	24.82	0.00
1977	3538.10	6297	772	52.38	52.38	52.32	71.88	25.03	17.48	30.14	0.00
1978	5704.50	8244	772	84.39	84.39	84.35	94.11	14.03	13.78	1.83	0.00
1979	4942.90	7141	772	73.09	73.09	73.09	81.52	9.04	7.27	19.64	0.00
1980	4580.40	8193	772	93.53	93.53	67.55	93.27	4.90	4.82	1.65	0.00
1981	3416.00	5260	772	60.11	60.68	50.51	60.05	6.66	4.33	34.99	0.57
1982	5123.10	8094	772	92.42	92.98	75.76	92.40	5.86	5.79	1.23	0.56
1983	3402.20	5076	772	58.91	59.23	50.31	57.95	15.72	11.05	29.73	0.32
1984	4468.36	6402	772	72.91	72.91	65.89	72.88	4.33	3.30	23.79	0.00
1985	3105.97	4678	772	54.52	54.52	45.93	53.40	12.95	8.11	37.36	0.00
1986	4655.67	6761	772	77.22	77.22	68.84	77.18	15.21	13.85	8.93	0.00
1987	3362.64	5342	772	61.03	61.03	49.72	60.98	8.49	5.67	33.31	0.00
1988	4325.16	6931	772	78.92	78.92	63.78	78.90	0.10	0.08	20.99	0.00
1989	4751.70	7023	772	80.19	80.19	70.26	80.17	2.74	2.26	17.55	0.00
1990	4116.85	5920	772	67.60	67.60	60.88	67.58	6.89	5.00	27.40	0.00
1991	2984.21	5031	772	57.96	57.96	44.13	57.43	34.46	30.48	11.56	0.00
1992	4185.75	7419	772	84.47	84.47	61.73	84.46	15.53	15.53	0.00	0.00
1993	3058.56	4790	772	54.69	54.69	45.23	54.68	15.70	10.18	35.13	0.00
1994	4086.10	5808	772	66.31	66.31	60.42	66.30	33.69	33.69	0.00	0.00
1995	1890.54	2938	772	33.54	33.54	27.96	33.54	20.62	8.71	57.75	0.00
1996	2161.41	3731	772	42.49	42.49	31.87	42.47	37.92	25.96	31.56	0.00
1997	5578.45	7738	772	89.44	89.44	82.49	88.33	10.56	10.56	0.00	0.00
1998	5632.86	7496	772	85.57	85.57	83.29	85.57	3.40	3.01	11.42	0.00
1999	6229.52	8122	772	92.72	92.72	92.12	92.72	0.00	0.00	7.28	0.00
2000	6867.43	8747	772	99.58	99.58	101.27	99.58	0.42	0.42	0.00	0.00
2001	6072.69	8005	772	91.21	91.21	89.80	91.38	3.47	3.28	5.50	0.00
2002	7527.47	8760	850	100.00	100.00	101.09	100.00	0.00	0.00	0.00	0.00
2003	6703.11	7999	850	91.96	91.96	90.02	91.31	0.78	0.72	7.32	0.00
2004	5909.32	7045	850	80.20	80.20	79.15	80.20	17.35	16.84	2.96	0.00
2005	6590.08	7710	850	88.04	88.04	88.51	88.01	5.56	5.18	6.77	0.00
2006	7273.22	8485	867	96.88	96.88	95.76	96.86	3.12	3.12	0.00	0.00

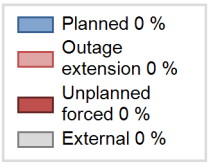
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2007	6972.69	8132	867	92.84	92.84	91.81	92.83	1.09	1.02	6.13	0.00
2008	7469.52	8639	867	98.37	98.37	98.08	98.35	1.63	1.63	0.00	0.00
2009	6902.62	8033	867	91.71	91.71	90.88	91.70	0.00	0.00	8.29	0.00
2010	7726.88	8760	867	100.00	100.00	101.74	100.00	0.00	0.00	0.00	0.00
2011	7181.34	8150	883	93.07	93.07	94.26	93.04	0.00	0.00	6.93	0.00
2012	7912.78	8634	883	98.30	98.30	102.02	98.29	1.70	1.70	0.00	0.00
2013	7546.81	8266	883	94.36	94.36	97.55	94.35	0.00	0.00	5.64	0.00
2014	7585.87	8315	894	94.99	94.99	96.86	94.92	5.01	5.01	0.00	0.00
2015	7360.79	8106	894	92.53	92.53	93.99	92.53	2.35	2.23	5.24	0.00
2016	8047.97	8784	894	100.00	100.00	102.48	100.00	0.00	0.00	0.00	0.00
2017	7409.85	8299	902	94.78	94.78	93.78	94.74	0.00	0.00	5.22	0.00
2018	8051.49	8760	894	100.00	100.00	102.81	100.00	0.00	0.00	0.00	0.00
2019	7139.16	8128	894	92.80	92.80	91.16	92.79	2.35	2.24	4.97	0.00
2020	7966.53	8674	894	99.97	99.97	101.45	98.75	0.03	0.03	0.00	0.00
2021	7032.49	8285	894	94.58	94.58	89.80	94.58	1.63	1.57	3.85	0.00
2022	8019.51	8712	894	99.45	99.45	102.40	99.45	0.55	0.55	0.00	0.00
2023	7408.14	8258	894	95.22	95.22	94.59	94.27	0.00	0.00	4.78	0.00
2024	Data not provided										

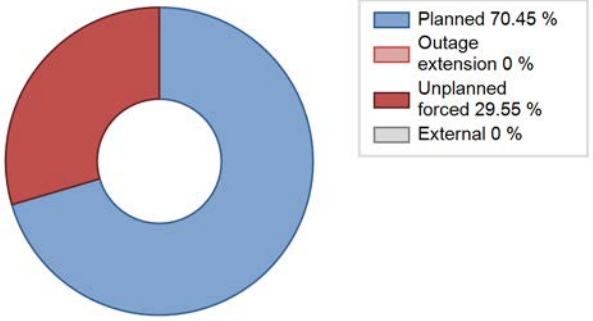
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1970 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					453	
B. Refuelling without maintenance				6		
C. Inspection, maintenance or repair combined with refuelling				971		
D. Inspection, maintenance or repair without refuelling				49		
E. Testing of plant systems or components				8	31	
H. Nuclear regulatory requirements					2	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					13	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
Z. Other					10	1
Subtotal				1034	509	4
Total		**0**			**1547**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1970 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		53
12. Reactor I&C Systems		55
13. Reactor Auxiliary Systems		10
14. Safety Systems		19
15. Reactor Cooling Systems		74
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		109
32. Feedwater and Main Steam System		28
34. Miscellaneous Systems		35
35. All other I&C Systems		15
41. Main Generator Systems		42
42. Electrical Power Supply Systems		49
Total		**490**

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2024 Operating Experience

US-249 DRESDEN-3 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-3 (Mark 1)
Thermal power	:	2957 MWth
Gross electrical power	:	935 MWe
Reference unit power (net)	:	879 MWe

Key Dates

Construction Date	:	1966-10-14
Grid Date	:	1971-07-22
Commercial Date	:	1971-11-16
Age at end of year	:	53 years

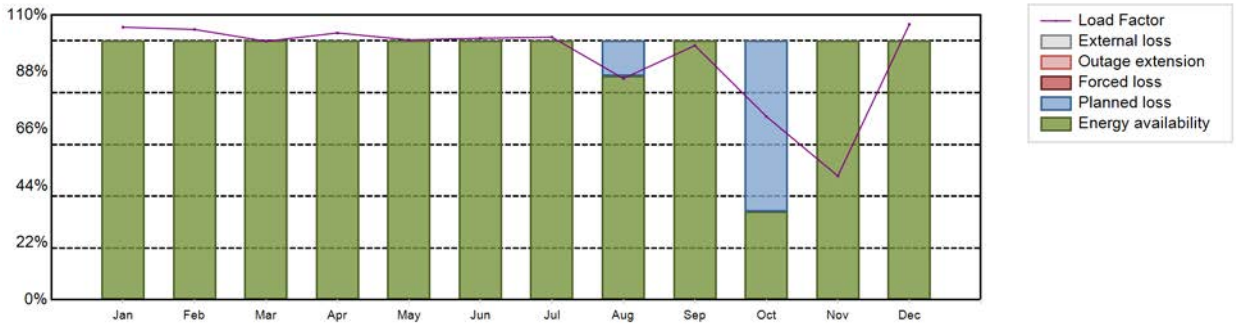
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.1
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	286
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.43
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	35	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	47000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.55	HP cylinder inlet steam pressure [MPa]	:	6.57
Active core height/length [m]	:	3.6	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	724	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	89	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7234.12 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	93.28 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	93.28 %	Planned Unavailability Factor (PUF)	:	6.72 %
Load Factor (LF)	:	93.69 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	93.4 %	Total off-line time	:	580 hours

Annual Summary



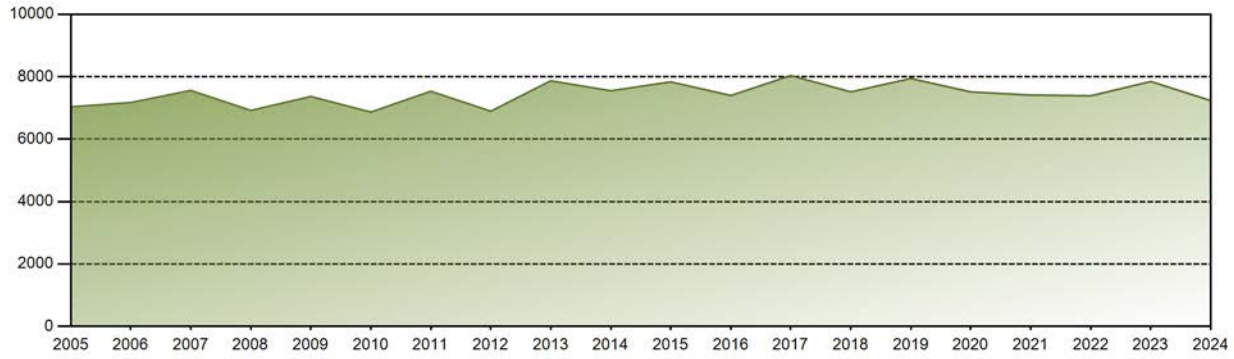
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	688.66	638.87	652.23	652.36	656.60	639.42	663.45	559.02	621.51	463.07	303.14	695.80	7234.12
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	86.46	100.00	34.20	100.00	100.00	93.28
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	86.46	100.00	34.20	100.00	100.00	93.28
LF [%]	105.30	104.43	99.87	103.08	100.40	101.03	101.45	85.48	98.20	70.81	47.83	106.39	93.69
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	86.69	100.00	87.10	46.60	100.00	93.40
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.54	0.00	65.80	0.00	0.00	6.72
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	292163.28 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.91 %
Cumulative Energy Availability Factor (EAF)	:	80.88 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.01 %
Cumulative Unit Capability Factor (UCF)	:	80.9 %	Cumulative Planned Unavailability Factor (PUF)	:	13.1 %
Cumulative Load Factor (LF)	:	76.87 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	81.37 %			

Electricity Production (net) [GWh]

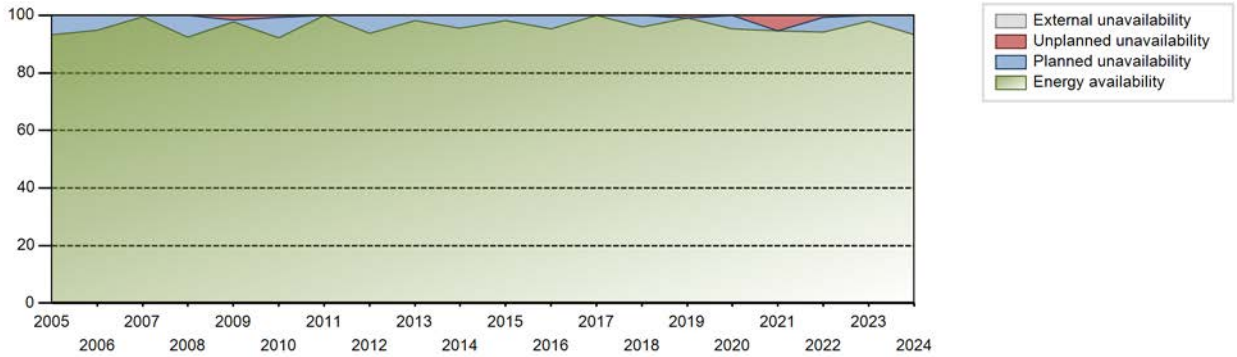


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1971	1188.60	2137	794	100.00	100.00	27.90	32.39	0.00	0.00	0.00	0.00
1972	5175.60	7549	815	100.00	100.00	72.30	85.94	0.00	0.00	0.00	0.00
1973	3703.60	5905	800	69.20	69.20	52.85	67.41	3.22	2.30	28.50	0.00
1974	3608.90	5778	800	65.78	65.78	51.50	65.96	12.31	9.24	24.99	0.00
1975	2211.20	4505	800	31.54	31.54	31.55	51.43	39.55	20.64	47.82	0.00
1976	4037.20	7231	781	58.75	58.75	58.85	82.32	21.91	16.48	24.77	0.00
1977	5186.40	8072	773	76.64	76.64	76.59	92.15	20.11	19.29	4.07	0.00
1978	3835.30	6280	773	56.63	56.63	56.64	71.69	22.30	16.25	27.12	0.00
1979	3482.90	5930	773	51.43	51.43	51.43	67.69	42.55	38.09	10.47	0.00
1980	4335.50	6307	773	72.31	72.31	63.85	71.80	2.52	1.87	25.82	0.00
1981	5177.70	8256	773	94.49	95.11	76.46	94.25	4.89	4.89	0.00	0.62
1982	3896.40	5562	773	63.79	64.34	57.54	63.49	3.40	2.27	33.39	0.55
1983	4159.70	6401	773	73.10	73.10	61.43	73.07	2.21	1.65	25.25	0.00
1984	2135.50	3309	773	37.72	37.72	31.45	37.67	14.16	6.22	56.06	0.00
1985	4401.33	6618	773	75.58	75.58	65.00	75.55	5.73	4.59	19.83	0.00
1986	1498.30	2456	773	28.06	28.06	22.13	28.04	15.97	5.33	66.61	0.00
1987	4395.50	6591	773	75.30	75.30	64.91	75.24	23.78	23.50	1.20	0.00
1988	4168.36	6278	773	71.50	71.50	61.39	71.47	0.00	0.00	28.50	0.00
1989	5119.46	7235	773	82.62	82.62	75.60	82.59	3.07	2.62	14.77	0.00
1990	5149.79	7272	773	83.01	83.01	76.05	83.01	4.75	4.14	12.84	0.00
1991	2584.21	5247	773	59.91	59.91	38.16	59.90	2.24	1.37	38.72	0.00
1992	3077.06	5364	773	61.08	61.08	45.32	61.07	10.64	7.27	31.65	0.00
1993	4969.04	7040	773	80.39	80.39	73.38	80.37	19.61	19.61	0.00	0.00
1994	1666.36	3009	773	34.35	34.35	24.61	34.35	0.00	0.00	65.65	0.00
1995	3477.26	5209	773	59.46	59.46	51.35	59.46	40.54	40.54	0.00	0.00
1996	2962.14	4273	773	48.88	48.88	43.62	48.65	51.12	51.12	0.00	0.00
1997	4046.20	5900	773	68.55	68.55	59.75	67.35	11.27	8.71	22.74	0.00
1998	6234.59	8157	773	93.12	93.12	92.07	93.12	3.26	3.14	3.75	0.00
1999	6129.96	7978	773	91.07	91.07	90.53	91.07	1.69	1.56	7.36	0.00
2000	6365.12	8243	773	93.84	93.84	93.74	93.84	0.73	0.69	5.46	0.00
2001	6465.95	8359	773	95.36	95.36	95.49	95.42	3.98	3.95	0.69	0.00
2002	6060.87	7915	850	90.46	90.46	87.31	90.35	2.39	2.21	7.33	0.00
2003	6963.86	8206	850	94.17	94.17	93.52	93.68	2.16	2.07	3.76	0.00
2004	6436.94	7544	850	85.88	85.88	86.21	85.88	2.87	2.54	11.58	0.00
2005	7032.37	8169	850	93.28	93.28	94.43	93.24	0.15	0.14	6.59	0.00
2006	7171.93	8298	867	94.73	94.73	94.43	94.73	0.00	0.00	5.27	0.00
2007	7558.09	8715	867	99.49	99.49	99.52	99.49	0.00	0.00	0.51	0.00

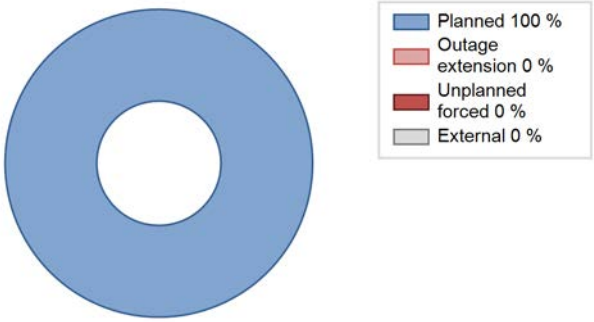
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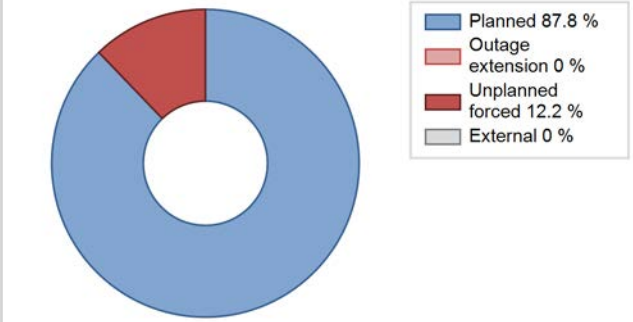
2008	6919.05	8118	867	92.43	92.43	90.85	92.42	0.00	0.00	7.57	0.00
2009	7364.79	8557	867	97.70	97.70	96.97	97.68	1.65	1.64	0.66	0.00
2010	6866.24	8076	867	92.21	92.21	90.41	92.19	0.79	0.73	7.05	0.00
2011	7533.02	8760	867	100.00	100.00	99.18	100.00	0.00	0.00	0.00	0.00
2012	6892.73	8218	867	93.69	93.69	90.51	93.56	0.00	0.00	6.31	0.00
2013	7869.99	8590	867	98.10	98.10	103.61	98.05	0.00	0.00	1.90	0.00
2014	7549.85	8361	879	95.51	95.51	98.05	95.45	0.00	0.00	4.49	0.00
2015	7832.94	8595	879	98.11	98.11	101.73	98.12	0.00	0.00	1.89	0.00
2016	7397.58	8376	879	95.35	95.35	95.81	95.36	0.00	0.00	4.65	0.00
2017	8036.77	8760	895	100.00	100.00	102.51	100.00	0.00	0.00	0.00	0.00
2018	7514.36	8401	879	95.94	95.94	97.59	95.90	0.00	0.00	4.06	0.00
2019	7942.88	8674	879	99.03	99.03	103.15	99.02	0.97	0.97	0.00	0.00
2020	7512.35	8372	879	95.30	95.30	97.30	95.31	0.00	0.00	4.70	0.00
2021	7411.09	8286	879	94.59	94.59	96.25	94.59	5.41	5.41	0.00	0.00
2022	7389.45	8251	879	94.19	94.19	95.97	94.19	0.76	0.72	5.09	0.00
2023	7845.87	8675	879	98.01	98.01	101.89	99.03	0.00	0.00	1.99	0.00
2024	7234.12	8204	879	93.28	93.28	93.69	93.40	0.00	0.00	6.72	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1971 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					474	
B. Refuelling without maintenance				21		
C. Inspection, maintenance or repair combined with refuelling	481			1002		
D. Inspection, maintenance or repair without refuelling	99			88		
E. Testing of plant systems or components				2	7	
H. Nuclear regulatory requirements					2	
L. Human factor related					17	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				1		
Z. Other					21	
Subtotal	580			1114	521	1
Total	**580**			**1636**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1971 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		14
13. Reactor Auxiliary Systems		2
14. Safety Systems		41
15. Reactor Cooling Systems		41
17. Safety I&C Systems (excluding reactor I&C)		46
31. Turbine and auxiliaries		151
32. Feedwater and Main Steam System		45
33. Circulating Water System		5
34. Miscellaneous Systems		58
35. All other I&C Systems		1
41. Main Generator Systems		12
42. Electrical Power Supply Systems		67
Total		**490**

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2024 Operating Experience

US-348 FARLEY-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	SOUTHERN (Southern Nuclear Operating Company, Inc.)
Owner	:	APCO (Alabama Power Company)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYAMB)
Thermal power	:	2775 MWth
Gross electrical power	:	918 MWe
Reference unit power (net)	:	874 MWe

Key Dates

Construction Date	:	1970-10-01
Grid Date	:	1977-08-18
Commercial Date	:	1977-12-01
Age at end of year	:	47 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.02
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.1
Number of control rod assemblies	:	45
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

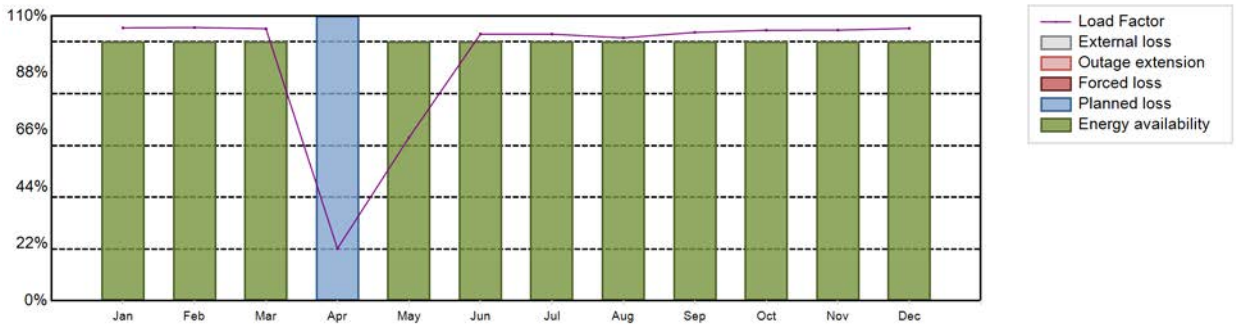
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	322
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.38
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.27
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7200.89 GW(e).h
Energy Availability Factor (EAF)	:	90.57 %
Unit Capability Factor (UCF)	:	90.57 %
Load Factor (LF)	:	93.8 %
Operating Factor (OF)	:	90.79 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	9.43 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	809 hours

Annual Summary



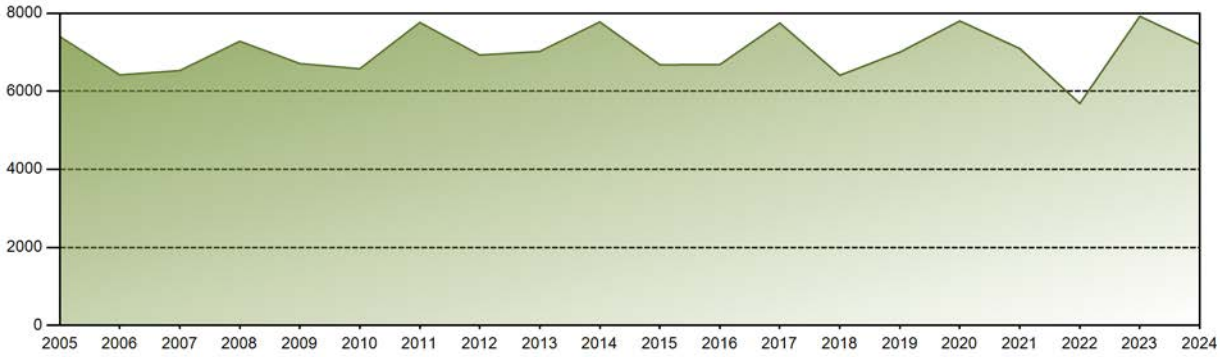
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	685.62	642.15	682.57	127.06	409.91	648.38	669.81	660.50	652.36	679.58	658.75	684.19	7200.89
EAF [%]	100.00	100.00	100.00	-15.11	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.57
UCF [%]	100.00	100.00	100.00	-15.11	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.57
LF [%]	105.44	105.56	105.11	20.19	63.04	103.04	103.01	101.58	103.67	104.51	104.54	105.22	93.80
OF [%]	100.00	100.00	100.00	21.11	67.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.79
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	115.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.43
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	295261.04 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.76 %
Cumulative Energy Availability Factor (EAF)	:	86.09 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.44 %
Cumulative Unit Capability Factor (UCF)	:	86.19 %	Cumulative Planned Unavailability Factor (PUF)	:	11.37 %
Cumulative Load Factor (LF)	:	85.23 %	Cumulative Externally cause unavailability (XUF)	:	0.1 %
Cumulative Operating Factor (OF)	:	86.08 %			

Electricity Production (net) [GWh]

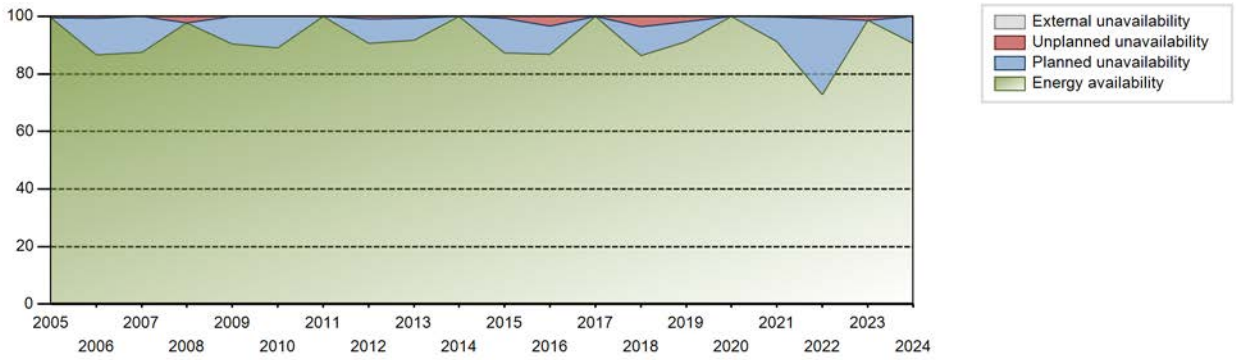


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1977	1047.90	1747	820	100.00	100.00	64.19	68.82	0.00	0.00	0.00	0.00
1978	5919.80	7568	829	81.52	81.52	81.52	86.39	11.24	10.32	8.16	0.00
1979	1732.40	2502	829	23.85	23.85	23.86	28.56	14.61	4.08	72.07	0.00
1980	4607.80	6110	814	70.17	74.38	64.44	69.56	5.04	3.94	21.68	4.21
1981	2653.00	3624	804	41.54	41.54	37.67	41.37	45.41	34.56	23.90	0.00
1982	5233.30	6936	804	79.29	79.29	74.30	79.18	20.47	20.41	0.31	0.00
1983	5268.60	6832	804	77.73	77.73	74.81	77.99	1.31	1.03	21.24	0.00
1984	5432.66	6920	804	78.50	78.50	76.92	78.78	1.16	0.92	20.58	0.00
1985	5868.67	7378	816	84.29	84.29	82.10	84.22	1.82	1.56	14.15	0.00
1986	5738.56	7247	827	82.41	82.41	79.21	82.73	1.58	1.32	16.27	0.00
1987	6444.86	8201	825	93.68	93.68	89.17	93.62	3.77	3.67	2.64	0.00
1988	5908.21	7363	813	83.80	83.80	82.73	83.82	0.68	0.58	15.62	0.00
1989	6022.64	7520	824	86.02	86.02	83.44	85.84	1.01	0.88	13.10	0.00
1990	6908.57	8681	824	99.11	99.11	95.71	99.10	0.89	0.89	0.00	0.00
1991	5416.06	6870	814	78.44	78.90	75.95	78.42	1.68	1.35	19.75	0.46
1992	5667.94	7119	812	80.98	80.98	79.47	81.05	0.46	0.38	18.65	0.00
1993	6873.90	8522	812	97.28	97.28	96.64	97.28	2.72	2.72	0.00	0.00
1994	6059.84	7546	812	86.11	86.11	85.19	86.14	0.00	0.00	13.89	0.00
1995	5751.98	7220	812	82.41	82.41	80.86	82.42	4.72	4.08	13.51	0.00
1996	7142.30	8740	812	99.50	99.50	100.14	99.50	0.00	0.00	0.50	0.00
1997	5433.98	6803	821	77.72	77.72	75.54	77.66	0.00	0.00	22.28	0.00
1998	5237.94	6539	822	74.81	74.81	72.74	74.65	6.58	5.27	19.92	0.00
1999	7226.52	8695	847	99.26	99.26	97.40	99.26	0.74	0.74	0.00	0.00
2000	5204.09	6775	828	76.82	76.82	71.55	77.13	0.42	0.32	22.86	0.00
2001	6392.53	7736	833	88.33	88.33	87.60	88.31	0.00	0.00	11.67	0.00
2002	7221.79	8641	833	98.65	98.65	98.97	98.64	1.35	1.35	0.00	0.00
2003	6609.90	7909	830	90.30	90.30	90.91	90.29	0.00	0.00	9.70	0.00
2004	6423.88	7627	851	86.99	86.99	86.83	86.83	0.53	0.46	12.54	0.00
2005	7402.19	8709	833	99.42	99.42	101.43	99.41	0.58	0.58	0.00	0.00
2006	6419.32	7578	851	86.53	86.53	86.11	86.51	0.71	0.62	12.85	0.00
2007	6530.77	7663	851	87.49	87.49	87.61	87.48	0.00	0.00	12.51	0.00
2008	7281.47	8579	851	97.68	97.68	97.41	97.67	2.32	2.32	0.00	0.00
2009	6711.12	7922	851	90.46	90.46	90.02	90.43	0.00	0.00	9.54	0.00
2010	6577.44	7806	851	89.13	89.13	88.23	89.11	0.00	0.00	10.87	0.00
2011	7764.30	8760	874	100.00	100.00	101.41	100.00	0.00	0.00	0.00	0.00
2012	6929.42	7967	874	90.71	90.71	90.26	90.70	0.99	0.91	8.38	0.00
2013	7021.41	8033	874	91.70	91.70	91.70	91.69	0.66	0.61	7.69	0.00

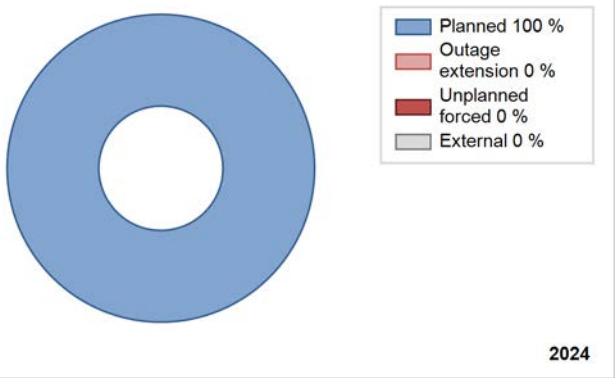
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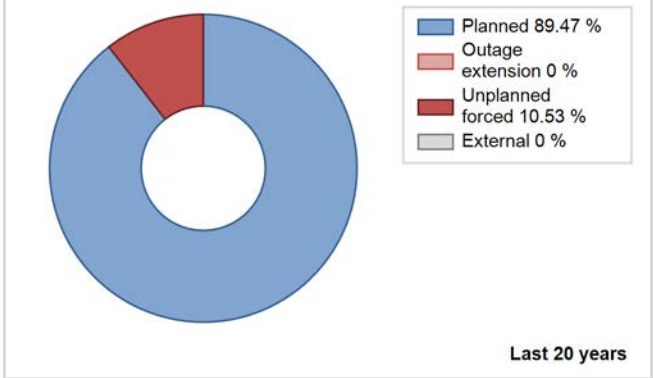
2014	7777.43	8760	874	100.00	100.00	101.58	100.00	0.00	0.00	0.00	0.00
2015	6680.66	7652	874	87.35	87.35	87.26	87.35	0.82	0.73	11.93	0.00
2016	6684.05	7617	874	86.72	86.72	87.06	86.71	3.78	3.41	9.87	0.00
2017	7750.07	8760	874	100.00	100.00	101.23	100.00	0.00	0.00	0.00	0.00
2018	6409.66	7567	874	86.37	86.37	83.72	86.38	4.03	3.63	10.00	0.00
2019	7003.19	7993	874	91.26	91.26	91.47	91.24	1.92	1.79	6.95	0.00
2020	7802.41	8783	874	100.00	100.00	101.63	99.99	0.00	0.00	0.00	0.00
2021	7096.20	7987	874	91.17	91.17	92.69	91.18	0.39	0.36	8.47	0.00
2022	5688.30	6367	874	72.68	72.68	74.30	72.68	0.96	0.71	26.61	0.00
2023	7922.18	8676	874	98.63	98.63	103.47	99.04	1.37	1.37	0.00	0.00
2024	7200.89	7975	874	90.57	90.57	93.80	90.79	0.00	0.00	9.43	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1977 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					182	
B.	Refuelling without maintenance				16		
C.	Inspection, maintenance or repair combined with refuelling	809			883		
D.	Inspection, maintenance or repair without refuelling				48		
E.	Testing of plant systems or components				1	0	
H.	Nuclear regulatory requirements				50	18	
L.	Human factor related					10	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
Z.	Other					3	
Subtotal		809			998	213	4
Total		**809**			**1215**		

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1977 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		1
14. Safety Systems		3
15. Reactor Cooling Systems		8
16. Steam generation systems		20
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		73
32. Feedwater and Main Steam System		16
33. Circulating Water System		1
34. Miscellaneous Systems		1
35. All other I&C Systems		2
41. Main Generator Systems		10
42. Electrical Power Supply Systems		48
Total		**195**

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2024 Operating Experience

US-364 FARLEY-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	SOUTHERN (Southern Nuclear Operating Company, Inc.)
Owner	:	APCO (Alabama Power Company)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYAMB)
Thermal power	:	2775 MWth
Gross electrical power	:	928 MWe
Reference unit power (net)	:	883 MWe

Key Dates

Construction Date	:	1970-10-01
Grid Date	:	1981-05-25
Commercial Date	:	1981-07-30
Age at end of year	:	43 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.02
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.1
Number of control rod assemblies	:	45
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

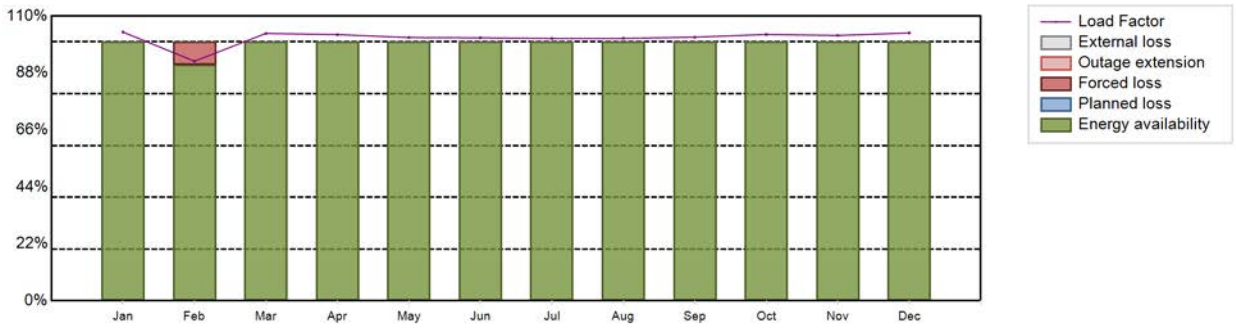
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	322
Number of SG	:	3
Containment type	:	Single
Containment design pressure [MPa]	:	0.38
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.27
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7883.08 GW(e).h
Energy Availability Factor (EAF)	:	99.29 %
Unit Capability Factor (UCF)	:	99.29 %
Load Factor (LF)	:	101.63 %
Operating Factor (OF)	:	99.31 %

Forced Loss Rate (FLR)	:	0.71 %
Unplanned Capability Loss Factor (UCL)	:	0.71 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	61 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	681.95	568.83	677.54	653.80	668.00	645.78	665.81	665.89	647.46	675.88	652.54	679.62	7883.08
EAF [%]	100.00	91.07	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.29
UCF [%]	100.00	91.07	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.29
LF [%]	103.80	92.56	103.27	102.84	101.68	101.58	101.35	101.36	101.84	102.88	102.50	103.45	101.63
OF [%]	100.00	91.24	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.31
FLR [%]	0.00	8.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
UCL [%]	0.00	8.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	285958.48 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.65 %
Cumulative Energy Availability Factor (EAF)	:	89.65 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.5 %
Cumulative Unit Capability Factor (UCF)	:	89.68 %	Cumulative Planned Unavailability Factor (PUF)	:	8.82 %
Cumulative Load Factor (LF)	:	88.34 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	89.4 %			

Electricity Production (net) [GWh]

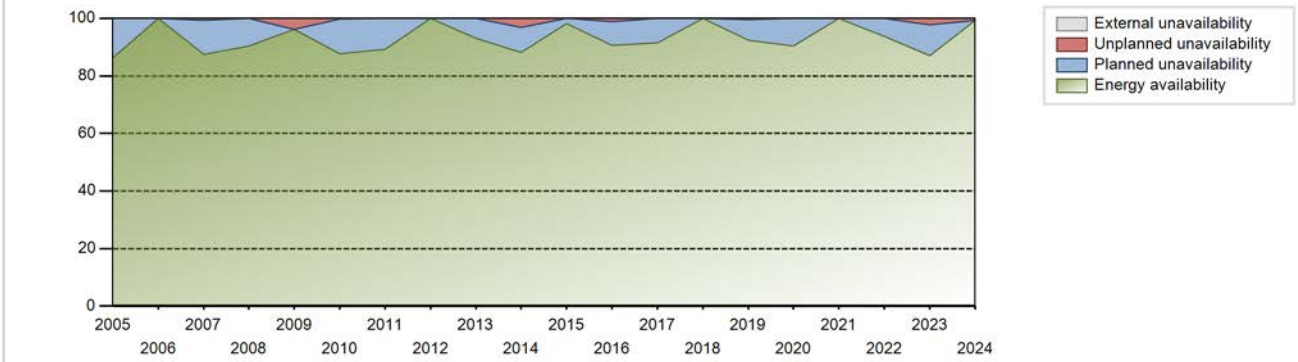


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	2920.80	3665	825	99.28	99.28	95.08	98.48	0.72	0.72	0.00	0.00
1982	5311.30	6931	814	79.41	79.41	74.49	79.12	10.30	9.12	11.47	0.00
1983	5984.10	7696	814	87.72	87.72	83.92	87.85	1.97	1.77	10.52	0.00
1984	6618.90	8276	814	94.18	94.41	92.57	94.22	5.59	5.59	0.00	0.22
1985	5474.18	6813	809	77.36	77.85	77.24	77.77	1.59	1.26	20.89	0.49
1986	5959.87	7455	829	85.22	85.22	82.07	85.10	2.41	2.11	12.67	0.00
1987	4910.40	6396	824	73.02	73.02	68.00	73.01	11.35	9.35	17.64	0.00
1988	6550.39	8039	823	100.00	100.00	90.59	91.52	0.00	0.00	0.00	0.00
1989	5621.62	7037	830	80.48	80.48	77.32	80.33	4.66	3.94	15.59	0.00
1990	5276.96	6478	828	71.77	71.77	72.75	73.95	4.34	3.25	24.98	0.00
1991	6739.94	8376	824	95.64	95.96	93.37	95.62	2.60	2.56	1.48	0.32
1992	5409.94	6987	824	79.53	79.53	74.74	79.54	2.77	2.27	18.20	0.00
1993	5248.51	6644	822	75.76	75.76	72.87	75.84	6.60	5.35	18.89	0.00
1994	7147.21	8660	822	98.88	98.88	99.26	98.86	1.12	1.12	0.00	0.00
1995	5091.35	6984	822	79.74	79.74	70.71	79.73	4.21	3.51	16.75	0.00
1996	5741.28	7160	822	81.46	81.46	79.51	81.51	0.00	0.00	18.54	0.00
1997	7280.91	8760	822	100.00	100.00	101.11	100.00	0.00	0.00	0.00	0.00
1998	6271.42	7514	824	85.82	85.82	86.83	85.78	0.00	0.00	14.18	0.00
1999	5356.22	7242	852	82.68	82.68	71.77	82.67	0.95	0.80	16.52	0.00
2000	7362.56	8736	839	99.45	99.45	99.88	99.45	0.55	0.55	0.00	0.00
2001	5777.73	6921	842	79.03	79.03	78.33	79.01	0.79	0.63	20.34	0.00
2002	6463.44	7682	842	87.71	87.71	87.63	87.69	0.00	0.00	12.29	0.00
2003	7379.36	8687	839	99.18	99.18	100.40	99.17	0.46	0.45	0.37	0.00
2004	6724.10	7949	849	90.53	90.53	90.70	90.49	0.31	0.28	9.19	0.00
2005	6351.74	7566	842	86.39	86.39	86.11	86.37	0.00	0.00	13.61	0.00
2006	7620.30	8760	860	100.00	100.00	101.15	100.00	0.00	0.00	0.00	0.00
2007	6572.09	7660	860	87.46	87.46	87.24	87.44	0.75	0.67	11.87	0.00
2008	6795.52	7956	860	90.47	90.47	89.96	90.57	0.14	0.12	9.41	0.00
2009	7262.45	8427	860	96.22	96.22	96.40	96.20	3.78	3.78	0.00	0.00
2010	6592.24	7682	860	87.71	87.71	87.50	87.69	0.38	0.34	11.95	0.00
2011	6666.95	7826	860	89.37	89.37	88.50	89.34	0.00	0.00	10.63	0.00
2012	7833.57	8784	883	100.00	100.00	101.00	100.00	0.00	0.00	0.00	0.00
2013	7076.62	8142	883	92.95	92.95	91.48	92.93	0.00	0.00	7.05	0.00
2014	6727.96	7718	883	88.10	88.10	86.98	88.11	3.46	3.15	8.75	0.00
2015	7606.92	8610	883	98.28	98.28	98.34	98.29	0.00	0.00	1.72	0.00
2016	7014.26	7954	883	90.55	90.55	90.43	90.55	1.15	1.05	8.39	0.00
2017	7054.03	8019	883	91.54	91.54	91.20	91.54	0.00	0.00	8.46	0.00

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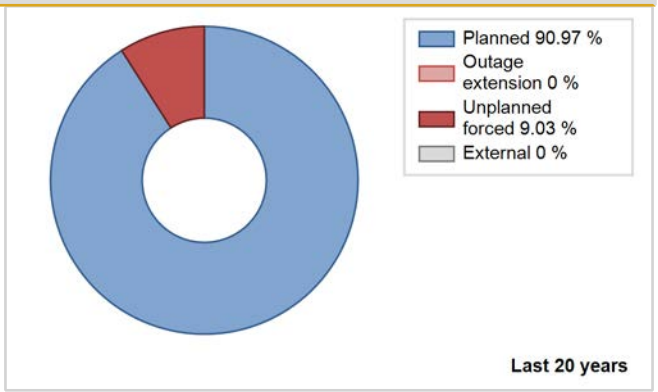
2018	7655.38	8760	883	100.00	100.00	98.97	100.00	0.00	0.00	0.00	0.00
2019	7133.77	8091	883	92.38	92.38	92.23	92.36	0.48	0.44	7.18	0.00
2020	6973.38	7938	883	90.37	90.37	89.91	90.37	0.00	0.00	9.63	0.00
2021	7847.08	8760	883	100.00	100.00	101.45	100.00	0.00	0.00	0.00	0.00
2022	7316.70	8204	883	93.66	93.66	94.59	93.65	0.00	0.00	6.34	0.00
2023	6836.35	7665	883	86.93	86.93	88.38	87.50	2.46	2.19	10.88	0.00
2024	7883.08	8723	883	99.29	99.29	101.63	99.31	0.71	0.71	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1981 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		61			117	
B. Refuelling without maintenance				19		
C. Inspection, maintenance or repair combined with refuelling				720		
D. Inspection, maintenance or repair without refuelling				29		
E. Testing of plant systems or components				5		
H. Nuclear regulatory requirements				13		
J. Grid limitation, failure or grid unavailability						0
L. Human factor related					10	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					0	
Z. Other					1	1
Subtotal		61		786	128	2
Total		**61**			**916**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	61	3
12. Reactor I&C Systems		14
13. Reactor Auxiliary Systems		10
14. Safety Systems		14
15. Reactor Cooling Systems		32
16. Steam generation systems		18
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		13
35. All other I&C Systems		1
41. Main Generator Systems		5
42. Electrical Power Supply Systems		4
Total	**61**	**126**

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2024 Operating Experience

US-341 FERMI-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	DTEDISON (DETROIT EDISON CO.)
Owner	:	DTE (DTE Energy Co.)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GECTG (GEC TURBINE GENERATORS, LTD.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	3486 MWth
Gross electrical power	:	1198 MWe
Reference unit power (net)	:	1115 MWe

Key Dates

Construction Date	:	1972-09-26
Grid Date	:	1986-09-21
Commercial Date	:	1988-01-23
Age at end of year	:	38 years

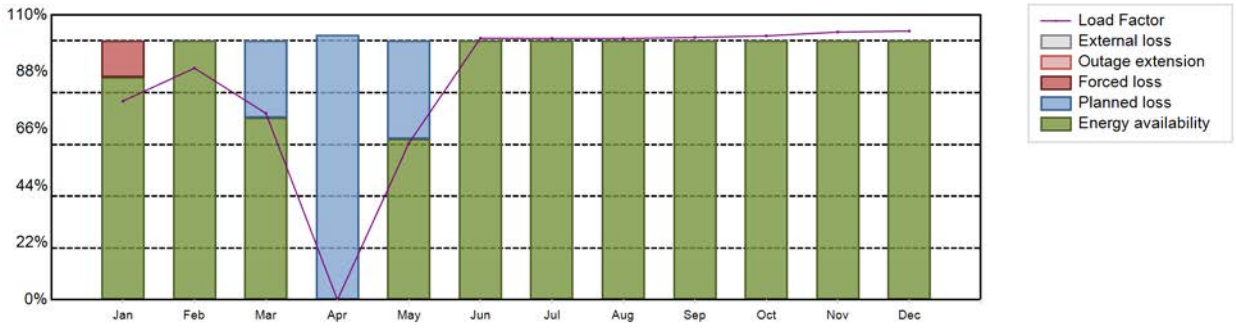
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.3
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	286
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.44
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	19404	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.75	HP cylinder inlet steam pressure [MPa]	:	6.8
Active core height/length [m]	:	3.8	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	764	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	37.73	Number of main condensate pumps	:	-
Number of control rod assemblies	:	185	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8267.52 GW(e).h	Forced Loss Rate (FLR)	:	1.38 %
Energy Availability Factor (EAF)	:	84.7 %	Unplanned Capability Loss Factor (UCL)	:	1.18 %
Unit Capability Factor (UCF)	:	84.7 %	Planned Unavailability Factor (PUF)	:	14.12 %
Load Factor (LF)	:	84.41 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	85.04 %	Total off-line time	:	1314 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	636.91	694.33	596.60	0.00	502.31	811.11	837.49	837.34	813.52	845.62	831.31	860.99	8267.52
EAF [%]	86.04	100.00	70.25	-2.33	62.04	100.00	100.00	100.00	100.00	100.00	100.00	100.00	84.70
UCF [%]	86.04	100.00	70.25	-2.33	62.04	100.00	100.00	100.00	100.00	100.00	100.00	100.00	84.70
LF [%]	76.78	89.47	72.01	0.00	60.55	101.03	100.96	100.94	101.34	101.94	103.41	103.79	84.41
OF [%]	86.29	100.00	70.93	0.00	62.90	100.00	100.00	100.00	100.00	100.00	100.00	100.00	85.04
FLR [%]	13.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.38
UCL [%]	13.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.18
PUF [%]	0.00	0.00	29.75	102.33	37.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.12
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	273446.19 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	9.3 %
Cumulative Energy Availability Factor (EAF)	:	80.9 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	8.29 %
Cumulative Unit Capability Factor (UCF)	:	80.9 %	Cumulative Planned Unavailability Factor (PUF)	:	10.81 %
Cumulative Load Factor (LF)	:	77.77 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	80.62 %			

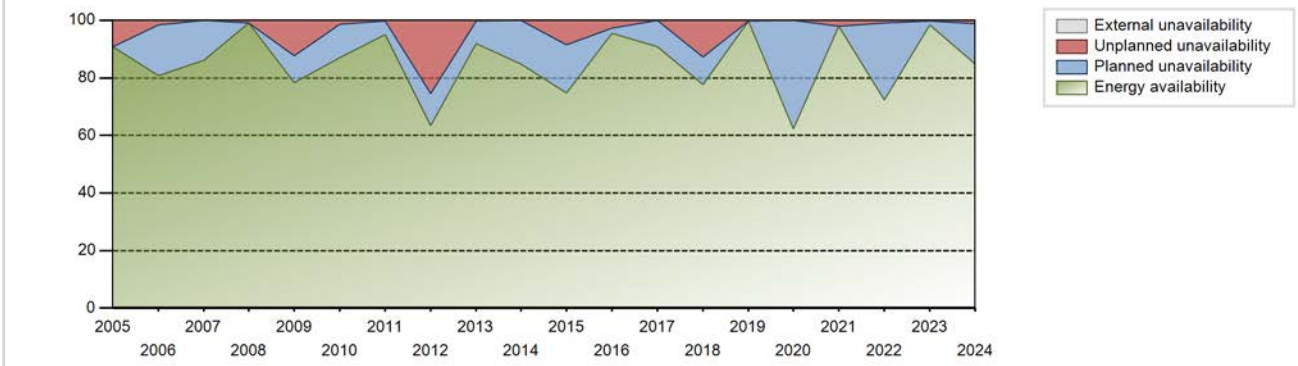
Electricity Production (net) [GWh]



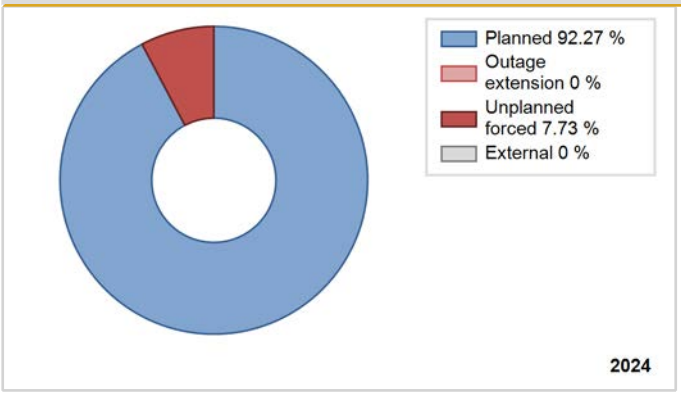
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	4060.06	4719	1093	55.90	55.90	43.95	56.13	42.89	41.98	2.11	0.00
1989	5230.72	5575	1093	63.42	63.42	54.63	63.64	11.35	8.12	28.46	0.00
1990	7118.28	7266	1059	82.30	82.30	76.70	82.95	1.82	1.53	16.17	0.00
1991	6180.93	6466	1059	72.83	72.83	66.63	73.81	1.19	0.88	26.29	0.00
1992	7356.77	7019	1060	79.15	79.15	79.01	79.91	2.84	2.32	18.54	0.00
1993	8284.71	8076	1085	92.10	92.10	87.17	92.19	4.48	4.32	3.59	0.00
1994	0.00	0	1085	0.00	0.00	0.00	0.00	100.00	84.69	15.31	0.00
1995	5132.02	6509	997	71.75	71.75	58.74	74.30	26.14	25.39	2.86	0.00
1996	4790.02	5859	876	58.23	58.23	62.25	66.70	28.83	23.59	18.18	0.00
1997	5579.95	5461	1000	70.45	70.45	63.60	62.34	28.62	28.24	1.30	0.00
1998	7146.77	6868	1098	78.39	78.39	74.30	78.40	7.84	6.67	14.95	0.00
1999	9484.66	8698	1081	99.29	99.29	100.11	99.29	0.71	0.71	0.00	0.00
2000	8237.80	7514	1083	85.72	85.72	86.59	85.54	0.00	0.00	14.28	0.00
2001	8564.03	7837	1089	89.27	89.27	89.77	89.46	0.60	0.54	10.19	0.00
2002	9302.88	8630	1089	98.49	98.49	97.52	98.52	1.51	1.51	0.00	0.00
2003	8127.82	7479	1089	85.28	85.28	85.20	85.38	3.59	3.18	11.54	0.00
2004	8453.11	7764	1089	88.18	88.18	88.37	88.39	4.58	4.23	7.58	0.00
2005	8767.61	7955	1111	90.85	90.85	90.08	90.80	9.15	9.15	0.00	0.00
2006	7497.33	7095	1111	80.86	80.86	77.67	80.99	1.83	1.50	17.63	0.00
2007	8318.37	7542	1122	86.11	86.11	84.63	86.10	0.00	0.00	13.89	0.00
2008	9614.34	8706	1122	99.14	99.14	97.55	99.11	0.86	0.86	0.00	0.00
2009	7424.68	6855	1122	78.29	78.29	75.54	78.25	13.62	12.34	9.37	0.00
2010	7743.27	7373	1106	87.05	87.05	79.92	84.17	1.62	1.43	11.52	0.00
2011	8916.72	8334	1085	95.08	95.08	93.52	95.14	0.16	0.16	4.77	0.00
2012	5176.46	5562	1037	63.37	63.37	56.83	63.32	28.68	25.48	11.15	0.00
2013	6609.50	8063	1037	92.04	92.04	72.75	92.03	0.19	0.17	7.78	0.00
2014	7809.50	7311	1122	84.71	84.71	79.46	83.46	0.00	0.00	15.29	0.00
2015	7346.14	6551	1122	74.79	74.79	74.74	74.78	10.18	8.48	16.74	0.00
2016	9153.92	8396	1122	95.58	95.58	92.88	95.58	2.77	2.73	1.69	0.00
2017	8698.33	7952	1122	90.77	90.77	88.50	90.78	0.00	0.00	9.23	0.00
2018	7438.80	6773	1115	77.73	77.73	76.16	77.32	14.08	12.74	9.54	0.00
2019	9886.26	8743	1115	99.81	99.81	101.22	99.81	0.19	0.19	0.00	0.00
2020	6070.78	5475	1115	62.35	62.35	61.98	62.33	0.00	0.00	37.65	0.00
2021	9572.97	8574	1115	97.88	97.88	98.01	97.88	2.13	2.13	0.00	0.00
2022	6681.70	6332	1115	72.28	72.28	68.41	72.28	1.34	0.98	26.74	0.00
2023	9366.83	8303	1115	98.41	98.41	95.90	94.78	0.33	0.32	1.26	0.00
2024	8267.52	7470	1115	84.70	84.70	84.41	85.04	1.38	1.18	14.12	0.00

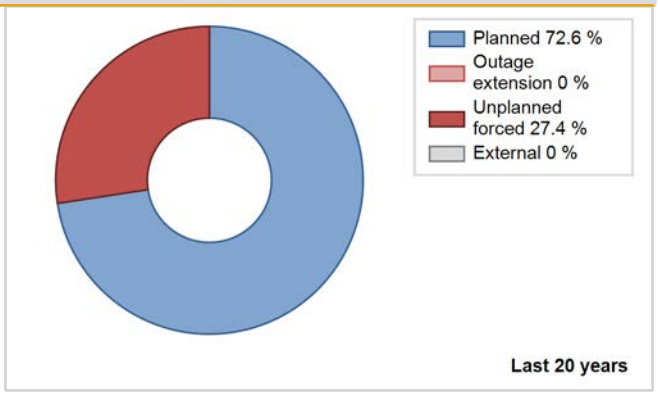
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		102			726	
B. Refuelling without maintenance				160		
C. Inspection, maintenance or repair combined with refuelling	1212			612		
D. Inspection, maintenance or repair without refuelling				166		
J. Grid limitation, failure or grid unavailability						10
L. Human factor related					5	
P. Fire					1	
Z. Other					5	
Subtotal	1212	102		938	737	10
Total		**1314**			**1685**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1988 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		24
12. Reactor I&C Systems		13
13. Reactor Auxiliary Systems		33
14. Safety Systems		21
15. Reactor Cooling Systems		17
17. Safety I&C Systems (excluding reactor I&C)		11
31. Turbine and auxiliaries		271
32. Feedwater and Main Steam System	102	28
33. Circulating Water System		2
34. Miscellaneous Systems		42
35. All other I&C Systems		9
41. Main Generator Systems		178
42. Electrical Power Supply Systems		81
Total	**102**	**730**

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2024 Operating Experience

US-333 FITZPATRICK UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	2536 MWth
Gross electrical power	:	849 MWe
Reference unit power (net)	:	813 MWe

Key Dates

Construction Date	:	1968-09-01
Grid Date	:	1975-02-01
Commercial Date	:	1975-07-28
Age at end of year	:	49 years

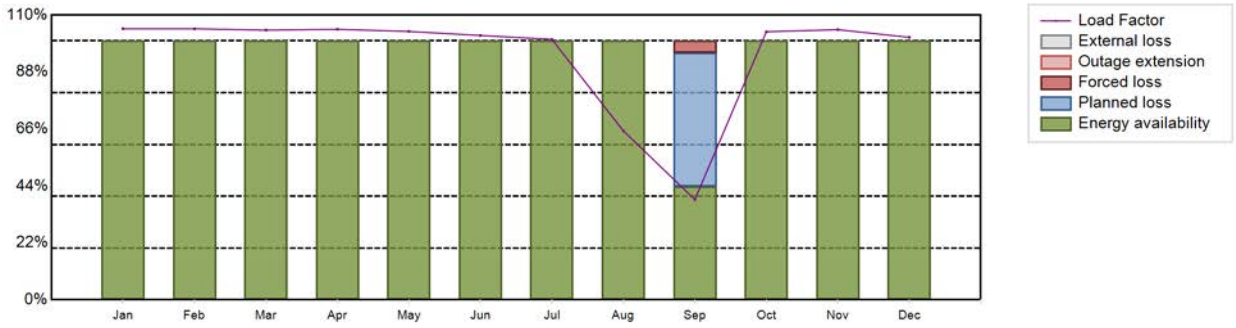
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.06
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	287
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.44
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	31800	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.26	HP cylinder inlet steam pressure [MPa]	:	6.8
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	560	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	19	Number of main condensate pumps	:	-
Number of control rod assemblies	:	137	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6772.13 GW(e).h	Forced Loss Rate (FLR)	:	0.4 %
Energy Availability Factor (EAF)	:	95.39 %	Unplanned Capability Loss Factor (UCL)	:	0.38 %
Unit Capability Factor (UCF)	:	95.39 %	Planned Unavailability Factor (PUF)	:	4.23 %
Load Factor (LF)	:	94.83 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	95.61 %	Total off-line time	:	386 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	633.40	592.36	629.12	611.60	627.01	597.68	608.46	394.69	226.63	626.36	611.60	613.23	6772.13
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	43.76	100.00	100.00	100.00	95.39
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	43.76	100.00	100.00	100.00	95.39
LF [%]	104.72	104.69	104.15	104.48	103.66	102.10	100.59	65.25	38.72	103.55	104.34	101.38	94.83
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	46.39	100.00	100.00	100.00	95.61
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.68	0.00	0.00	0.00	0.40
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.69	0.00	0.00	0.00	0.38
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.56	0.00	0.00	0.00	4.23
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	279571.64 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.87 %
Cumulative Energy Availability Factor (EAF)	:	82.67 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.27 %
Cumulative Unit Capability Factor (UCF)	:	82.82 %	Cumulative Planned Unavailability Factor (PUF)	:	11.92 %
Cumulative Load Factor (LF)	:	80.17 %	Cumulative Externally cause unavailability (XUF)	:	0.14 %
Cumulative Operating Factor (OF)	:	82.71 %			

Electricity Production (net) [GWh]

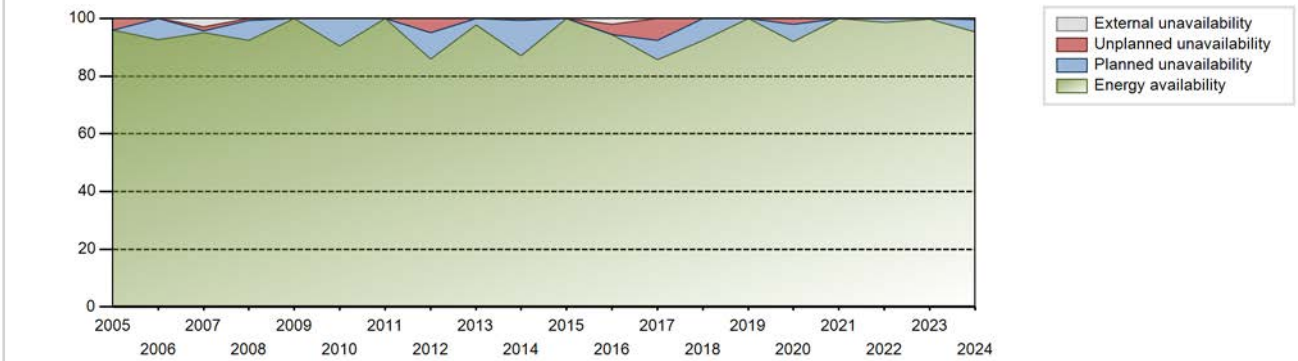


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	2153.70	4369	819	100.00	100.00	50.37	70.13	0.00	0.00	0.00	0.00
1976	4156.40	6284	670	70.45	70.45	70.62	71.54	21.74	19.58	9.97	0.00
1977	3893.40	5986	770	57.72	57.72	57.72	68.33	29.58	24.25	18.03	0.00
1978	4197.40	6311	800	59.87	59.87	59.89	72.04	11.41	7.71	32.41	0.00
1979	2964.70	4450	800	42.30	42.30	42.30	50.80	55.65	53.08	4.61	0.00
1980	4334.10	6162	802	70.45	71.04	61.52	70.15	3.77	2.78	26.18	0.59
1981	4779.70	6539	810	74.75	74.75	67.36	74.65	9.98	8.29	16.96	0.00
1982	4959.70	6570	810	75.28	75.28	69.90	75.00	7.76	6.33	18.39	0.00
1983	4634.30	6183	810	70.66	70.66	65.31	70.58	5.08	3.78	25.56	0.00
1984	4899.36	6745	810	76.88	76.88	68.86	76.79	5.04	4.08	19.04	0.00
1985	4166.52	5576	810	64.08	64.08	58.72	63.65	10.19	7.27	28.65	0.00
1986	6015.61	7931	797	90.52	90.52	86.14	90.54	1.77	1.63	7.84	0.00
1987	4198.34	5891	795	67.11	67.11	60.27	67.25	5.61	3.99	28.90	0.00
1988	4356.87	5844	780	66.53	66.53	63.54	66.53	5.94	4.20	29.26	0.00
1989	6155.35	7944	757	90.27	90.27	92.82	90.68	3.65	3.42	6.31	0.00
1990	4601.93	6045	782	68.42	68.42	67.18	69.01	5.93	4.32	27.26	0.00
1991	3376.75	4534	780	55.98	55.98	49.42	51.76	42.41	41.22	2.80	0.00
1992	0.00	0	780	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1993	4746.46	6301	780	71.57	71.57	69.47	71.93	13.52	11.19	17.24	0.00
1994	4972.63	7224	774	81.91	81.91	73.34	82.47	0.00	0.00	18.09	0.00
1995	4804.03	6336	777	71.58	71.58	70.53	72.33	6.06	4.62	23.81	0.00
1996	5290.38	7036	765	79.26	79.26	78.63	80.10	8.37	7.24	13.50	0.00
1997	6624.58	8310	799	94.89	96.32	94.65	94.86	1.65	1.61	2.07	1.43
1998	4930.50	6613	785	75.21	75.21	71.70	75.49	8.50	6.99	17.81	0.00
1999	6567.39	8205	799	93.52	93.52	93.73	93.66	6.48	6.48	0.00	0.00
2000	6024.77	7617	813	86.63	86.63	84.36	86.71	3.18	2.84	10.53	0.00
2001	7090.50	8639	813	98.61	98.61	99.56	98.62	0.00	0.00	1.39	0.00
2002	6595.02	8112	813	92.36	92.36	92.60	92.60	0.00	0.00	7.64	0.00
2003	6965.97	8435	813	96.19	96.19	97.81	96.29	3.81	3.81	0.00	0.00
2004	6455.92	7984	813	90.80	90.80	90.40	90.89	0.99	0.91	8.30	0.00
2005	7052.31	8403	825	95.94	95.94	97.57	95.91	4.06	4.06	0.00	0.00
2006	6758.75	8108	852	92.58	92.58	90.56	92.56	0.00	0.00	7.42	0.00
2007	6918.35	8318	852	94.98	97.81	92.70	94.95	1.56	1.55	0.64	2.83
2008	6691.05	8105	852	92.28	92.28	89.41	92.27	0.72	0.67	7.05	0.00
2009	7398.07	8760	854	100.00	100.00	98.89	100.00	0.00	0.00	0.00	0.00
2010	6361.48	7908	855	90.30	90.30	84.94	90.27	0.00	0.00	9.70	0.00
2011	7243.97	8760	855	100.00	100.00	96.72	100.00	0.00	0.00	0.00	0.00

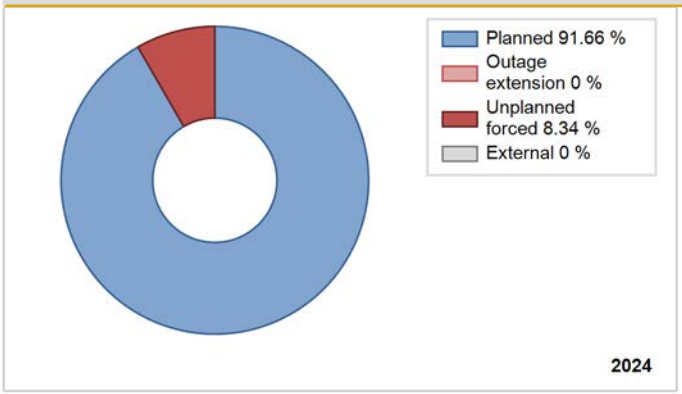
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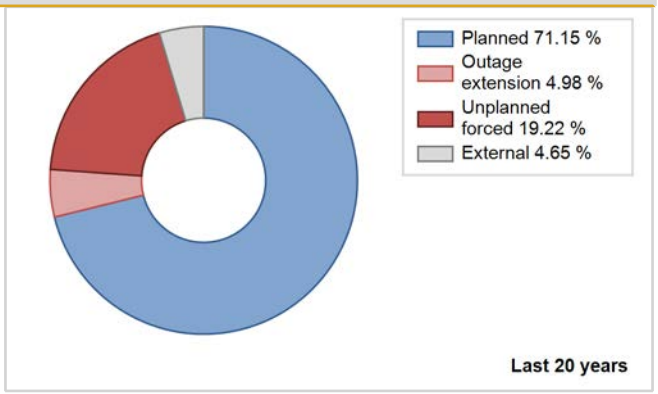
2012	6070.46	7536	813	85.81	85.81	85.00	85.79	5.48	4.97	9.22	0.00
2013	6839.79	8557	813	97.68	97.68	96.03	97.67	0.00	0.00	2.32	0.00
2014	5828.69	7627	813	87.08	87.08	81.84	87.07	0.85	0.75	12.18	0.00
2015	7382.19	8760	813	100.00	100.00	103.66	100.00	0.00	0.00	0.00	0.00
2016	5857.96	8302	813	94.50	96.49	82.03	94.51	3.51	3.51	0.00	1.98
2017	6183.13	7708	813	85.78	85.78	86.82	87.99	2.54	7.55	6.67	0.00
2018	6527.73	8096	813	92.43	92.43	91.66	92.42	0.00	0.00	7.57	0.00
2019	7354.21	8760	813	100.00	100.00	103.26	100.00	0.00	0.00	0.00	0.00
2020	6608.23	8083	813	92.03	92.03	92.53	92.02	2.22	2.09	5.87	0.00
2021	7372.93	8760	813	100.00	100.00	103.53	100.00	0.00	0.00	0.00	0.00
2022	6612.74	8241	813	98.63	98.63	92.85	94.08	0.00	0.00	1.37	0.00
2023	7373.13	8760	813	99.63	99.63	103.53	100.00	0.06	0.06	0.31	0.00
2024	6772.13	8398	813	95.39	95.39	94.83	95.61	0.40	0.38	4.23	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1975 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		32			307	
B. Refuelling without maintenance				34		
C. Inspection, maintenance or repair combined with refuelling	354			858		
D. Inspection, maintenance or repair without refuelling				166		
E. Testing of plant systems or components				2	3	
H. Nuclear regulatory requirements					94	
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					38	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						11
Z. Other				3	17	
Subtotal	354	32		1063	459	14
Total	**386**			**1536**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	32	18
12. Reactor I&C Systems		16
13. Reactor Auxiliary Systems		6
14. Safety Systems		58
15. Reactor Cooling Systems		38
17. Safety I&C Systems (excluding reactor I&C)		0
21. Fuel Handling and Storage Facilities		14
31. Turbine and auxiliaries		49
32. Feedwater and Main Steam System		27
33. Circulating Water System		5
34. Miscellaneous Systems		23
35. All other I&C Systems		4
41. Main Generator Systems		17
42. Electrical Power Supply Systems		44
Total	**32**	**319**

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2024 Operating Experience

US-244 GINNA UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP (DRYAMB)
Thermal power	:	1775 MWth
Gross electrical power	:	608 MWe
Reference unit power (net)	:	560 MWe

Key Dates

Construction Date	:	1966-04-25
Grid Date	:	1969-12-02
Commercial Date	:	1970-07-01
Age at end of year	:	55 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	74
Average discharge burnup [MWd/t]	:	39000
Active core diameter [m]	:	2.46
Active core height/length [m]	:	3.59
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	19.02
Number of control rod assemblies	:	17
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

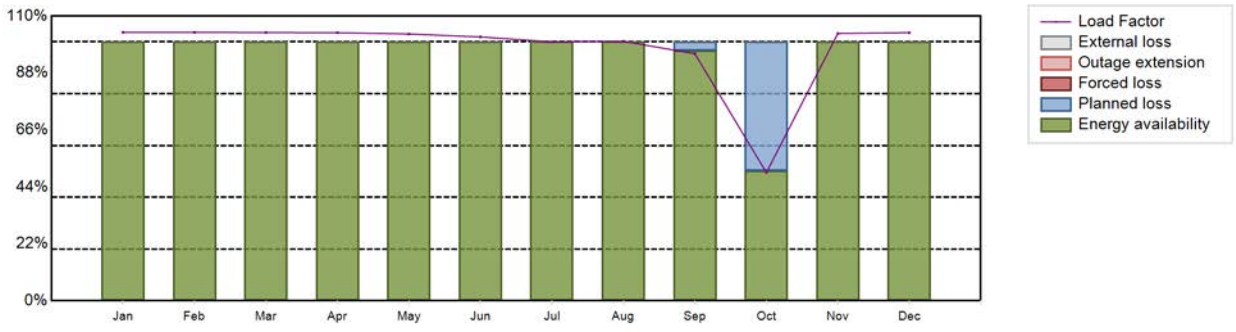
Operating coolant pressure [MPa]	:	15.82
Reactor outlet temperature [°C]	:	317
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.423
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.1
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4799.09 GW(e).h
Energy Availability Factor (EAF)	:	95.5 %
Unit Capability Factor (UCF)	:	95.5 %
Load Factor (LF)	:	97.56 %
Operating Factor (OF)	:	95.67 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	4.5 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	380 hours

Annual Summary



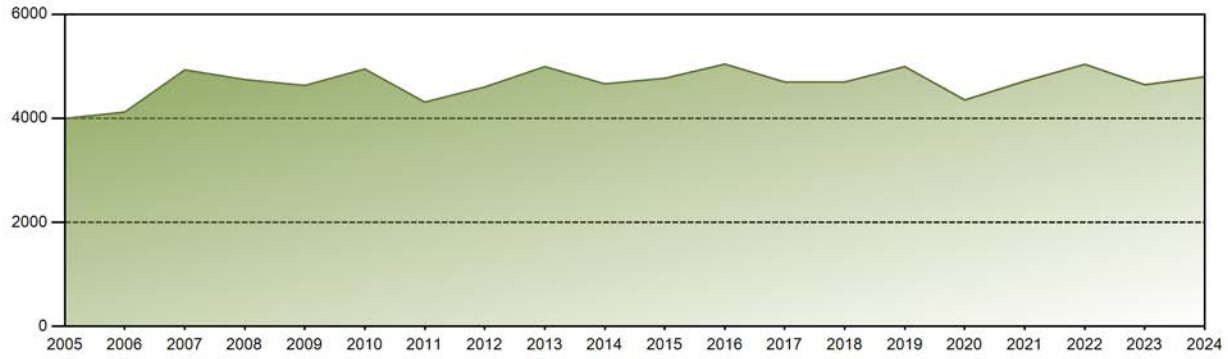
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	431.85	404.17	431.14	417.50	429.39	410.92	416.76	417.62	384.74	206.47	416.97	431.56	4799.09
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	96.54	50.25	100.00	100.00	95.50
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	96.54	50.25	100.00	100.00	95.50
LF [%]	103.65	103.70	103.62	103.55	103.06	101.91	100.03	100.23	95.42	49.56	103.27	103.58	97.56
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	96.67	52.15	100.00	100.00	95.67
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.46	49.75	0.00	0.00	4.50
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	209213.5 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.42 %
Cumulative Energy Availability Factor (EAF)	:	87.91 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.18 %
Cumulative Unit Capability Factor (UCF)	:	87.92 %	Cumulative Planned Unavailability Factor (PUF)	:	9.9 %
Cumulative Load Factor (LF)	:	86.22 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	87 %			

Electricity Production (net) [GWh]

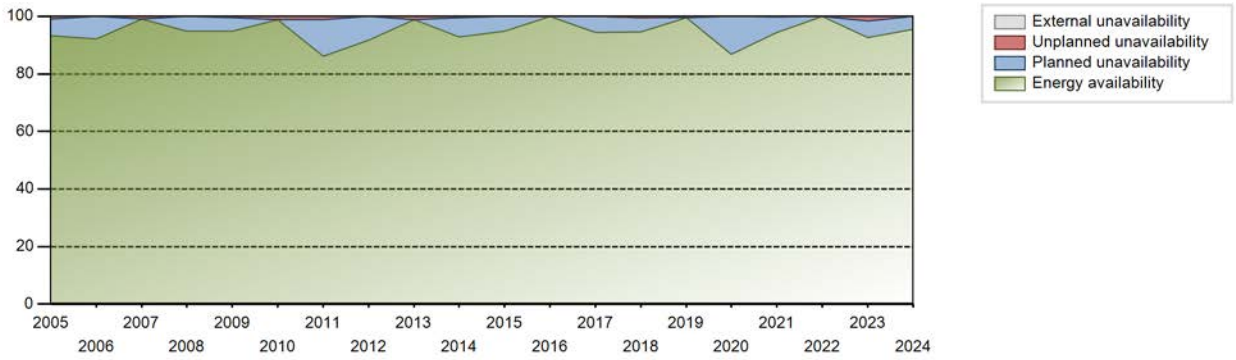


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1970	2313.00	6079	448	100.00	100.00	80.72	87.59	0.00	0.00	0.00	0.00
1971	2871.80	6592	493	100.00	100.00	66.50	75.25	0.00	0.00	0.00	0.00
1972	2572.10	6029	504	100.00	100.00	58.10	68.64	0.00	0.00	0.00	0.00
1973	3398.80	8325	490	95.04	95.04	79.18	95.03	4.96	4.96	0.00	0.00
1974	2097.20	5465	490	48.86	48.86	48.86	62.39	23.21	14.77	36.37	0.00
1975	3041.10	6709	470	73.39	73.39	73.86	76.59	6.78	5.34	21.27	0.00
1976	2060.80	5113	470	49.73	49.73	49.92	58.21	37.28	29.55	20.72	0.00
1977	3028.50	7489	470	73.59	73.59	73.56	85.49	10.47	8.61	17.80	0.00
1978	3218.70	7058	470	77.49	77.49	78.18	80.57	5.96	4.91	17.59	0.00
1979	2960.50	6375	470	71.26	71.26	71.91	72.77	6.50	4.96	23.78	0.00
1980	3093.50	6673	470	76.00	76.00	74.93	75.97	0.00	0.00	24.00	0.00
1981	3322.50	7194	470	82.15	82.15	80.70	82.12	0.42	0.35	17.50	0.00
1982	2408.00	5150	470	58.91	58.91	58.49	58.79	3.35	2.04	39.05	0.00
1983	3040.10	6529	470	74.88	74.88	73.84	74.53	0.30	0.23	24.90	0.00
1984	3156.78	6779	470	77.19	77.19	76.46	77.17	4.19	3.38	19.43	0.00
1985	3620.30	7700	470	87.93	87.93	87.93	87.90	1.85	1.66	10.41	0.00
1986	3610.27	7659	470	87.45	87.45	87.69	87.43	1.04	0.92	11.63	0.00
1987	3797.70	7994	470	91.26	91.26	92.24	91.26	0.00	0.00	8.74	0.00
1988	3533.17	7592	470	86.45	86.45	85.58	86.43	4.26	3.84	9.71	0.00
1989	3073.45	6569	470	75.03	75.03	74.65	74.99	5.89	4.70	20.27	0.00
1990	3451.38	7325	470	83.63	83.63	83.83	83.62	4.59	4.02	12.35	0.00
1991	3483.25	7536	470	86.04	86.04	84.60	86.03	0.40	0.34	13.62	0.00
1992	3483.38	7536	470	85.80	85.80	84.37	85.79	2.04	1.79	12.41	0.00
1993	3499.44	7509	470	85.72	85.72	85.00	85.72	2.11	1.85	12.43	0.00
1994	3373.71	7219	470	82.44	82.44	81.94	82.41	5.66	4.94	12.61	0.00
1995	3638.58	7776	470	88.79	88.79	88.38	88.77	0.58	0.51	10.70	0.00
1996	2898.05	6175	470	70.39	70.39	70.20	70.30	12.58	10.13	19.48	0.00
1997	3894.65	8011	480	91.65	91.65	92.62	91.45	0.00	0.00	8.35	0.00
1998	4308.56	8760	480	100.00	100.00	102.47	100.00	0.00	0.00	0.00	0.00
1999	3534.05	7444	480	85.31	85.31	84.05	84.98	0.74	0.63	14.06	0.00
2000	3814.15	8001	480	91.02	91.02	90.46	91.09	0.28	0.26	8.73	0.00
2001	4286.28	8760	480	100.00	100.00	101.94	100.00	0.00	0.00	0.00	0.00
2002	3843.35	7951	480	90.44	90.44	91.40	90.76	0.45	0.41	9.14	0.00
2003	3868.59	7925	480	90.13	90.13	92.00	90.47	1.16	1.06	8.81	0.00
2004	4308.49	8733	480	99.40	99.40	102.19	99.42	0.60	0.60	0.00	0.00
2005	3996.68	8166	498	93.26	93.26	91.60	93.21	0.98	0.92	5.82	0.00
2006	4119.17	8157	560	92.21	92.21	95.31	93.12	0.00	0.00	7.79	0.00

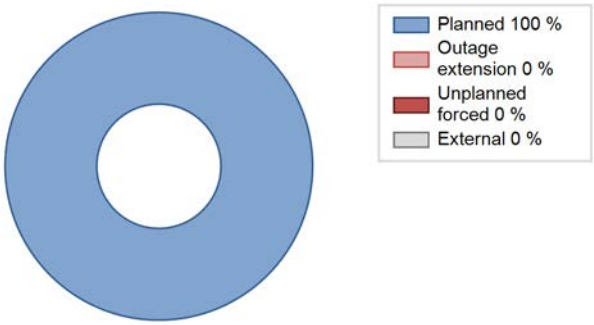
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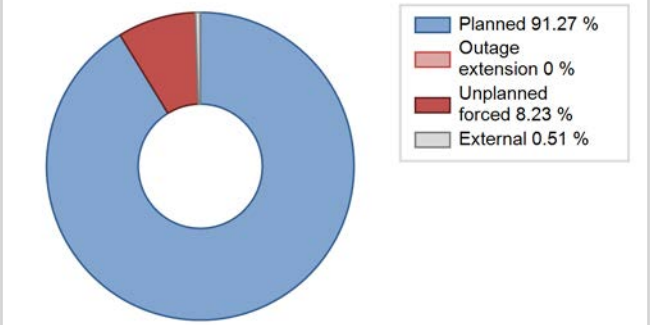
2007	4930.53	8675	560	99.15	99.15	100.51	99.03	0.85	0.85	0.00	0.00
2008	4744.00	8280	560	94.92	94.92	96.44	94.26	0.00	0.00	5.08	0.00
2009	4630.90	8235	580	94.87	94.87	91.15	94.01	0.45	0.43	4.70	0.00
2010	4948.36	8654	580	98.79	98.79	97.39	98.79	1.21	1.21	0.00	0.00
2011	4311.21	7539	580	86.08	86.08	84.85	86.06	1.25	1.09	12.83	0.00
2012	4601.72	8055	580	91.71	91.71	90.32	91.70	0.00	0.00	8.29	0.00
2013	4993.29	8668	581	98.95	98.95	98.10	98.94	1.05	1.05	0.00	0.00
2014	4662.50	8142	580	92.94	92.94	91.77	92.95	0.62	0.58	6.48	0.00
2015	4769.42	8313	580	94.89	94.89	93.87	94.90	0.00	0.00	5.11	0.00
2016	5042.06	8784	580	100.00	100.00	98.97	100.00	0.00	0.00	0.00	0.00
2017	4697.68	8261	580	94.31	94.31	92.46	94.30	0.00	0.00	5.69	0.00
2018	4698.44	8283	560	94.55	95.08	95.78	94.55	0.00	0.00	4.92	0.53
2019	4993.69	8713	560	99.47	99.47	101.80	99.46	0.53	0.53	0.00	0.00
2020	4353.10	7618	560	86.73	86.73	88.49	86.73	0.00	0.00	13.27	0.00
2021	4715.12	8274	560	94.46	94.46	96.12	94.45	0.27	0.26	5.28	0.00
2022	5038.60	8760	560	100.00	100.00	102.71	100.00	0.00	0.00	0.00	0.00
2023	4644.95	8154	560	92.60	92.60	94.69	93.08	1.74	1.64	5.76	0.00
2024	4799.09	8404	560	95.50	95.50	97.56	95.67	0.00	0.00	4.50	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1970 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					153	
B. Refuelling without maintenance				30		
C. Inspection, maintenance or repair combined with refuelling	380			874		
D. Inspection, maintenance or repair without refuelling				52		
E. Testing of plant systems or components				14	0	
H. Nuclear regulatory requirements					0	
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					4	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
Z. Other					7	
Subtotal	380			970	164	2
Total	**380**			**1136**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1970 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		14
13. Reactor Auxiliary Systems		2
14. Safety Systems		12
15. Reactor Cooling Systems		7
16. Steam generation systems		32
31. Turbine and auxiliaries		32
32. Feedwater and Main Steam System		25
33. Circulating Water System		4
34. Miscellaneous Systems		14
35. All other I&C Systems		1
41. Main Generator Systems		2
42. Electrical Power Supply Systems		13
Total		**160**

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2024 Operating Experience

US-416 GRAND GULF-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	ENTERGY (Entergy Nuclear Operations, Inc.)
Owner	:	SERI (Systems Energy Resources, Inc)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	KWU (KRAFTWERK UNION, AG)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-6 (Mark 3)
Thermal power	:	4408 MWth
Gross electrical power	:	1500 MWe
Reference unit power (net)	:	1401 MWe

Key Dates

Construction Date	:	1974-05-04
Grid Date	:	1984-10-20
Commercial Date	:	1985-07-01
Age at end of year	:	40 years

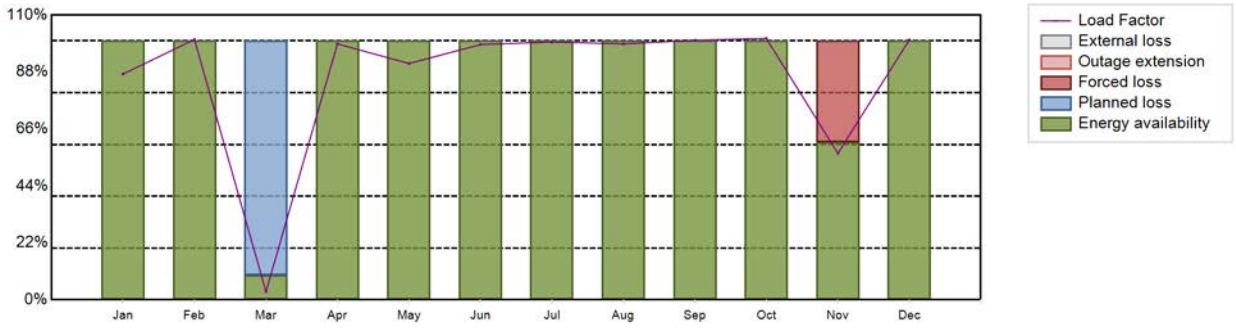
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.31
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	288
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.105
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	28000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.8	HP cylinder inlet steam pressure [MPa]	:	6.925
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	800	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	19.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	193	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10615.17 GW(e).h	Forced Loss Rate (FLR)	:	3.47 %
Energy Availability Factor (EAF)	:	89.14 %	Unplanned Capability Loss Factor (UCL)	:	3.21 %
Unit Capability Factor (UCF)	:	89.14 %	Planned Unavailability Factor (PUF)	:	7.65 %
Load Factor (LF)	:	86.26 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	88.37 %	Total off-line time	:	1022 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	908.99	980.16	33.01	997.12	951.39	994.35	1038.21	1030.13	1011.54	1052.08	571.46	1046.72	10615.17
EAF [%]	100.00	100.00	9.54	100.00	100.00	100.00	100.00	100.00	100.00	100.00	60.92	100.00	89.14
UCF [%]	100.00	100.00	9.54	100.00	100.00	100.00	100.00	100.00	100.00	100.00	60.92	100.00	89.14
LF [%]	87.21	100.52	3.17	98.85	91.27	98.58	99.60	98.83	100.28	100.93	56.57	100.42	86.26
OF [%]	91.80	100.00	8.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	60.61	100.00	88.37
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.08	0.00	3.47
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.08	0.00	3.21
PUF [%]	0.00	0.00	90.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.65
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	365056.3 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.98 %
Cumulative Energy Availability Factor (EAF)	:	84.96 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.44 %
Cumulative Unit Capability Factor (UCF)	:	85.11 %	Cumulative Planned Unavailability Factor (PUF)	:	9.45 %
Cumulative Load Factor (LF)	:	83.28 %	Cumulative Externally cause unavailability (XUF)	:	0.15 %
Cumulative Operating Factor (OF)	:	84.99 %			

Electricity Production (net) [GWh]

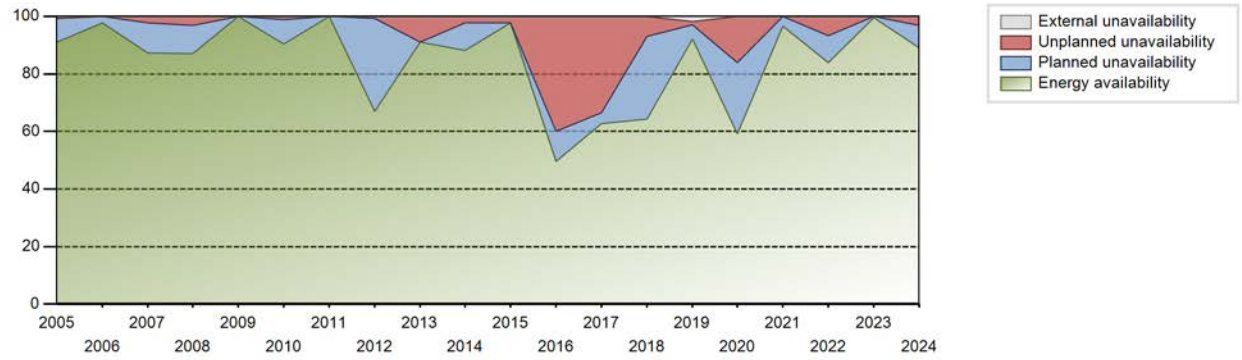


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	4316.40	5042	1108	58.70	58.70	54.23	60.92	11.21	7.41	33.89	0.00
1986	4098.05	5326	1108	60.54	60.54	42.22	60.80	11.22	7.65	31.82	0.00
1987	7726.99	7098	1130	80.87	80.87	78.00	81.03	2.18	1.80	17.33	0.00
1988	9590.95	8250	1142	93.80	93.80	95.61	93.92	4.83	4.76	1.44	0.00
1989	7846.28	6815	1142	76.93	76.93	78.43	77.80	4.99	4.04	19.02	0.00
1990	7404.01	6765	1142	76.61	76.61	74.01	77.23	9.35	7.90	15.49	0.00
1991	9118.72	8035	1142	88.36	89.62	91.08	91.72	10.38	10.38	0.00	1.27
1992	8171.15	7163	1143	81.06	81.06	81.39	81.55	4.89	4.17	14.77	0.00
1993	7898.46	6845	1143	77.61	77.61	78.88	78.14	9.06	7.74	14.65	0.00
1994	9614.75	8284	1143	94.49	94.49	96.03	94.57	5.51	5.51	0.00	0.00
1995	7809.73	6829	1153	77.67	77.67	77.32	77.96	7.47	6.27	16.06	0.00
1996	9224.70	7696	1175	87.70	87.70	89.34	87.61	3.90	3.56	8.75	0.00
1997	10817.56	8760	1200	100.00	100.00	102.91	100.00	0.00	0.00	0.00	0.00
1998	9190.81	7641	1200	87.54	87.54	87.41	87.23	1.70	1.51	10.95	0.00
1999	8428.40	6944	1204	79.30	79.30	79.91	79.27	8.47	7.34	13.36	0.00
2000	10694.61	8634	1208	98.31	99.22	100.74	98.29	0.78	0.78	0.00	0.91
2001	9923.98	8040	1210	91.80	92.28	93.63	91.78	0.15	0.14	7.58	0.47
2002	10059.47	8139	1207	92.91	93.75	95.14	92.91	0.00	0.00	6.25	0.84
2003	10902.49	8574	1207	97.88	97.88	103.11	97.88	2.12	2.12	0.00	0.00
2004	10235.07	8047	1207	91.22	91.22	96.54	91.61	0.00	0.00	8.78	0.00
2005	10077.85	7974	1263	91.05	91.66	91.09	91.03	0.16	0.15	8.20	0.61
2006	10807.33	8570	1266	97.83	97.83	97.45	97.83	0.00	0.00	2.17	0.00
2007	9358.78	7643	1268	87.29	87.29	84.26	87.25	2.44	2.19	10.52	0.00
2008	9417.15	7637	1268	86.97	86.97	84.55	86.94	3.53	3.18	9.85	0.00
2009	10998.51	8760	1259	100.00	100.00	99.73	100.00	0.00	0.00	0.00	0.00
2010	9643.24	7912	1251	90.28	90.28	88.00	90.32	1.23	1.13	8.59	0.00
2011	10336.52	8760	1251	100.00	100.00	94.32	100.00	0.00	0.00	0.00	0.00
2012	7336.44	5740	1401	67.00	67.00	63.58	65.35	1.16	0.79	32.21	0.00
2013	10784.30	7891	1401	91.04	91.04	87.86	90.07	8.96	8.96	0.00	0.00
2014	10279.50	7744	1401	88.25	88.25	83.76	88.40	2.42	2.19	9.56	0.00
2015	11718.78	8563	1401	97.72	97.72	95.49	97.75	2.28	2.28	0.00	0.00
2016	5981.59	4407	1401	49.53	49.53	48.61	50.17	44.68	39.99	10.48	0.00
2017	7437.97	6208	1401	62.76	62.76	60.61	70.87	34.80	33.49	3.75	0.00
2018	6957.96	5664	1401	64.31	64.31	56.69	64.66	9.88	7.05	28.65	0.00
2019	11032.60	8068	1401	92.12	94.06	89.89	92.10	1.11	1.06	4.89	1.94
2020	6470.93	5202	1401	59.21	59.21	52.58	59.22	20.62	16.02	24.77	0.00
2021	11803.75	8473	1401	96.73	96.73	96.18	96.72	0.00	0.00	3.27	0.00

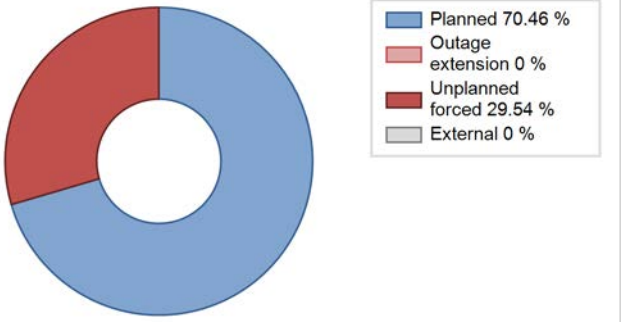
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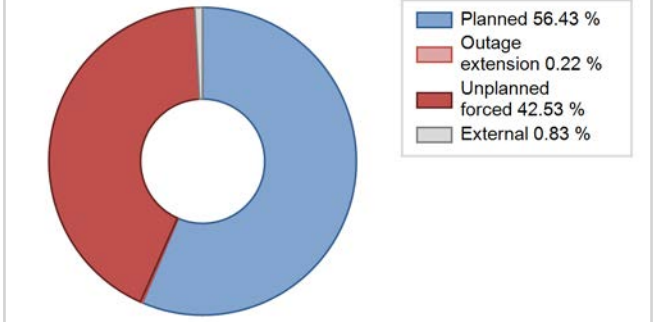
2022	8761.20	6400	1401	83.82	83.82	71.39	73.06	7.42	6.72	9.46	0.00
2023	11750.13	8380	1401	99.54	99.54	95.74	95.66	0.00	0.00	0.46	0.00
2024	10615.17	7762	1401	89.14	89.14	86.26	88.37	3.47	3.21	7.65	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		284			363	
B. Refuelling without maintenance				101		
C. Inspection, maintenance or repair combined with refuelling	677			656	12	
D. Inspection, maintenance or repair without refuelling				91		
E. Testing of plant systems or components				0	0	
H. Nuclear regulatory requirements					18	
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					21	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						16
Z. Other					52	3
Subtotal	677	284		848	466	21
Total	**961**			**1335**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		22
12. Reactor I&C Systems		20
13. Reactor Auxiliary Systems		83
14. Safety Systems		42
15. Reactor Cooling Systems		28
17. Safety I&C Systems (excluding reactor I&C)		8
31. Turbine and auxiliaries		62
32. Feedwater and Main Steam System		45
33. Circulating Water System		2
34. Miscellaneous Systems		28
35. All other I&C Systems		3
41. Main Generator Systems		27
42. Electrical Power Supply Systems	284	45
Total	**284**	**415**

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2024 Operating Experience

US-400 HARRIS-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	PROGRESS (Progress Energy)
Owner	:	PROG_E_C (PROGRESS ENERGY Carolinas, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYAMB)
Thermal power	:	2900 MWth
Gross electrical power	:	980 MWe
Reference unit power (net)	:	964 MWe

Key Dates

Construction Date	:	1978-01-28
Grid Date	:	1987-01-19
Commercial Date	:	1987-05-02
Age at end of year	:	37 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	31500
Active core diameter [m]	:	3.03
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	-
Number of control rod assemblies	:	52
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

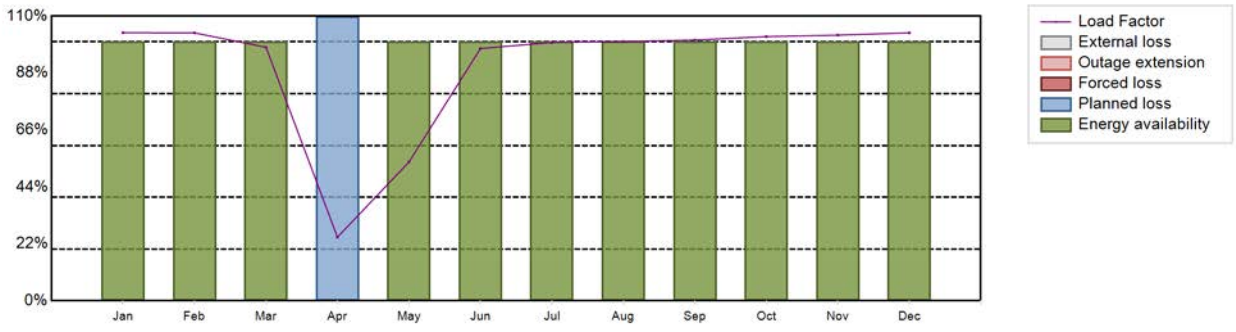
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	326
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.32
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.56
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7690.46 GW(e).h
Energy Availability Factor (EAF)	:	91.01 %
Unit Capability Factor (UCF)	:	91.01 %
Load Factor (LF)	:	90.82 %
Operating Factor (OF)	:	90.54 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	8.99 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	831 hours

Annual Summary



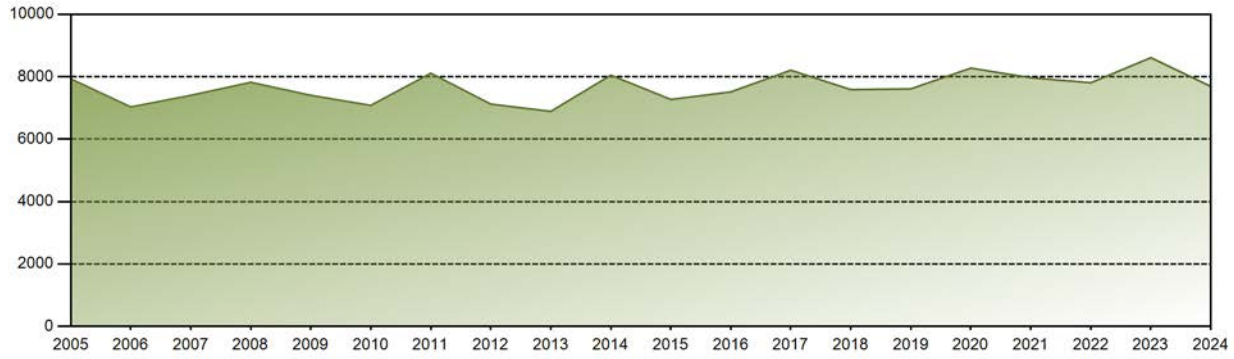
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	742.74	694.34	701.46	170.66	384.41	676.25	715.70	718.37	699.02	731.94	713.24	742.33	7690.46
EAF [%]	100.00	100.00	100.00	-9.72	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.01
UCF [%]	100.00	100.00	100.00	-9.72	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	91.01
LF [%]	103.56	103.49	97.93	24.59	53.60	97.43	99.79	100.16	100.71	102.05	102.62	103.50	90.82
OF [%]	100.00	100.00	100.00	30.14	57.66	98.19	100.00	100.00	100.00	100.00	100.00	100.00	90.54
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	109.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.99
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	266188.4 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.73 %
Cumulative Energy Availability Factor (EAF)	:	89.97 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.58 %
Cumulative Unit Capability Factor (UCF)	:	90 %	Cumulative Planned Unavailability Factor (PUF)	:	8.42 %
Cumulative Load Factor (LF)	:	89.95 %	Cumulative Externally cause unavailability (XUF)	:	0.03 %
Cumulative Operating Factor (OF)	:	89.79 %			

Electricity Production (net) [GWh]

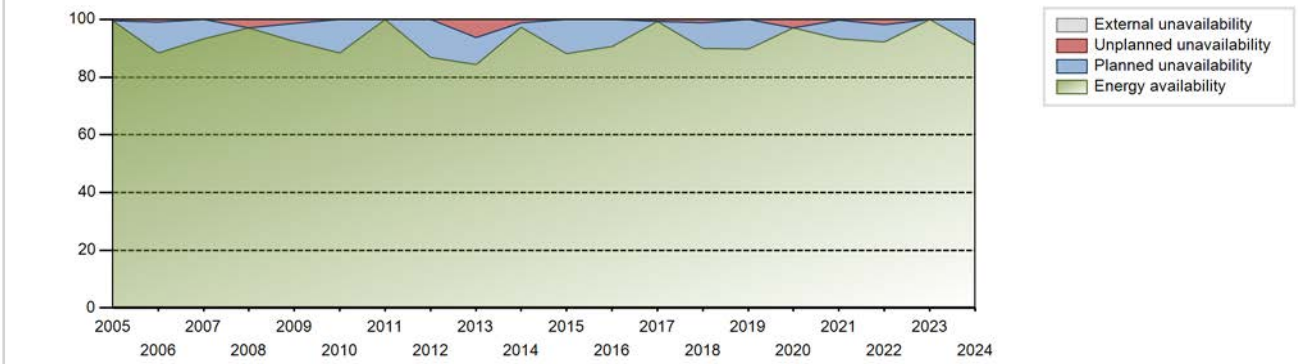


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	Data not provided										
1988	5345.56	6458	860	73.56	73.56	70.76	73.52	4.05	3.10	23.34	0.00
1989	5638.85	6873	860	78.49	78.49	74.85	78.46	1.86	1.49	20.02	0.00
1990	6339.00	7812	860	89.19	89.19	84.14	89.18	4.03	3.74	7.07	0.00
1991	5927.44	7080	860	80.83	80.83	78.68	80.82	0.80	0.65	18.52	0.00
1992	5427.88	6501	860	74.01	74.01	71.85	74.01	5.07	3.95	22.04	0.00
1993	7527.73	8721	860	99.55	99.55	99.92	99.55	0.00	0.00	0.45	0.00
1994	6065.06	7195	860	82.17	82.17	80.51	82.13	0.00	0.00	17.83	0.00
1995	5966.34	7279	860	83.13	83.13	79.20	83.09	4.92	4.30	12.57	0.00
1996	7067.74	8301	860	94.56	95.33	93.56	94.50	2.50	2.45	2.22	0.77
1997	5909.03	6934	860	79.20	79.20	78.44	79.16	4.09	3.38	17.42	0.00
1998	6711.57	7891	860	90.10	90.10	89.09	90.08	7.87	7.69	2.20	0.00
1999	7244.15	8484	860	96.87	96.87	96.16	96.85	3.13	3.13	0.00	0.00
2000	6877.96	8098	860	92.21	92.21	91.05	92.19	0.35	0.32	7.47	0.00
2001	5401.46	6335	860	72.32	72.32	71.70	72.32	0.00	0.00	27.68	0.00
2002	7835.04	8643	900	98.67	98.97	99.38	98.66	0.39	0.39	0.65	0.29
2003	7236.92	8082	900	92.27	92.27	91.79	92.26	1.64	1.53	6.20	0.00
2004	7008.43	7687	900	87.54	87.54	88.65	87.51	3.92	3.57	8.89	0.00
2005	7930.83	8710	900	99.43	99.43	100.58	99.42	0.57	0.57	0.00	0.00
2006	7029.27	7749	900	88.48	88.48	89.16	88.46	1.13	1.01	10.51	0.00
2007	7403.05	8176	900	93.35	93.35	93.90	93.33	0.02	0.02	6.63	0.00
2008	7821.41	8534	900	97.16	97.16	98.94	97.15	2.84	2.84	0.00	0.00
2009	7403.16	8091	900	92.38	92.38	93.90	92.36	1.43	1.34	6.28	0.00
2010	7080.62	7746	900	88.44	88.44	89.81	88.42	0.00	0.00	11.56	0.00
2011	8111.77	8760	900	100.00	100.00	102.89	100.00	0.00	0.00	0.00	0.00
2012	7121.94	7612	928	86.87	86.87	88.70	86.66	0.00	0.00	13.13	0.00
2013	6888.36	7392	928	84.38	84.38	84.73	84.37	6.89	6.24	9.38	0.00
2014	8048.57	8522	928	97.28	97.28	99.01	97.28	1.09	1.08	1.64	0.00
2015	7272.18	7712	928	88.04	88.04	89.46	88.04	0.00	0.00	11.96	0.00
2016	7513.05	7961	928	90.63	90.63	92.17	90.63	0.00	0.00	9.37	0.00
2017	8208.57	8708	928	99.40	99.40	100.98	99.41	0.60	0.60	0.00	0.00
2018	7587.91	7843	964	89.89	89.89	89.85	89.53	1.27	1.16	8.96	0.00
2019	7610.59	7857	964	89.70	89.70	90.12	89.69	0.00	0.00	10.30	0.00
2020	8275.59	8521	964	97.02	97.02	97.73	97.01	2.98	2.98	0.00	0.00
2021	7967.06	8178	964	93.36	93.36	94.34	93.36	0.16	0.15	6.49	0.00
2022	7806.87	8078	964	92.21	92.21	92.45	92.21	1.83	1.72	6.07	0.00
2023	8609.28	8760	964	99.99	99.99	101.95	100.00	0.00	0.00	0.01	0.00

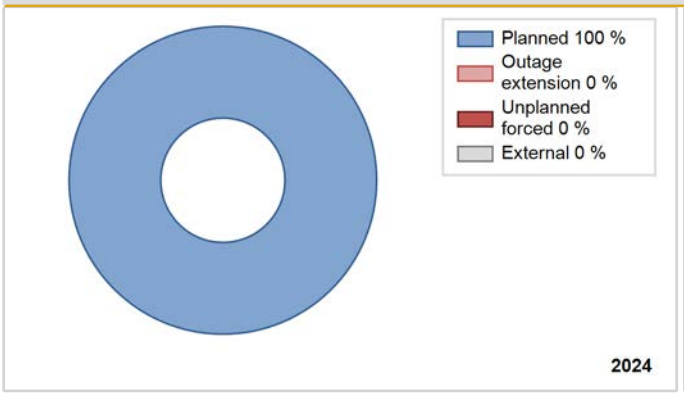
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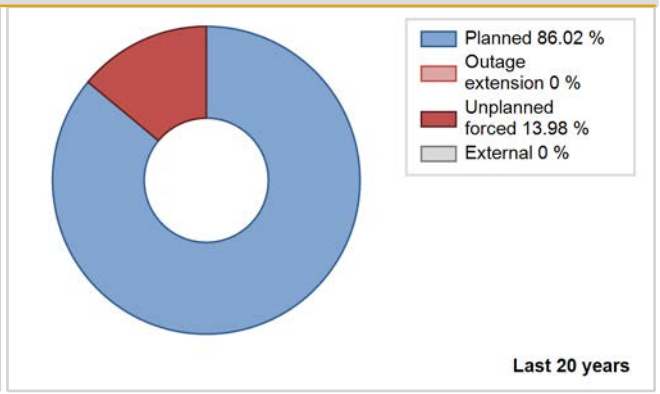
2024	7690.46	7953	964	91.01	91.01	90.82	90.54	0.00	0.00	8.99	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1987 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		42			124	
B. Refuelling without maintenance				30		
C. Inspection, maintenance or repair combined with refuelling	790			676		
D. Inspection, maintenance or repair without refuelling				44		
E. Testing of plant systems or components				1		
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						1
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
Z. Other					9	
Subtotal	790	42		751	134	3
Total		**832**			**888**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		15
12. Reactor I&C Systems		7
14. Safety Systems		1
15. Reactor Cooling Systems		4
16. Steam generation systems		3
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		44
32. Feedwater and Main Steam System		30
34. Miscellaneous Systems		3
41. Main Generator Systems		13
42. Electrical Power Supply Systems	42	5
Total	**42**	**126**

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2024 Operating Experience

US-321 HATCH-1 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	SOUTHERN (Southern Nuclear Operating Company, Inc.)
Owner	:	GPCO (GEORGIA POWER CO.)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	2804 MWth
Gross electrical power	:	911 MWe
Reference unit power (net)	:	876 MWe

Key Dates

Construction Date	:	1968-09-30
Grid Date	:	1974-11-11
Commercial Date	:	1975-12-31
Age at end of year	:	50 years

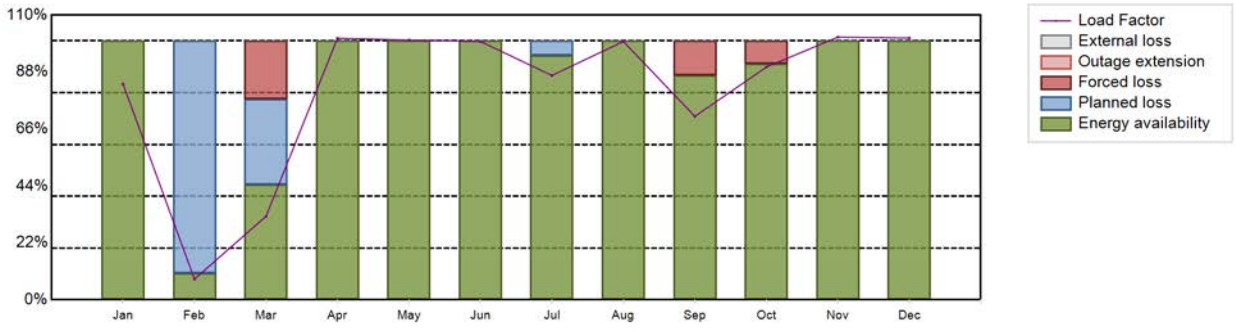
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.07
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	279
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.435
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	17000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.27	HP cylinder inlet steam pressure [MPa]	:	6.68
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	560	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	18.4	Number of main condensate pumps	:	-
Number of control rod assemblies	:	137	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6270.66 GW(e).h	Forced Loss Rate (FLR)	:	4.17 %
Energy Availability Factor (EAF)	:	85.89 %	Unplanned Capability Loss Factor (UCL)	:	3.74 %
Unit Capability Factor (UCF)	:	85.89 %	Planned Unavailability Factor (PUF)	:	10.37 %
Load Factor (LF)	:	81.49 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	85.89 %	Total off-line time	:	1239 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	543.67	48.84	209.74	637.17	653.94	629.39	564.88	650.38	446.97	585.79	640.90	658.97	6270.66
EAF [%]	100.00	10.34	44.64	100.00	100.00	100.00	94.31	100.00	86.67	91.13	100.00	100.00	85.89
UCF [%]	100.00	10.34	44.64	100.00	100.00	100.00	94.31	100.00	86.67	91.13	100.00	100.00	85.89
LF [%]	83.42	8.01	32.23	101.02	100.34	99.79	86.67	99.79	70.87	89.88	101.47	101.11	81.49
OF [%]	100.00	10.34	44.68	100.00	100.00	100.00	94.35	100.00	87.22	90.59	100.00	100.00	85.89
FLR [%]	0.00	0.00	33.44	0.00	0.00	0.00	0.00	0.00	13.33	8.88	0.00	0.00	4.17
UCL [%]	0.00	0.00	22.43	0.00	0.00	0.00	0.00	0.00	13.33	8.88	0.00	0.00	3.74
PUF [%]	0.00	89.66	32.93	0.00	0.00	0.00	5.69	0.00	0.00	0.00	0.00	0.00	10.37
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	288678.22 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.78 %
Cumulative Energy Availability Factor (EAF)	:	84.55 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.25 %
Cumulative Unit Capability Factor (UCF)	:	84.57 %	Cumulative Planned Unavailability Factor (PUF)	:	11.18 %
Cumulative Load Factor (LF)	:	82.48 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	84.59 %			

Electricity Production (net) [GWh]

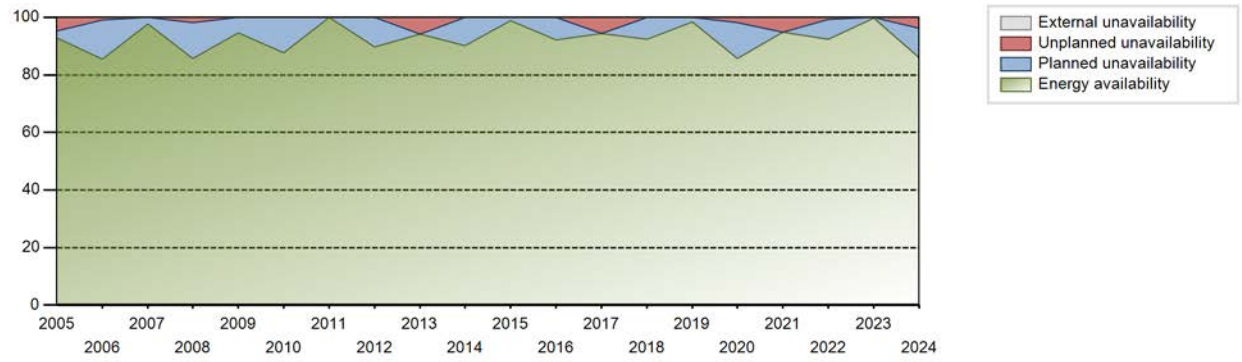


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	3095.80	6158	786	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1976	4133.80	7299	786	59.96	59.96	59.87	83.09	29.04	24.54	15.50	0.00
1977	3716.70	5802	700	60.16	60.16	60.61	66.23	28.13	23.55	16.29	0.00
1978	4277.20	6370	717	68.15	68.15	68.10	72.72	21.90	19.11	12.74	0.00
1979	3349.50	4781	739	51.70	51.70	51.74	54.58	16.57	10.27	38.03	0.00
1980	4790.20	7174	764	82.13	82.27	71.38	81.67	17.73	17.73	0.00	0.14
1981	2770.70	4384	757	50.56	50.56	41.78	50.05	12.31	7.10	42.35	0.00
1982	2893.90	4313	758	49.39	49.39	43.58	49.24	25.88	17.25	33.37	0.00
1983	3968.90	6240	764	71.55	71.55	59.30	71.23	5.34	4.03	24.42	0.00
1984	3609.18	5473	752	62.28	62.53	54.64	62.31	14.75	10.82	26.66	0.25
1985	4761.37	6694	752	76.47	76.47	72.28	76.42	12.33	10.76	12.77	0.00
1986	3645.39	5162	768	58.97	58.97	54.18	58.93	3.47	2.12	38.91	0.00
1987	5080.69	7043	750	80.43	80.43	77.33	80.40	2.18	1.80	17.77	0.00
1988	4115.82	5802	756	66.04	66.04	61.98	66.05	15.56	12.17	21.78	0.00
1989	6479.72	8760	757	100.00	100.00	97.71	100.00	0.00	0.00	0.00	0.00
1990	4103.39	5722	753	65.08	65.08	62.21	65.32	5.81	4.02	30.91	0.00
1991	4707.49	6530	741	73.96	74.64	72.52	74.54	6.19	4.92	20.44	0.68
1992	6157.15	8444	741	96.08	96.08	94.60	96.13	2.98	2.95	0.97	0.00
1993	4956.71	6913	737	78.38	78.38	76.78	78.92	5.25	4.34	17.28	0.00
1994	5512.20	7542	741	85.80	85.80	84.92	86.10	1.57	1.37	12.83	0.00
1995	6465.83	8760	741	100.00	100.00	99.61	100.00	0.00	0.00	0.00	0.00
1996	5726.66	7666	788	87.80	87.80	82.65	87.27	2.35	2.11	10.09	0.00
1997	6009.00	7637	800	87.88	87.88	85.74	87.18	0.00	0.00	12.12	0.00
1998	6951.75	8751	800	99.91	99.91	99.20	99.90	0.09	0.09	0.00	0.00
1999	5968.79	7153	808	82.16	82.16	84.29	81.66	2.48	2.09	15.76	0.00
2000	6413.39	7530	863	86.23	86.23	84.81	85.72	4.90	4.44	9.33	0.00
2001	7496.17	8689	863	99.14	99.14	99.16	99.19	0.86	0.86	0.00	0.00
2002	6627.11	7778	856	88.81	88.81	88.38	88.79	1.49	1.34	9.85	0.00
2003	7146.92	8438	856	96.33	96.33	95.31	96.32	0.00	0.00	3.67	0.00
2004	6896.11	8046	869	91.70	91.70	90.79	91.60	0.29	0.27	8.04	0.00
2005	6993.53	8121	856	92.72	92.72	93.26	92.71	4.88	4.76	2.52	0.00
2006	6422.81	7516	876	85.37	85.37	86.27	85.80	0.98	0.84	13.79	0.00
2007	7499.08	8550	876	97.63	97.63	97.72	97.60	0.00	0.00	2.37	0.00
2008	6433.74	7527	876	85.72	85.72	83.61	85.69	2.19	1.92	12.36	0.00
2009	7190.01	8289	876	94.63	94.63	93.70	94.62	0.00	0.00	5.37	0.00
2010	6509.87	7690	876	87.80	87.80	84.83	87.79	0.00	0.00	12.20	0.00
2011	7529.65	8760	876	100.00	100.00	98.12	100.00	0.00	0.00	0.00	0.00

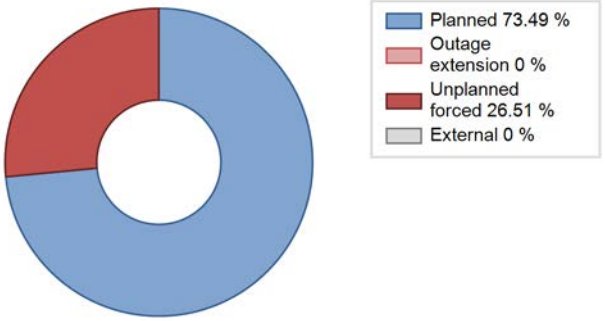
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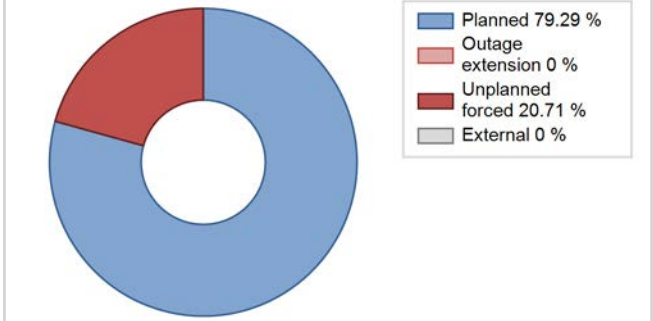
2012	6802.03	7876	876	89.69	89.69	88.40	89.66	0.00	0.00	10.31	0.00
2013	7056.54	8251	876	94.19	94.19	91.95	94.18	5.81	5.81	0.00	0.00
2014	6816.80	7901	876	90.20	90.20	88.83	90.19	0.00	0.00	9.80	0.00
2015	7570.54	8657	876	98.84	98.84	98.65	98.82	0.00	0.00	1.16	0.00
2016	6991.13	8096	876	92.16	92.16	90.86	92.17	0.14	0.13	7.71	0.00
2017	7318.73	8425	876	94.36	94.36	95.37	96.18	5.55	5.55	0.09	0.00
2018	7009.59	8098	876	92.44	92.44	91.34	92.44	0.00	0.00	7.56	0.00
2019	7558.09	8624	876	98.46	98.46	98.49	98.45	0.00	0.00	1.54	0.00
2020	6410.21	7518	876	85.60	85.60	83.31	85.59	2.07	1.81	12.59	0.00
2021	7247.27	8308	876	94.83	94.83	94.44	94.84	5.17	5.17	0.00	0.00
2022	6962.10	8033	876	92.28	92.28	90.73	91.70	0.86	0.80	6.92	0.00
2023	7517.55	8667	876	99.72	99.72	97.96	98.94	0.04	0.04	0.24	0.00
2024	6270.66	7545	876	85.89	85.89	81.49	85.89	4.17	3.74	10.37	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1975 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		329			275	
B. Refuelling without maintenance				35		
C. Inspection, maintenance or repair combined with refuelling	869			869		
D. Inspection, maintenance or repair without refuelling	42			82		
E. Testing of plant systems or components				1	2	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					14	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						0
P. Fire					8	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					1	
Z. Other				2	45	
Subtotal	911	329		989	345	1
Total	**1240**			**1335**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	162	5
12. Reactor I&C Systems		14
13. Reactor Auxiliary Systems		37
14. Safety Systems		25
15. Reactor Cooling Systems		34
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		57
32. Feedwater and Main Steam System	167	60
33. Circulating Water System		1
34. Miscellaneous Systems		14
35. All other I&C Systems		6
41. Main Generator Systems		22
42. Electrical Power Supply Systems		24
Total	**329**	**300**

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2024 Operating Experience

US-366 HATCH-2 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	SOUTHERN (Southern Nuclear Operating Company, Inc.)
Owner	:	GPCO (GEORGIA POWER CO.)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	2804 MWth
Gross electrical power	:	921 MWe
Reference unit power (net)	:	883 MWe

Key Dates

Construction Date	:	1972-02-01
Grid Date	:	1978-09-22
Commercial Date	:	1979-09-05
Age at end of year	:	46 years

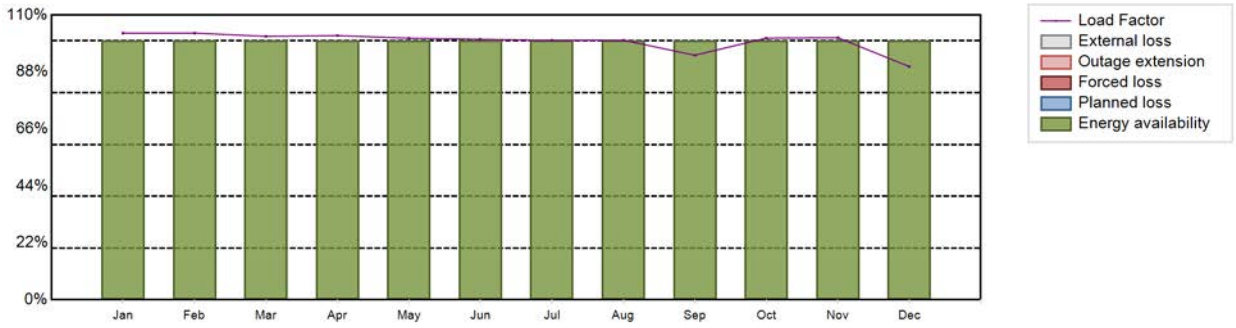
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.07
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	279
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.435
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	2
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	18750	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.27	HP cylinder inlet steam pressure [MPa]	:	6.68
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	560	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	18.4	Number of main condensate pumps	:	-
Number of control rod assemblies	:	137	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	99.9 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	676.72	633.14	667.62	648.81	663.84	639.69	658.53	658.82	600.45	664.14	644.53	591.86	7748.17
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	103.01	103.02	101.76	102.05	101.05	100.62	100.24	100.28	94.45	101.09	101.24	90.09	99.90
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.7 %
Cumulative Energy Availability Factor (EAF)	:	86.33 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.39 %
Cumulative Unit Capability Factor (UCF)	:	86.37 %	Cumulative Planned Unavailability Factor (PUF)	:	11.24 %
Cumulative Load Factor (LF)	:	83.5 %	Cumulative Externally cause unavailability (XUF)	:	0.04 %
Cumulative Operating Factor (OF)	:	85.93 %			

Electricity Production (net) [GWh]

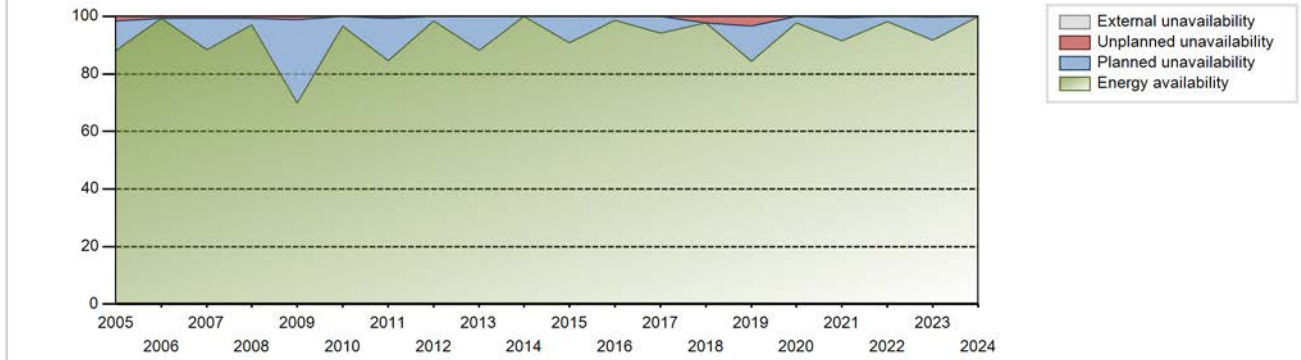


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1979	2632.60	4155	749	100.00	100.00	80.12	84.70	0.00	0.00	0.00	0.00
1980	3653.10	5269	767	59.14	61.00	54.22	59.98	9.09	6.10	32.90	1.86
1981	4481.50	6872	772	78.68	78.68	66.27	78.45	8.17	7.00	14.33	0.00
1982	3734.20	5588	771	63.90	63.90	55.29	63.79	11.54	8.34	27.76	0.00
1983	3817.20	5774	771	66.14	66.14	56.52	65.91	16.68	13.24	20.62	0.00
1984	1893.50	2833	748	26.70	26.70	28.82	32.25	11.91	3.61	69.69	0.00
1985	5376.13	7239	748	82.65	82.65	82.05	82.64	3.03	2.58	14.77	0.00
1986	3618.71	6169	777	70.41	70.41	53.17	70.42	6.53	4.92	24.67	0.00
1987	5755.61	8388	761	95.73	95.73	86.34	95.75	3.20	3.16	1.11	0.00
1988	4254.48	5917	768	65.65	65.65	63.07	67.36	16.67	13.13	21.22	0.00
1989	4147.17	6155	768	68.60	68.60	61.64	70.26	0.39	0.27	31.13	0.00
1990	6527.75	8649	766	98.66	98.66	97.28	98.73	1.34	1.34	0.00	0.00
1991	4932.15	6656	761	74.38	74.38	73.99	75.98	4.84	3.78	21.84	0.00
1992	4692.39	6668	764	74.52	74.52	69.86	75.91	2.95	2.26	23.21	0.00
1993	4999.71	7734	757	87.45	87.45	75.40	88.29	12.55	12.55	0.00	0.00
1994	5275.59	7534	765	85.19	85.19	78.72	86.00	1.87	1.63	13.19	0.00
1995	5055.51	6888	768	77.45	77.45	75.07	78.63	6.54	5.42	17.13	0.00
1996	7021.70	8639	809	98.36	98.36	98.81	98.35	0.70	0.70	0.94	0.00
1997	6033.58	7560	818	86.43	86.43	84.20	86.30	2.77	2.46	11.11	0.00
1998	5829.91	7247	821	82.84	82.84	81.05	82.73	0.00	0.00	17.16	0.00
1999	7073.63	8173	855	93.31	93.31	94.44	93.30	5.10	5.01	1.68	0.00
2000	6900.28	7884	878	89.65	89.65	89.93	89.75	0.24	0.21	10.14	0.00
2001	6584.53	7618	878	86.29	86.29	85.61	86.96	2.95	2.62	11.09	0.00
2002	7423.29	8544	870	97.34	97.34	97.40	97.53	2.66	2.66	0.00	0.00
2003	6962.51	8052	883	91.94	91.94	91.13	91.92	0.07	0.07	7.99	0.00
2004	7520.63	8589	883	97.79	97.79	96.96	97.78	0.00	0.00	2.21	0.00
2005	6727.80	7724	883	88.20	88.20	86.97	88.16	1.78	1.60	10.20	0.00
2006	7641.83	8694	883	99.25	99.25	98.79	99.25	0.75	0.75	0.00	0.00
2007	6749.03	7744	883	88.41	88.41	87.25	88.40	0.73	0.65	10.94	0.00
2008	7479.80	8516	883	96.96	96.96	96.44	96.95	0.81	0.79	2.25	0.00
2009	5218.51	6119	883	69.87	69.87	67.47	69.85	1.54	1.09	29.04	0.00
2010	7391.68	8456	883	96.54	96.54	95.56	96.53	0.00	0.00	3.46	0.00
2011	6052.02	7405	883	84.57	84.57	78.24	84.53	0.74	0.63	14.80	0.00
2012	7581.41	8634	883	98.30	98.30	97.75	98.29	0.00	0.00	1.70	0.00
2013	6767.29	7728	883	88.22	88.22	87.48	88.21	0.00	0.00	11.78	0.00
2014	7693.19	8760	883	100.00	100.00	99.46	100.00	0.00	0.00	0.00	0.00
2015	6926.72	7950	883	90.75	90.75	89.55	90.75	0.00	0.00	9.25	0.00

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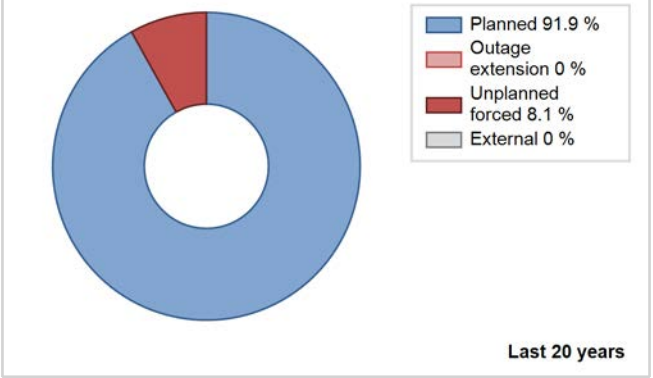
2016	7656.23	8657	883	98.55	98.55	98.71	98.55	0.00	0.00	1.45	0.00
2017	7212.21	8254	883	94.22	94.22	93.24	94.22	0.00	0.00	5.78	0.00
2018	7393.99	8562	883	97.74	97.74	95.59	97.74	2.26	2.26	0.00	0.00
2019	6358.89	7386	883	84.33	84.33	82.21	84.32	3.75	3.28	12.39	0.00
2020	7557.67	8590	883	97.80	97.80	97.44	97.79	0.00	0.00	2.20	0.00
2021	6981.87	8023	883	91.58	91.58	90.26	91.59	0.44	0.40	8.01	0.00
2022	7557.77	8605	883	98.23	98.23	97.71	98.23	0.00	0.00	1.77	0.00
2023	6833.54	7811	883	91.76	91.76	88.34	89.17	0.30	0.27	7.96	0.00
2024	Data not provided										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1979 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					170	
B. Refuelling without maintenance				15		
C. Inspection, maintenance or repair combined with refuelling				879		
D. Inspection, maintenance or repair without refuelling				125		
E. Testing of plant systems or components				11	60	
L. Human factor related					29	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				0		
Z. Other					27	
Subtotal				1030	286	
Total	**0**			**1316**		

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1979 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		23
12. Reactor I&C Systems		14
13. Reactor Auxiliary Systems		10
14. Safety Systems		4
15. Reactor Cooling Systems		91
31. Turbine and auxiliaries		25
32. Feedwater and Main Steam System		32
33. Circulating Water System		3
34. Miscellaneous Systems		5
41. Main Generator Systems		19
42. Electrical Power Supply Systems		10
Total		**236**

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2024 Operating Experience

US-354 HOPE CREEK-1 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	PSEG (PSEG Nuclear, LLC)
Owner	:	PSEGPOWR (PSEG Power, Inc.)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	3840 MWth
Gross electrical power	:	1240 MWe
Reference unit power (net)	:	1172 MWe

Key Dates

Construction Date	:	1976-03-01
Grid Date	:	1986-08-01
Commercial Date	:	1986-12-20
Age at end of year	:	38 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	30000
Active core diameter [m]	:	4.8
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	764
Fuel linear heat generation rate [kW/m]	:	17.52
Number of control rod assemblies	:	185
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

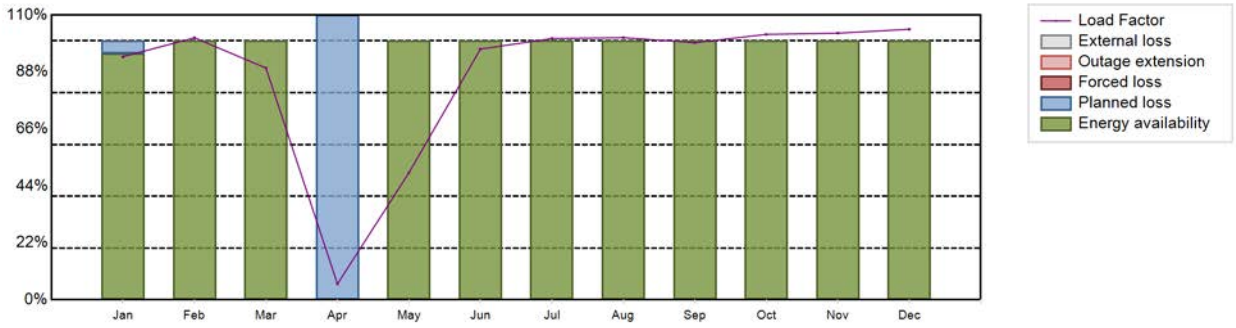
Operating coolant pressure [MPa]	:	7.17
Reactor outlet temperature [°C]	:	287
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.42
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.56
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8997.25 GW(e).h
Energy Availability Factor (EAF)	:	88.44 %
Unit Capability Factor (UCF)	:	88.44 %
Load Factor (LF)	:	87.4 %
Operating Factor (OF)	:	88.44 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	11.56 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1015 hours

Annual Summary



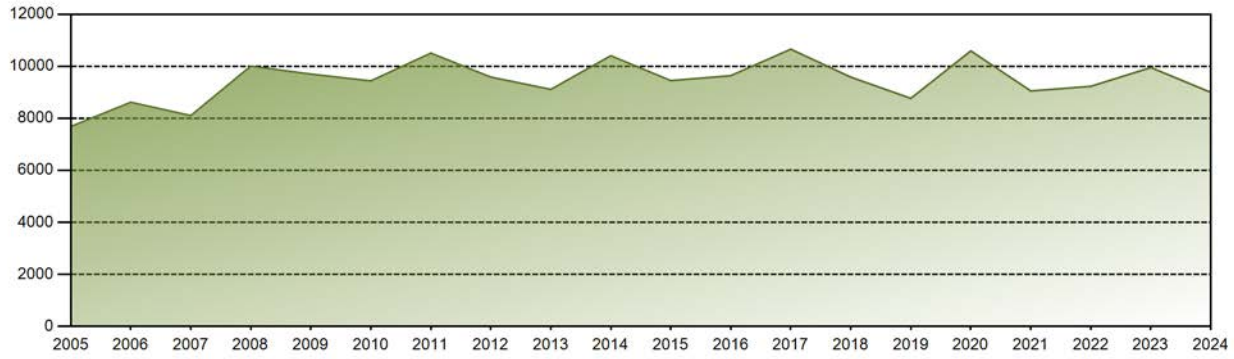
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	818.66	825.56	779.58	51.89	428.07	817.20	879.98	882.88	838.04	894.02	870.27	911.12	8997.26
EAF [%]	95.27	100.00	100.00	-36.10	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	88.44
UCF [%]	95.27	100.00	100.00	-36.10	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	88.44
LF [%]	93.89	101.21	89.53	6.15	49.09	96.84	100.92	101.25	99.31	102.53	102.99	104.49	87.40
OF [%]	95.30	100.00	100.00	8.33	56.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00	88.44
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	4.73	0.00	0.00	136.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.56
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	323087.16 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.27 %
Cumulative Energy Availability Factor (EAF)	:	88.97 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.07 %
Cumulative Unit Capability Factor (UCF)	:	88.97 %	Cumulative Planned Unavailability Factor (PUF)	:	8.96 %
Cumulative Load Factor (LF)	:	88.04 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	88.23 %			

Electricity Production (net) [GWh]

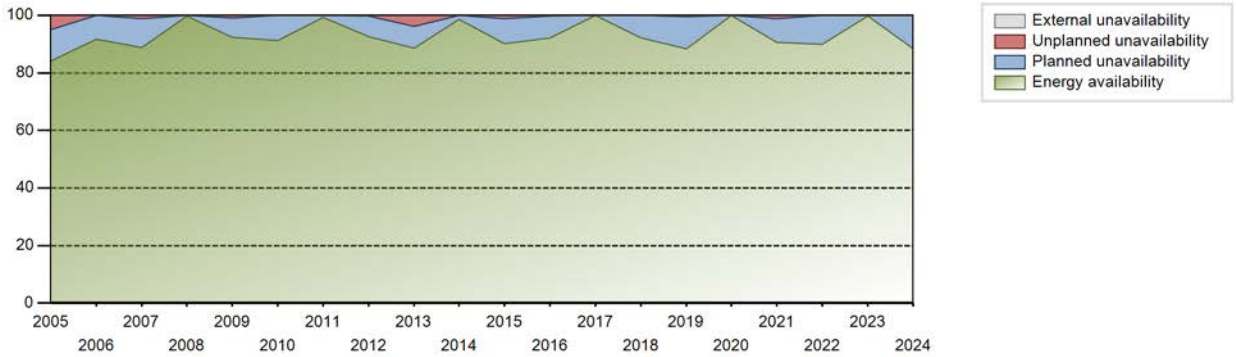


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	Data not provided										
1987	7308.74	7457	1067	92.67	92.67	78.19	85.13	4.09	3.95	3.38	0.00
1988	6470.87	6369	1061	79.03	79.03	69.43	72.51	5.32	4.44	16.53	0.00
1989	6614.33	6717	1031	76.72	76.72	73.24	76.68	1.41	1.10	22.18	0.00
1990	8100.14	7940	1031	90.66	90.66	89.69	90.64	6.26	6.05	3.29	0.00
1991	7402.71	7280	1031	83.07	83.07	81.96	83.11	4.06	3.52	13.41	0.00
1992	7059.11	6930	1031	78.92	78.92	77.95	78.89	2.57	2.08	19.00	0.00
1993	8825.34	8526	1031	97.35	97.35	97.72	97.33	2.65	2.65	0.00	0.00
1994	7125.64	6969	1031	79.60	79.60	78.90	79.55	6.85	5.86	14.54	0.00
1995	7072.28	6937	1031	79.21	79.21	78.31	79.19	7.95	6.84	13.95	0.00
1996	6770.72	6618	1031	75.36	75.36	74.76	75.34	0.00	0.00	24.64	0.00
1997	6417.76	6511	1031	74.32	74.32	71.06	74.33	0.93	0.70	24.99	0.00
1998	8700.37	8539	1031	97.48	97.48	96.33	97.48	2.52	2.52	0.00	0.00
1999	7701.08	7538	1031	86.05	86.05	85.27	86.05	0.00	0.00	13.95	0.00
2000	7271.74	7259	1031	82.57	82.57	80.29	82.64	8.12	7.30	10.13	0.00
2001	8065.27	7859	1049	89.79	89.79	88.65	89.71	3.66	3.41	6.80	0.00
2002	8843.08	8555	1049	97.66	97.66	96.23	97.66	1.33	1.31	1.03	0.00
2003	7260.58	7137	1049	81.47	81.47	79.01	81.47	9.64	8.69	9.84	0.00
2004	6048.87	6123	1049	69.71	69.71	65.65	69.71	9.29	7.14	23.16	0.00
2005	7684.77	7379	1049	84.24	84.24	83.62	84.23	5.55	4.95	10.81	0.00
2006	8617.78	8042	1059	91.82	91.82	92.90	91.80	0.08	0.07	8.10	0.00
2007	8104.54	7774	1061	88.78	88.78	87.20	88.74	1.27	1.14	10.08	0.00
2008	10006.26	8756	1186	99.67	99.67	100.44	99.68	0.00	0.00	0.33	0.00
2009	9700.30	8104	1161	92.37	92.37	95.38	92.51	1.09	1.01	6.61	0.00
2010	9438.54	8001	1191	91.37	91.37	92.60	91.34	0.00	0.00	8.63	0.00
2011	10505.93	8690	1191	99.20	99.20	100.70	99.20	0.00	0.00	0.80	0.00
2012	9586.25	8141	1172	92.70	92.70	93.12	92.68	0.20	0.18	7.12	0.00
2013	9112.68	7751	1172	88.49	88.49	88.75	88.47	4.20	3.88	7.63	0.00
2014	10406.06	8636	1172	98.58	98.58	101.36	98.58	0.00	0.00	1.42	0.00
2015	9450.74	7895	1172	90.13	90.13	92.05	90.13	1.16	1.06	8.81	0.00
2016	9639.69	8087	1172	92.07	92.07	93.64	92.07	0.25	0.23	7.70	0.00
2017	10657.91	8760	1172	100.00	100.00	103.81	100.00	0.00	0.00	0.00	0.00
2018	9583.40	8071	1172	92.14	92.14	93.34	92.13	0.00	0.00	7.86	0.00
2019	8767.20	7746	1172	88.44	88.44	85.39	88.42	0.57	0.51	11.05	0.00
2020	10592.70	8783	1172	100.00	100.00	102.89	99.99	0.00	0.00	0.00	0.00
2021	9051.91	7942	1172	90.65	90.65	88.17	90.66	1.16	1.07	8.28	0.00
2022	9229.60	7882	1172	89.98	89.98	89.90	89.98	0.06	0.05	9.97	0.00

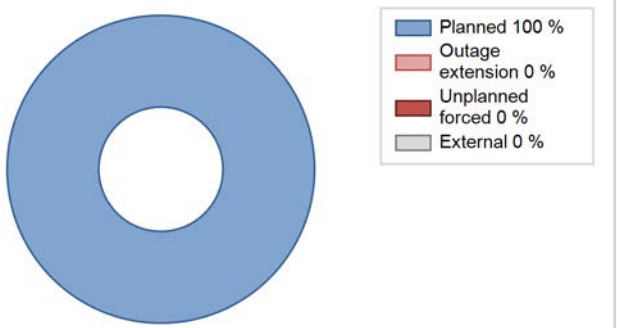
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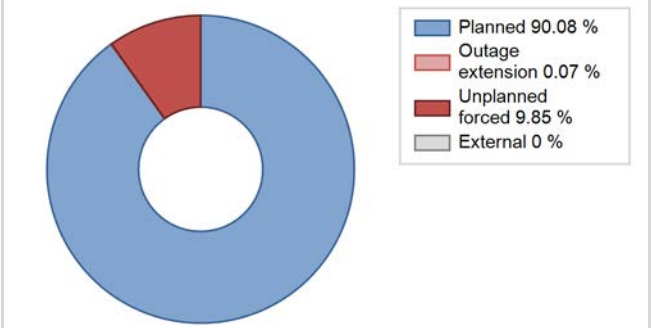
2023	9953.82	8443	1172	99.80	99.80	96.95	96.38	0.04	0.13	0.07	0.00
2024	8997.25	7769	1172	88.44	88.44	87.40	88.44	0.00	0.00	11.56	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1986 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					153	
B. Refuelling without maintenance				35		
C. Inspection, maintenance or repair combined with refuelling	980			677		
D. Inspection, maintenance or repair without refuelling	35			90		
E. Testing of plant systems or components				0		
H. Nuclear regulatory requirements					0	
L. Human factor related					14	
P. Fire					1	
Z. Other					5	
Subtotal	1015			802	173	
Total	**1015**			**975**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		12
12. Reactor I&C Systems		6
13. Reactor Auxiliary Systems		19
15. Reactor Cooling Systems		24
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		28
32. Feedwater and Main Steam System		23
33. Circulating Water System		7
34. Miscellaneous Systems		1
35. All other I&C Systems		1
41. Main Generator Systems		14
42. Electrical Power Supply Systems		22
Total		**159**

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2024 Operating Experience

US-373 LASALLE-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-5 (Mark 2)
Thermal power	:	3546 MWth
Gross electrical power	:	1207 MWe
Reference unit power (net)	:	1137 MWe

Key Dates

Construction Date	:	1973-09-10
Grid Date	:	1982-09-04
Commercial Date	:	1984-01-01
Age at end of year	:	42 years

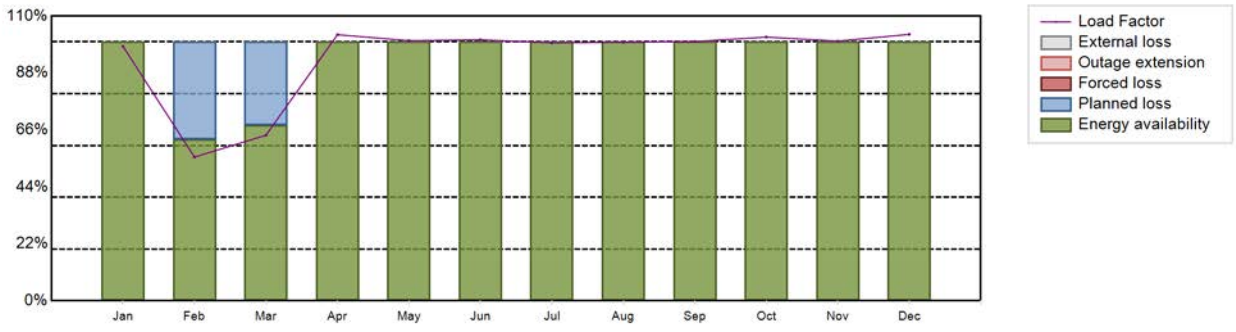
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	40
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	4.88
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	764
Fuel linear heat generation rate [kW/m]	:	44
Number of control rod assemblies	:	185
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7.1
Reactor outlet temperature [°C]	:	286
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.65
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Pond (closed-cycle)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9390.07 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	94.29 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	94.29 %	Planned Unavailability Factor (PUF)	:	5.71 %
Load Factor (LF)	:	94.02 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	94.25 %	Total off-line time	:	505 hours

Annual Summary



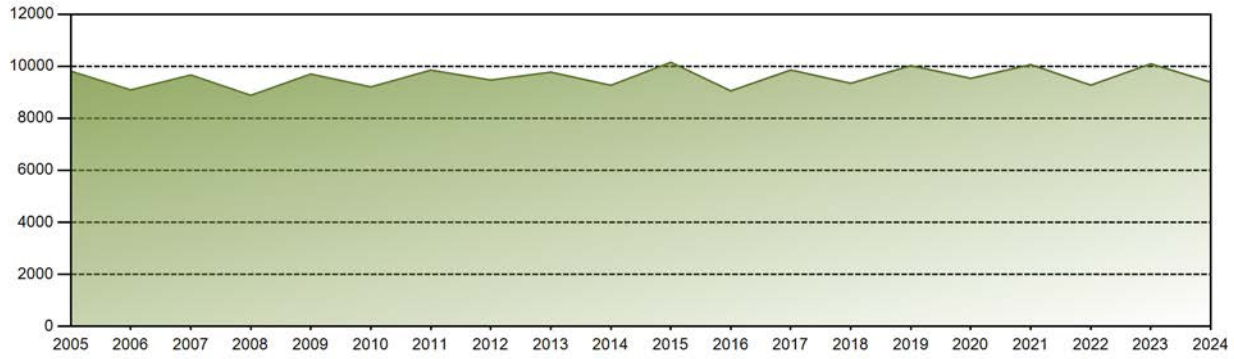
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	831.55	439.42	540.32	841.41	850.13	825.27	842.99	844.59	819.86	861.62	822.38	870.53	9390.07
EAF [%]	100.00	62.29	67.82	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.29
UCF [%]	100.00	62.29	67.82	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.29
LF [%]	98.30	55.53	63.96	102.78	100.50	100.81	99.65	99.84	100.15	101.85	100.32	102.91	94.02
OF [%]	100.00	62.07	67.56	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	94.25
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	37.71	32.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.71
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	323859.31 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.09 %
Cumulative Energy Availability Factor (EAF)	:	83.6 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.48 %
Cumulative Unit Capability Factor (UCF)	:	83.61 %	Cumulative Planned Unavailability Factor (PUF)	:	11.91 %
Cumulative Load Factor (LF)	:	82.47 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	82.94 %			

Electricity Production (net) [GWh]

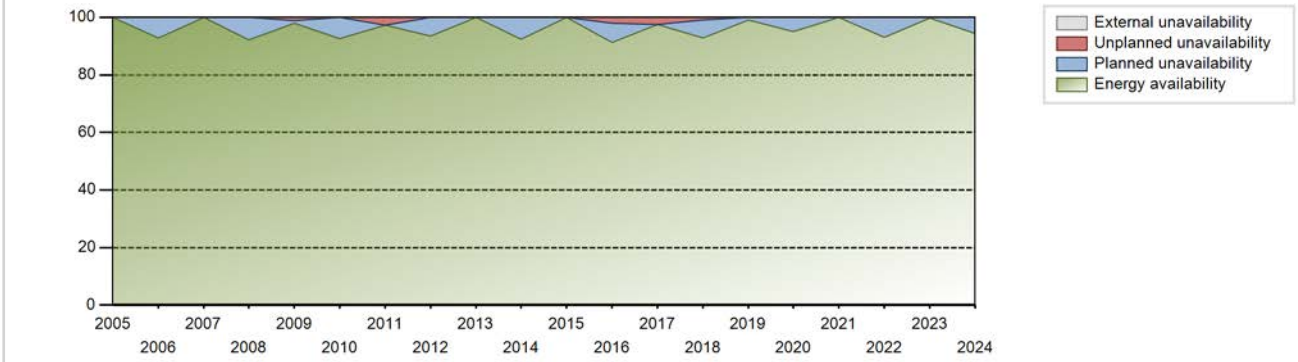


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	5206.21	6052	1078	69.43	69.43	54.99	68.91	16.31	13.53	17.04	0.00
1985	4827.46	5581	1036	63.69	64.26	53.19	63.71	19.25	15.32	20.42	0.57
1986	2100.75	2331	1036	25.78	25.78	23.15	26.61	2.65	0.70	73.52	0.00
1987	4108.12	5455	1036	61.89	61.89	45.27	62.27	38.11	38.11	0.00	0.00
1988	5453.67	5818	1036	65.86	65.86	59.93	66.23	2.49	1.68	32.45	0.00
1989	6180.58	6103	1036	69.67	69.67	68.10	69.67	1.37	0.97	29.36	0.00
1990	8637.38	8329	1036	95.02	95.02	95.17	95.08	1.85	1.79	3.19	0.00
1991	6841.44	6627	1036	75.39	75.39	75.38	75.65	2.23	1.72	22.89	0.00
1992	6469.28	6528	1036	74.04	74.04	71.09	74.32	1.44	1.08	24.87	0.00
1993	7207.51	7102	1036	80.97	80.97	79.42	81.07	11.79	10.82	8.21	0.00
1994	4945.32	5095	1036	57.78	57.78	54.49	58.16	16.78	11.65	30.57	0.00
1995	8239.56	8226	1036	93.88	93.88	90.79	93.90	6.12	6.12	0.00	0.00
1996	3300.36	3349	1036	37.48	37.48	36.27	38.13	30.53	16.47	46.05	0.00
1997	0.00	0	1036	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1998	3336.67	3174	1036	36.27	36.27	36.77	36.23	63.06	61.91	1.82	0.00
1999	8013.68	7963	1036	90.81	90.81	88.30	90.90	0.75	0.69	8.50	0.00
2000	9745.39	8784	1114	100.00	100.00	102.81	100.00	0.00	0.00	0.00	0.00
2001	9850.36	8708	1111	99.42	99.42	101.01	99.41	0.58	0.58	0.00	0.00
2002	8927.60	7945	1111	90.57	90.57	91.73	90.70	0.00	0.00	9.43	0.00
2003	9739.03	8716	1111	99.50	99.50	100.07	99.50	0.00	0.00	0.50	0.00
2004	9051.53	8059	1111	91.50	91.50	92.75	91.75	0.00	0.00	8.50	0.00
2005	9811.96	8760	1146	100.00	100.00	97.73	99.99	0.00	0.00	0.00	0.00
2006	9092.07	8129	1118	92.81	92.81	92.84	92.80	0.00	0.00	7.19	0.00
2007	9664.63	8760	1118	100.00	100.00	98.68	100.00	0.00	0.00	0.00	0.00
2008	8883.77	8103	1118	92.26	92.26	90.46	92.25	0.00	0.00	7.74	0.00
2009	9700.71	8580	1118	97.95	97.95	99.05	97.95	1.10	1.09	0.96	0.00
2010	9207.03	8119	1118	92.69	92.69	94.01	92.68	0.00	0.00	7.31	0.00
2011	9851.68	8529	1118	97.37	97.37	100.59	97.36	2.63	2.63	0.00	0.00
2012	9471.23	8213	1137	93.60	93.60	95.09	93.50	0.00	0.00	6.40	0.00
2013	9774.52	8465	1137	100.00	100.00	98.13	96.62	0.00	0.00	0.00	0.00
2014	9267.74	8092	1137	92.37	92.37	93.05	92.37	0.00	0.00	7.63	0.00
2015	10153.40	8760	1137	100.00	100.00	101.94	100.00	0.00	0.00	0.00	0.00
2016	9054.09	8019	1137	91.29	91.29	90.66	91.29	2.29	2.14	6.56	0.00
2017	9856.32	8541	1137	97.51	97.51	98.96	97.50	2.49	2.49	0.00	0.00
2018	9347.13	8117	1137	92.83	92.83	93.85	92.66	0.88	0.83	6.34	0.00
2019	10026.81	8680	1137	99.10	99.10	100.67	99.09	0.00	0.00	0.90	0.00
2020	9535.89	8342	1137	94.98	94.98	95.48	94.97	0.00	0.00	5.02	0.00

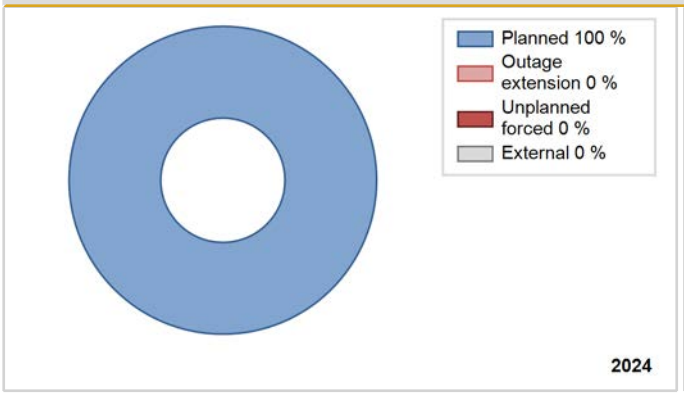
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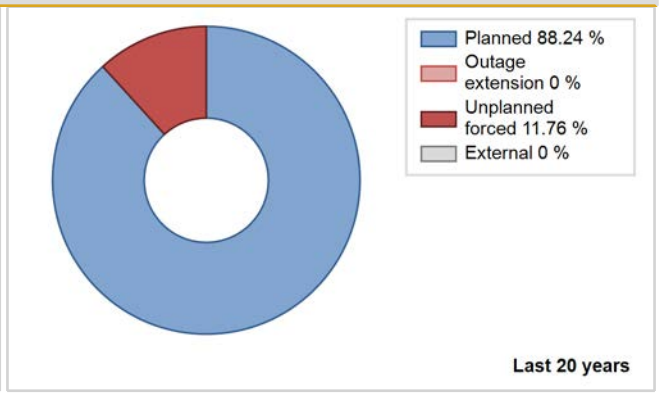
2021	10066.17	8760	1137	100.00	100.00	101.06	100.00	0.00	0.00	0.00	0.00
2022	9275.00	8160	1137	93.15	93.15	93.12	93.15	0.00	0.00	6.85	0.00
2023	10095.55	8760	1137	99.77	99.77	101.36	100.00	0.00	0.00	0.23	0.00
2024	9390.07	8279	1137	94.29	94.29	94.02	94.25	0.00	0.00	5.71	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					316	
B. Refuelling without maintenance				25		
C. Inspection, maintenance or repair combined with refuelling	481			764		
D. Inspection, maintenance or repair without refuelling	23			284		
E. Testing of plant systems or components				38	3	
H. Nuclear regulatory requirements					131	
J. Grid limitation, failure or grid unavailability						8
L. Human factor related					24	
Z. Other					4	
Subtotal	504			1111	478	8
Total	**504**			**1597**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		26
12. Reactor I&C Systems		23
13. Reactor Auxiliary Systems		10
14. Safety Systems		31
15. Reactor Cooling Systems		91
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		69
32. Feedwater and Main Steam System		13
33. Circulating Water System		6
34. Miscellaneous Systems		10
35. All other I&C Systems		3
41. Main Generator Systems		11
42. Electrical Power Supply Systems		29
Total		**323**

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2024 Operating Experience

US-374 LASALLE-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-5 (Mark 2)
Thermal power	:	3546 MWth
Gross electrical power	:	1207 MWe
Reference unit power (net)	:	1140 MWe

Key Dates

Construction Date	:	1973-09-10
Grid Date	:	1984-04-20
Commercial Date	:	1984-10-19
Age at end of year	:	40 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	40
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	4.88
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	764
Fuel linear heat generation rate [kW/m]	:	44
Number of control rod assemblies	:	185
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

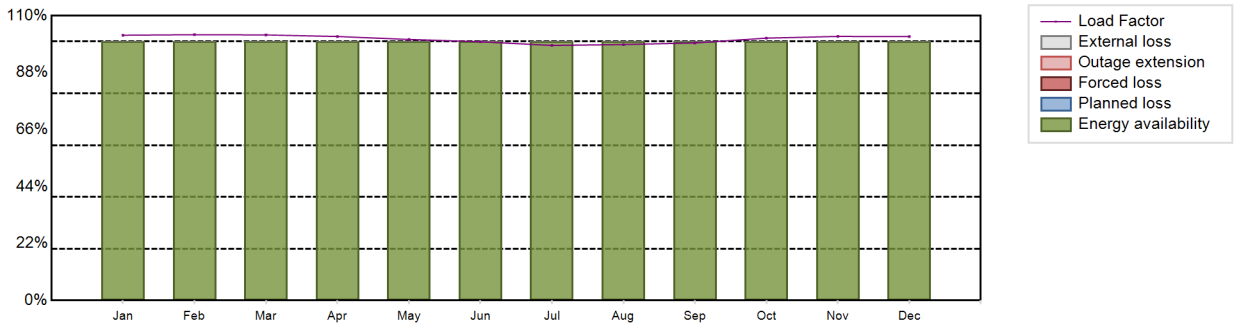
Operating coolant pressure [MPa]	:	7.1
Reactor outlet temperature [°C]	:	286
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.65
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Pond (closed-cycle)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	101.04 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



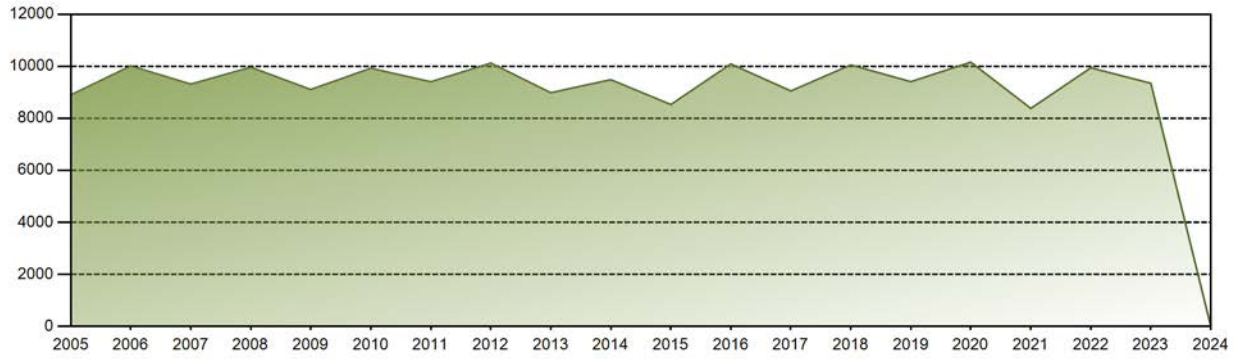
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	869.00	814.55	868.84	836.88	855.25	820.24	835.64	838.50	816.56	859.50	838.38	864.45	10117.77
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	102.46	102.66	102.58	101.96	100.84	99.93	98.52	98.86	99.48	101.34	102.00	101.92	101.04
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.01 %
Cumulative Energy Availability Factor (EAF)	:	82.97 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.31 %
Cumulative Unit Capability Factor (UCF)	:	82.98 %	Cumulative Planned Unavailability Factor (PUF)	:	11.71 %
Cumulative Load Factor (LF)	:	82.31 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	82.32 %			

Electricity Production (net) [GWh]

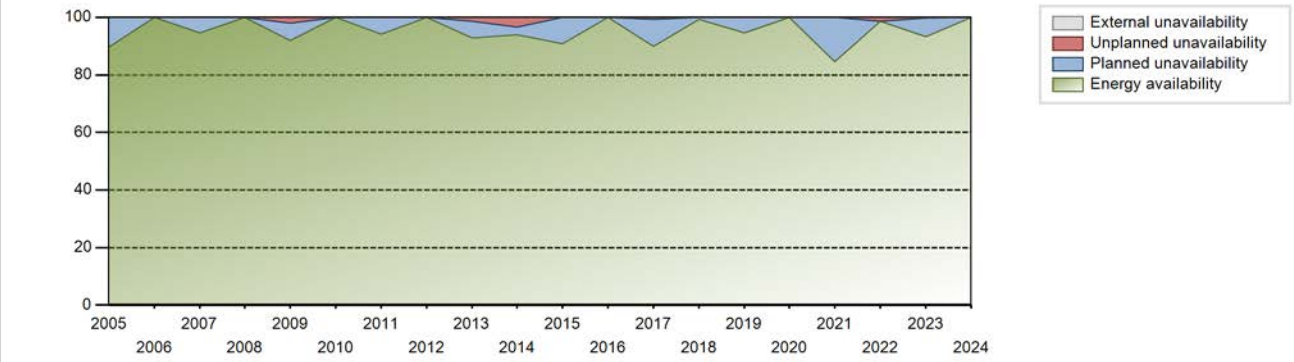


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	2735.73	4058	1039	86.57	86.57	77.10	86.68	13.43	13.43	0.00	0.00
1985	3476.96	3698	1036	41.81	41.81	38.31	42.21	30.40	18.26	39.93	0.00
1986	5727.77	6533	1036	74.58	75.00	63.11	74.58	24.61	24.49	0.51	0.43
1987	4573.28	4699	1036	53.13	53.13	50.39	53.64	1.67	0.90	45.97	0.00
1988	5662.76	6593	1036	75.07	75.07	62.23	75.06	4.26	3.34	21.59	0.00
1989	6506.76	6591	1036	75.13	75.13	71.70	75.24	0.00	0.00	24.87	0.00
1990	6216.77	6162	1036	70.01	70.01	68.50	70.34	7.34	5.55	24.45	0.00
1991	8712.41	8357	1036	95.35	95.35	96.00	95.40	4.65	4.65	0.00	0.00
1992	5797.87	5850	1036	66.28	66.28	63.71	66.60	8.49	6.15	27.57	0.00
1993	5859.19	5825	1036	66.12	66.12	64.56	66.50	0.00	0.00	33.88	0.00
1994	8428.87	8101	1036	92.44	92.44	92.88	92.48	4.45	4.31	3.26	0.00
1995	5905.70	5855	1036	66.49	66.49	65.07	66.84	3.18	2.18	31.33	0.00
1996	5642.33	5649	1036	64.50	64.50	62.00	64.31	10.53	7.59	27.92	0.00
1997	0.00	0	1036	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1998	0.00	0	1036	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1999	6632.33	6231	1036	71.11	71.11	73.08	71.13	28.89	28.89	0.00	0.00
2000	9040.45	8229	1114	93.08	93.08	95.97	93.68	0.81	0.76	6.17	0.00
2001	9683.43	8515	1111	97.18	97.18	99.30	97.20	2.82	2.82	0.00	0.00
2002	8995.59	8078	1111	92.09	92.09	92.43	92.21	0.00	0.00	7.91	0.00
2003	8709.05	7762	1111	88.43	88.43	89.49	88.61	3.07	2.80	8.77	0.00
2004	9940.43	8764	1111	99.77	99.77	101.86	99.77	0.23	0.23	0.00	0.00
2005	8901.22	7857	1147	89.71	89.71	88.58	89.68	0.00	0.00	10.29	0.00
2006	10015.75	8760	1120	100.00	100.00	102.08	100.00	0.00	0.00	0.00	0.00
2007	9315.51	8287	1120	94.61	94.61	94.95	94.60	0.00	0.00	5.39	0.00
2008	9964.59	8784	1120	100.00	100.00	101.29	100.00	0.00	0.00	0.00	0.00
2009	9108.04	8058	1120	92.01	92.01	92.83	91.99	2.07	1.95	6.04	0.00
2010	9925.54	8760	1120	100.00	100.00	101.17	100.00	0.00	0.00	0.00	0.00
2011	9404.75	8238	1140	94.14	94.14	94.44	94.04	0.00	0.00	5.86	0.00
2012	10123.73	8784	1140	100.00	100.00	101.10	100.00	0.00	0.00	0.00	0.00
2013	8985.77	7962	1140	92.90	92.90	89.97	90.88	1.43	1.34	5.76	0.00
2014	9487.27	8228	1140	93.93	93.93	95.00	93.93	3.52	3.43	2.64	0.00
2015	8530.63	7955	1140	90.81	90.81	85.42	90.81	0.00	0.00	9.19	0.00
2016	10090.77	8784	1140	100.00	100.00	100.77	100.00	0.00	0.00	0.00	0.00
2017	9052.14	7877	1140	89.92	89.92	90.64	89.92	0.77	0.70	9.38	0.00
2018	10053.26	8687	1140	99.19	99.19	100.67	99.17	0.00	0.00	0.81	0.00
2019	9408.48	8290	1140	94.64	94.64	94.21	94.63	0.00	0.00	5.36	0.00
2020	10159.80	8783	1140	100.00	100.00	101.46	99.99	0.00	0.00	0.00	0.00

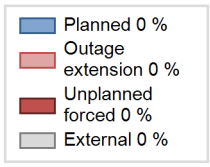
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2021	8380.54	7402	1140	84.50	84.50	83.92	84.50	0.00	0.00	15.50	0.00
2022	9941.96	8641	1140	98.63	98.63	99.56	98.64	1.37	1.37	0.00	0.00
2023	9348.50	8181	1140	93.21	93.21	93.61	93.39	0.00	0.17	6.62	0.00
2024	Data not provided										

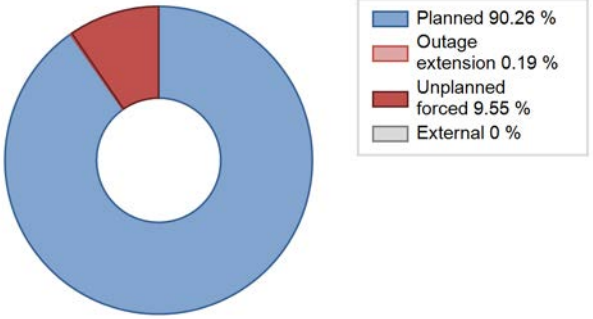
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					188	
B. Refuelling without maintenance				34		
C. Inspection, maintenance or repair combined with refuelling				861		
D. Inspection, maintenance or repair without refuelling				130		
E. Testing of plant systems or components				1		
H. Nuclear regulatory requirements					281	
J. Grid limitation, failure or grid unavailability						5
L. Human factor related					5	
Z. Other					44	
Subtotal				1026	518	5
Total		**0**			**1549**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		45
12. Reactor I&C Systems		41
15. Reactor Cooling Systems		18
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		35
32. Feedwater and Main Steam System		8
34. Miscellaneous Systems		13
35. All other I&C Systems		8
41. Main Generator Systems		4
42. Electrical Power Supply Systems		16
Total		**189**

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2024 Operating Experience

US-352 LIMERICK-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 2)
Thermal power	:	3515 MWth
Gross electrical power	:	1194 MWe
Reference unit power (net)	:	1134 MWe

Key Dates

Construction Date	:	1974-06-19
Grid Date	:	1985-04-13
Commercial Date	:	1986-02-01
Age at end of year	:	39 years

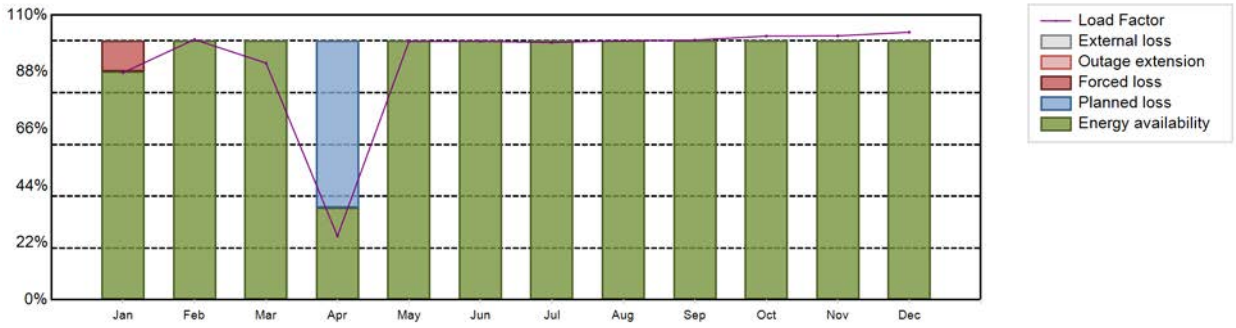
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.1
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	282
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.38
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	40	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	45000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.57	HP cylinder inlet steam pressure [MPa]	:	6.65
Active core height/length [m]	:	3.71	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	764	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	16.4	Number of main condensate pumps	:	-
Number of control rod assemblies	:	185	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9229.36 GW(e).h	Forced Loss Rate (FLR)	:	1.06 %
Energy Availability Factor (EAF)	:	93.71 %	Unplanned Capability Loss Factor (UCL)	:	1 %
Unit Capability Factor (UCF)	:	93.71 %	Planned Unavailability Factor (PUF)	:	5.28 %
Load Factor (LF)	:	92.65 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	93.64 %	Total off-line time	:	559 hours

Annual Summary



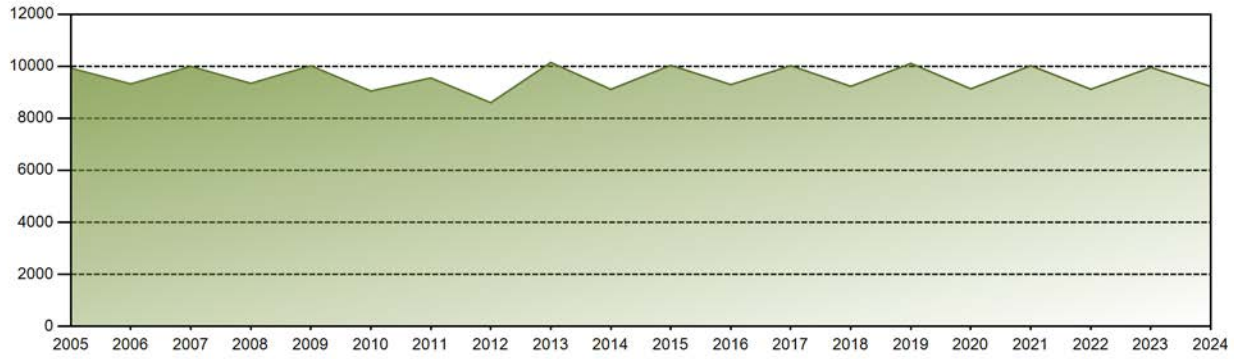
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	740.34	793.51	770.68	200.91	841.80	815.09	838.80	844.26	819.05	859.43	833.59	871.91	9229.36
EAF [%]	88.14	100.00	100.00	35.53	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	93.71
UCF [%]	88.14	100.00	100.00	35.53	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	93.71
LF [%]	87.75	100.54	91.47	24.61	99.78	99.83	99.42	100.07	100.31	101.86	101.95	103.34	92.65
OF [%]	88.04	100.00	100.00	34.72	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	93.64
FLR [%]	11.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06
UCL [%]	11.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
PUF [%]	0.00	0.00	0.00	64.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.28
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	342680.56 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.6 %
Cumulative Energy Availability Factor (EAF)	:	92.14 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.5 %
Cumulative Unit Capability Factor (UCF)	:	92.14 %	Cumulative Planned Unavailability Factor (PUF)	:	6.36 %
Cumulative Load Factor (LF)	:	90.48 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	91.79 %			

Electricity Production (net) [GWh]

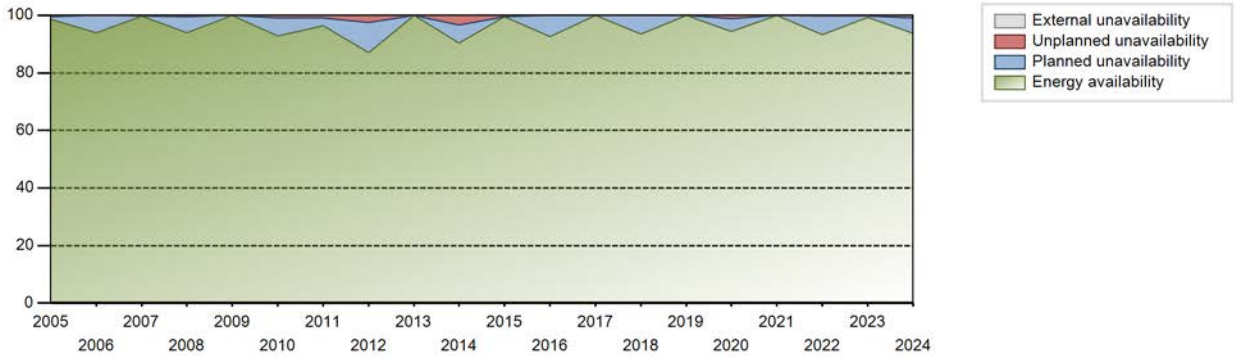


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	7210.57	7022	1055	82.79	82.79	80.99	82.76	3.46	2.97	14.25	0.00
1987	5341.32	5924	1055	67.66	67.66	57.80	67.63	4.11	2.90	29.44	0.00
1988	6674.75	8470	1055	96.43	96.43	72.03	96.43	3.57	3.57	0.00	0.00
1989	5244.25	5638	1055	69.36	69.36	56.74	64.36	0.00	0.00	30.64	0.00
1990	5633.12	5724	1055	65.34	65.34	60.95	65.34	6.61	4.62	30.03	0.00
1991	8133.85	8043	1055	91.83	91.83	88.01	91.82	8.17	8.17	0.00	0.00
1992	6239.64	6115	1055	69.63	69.63	67.33	69.62	0.10	0.07	30.31	0.00
1993	8745.47	8626	1055	98.48	98.48	94.63	98.47	1.52	1.52	0.00	0.00
1994	7858.02	7840	1055	89.52	89.52	85.03	89.50	0.86	0.78	9.70	0.00
1995	8147.47	7973	1055	91.06	91.06	88.16	91.02	7.90	7.81	1.13	0.00
1996	8141.62	7758	1096	88.83	88.83	84.51	88.32	3.15	2.89	8.28	0.00
1997	9227.48	8534	1105	97.54	97.54	95.33	97.42	0.00	0.00	2.46	0.00
1998	7449.12	7061	1112	81.62	81.62	76.45	80.61	8.24	7.33	11.04	0.00
1999	9744.01	8588	1134	98.05	98.05	98.09	98.04	1.95	1.95	0.00	0.00
2000	8988.10	7982	1143	90.94	90.94	89.82	90.87	1.04	0.96	8.10	0.00
2001	10133.10	8735	1143	99.73	99.73	101.20	99.71	0.00	0.00	0.27	0.00
2002	9286.82	8244	1134	94.07	94.07	93.49	94.11	1.20	1.14	4.78	0.00
2003	10057.46	8672	1134	99.00	99.00	101.24	99.00	1.00	1.00	0.00	0.00
2004	9539.06	8345	1134	95.01	95.01	95.76	95.00	0.00	0.00	4.99	0.00
2005	9926.94	8642	1134	98.67	98.67	99.92	98.64	0.45	0.45	0.89	0.00
2006	9320.36	8224	1134	93.90	93.90	93.82	93.88	0.00	0.00	6.10	0.00
2007	9994.36	8744	1134	99.82	99.82	100.61	99.82	0.18	0.18	0.00	0.00
2008	9342.51	8251	1134	93.94	93.94	93.79	93.93	0.63	0.59	5.47	0.00
2009	10019.44	8760	1130	100.00	100.00	101.22	100.00	0.00	0.00	0.00	0.00
2010	9046.94	8129	1130	92.81	92.81	91.39	92.80	1.02	0.96	6.23	0.00
2011	9550.19	8435	1130	96.29	96.29	96.48	96.29	0.88	0.85	2.86	0.00
2012	8599.50	7637	1130	86.99	86.99	86.64	86.94	2.80	2.51	10.50	0.00
2013	10147.12	8760	1130	100.00	100.00	102.50	99.99	0.00	0.00	0.00	0.00
2014	9112.31	7926	1130	90.48	90.48	92.05	90.48	3.50	3.28	6.24	0.00
2015	10037.82	8718	1130	99.52	99.52	101.40	99.52	0.48	0.48	0.00	0.00
2016	9294.59	8132	1130	92.58	92.58	93.64	92.58	0.00	0.00	7.42	0.00
2017	10023.55	8760	1130	100.00	100.00	101.26	100.00	0.00	0.00	0.00	0.00
2018	9228.95	8197	1099	93.57	93.57	95.86	93.57	0.00	0.00	6.43	0.00
2019	10112.18	8760	1134	100.00	100.00	101.80	100.00	0.00	0.00	0.00	0.00
2020	9133.19	8283	1134	94.30	94.30	91.69	94.30	1.29	1.24	4.47	0.00
2021	10024.41	8760	1134	100.00	100.00	100.91	100.00	0.00	0.00	0.00	0.00
2022	9117.79	8167	1134	93.23	93.23	91.79	93.23	0.33	0.31	6.46	0.00

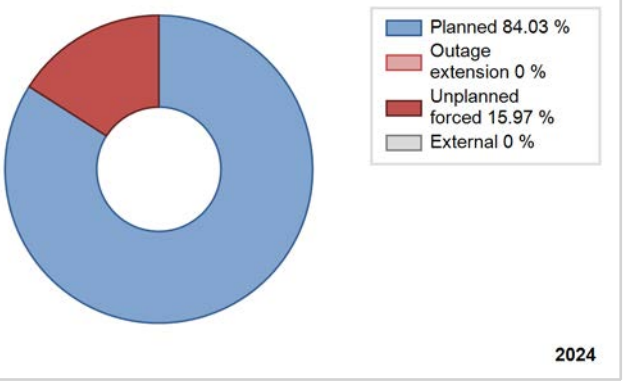
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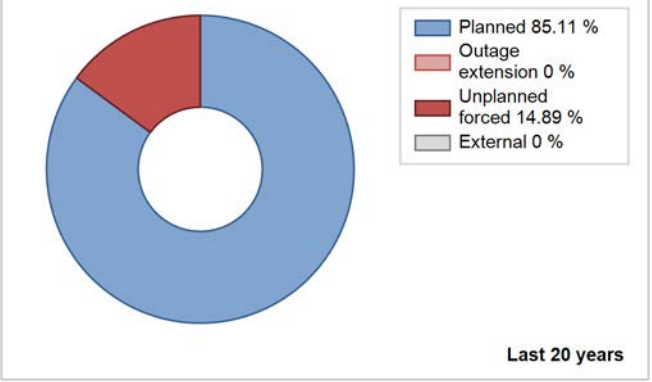
2023	9955.71	8716	1134	99.23	99.23	100.22	99.50	0.19	0.19	0.59	0.00
2024	9229.36	8225	1134	93.71	93.71	92.65	93.64	1.06	1.00	5.28	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		89			120	
B. Refuelling without maintenance				32		
C. Inspection, maintenance or repair combined with refuelling	470			529		
D. Inspection, maintenance or repair without refuelling				162		
E. Testing of plant systems or components				8	8	
H. Nuclear regulatory requirements					1	
Z. Other				67	26	
Subtotal	470	89		798	155	
Total		**559**			**953**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1986 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories	89	10
12. Reactor I&C Systems		1
13. Reactor Auxiliary Systems		5
14. Safety Systems		8
15. Reactor Cooling Systems		24
31. Turbine and auxiliaries		42
32. Feedwater and Main Steam System		8
34. Miscellaneous Systems		9
41. Main Generator Systems		8
42. Electrical Power Supply Systems		18
Total	**89**	**133**

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2024 Operating Experience

US-353 LIMERICK-2 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXELCORP (Exelon Corporation
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 2)
Thermal power	:	3515 MWth
Gross electrical power	:	1194 MWe
Reference unit power (net)	:	1134 MWe

Key Dates

Construction Date	:	1974-06-19
Grid Date	:	1989-09-01
Commercial Date	:	1990-01-08
Age at end of year	:	35 years

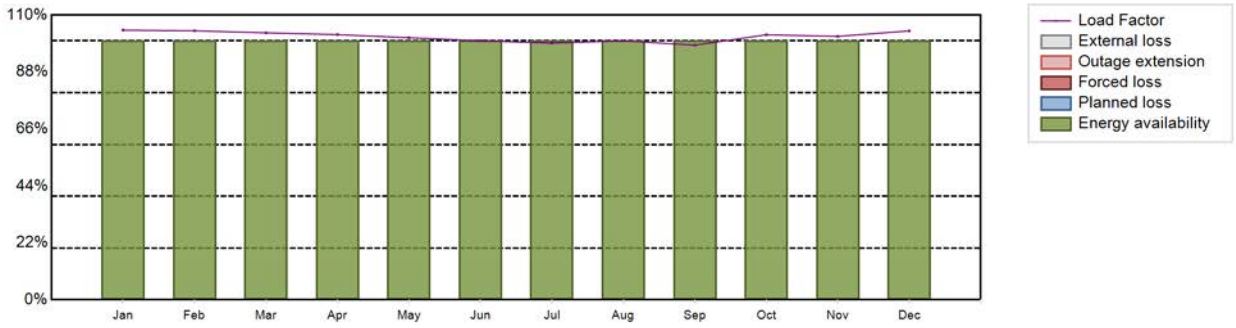
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.1
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	282
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.38
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	40	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	45000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.57	HP cylinder inlet steam pressure [MPa]	:	6.65
Active core height/length [m]	:	3.71	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	764	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	16.4	Number of main condensate pumps	:	-
Number of control rod assemblies	:	185	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	101.7 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



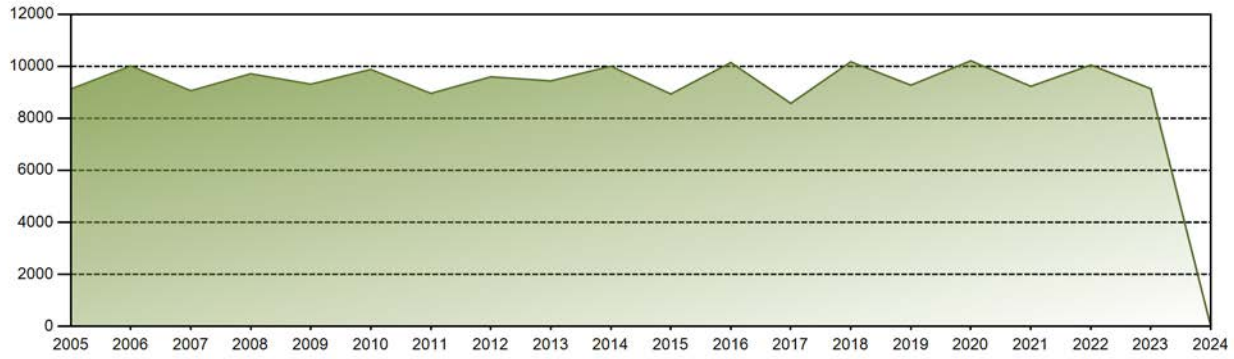
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	878.71	820.01	868.90	836.35	854.10	816.91	836.57	844.03	802.97	863.72	831.98	876.37	10130.63
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	104.15	103.90	103.13	102.43	101.23	100.05	99.15	100.04	98.35	102.37	101.76	103.87	101.70
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.23 %
Cumulative Energy Availability Factor (EAF)	:	94.29 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.17 %
Cumulative Unit Capability Factor (UCF)	:	94.31 %	Cumulative Planned Unavailability Factor (PUF)	:	4.52 %
Cumulative Load Factor (LF)	:	93.64 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	94.14 %			

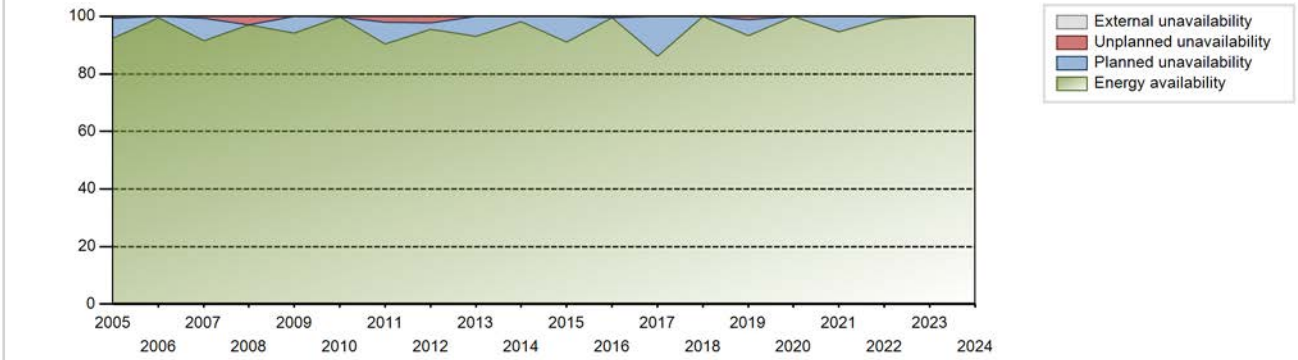
Electricity Production (net) [GWh]



Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1990	7232.60	7174	1055	81.81	81.81	79.79	83.50	13.12	12.35	5.84	0.00
1991	7146.91	6919	1055	77.82	77.82	77.33	78.98	0.55	0.43	21.74	0.00
1992	8489.18	8557	1055	97.42	97.42	91.61	97.42	2.58	2.58	0.00	0.00
1993	7468.72	7289	1055	82.26	82.26	80.81	83.21	2.60	2.20	15.54	0.00
1994	8571.51	8657	1055	98.78	98.78	92.75	98.82	1.22	1.22	0.00	0.00
1995	8401.43	7984	1110	91.17	91.17	86.41	91.14	2.66	2.49	6.34	0.00
1996	9001.10	8346	1115	95.08	95.72	91.90	95.01	4.28	4.28	0.00	0.64
1997	8307.46	7840	1115	89.33	89.33	85.05	89.50	0.00	0.00	10.67	0.00
1998	9257.88	8346	1115	95.30	95.30	94.78	95.27	0.00	0.00	4.70	0.00
1999	8560.96	7726	1135	88.42	88.42	86.06	88.20	1.25	1.12	10.46	0.00
2000	9940.73	8661	1145	98.64	98.64	98.76	98.60	1.36	1.36	0.00	0.00
2001	9243.35	8230	1143	93.93	93.93	92.32	93.95	1.60	1.53	4.55	0.00
2002	10009.52	8672	1134	98.99	98.99	100.76	99.00	1.01	1.01	0.00	0.00
2003	9387.12	8252	1134	94.21	94.21	94.50	94.20	0.37	0.35	5.44	0.00
2004	9952.00	8734	1134	99.43	99.43	99.91	99.43	0.57	0.57	0.00	0.00
2005	9124.68	8085	1134	92.31	92.31	91.85	92.29	0.77	0.71	6.98	0.00
2006	10015.11	8710	1134	99.43	99.43	100.82	99.43	0.00	0.00	0.57	0.00
2007	9059.17	8007	1134	91.42	91.42	91.20	91.40	0.77	0.71	7.87	0.00
2008	9712.13	8517	1134	96.97	96.97	97.50	96.96	3.03	3.03	0.00	0.00
2009	9311.40	8241	1134	94.09	94.09	93.73	94.08	0.00	0.00	5.91	0.00
2010	9879.13	8727	1134	99.63	99.63	99.45	99.62	0.37	0.37	0.00	0.00
2011	8956.99	7917	1134	90.40	90.40	90.17	90.38	2.29	2.12	7.48	0.00
2012	9595.26	8392	1134	95.55	95.55	96.33	95.54	2.23	2.18	2.26	0.00
2013	9437.56	8143	1134	92.96	92.96	94.99	92.95	0.00	0.00	7.04	0.00
2014	10003.11	8607	1134	98.25	98.25	100.70	98.25	0.00	0.00	1.75	0.00
2015	8933.00	7982	1134	91.11	91.11	89.92	91.12	0.00	0.00	8.89	0.00
2016	10144.92	8744	1134	99.55	99.55	101.85	99.54	0.45	0.45	0.00	0.00
2017	8574.81	7552	1134	86.21	86.21	86.32	86.21	0.00	0.00	13.79	0.00
2018	10173.71	8760	1134	100.00	100.00	102.41	100.00	0.00	0.00	0.00	0.00
2019	9274.51	8170	1134	93.29	93.29	93.36	93.26	1.16	1.10	5.62	0.00
2020	10211.57	8783	1134	100.00	100.00	102.51	99.99	0.00	0.00	0.00	0.00
2021	9229.49	8281	1134	94.54	94.54	92.91	94.53	0.00	0.00	5.46	0.00
2022	10049.36	8681	1134	99.10	99.10	101.16	99.10	0.00	0.00	0.90	0.00
2023	9138.37	8199	1134	99.99	99.99	91.99	93.60	0.01	0.01	0.00	0.00
2024	Data not provided										

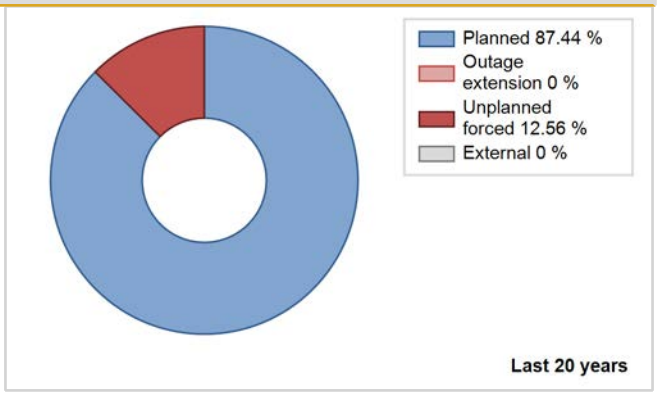
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1990 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					90	
B. Refuelling without maintenance				14		
C. Inspection, maintenance or repair combined with refuelling				315		
D. Inspection, maintenance or repair without refuelling				65		
E. Testing of plant systems or components				0		
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					8	
Z. Other					4	
Subtotal				394	102	2
Total		**0**			**498**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1990 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		3
13. Reactor Auxiliary Systems		2
15. Reactor Cooling Systems		11
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		47
32. Feedwater and Main Steam System		5
34. Miscellaneous Systems		2
35. All other I&C Systems		5
41. Main Generator Systems		9
42. Electrical Power Supply Systems		9
Total		**99**

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2024 Operating Experience

US-369 MCGUIRE-1 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	DUKEENER (Duke Energy Corp.)
Owner	:	DUKEENER (Duke Energy Corp.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)



Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (ICECND)
Thermal power	:	3411 MWth
Gross electrical power	:	1215 MWe
Reference unit power (net)	:	1158 MWe

Key Dates

Construction Date	:	1971-04-01
Grid Date	:	1981-09-12
Commercial Date	:	1981-12-01
Age at end of year	:	43 years

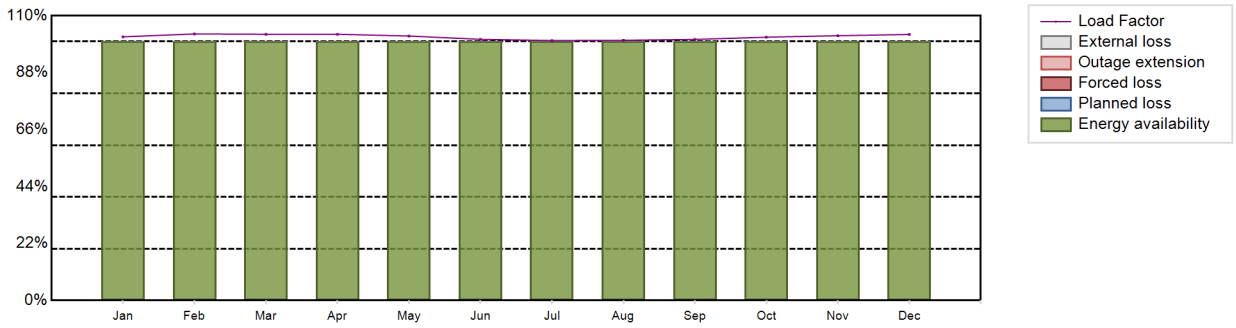
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	325
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.204
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	37	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	40200	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.83
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	18.3	Number of main condensate pumps	:	-
Number of control rod assemblies	:	25	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	101.82 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



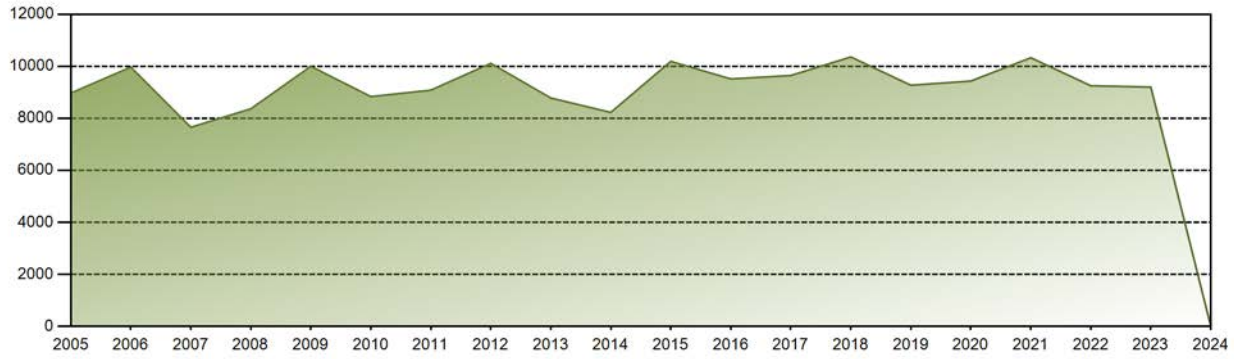
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	877.38	829.79	884.73	857.37	880.10	841.06	864.92	865.82	840.83	876.16	853.87	885.27	10357.32
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	101.84	102.96	102.83	102.83	102.15	100.88	100.39	100.50	100.85	101.70	102.27	102.75	101.82
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.78 %
Cumulative Energy Availability Factor (EAF)	:	85.12 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.3 %
Cumulative Unit Capability Factor (UCF)	:	85.33 %	Cumulative Planned Unavailability Factor (PUF)	:	10.36 %
Cumulative Load Factor (LF)	:	83.29 %	Cumulative Externally cause unavailability (XUF)	:	0.21 %
Cumulative Operating Factor (OF)	:	84.69 %			

Electricity Production (net) [GWh]

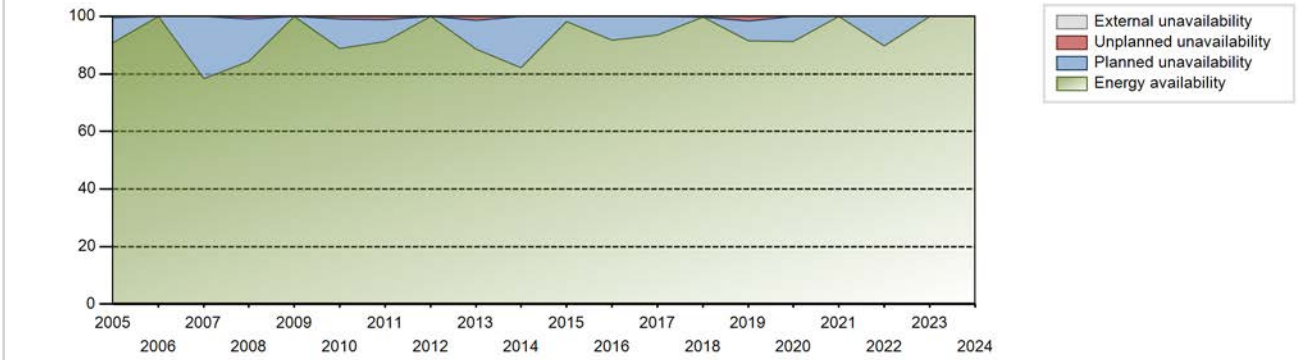


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	19.10	45	1146	10.20	10.20	2.18	6.05	89.80	89.80	0.00	0.00
1982	4302.30	7043	1180	81.62	81.62	41.62	80.40	14.80	14.18	4.20	0.00
1983	4650.00	4852	1180	57.26	57.26	44.98	55.39	16.60	11.39	31.34	0.00
1984	6434.27	6011	1180	69.33	78.14	62.08	68.43	4.14	3.38	18.48	8.81
1985	6780.08	6747	1180	77.10	77.10	65.59	77.02	8.75	7.39	15.51	0.00
1986	5181.08	4912	1150	56.16	56.16	51.43	56.07	27.72	21.54	22.29	0.00
1987	7352.88	6713	1150	76.70	76.70	72.99	76.63	4.75	3.82	19.48	0.00
1988	7406.41	6763	1129	77.04	77.04	74.68	76.99	1.35	1.06	21.90	0.00
1989	7807.23	7187	1129	84.49	84.49	78.94	82.04	15.49	15.48	0.03	0.00
1990	4755.31	4718	1129	56.90	56.90	48.08	53.86	13.38	8.79	34.30	0.00
1991	6851.08	6259	1129	71.45	71.45	69.27	71.45	9.09	7.15	21.40	0.00
1992	7485.28	6839	1129	77.89	77.89	75.48	77.86	22.11	22.11	0.00	0.00
1993	5537.09	5095	1129	58.18	58.18	55.99	58.16	23.34	17.72	24.10	0.00
1994	6877.25	6291	1129	71.86	71.86	69.54	71.82	16.20	13.89	14.25	0.00
1995	8860.20	8017	1129	91.58	91.58	89.59	91.52	3.72	3.54	4.89	0.00
1996	8558.29	7858	1129	89.50	89.50	86.30	89.46	3.79	3.53	6.97	0.00
1997	7011.25	6361	1129	72.68	72.68	70.89	72.61	1.83	1.36	25.96	0.00
1998	8822.61	7889	1119	89.99	89.99	89.98	90.06	0.73	0.66	9.35	0.00
1999	8593.31	7584	1100	86.58	86.58	89.18	86.58	2.15	1.91	11.51	0.00
2000	9995.02	8741	1100	99.52	99.52	103.44	99.51	0.48	0.48	0.00	0.00
2001	8684.94	7708	1100	88.00	88.00	90.13	87.99	1.70	1.53	10.47	0.00
2002	9100.83	8042	1100	91.83	91.83	94.45	91.80	1.04	1.87	6.30	0.00
2003	9912.47	8760	1100	100.00	100.00	102.87	100.00	0.00	0.00	0.00	0.00
2004	8238.51	7321	1100	83.37	83.37	85.26	83.34	7.74	6.99	9.63	0.00
2005	8968.59	7963	1100	90.91	90.91	93.07	90.90	0.51	0.47	8.62	0.00
2006	9967.23	8760	1100	100.00	100.00	103.44	100.00	0.00	0.00	0.00	0.00
2007	7656.08	6852	1100	78.24	78.24	79.45	78.22	0.00	0.00	21.76	0.00
2008	8364.40	7412	1100	84.38	84.38	86.57	84.38	1.09	0.93	14.68	0.00
2009	9999.08	8760	1100	100.00	100.00	103.77	100.00	0.00	0.00	0.00	0.00
2010	8835.73	7778	1100	88.81	88.81	91.70	88.79	1.01	0.91	10.29	0.00
2011	9081.86	7979	1129	91.17	91.17	93.63	91.08	1.28	1.19	7.64	0.00
2012	10114.04	8784	1129	100.00	100.00	101.99	100.00	0.00	0.00	0.00	0.00
2013	8780.45	7740	1158	88.65	88.65	86.55	88.35	1.46	1.31	10.04	0.00
2014	8227.61	7194	1158	82.13	82.13	81.11	82.12	0.00	0.00	17.87	0.00
2015	10188.92	8603	1160	98.21	98.21	100.27	98.21	0.00	0.00	1.79	0.00
2016	9515.88	8085	1160	91.77	91.77	93.39	92.04	0.00	0.00	8.23	0.00
2017	9646.27	8196	1158	93.55	93.55	95.09	93.56	0.00	0.00	6.45	0.00

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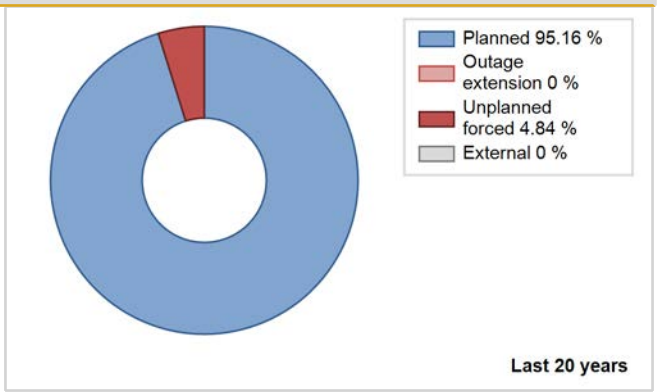
2018	10359.25	8730	1158	99.66	99.66	102.12	99.66	0.34	0.34	0.00	0.00
2019	9271.86	8022	1158	91.59	91.59	91.40	91.58	1.75	1.63	6.78	0.00
2020	9434.12	8013	1158	91.23	91.23	92.75	91.22	0.00	0.00	8.77	0.00
2021	10329.64	8760	1158	100.00	100.00	101.83	100.00	0.00	0.00	0.00	0.00
2022	9252.30	7867	1158	89.81	89.81	91.21	89.81	0.00	0.00	10.19	0.00
2023	9202.10	7826	1158	99.99	99.99	90.71	89.34	0.00	0.00	0.01	0.00
2024	Data not provided										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1981 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					363	
B. Refuelling without maintenance				39		
C. Inspection, maintenance or repair combined with refuelling				752		
D. Inspection, maintenance or repair without refuelling				97	0	
E. Testing of plant systems or components				13	1	
G. Major backfitting, refurbishment or upgrading activities without refuelling				1		
H. Nuclear regulatory requirements					6	
L. Human factor related					4	
Z. Other				9	3	18
Subtotal				911	377	18
Total		**0**			**1306**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		28
12. Reactor I&C Systems		14
13. Reactor Auxiliary Systems		15
14. Safety Systems		20
15. Reactor Cooling Systems		52
16. Steam generation systems		54
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		36
32. Feedwater and Main Steam System		113
34. Miscellaneous Systems		18
41. Main Generator Systems		4
42. Electrical Power Supply Systems		16
Total		**372**

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2024 Operating Experience

US-370 MCGUIRE-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	DUKEENER (Duke Energy Corp.)
Owner	:	DUKEENER (Duke Energy Corp.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (ICECND)
Thermal power	:	3411 MWth
Gross electrical power	:	1215 MWe
Reference unit power (net)	:	1158 MWe

Key Dates

Construction Date	:	1971-04-01
Grid Date	:	1983-05-23
Commercial Date	:	1984-03-01
Age at end of year	:	41 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	39
Average discharge burnup [MWd/t]	:	40600
Active core diameter [m]	:	3.4
Active core height/length [m]	:	3.7
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	18.3
Number of control rod assemblies	:	25
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

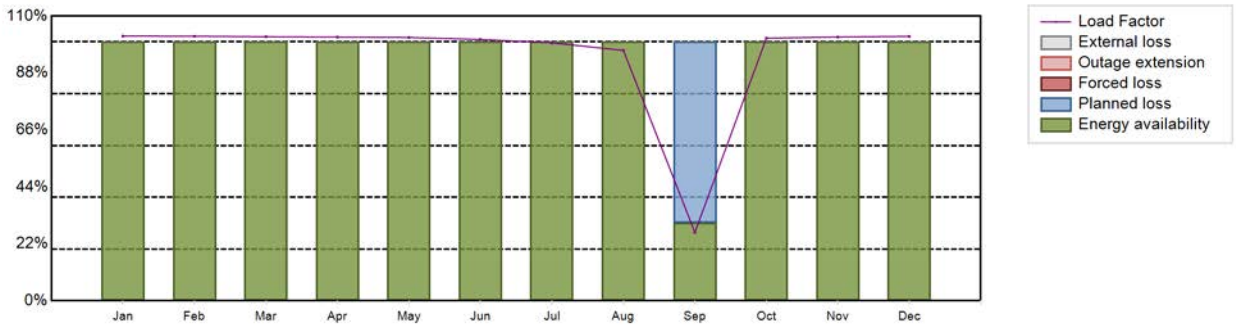
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	325
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.2
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.83
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9666.02 GW(e).h
Energy Availability Factor (EAF)	:	94.28 %
Unit Capability Factor (UCF)	:	94.28 %
Load Factor (LF)	:	95.03 %
Operating Factor (OF)	:	94.27 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	5.72 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	503 hours

Annual Summary



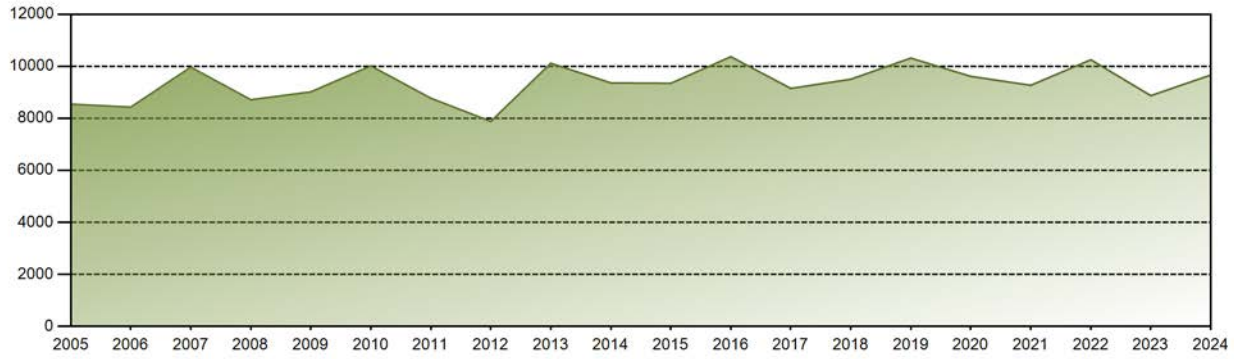
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	880.82	823.80	877.55	849.23	876.28	841.63	858.42	833.27	220.31	873.86	850.83	880.03	9666.02
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	30.22	100.00	100.00	100.00	94.28
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	30.22	100.00	100.00	100.00	94.28
LF [%]	102.24	102.21	101.99	101.86	101.71	100.94	99.64	96.72	26.42	101.43	101.91	102.14	95.03
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	30.14	100.00	100.00	100.00	94.27
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69.78	0.00	0.00	0.00	5.72
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	354555.64 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.44 %
Cumulative Energy Availability Factor (EAF)	:	87.59 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.23 %
Cumulative Unit Capability Factor (UCF)	:	87.59 %	Cumulative Planned Unavailability Factor (PUF)	:	10.17 %
Cumulative Load Factor (LF)	:	87.53 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	87.46 %			

Electricity Production (net) [GWh]

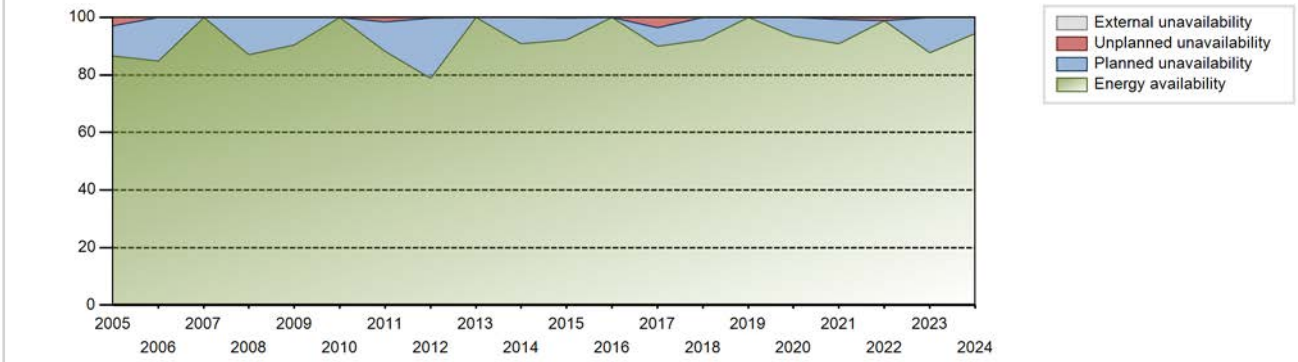


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	6557.80	6086	1171	82.97	82.97	75.67	82.87	16.04	15.85	1.18	0.00
1985	5609.29	5171	1180	61.05	61.05	54.27	59.03	18.66	14.01	24.95	0.00
1986	6216.62	5601	1150	64.53	64.53	61.71	63.94	10.88	7.88	27.59	0.00
1987	7577.35	6954	1150	80.16	80.16	75.22	79.38	2.75	2.26	17.58	0.00
1988	8058.02	7229	1129	82.34	82.34	81.25	82.30	1.02	0.84	16.82	0.00
1989	7418.33	6867	1129	78.42	78.42	75.01	78.39	0.89	0.71	20.87	0.00
1990	6496.16	5873	1129	69.52	69.52	65.68	67.04	1.22	0.86	29.62	0.00
1991	9515.97	8548	1129	97.60	97.60	96.22	97.58	2.40	2.40	0.00	0.00
1992	6785.04	6141	1129	69.96	69.96	68.42	69.91	3.64	2.64	27.40	0.00
1993	6821.09	6378	1129	72.82	72.82	68.97	72.81	2.95	2.21	24.97	0.00
1994	8659.96	7708	1129	88.01	88.01	87.56	87.99	1.83	1.64	10.34	0.00
1995	9090.01	8144	1129	93.01	93.01	91.91	92.97	4.07	3.95	3.04	0.00
1996	7265.11	6543	1129	74.57	74.57	73.26	74.49	16.44	14.67	10.76	0.00
1997	6648.44	6214	1129	70.97	70.97	67.22	70.94	10.12	7.99	21.04	0.00
1998	9928.27	8715	1119	99.49	99.49	101.26	99.49	0.51	0.51	0.00	0.00
1999	8596.72	7927	1100	90.51	90.51	89.21	90.49	0.40	0.36	9.13	0.00
2000	8452.37	7757	1100	88.32	88.32	87.48	88.31	0.46	0.41	11.27	0.00
2001	9878.04	8698	1100	99.30	99.30	102.51	99.29	0.70	0.70	0.00	0.00
2002	8913.51	7940	1100	90.65	90.65	92.50	90.64	0.54	1.94	7.41	0.00
2003	9027.81	8024	1100	91.61	91.61	93.69	91.60	0.00	0.52	7.86	0.00
2004	9994.02	8784	1100	100.00	100.00	103.43	100.00	0.00	0.00	0.00	0.00
2005	8545.57	7589	1100	86.66	86.66	88.67	86.62	3.20	2.87	10.47	0.00
2006	8430.33	7418	1100	84.70	84.70	87.49	84.68	0.00	0.00	15.30	0.00
2007	9967.57	8760	1100	100.00	100.00	103.44	100.00	0.00	0.00	0.00	0.00
2008	8713.27	7651	1100	87.11	87.11	90.18	87.10	0.00	0.00	12.89	0.00
2009	9015.67	7907	1100	90.27	90.27	93.56	90.26	0.00	0.00	9.73	0.00
2010	10014.70	8760	1100	100.00	100.00	103.93	100.00	0.00	0.00	0.00	0.00
2011	8773.24	7705	1129	88.22	88.22	89.27	87.96	1.75	1.57	10.21	0.00
2012	7878.65	6923	1129	78.83	78.83	79.44	78.81	0.34	0.27	20.90	0.00
2013	10117.09	8760	1158	100.00	100.00	99.72	99.99	0.00	0.00	0.00	0.00
2014	9362.49	7956	1158	90.82	90.82	92.30	90.82	0.00	0.00	9.18	0.00
2015	9347.08	8079	1158	92.22	92.22	92.14	92.23	0.19	0.17	7.60	0.00
2016	10368.41	8784	1158	100.00	100.00	101.93	100.00	0.00	0.00	0.00	0.00
2017	9149.27	7878	1158	89.94	89.94	90.19	89.93	3.79	3.55	6.52	0.00
2018	9502.82	8076	1158	92.20	92.20	93.68	92.19	0.00	0.00	7.80	0.00
2019	10316.39	8760	1158	100.00	100.00	101.70	100.00	0.00	0.00	0.00	0.00
2020	9612.83	8221	1158	93.60	93.60	94.50	93.59	0.00	0.00	6.40	0.00

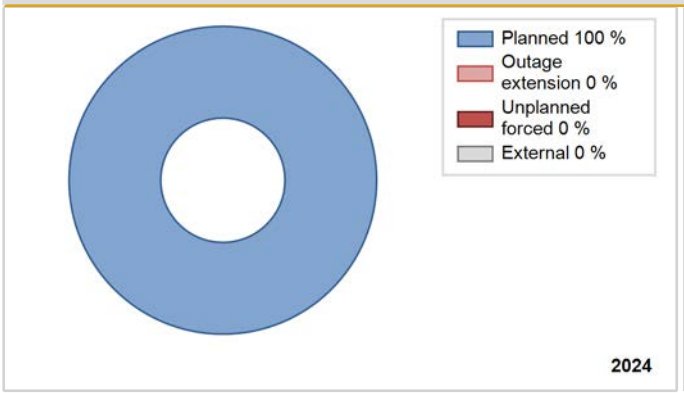
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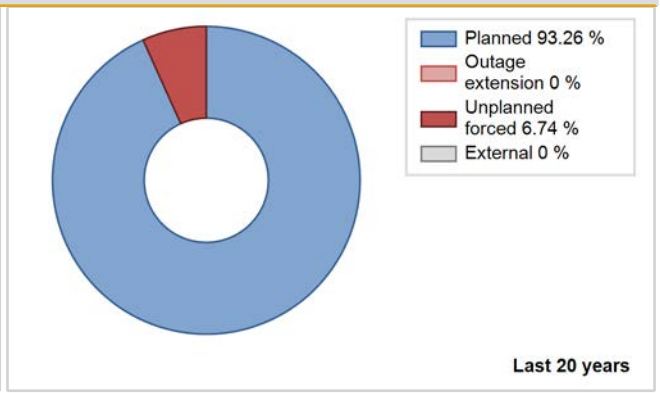
2021	9269.56	7963	1158	90.90	90.90	91.38	90.90	0.88	0.81	8.29	0.00
2022	10252.47	8664	1158	98.90	98.90	101.07	98.90	1.10	1.10	0.00	0.00
2023	8872.14	7675	1158	87.61	87.61	87.46	87.61	0.00	0.00	12.39	0.00
2024	9666.02	8281	1158	94.28	94.28	95.03	94.27	0.00	0.00	5.72	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					180	
B. Refuelling without maintenance				32		
C. Inspection, maintenance or repair combined with refuelling	503			806		
D. Inspection, maintenance or repair without refuelling				63	0	
E. Testing of plant systems or components				0	0	
H. Nuclear regulatory requirements					7	
L. Human factor related					3	
Z. Other				0	5	
Subtotal	503			901	195	
Total	**503**			**1096**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		16
13. Reactor Auxiliary Systems		13
14. Safety Systems		12
15. Reactor Cooling Systems		54
16. Steam generation systems		9
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		6
32. Feedwater and Main Steam System		28
34. Miscellaneous Systems		1
41. Main Generator Systems		33
42. Electrical Power Supply Systems		13
Total		**190**

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2024 Operating Experience

US-336 MILLSTONE-2 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	DOMINION (Dominion Energy)
Owner	:	DOMINRES (Dominion Resources, Inc.)
Reactor Supplier	:	CE (COMBUSTION ENGINEERING CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	PWR / CE 2LP (DRYAMB)
Thermal power	:	2700 MWth
Gross electrical power	:	918 MWe
Reference unit power (net)	:	869 MWe

Key Dates

Construction Date	:	1969-11-01
Grid Date	:	1975-11-09
Commercial Date	:	1975-12-26
Age at end of year	:	49 years

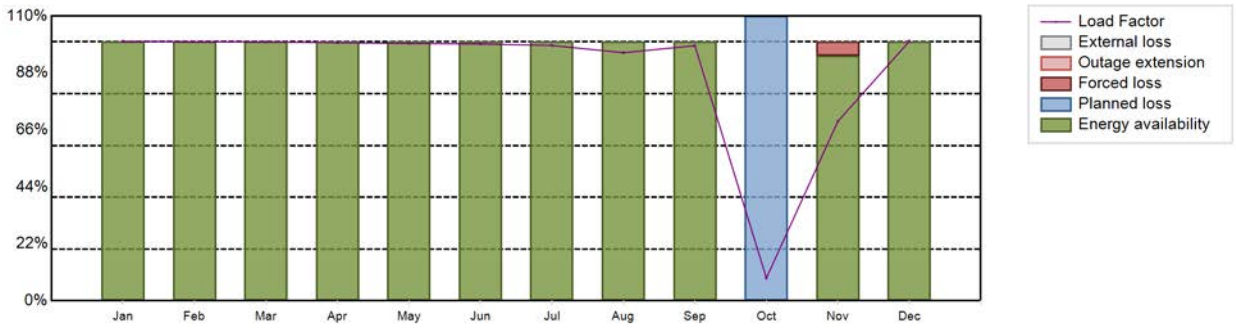
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	312.7
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.483
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.45	HP cylinder inlet steam pressure [MPa]	:	5.73
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	157	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	49	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	6798.72 GW(e).h	Forced Loss Rate (FLR)	:	0.49 %
Energy Availability Factor (EAF)	:	90.15 %	Unplanned Capability Loss Factor (UCL)	:	0.44 %
Unit Capability Factor (UCF)	:	90.15 %	Planned Unavailability Factor (PUF)	:	9.41 %
Load Factor (LF)	:	89.07 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	90.06 %	Total off-line time	:	873 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	647.89	604.93	645.28	623.80	642.92	620.59	637.68	619.64	616.56	57.04	434.28	648.12	6798.72
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-11.06	94.64	100.00	90.15
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-11.06	94.64	100.00	90.15
LF [%]	100.21	100.02	99.94	99.70	99.44	99.19	98.63	95.84	98.54	8.82	69.31	100.25	89.07
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	9.27	72.54	100.00	90.06
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.36	0.00	0.49
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.36	0.00	0.44
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	111.06	0.00	0.00	9.41
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	268534.43 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	14.19 %
Cumulative Energy Availability Factor (EAF)	:	73.9 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.31 %
Cumulative Unit Capability Factor (UCF)	:	74.44 %	Cumulative Planned Unavailability Factor (PUF)	:	13.25 %
Cumulative Load Factor (LF)	:	72.47 %	Cumulative Externally cause unavailability (XUF)	:	0.54 %
Cumulative Operating Factor (OF)	:	74.15 %			

Electricity Production (net) [GWh]

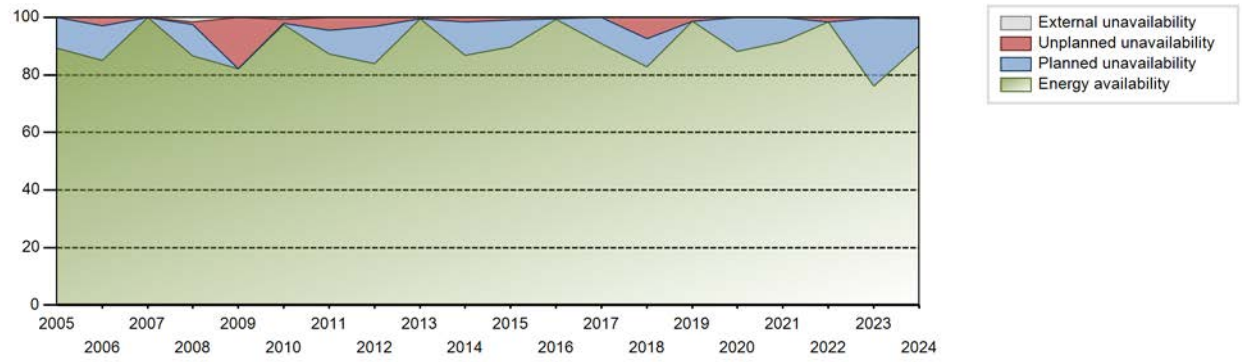


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1975	134.70	623	851	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1976	4543.20	6815	780	66.37	66.37	66.31	77.58	31.06	29.91	3.72	0.00
1977	4345.70	5756	790	62.88	62.88	62.80	65.71	19.40	15.13	21.99	0.00
1978	4507.20	5756	802	64.12	64.12	64.15	65.71	23.99	20.24	15.64	0.00
1979	4370.90	5385	837	59.58	59.58	59.61	61.47	23.78	18.59	21.82	0.00
1980	4884.30	5947	864	68.17	80.81	64.36	67.70	2.03	1.68	17.51	12.65
1981	6091.70	7229	864	82.71	82.71	80.49	82.52	10.74	9.95	7.33	0.00
1982	5015.60	6183	864	70.48	70.48	66.27	70.58	11.29	8.97	20.55	0.00
1983	2474.40	2993	861	34.07	34.07	32.81	34.17	13.92	5.51	60.42	0.00
1984	6608.34	8209	860	93.40	93.40	87.48	93.45	3.79	3.68	2.92	0.00
1985	3515.65	4322	841	47.66	59.35	47.72	49.34	2.23	1.35	39.29	11.69
1986	5164.85	6352	857	72.50	72.50	68.80	72.51	2.59	1.93	25.58	0.00
1987	6892.53	8177	857	93.29	93.29	91.81	93.34	6.47	6.45	0.26	0.00
1988	5735.94	6810	860	77.24	77.24	75.89	77.53	3.29	2.63	20.13	0.00
1989	4763.57	5705	863	66.85	66.85	62.95	65.13	0.00	0.00	33.15	0.00
1990	5309.94	6389	863	72.84	72.84	70.24	72.93	2.54	1.90	25.26	0.00
1991	3948.13	4820	863	55.28	55.28	52.22	55.02	44.49	44.31	0.41	0.00
1992	2725.02	3187	870	36.12	36.12	35.64	36.28	11.45	4.67	59.21	0.00
1993	6295.91	7431	873	84.79	84.79	82.33	84.83	11.85	11.39	3.81	0.00
1994	3676.45	4289	873	49.02	49.02	48.07	48.96	34.50	25.82	25.16	0.00
1995	2740.54	3273	873	37.39	37.39	35.84	37.36	8.62	3.53	59.09	0.00
1996	1046.48	1222	871	13.73	13.73	13.68	13.91	85.90	83.63	2.65	0.00
1997	0.00	0	871	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1998	0.00	0	871	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1999	4433.22	5310	870	60.63	60.63	58.17	60.62	39.37	39.37	0.00	0.00
2000	6268.50	7353	873	83.70	83.70	81.77	83.71	6.03	5.38	10.93	0.00
2001	7284.02	8587	869	98.04	98.04	95.44	98.03	1.96	1.96	0.00	0.00
2002	6209.31	7285	871	83.20	83.20	81.47	83.16	4.90	4.29	12.51	0.00
2003	6109.80	7083	866	80.88	80.88	80.19	80.86	7.18	6.25	12.87	0.00
2004	7596.04	8677	877	98.81	98.81	98.71	98.78	1.19	1.19	0.00	0.00
2005	6843.02	7812	866	89.19	89.19	90.19	89.17	0.00	0.00	10.81	0.00
2006	6519.46	7453	882	85.10	85.10	84.38	85.08	3.42	3.02	11.88	0.00
2007	7686.76	8760	877	100.00	100.00	100.06	100.00	0.00	0.00	0.00	0.00
2008	6619.59	7596	877	86.50	88.17	85.93	86.48	0.97	0.86	10.97	1.67
2009	6239.17	7196	877	82.18	82.18	81.21	82.15	17.82	17.82	0.00	0.00
2010	7414.57	8547	869	97.56	98.22	97.40	97.57	1.29	1.28	0.50	0.67
2011	6601.01	7620	869	87.17	87.17	86.71	86.99	5.00	4.59	8.24	0.00

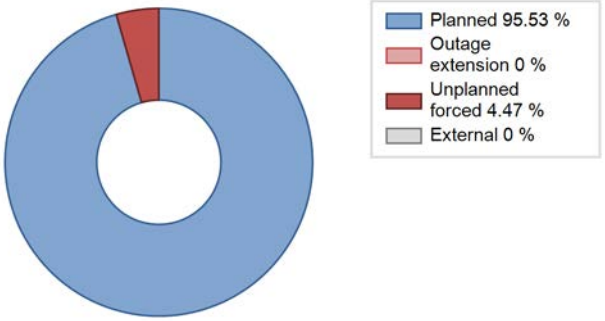
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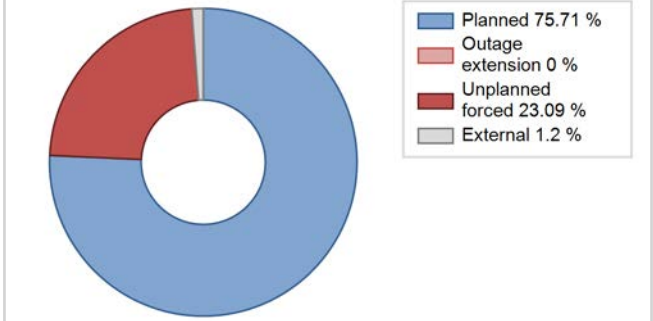
2012	6342.84	7363	869	83.85	83.85	83.09	83.82	3.66	3.18	12.97	0.00
2013	7578.99	8711	869	99.44	99.44	99.55	99.43	0.56	0.56	0.00	0.00
2014	6518.71	7534	869	86.75	86.75	85.63	86.00	1.84	1.62	11.62	0.00
2015	6775.63	7860	869	89.72	89.72	89.01	89.73	0.94	0.85	9.43	0.00
2016	7469.89	8725	869	99.33	99.33	97.86	99.33	0.54	0.54	0.13	0.00
2017	6798.76	7953	869	90.79	90.79	89.31	90.79	0.00	0.00	9.21	0.00
2018	6163.60	7251	869	82.77	82.77	80.97	82.77	8.14	7.34	9.89	0.00
2019	7257.73	8637	869	98.61	98.61	95.34	98.60	1.39	1.39	0.00	0.00
2020	6690.50	7748	869	88.22	88.22	87.65	88.21	0.00	0.00	11.78	0.00
2021	6733.75	8009	869	91.42	91.42	88.46	91.43	0.00	0.00	8.58	0.00
2022	7477.47	8612	869	98.31	98.31	98.23	98.31	1.69	1.69	0.00	0.00
2023	5476.38	6681	869	76.07	76.07	71.94	76.27	0.26	0.20	23.73	0.00
2024	6798.72	7911	869	90.15	90.15	89.07	90.06	0.49	0.44	9.41	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1975 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		39			443	
B.	Refuelling without maintenance				36		
C.	Inspection, maintenance or repair combined with refuelling	834			1064		
D.	Inspection, maintenance or repair without refuelling				35		
E.	Testing of plant systems or components				7	149	
H.	Nuclear regulatory requirements					453	
J.	Grid limitation, failure or grid unavailability						1
L.	Human factor related					19	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						26
Z.	Other				17	5	
Subtotal		834	39		1159	1069	27
Total		**873**			**2255**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1975 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		46
13. Reactor Auxiliary Systems		9
14. Safety Systems		12
15. Reactor Cooling Systems		90
16. Steam generation systems		68
31. Turbine and auxiliaries		60
32. Feedwater and Main Steam System		73
33. Circulating Water System		11
34. Miscellaneous Systems		162
35. All other I&C Systems		1
41. Main Generator Systems		8
42. Electrical Power Supply Systems	39	65
Total	**39**	**607**

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2024 Operating Experience

US-423 MILLSTONE-3 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	DOMINION (Dominion Energy)
Owner	:	DOMINRES (Dominion Resources, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYSUB)
Thermal power	:	3650 MWth
Gross electrical power	:	1280 MWe
Reference unit power (net)	:	1210 MWe

Key Dates

Construction Date	:	1974-08-09
Grid Date	:	1986-02-12
Commercial Date	:	1986-04-23
Age at end of year	:	38 years

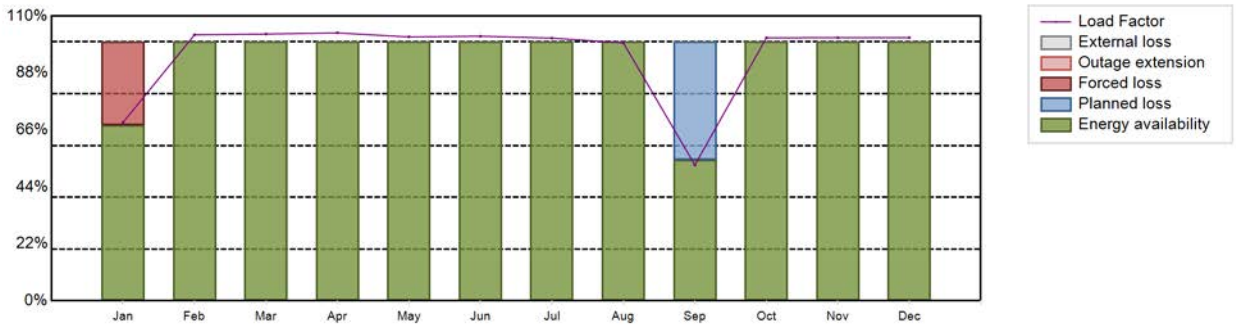
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.9
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.17
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	33000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.4	HP cylinder inlet steam pressure [MPa]	:	6.7
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	580	Primary means of condenser cooling	:	Sea (once-through)
Fuel linear heat generation rate [kW/m]	:	18.2	Number of main condensate pumps	:	-
Number of control rod assemblies	:	24	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10104.63 GW(e).h	Forced Loss Rate (FLR)	:	2.83 %
Energy Availability Factor (EAF)	:	93.55 %	Unplanned Capability Loss Factor (UCL)	:	2.72 %
Unit Capability Factor (UCF)	:	93.55 %	Planned Unavailability Factor (PUF)	:	3.72 %
Load Factor (LF)	:	95.07 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	93.73 %	Total off-line time	:	551 hours

Annual Summary



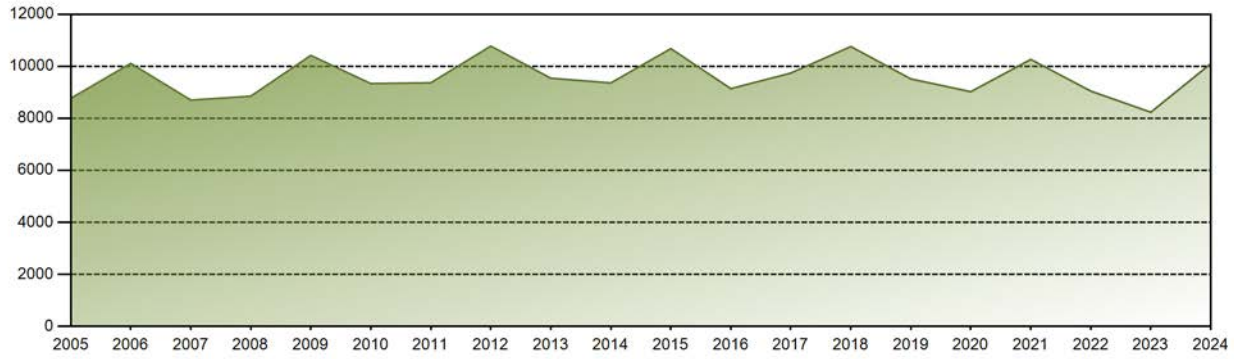
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	620.06	865.26	926.42	901.42	917.48	890.46	913.40	896.73	457.12	914.31	886.80	915.15	10104.63
EAF [%]	67.87	100.00	100.00	100.00	100.00	100.00	100.00	100.00	54.56	100.00	100.00	100.00	93.55
UCF [%]	67.87	100.00	100.00	100.00	100.00	100.00	100.00	100.00	54.56	100.00	100.00	100.00	93.55
LF [%]	68.88	102.74	103.05	103.47	101.92	102.21	101.46	99.61	52.47	101.56	101.65	101.66	95.07
OF [%]	68.68	100.00	100.00	100.00	100.00	100.00	100.00	100.00	55.83	100.00	100.00	100.00	93.73
FLR [%]	32.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83
UCL [%]	32.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.72
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.44	0.00	0.00	0.00	3.72
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	320633.92 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	10.4 %
Cumulative Energy Availability Factor (EAF)	:	82.23 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	9.56 %
Cumulative Unit Capability Factor (UCF)	:	82.24 %	Cumulative Planned Unavailability Factor (PUF)	:	8.2 %
Cumulative Load Factor (LF)	:	80.8 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	81.35 %			

Electricity Production (net) [GWh]

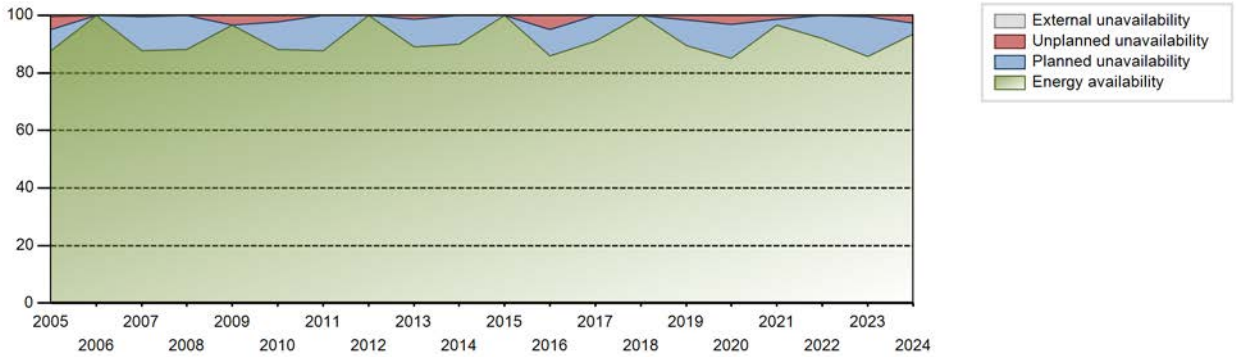


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	Data not provided										
1987	6748.20	6235	1142	71.36	71.36	67.46	71.18	5.40	4.07	24.56	0.00
1988	7683.62	6954	1142	79.50	79.50	76.60	79.17	11.03	9.85	10.65	0.00
1989	7082.60	6636	1142	75.89	75.89	70.80	75.75	9.03	7.54	16.57	0.00
1990	8218.24	7798	1137	89.18	89.18	82.51	89.02	10.63	10.60	0.22	0.00
1991	2876.71	2850	1137	33.57	33.57	28.88	32.53	58.17	46.68	19.76	0.00
1992	6593.81	6311	1137	72.11	72.11	66.02	71.85	23.89	22.64	5.25	0.00
1993	6502.83	6106	1137	70.15	70.15	65.29	69.70	4.20	3.08	26.77	0.00
1994	9416.15	8426	1137	96.26	96.26	94.54	96.19	3.74	3.74	0.00	0.00
1995	7993.62	7083	1137	81.20	81.20	80.26	80.86	0.00	0.00	18.80	0.00
1996	2476.71	2156	1137	25.68	25.68	24.80	24.54	74.32	74.32	0.00	0.00
1997	0.00	0	1137	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1998	3392.06	3402	1137	38.87	38.87	34.06	38.84	61.01	60.83	0.30	0.00
1999	8307.55	7329	1139	83.67	83.67	83.21	83.66	0.00	0.00	16.33	0.00
2000	10125.72	8784	1151	100.00	100.00	100.09	100.00	0.00	0.00	0.00	0.00
2001	8169.69	7392	1136	84.33	84.33	81.35	84.38	0.00	0.00	15.67	0.00
2002	8746.21	7803	1130	88.96	88.96	88.12	89.08	2.70	2.47	8.57	0.00
2003	10005.70	8729	1130	99.65	99.65	101.08	99.65	0.35	0.35	0.00	0.00
2004	8983.70	7905	1148	90.06	90.06	89.91	89.99	0.00	0.00	9.94	0.00
2005	8766.99	7677	1131	87.65	88.04	88.49	87.64	4.98	4.61	7.34	0.40
2006	10111.10	8760	1155	100.00	100.00	99.93	100.00	0.00	0.00	0.00	0.00
2007	8699.38	7694	1145	87.74	87.74	86.73	87.83	0.62	0.55	11.71	0.00
2008	8850.30	7739	1145	88.12	88.12	88.00	88.10	0.00	0.00	11.88	0.00
2009	10418.22	8470	1137	96.68	96.68	104.60	96.69	3.32	3.32	0.00	0.00
2010	9335.74	7623	1233	88.05	88.05	86.43	87.02	2.61	2.36	9.59	0.00
2011	9365.73	7674	1233	87.61	87.61	86.71	87.60	0.00	0.00	12.39	0.00
2012	10776.49	8784	1218	100.00	100.00	100.73	100.00	0.00	0.00	0.00	0.00
2013	9542.43	7803	1210	89.01	89.01	89.92	89.07	1.41	1.28	9.71	0.00
2014	9360.53	7676	1218	89.99	89.99	87.73	87.63	0.00	0.00	10.01	0.00
2015	10677.97	8760	1229	100.00	100.00	99.18	100.00	0.00	0.00	0.00	0.00
2016	9140.32	7539	1229	85.83	85.83	84.67	85.83	5.47	4.96	9.21	0.00
2017	9740.29	7972	1229	91.00	91.00	90.47	91.00	0.00	0.00	9.00	0.00
2018	10758.28	8760	1210	100.00	100.00	101.50	100.00	0.00	0.00	0.00	0.00
2019	9516.62	7834	1210	89.45	89.45	89.78	89.43	1.63	1.48	9.06	0.00
2020	9024.35	7438	1210	85.13	85.13	84.91	84.68	3.54	3.12	11.75	0.00
2021	10265.20	8459	1210	96.56	96.56	96.85	96.56	1.36	1.33	2.11	0.00
2022	9046.54	7380	1210	91.89	91.89	85.35	84.25	0.00	0.00	8.11	0.00

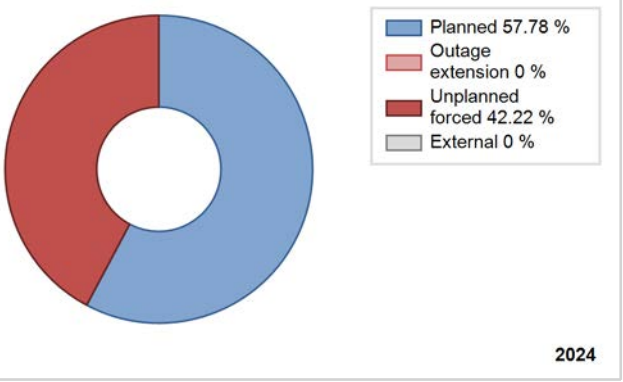
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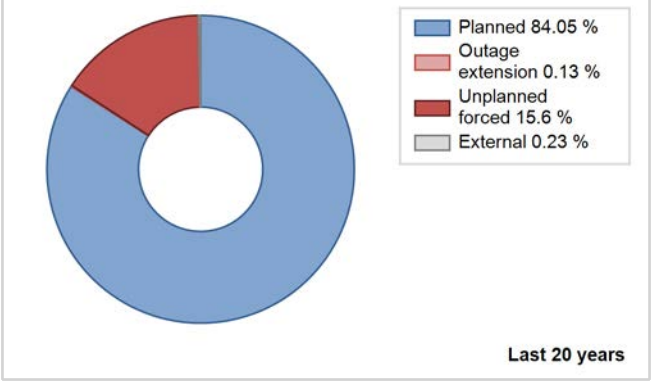
2023	8234.86	6827	1210	85.79	85.79	77.69	77.93	0.37	0.54	13.67	0.00
2024	10104.63	8233	1210	93.55	93.55	95.07	93.73	2.83	2.72	3.72	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure	318	233		8	376	
B.	Refuelling without maintenance				75		
C.	Inspection, maintenance or repair combined with refuelling				619		
D.	Inspection, maintenance or repair without refuelling				41		
E.	Testing of plant systems or components				2		
H.	Nuclear regulatory requirements					231	
J.	Grid limitation, failure or grid unavailability						5
L.	Human factor related					5	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						20
Z.	Other					232	
Subtotal		318	233		745	844	25
Total			**551**			**1614**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	233	7
12. Reactor I&C Systems		11
13. Reactor Auxiliary Systems		14
14. Safety Systems		293
15. Reactor Cooling Systems		38
16. Steam generation systems		23
17. Safety I&C Systems (excluding reactor I&C)		6
31. Turbine and auxiliaries		10
32. Feedwater and Main Steam System		14
33. Circulating Water System		16
34. Miscellaneous Systems		103
41. Main Generator Systems		19
42. Electrical Power Supply Systems		10
Total	**233**	**564**

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2024 Operating Experience

US-263 MONTICELLO UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	NSP (Northern States Power Co. (subsidiary of Xcel Energy))
Owner	:	XCEL (Xcel Energy)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-3 (Mark 1)
Thermal power	:	2004 MWth
Gross electrical power	:	691 MWe
Reference unit power (net)	:	628 MWe

Key Dates

Construction Date	:	1967-06-19
Grid Date	:	1971-03-05
Commercial Date	:	1971-06-30
Age at end of year	:	53 years

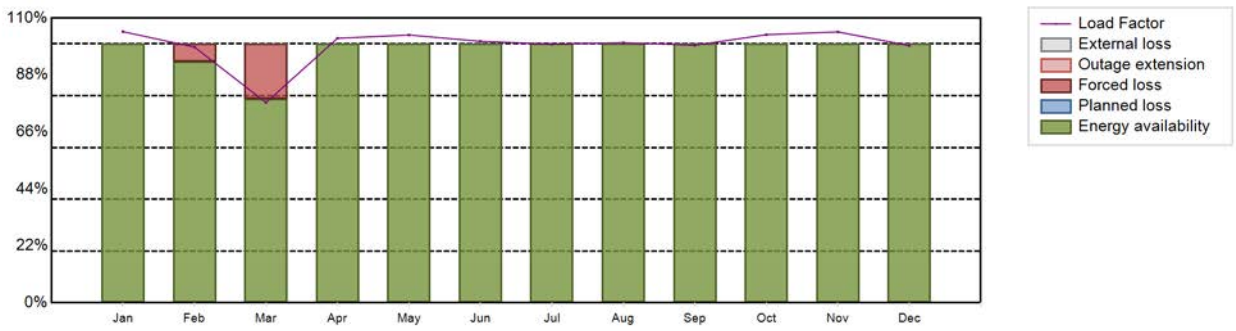
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.17
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	285
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.394
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	75	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	27000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.96	HP cylinder inlet steam pressure [MPa]	:	6.78
Active core height/length [m]	:	3.66	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	484	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	39	Number of main condensate pumps	:	-
Number of control rod assemblies	:	121	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5491.78 GW(e).h	Forced Loss Rate (FLR)	:	2.33 %
Energy Availability Factor (EAF)	:	97.67 %	Unplanned Capability Loss Factor (UCL)	:	2.33 %
Unit Capability Factor (UCF)	:	97.67 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	99.55 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	97.63 %	Total off-line time	:	208 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	489.29	431.75	360.91	461.96	483.32	456.71	466.82	469.42	449.79	483.87	473.76	464.17	5491.78
EAF [%]	100.00	93.22	78.77	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	97.67
UCF [%]	100.00	93.22	78.77	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	97.67
LF [%]	104.72	98.78	77.35	102.17	103.44	101.01	99.91	100.47	99.48	103.56	104.63	99.34	99.55
OF [%]	100.00	94.40	77.25	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	97.63
FLR [%]	0.00	6.78	21.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33
UCL [%]	0.00	6.78	21.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	221259.95 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.66 %
Cumulative Energy Availability Factor (EAF)	:	86.63 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.37 %
Cumulative Unit Capability Factor (UCF)	:	86.64 %	Cumulative Planned Unavailability Factor (PUF)	:	10.99 %
Cumulative Load Factor (LF)	:	82.97 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	85.54 %			

Electricity Production (net) [GWh]

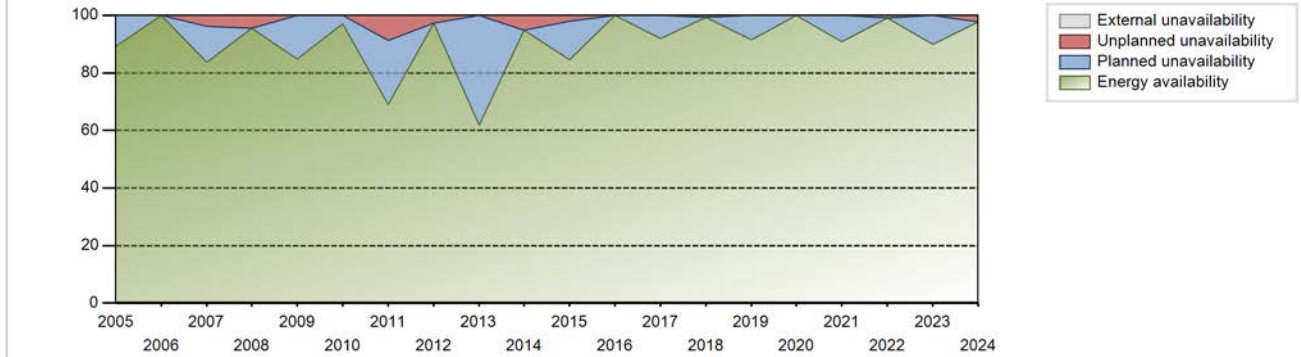


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1971	1465.90	3357	564	100.00	100.00	50.25	59.13	0.00	0.00	0.00	0.00
1972	3717.90	6975	580	100.00	100.00	72.98	79.41	0.00	0.00	0.00	0.00
1973	3271.60	6242	580	100.00	100.00	64.39	71.26	0.00	0.00	0.00	0.00
1974	2925.20	6567	538	74.98	74.98	62.07	74.97	8.03	6.55	18.47	0.00
1975	2881.40	6322	538	61.05	61.05	61.14	72.17	5.95	3.86	35.09	0.00
1976	3986.20	8033	537	84.30	84.30	84.51	91.45	2.80	2.43	13.27	0.00
1977	3570.70	7001	536	75.95	75.95	76.05	79.92	0.77	0.59	23.46	0.00
1978	3856.20	7638	536	81.70	81.70	82.13	87.19	5.75	4.98	13.32	0.00
1979	4399.70	8549	536	93.41	93.41	93.70	97.59	3.13	3.02	3.57	0.00
1980	3455.50	6876	536	78.22	79.04	73.39	78.28	7.46	6.37	14.59	0.81
1981	3262.30	6362	536	72.34	72.34	69.48	72.63	2.11	1.56	26.11	0.00
1982	2425.10	5543	525	62.22	62.22	52.73	63.28	1.82	1.15	36.63	0.00
1983	4147.70	8438	525	96.29	96.29	90.19	96.32	0.22	0.21	3.50	0.00
1984	279.13	808	525	9.21	9.21	6.05	9.20	0.00	0.00	90.79	0.00
1985	4286.99	8028	536	91.63	91.63	91.30	91.64	0.58	0.54	7.84	0.00
1986	3379.91	6926	536	78.77	78.77	71.98	79.06	0.81	0.65	20.59	0.00
1987	3535.62	7051	536	80.23	80.23	75.30	80.49	2.07	1.70	18.07	0.00
1988	4573.58	8759	536	99.71	99.71	97.14	99.72	0.29	0.29	0.00	0.00
1989	2650.40	6578	536	74.73	74.73	56.45	75.09	1.95	1.49	23.79	0.00
1990	4505.93	8414	536	96.00	96.00	95.97	96.05	2.54	2.50	1.49	0.00
1991	3596.53	6996	536	79.56	79.56	76.60	79.86	3.15	2.58	17.85	0.00
1992	4453.67	8527	536	97.04	97.04	94.59	97.07	1.03	1.01	1.95	0.00
1993	3864.38	7322	536	83.37	83.37	82.30	83.58	1.49	1.26	15.36	0.00
1994	3956.18	7508	536	85.55	85.55	84.26	85.71	2.88	2.54	11.91	0.00
1995	4756.26	8760	536	100.00	100.00	101.30	100.00	0.00	0.00	0.00	0.00
1996	3872.94	7443	541	84.76	84.76	81.37	84.73	3.99	3.52	11.72	0.00
1997	3661.60	6609	544	75.23	75.23	76.84	75.45	24.77	24.77	0.00	0.00
1998	4118.93	7659	553	87.68	87.68	84.91	87.43	2.70	2.43	9.89	0.00
1999	4649.34	8092	578	92.38	92.38	91.82	92.37	7.62	7.62	0.00	0.00
2000	4251.42	7332	578	83.49	83.49	83.74	83.47	1.85	1.57	14.94	0.00
2001	3880.58	6774	578	76.90	76.90	76.64	77.33	12.66	11.14	11.96	0.00
2002	5015.56	8620	578	98.35	98.35	99.06	98.40	1.65	1.65	0.00	0.00
2003	4592.46	7969	578	90.70	90.70	90.70	90.97	0.00	0.00	9.30	0.00
2004	5034.88	8689	578	98.94	98.94	99.17	98.92	0.00	0.00	1.06	0.00
2005	4474.92	7826	569	89.35	89.35	89.77	89.33	0.00	0.00	10.65	0.00
2006	5072.59	8760	572	100.00	100.00	101.23	100.00	0.00	0.00	0.00	0.00
2007	4192.27	7327	572	83.66	83.66	83.67	83.64	4.35	3.81	12.53	0.00

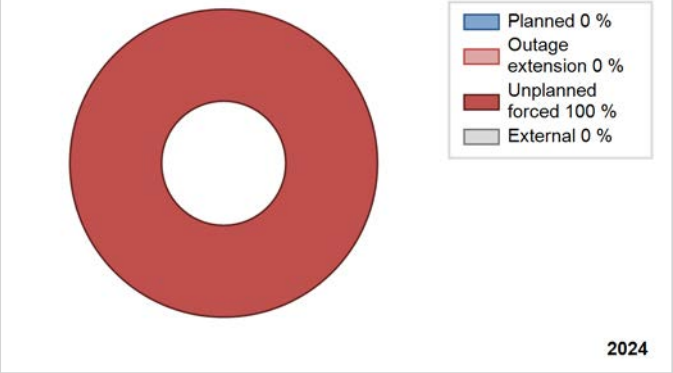
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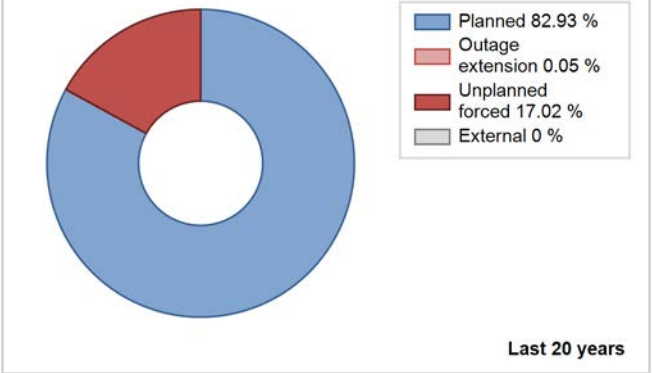
2008	4878.02	8398	572	95.61	95.61	97.09	95.61	4.39	4.39	0.00	0.00
2009	4144.69	7421	572	84.73	84.73	82.72	84.71	0.00	0.00	15.27	0.00
2010	4695.11	8504	572	97.08	97.08	93.70	97.08	0.00	0.00	2.92	0.00
2011	3358.49	6045	572	69.04	69.04	67.03	69.01	11.16	8.67	22.29	0.00
2012	4890.37	8552	578	97.36	97.36	96.32	97.36	2.64	2.64	0.00	0.00
2013	2998.28	5419	578	61.87	61.87	59.21	61.85	0.00	0.00	38.13	0.00
2014	4323.97	8304	647	94.79	94.79	76.29	94.79	5.21	5.21	0.00	0.00
2015	4663.53	7407	647	84.55	84.55	82.28	84.55	2.39	2.07	13.38	0.00
2016	5597.76	8784	647	100.00	100.00	98.50	100.00	0.00	0.00	0.00	0.00
2017	5159.59	8051	647	91.91	91.91	91.03	91.91	0.00	0.00	8.09	0.00
2018	5618.02	8691	628	99.21	99.21	102.12	99.21	0.79	0.79	0.00	0.00
2019	4964.57	8023	628	91.59	91.59	90.24	91.59	0.00	0.00	8.41	0.00
2020	5593.31	8783	628	100.00	100.00	101.40	99.99	0.00	0.00	0.00	0.00
2021	5011.01	7962	628	90.89	90.89	91.09	90.89	0.00	0.00	9.11	0.00
2022	5545.27	8683	628	99.12	99.12	100.80	99.12	0.88	0.88	0.00	0.00
2023	4793.50	7662	628	89.83	89.83	87.13	87.47	0.00	0.08	10.09	0.00
2024	5491.78	8576	628	97.67	97.67	99.55	97.63	2.33	2.33	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1971 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		116			201	
B. Refuelling without maintenance				15		
C. Inspection, maintenance or repair combined with refuelling				868		
D. Inspection, maintenance or repair without refuelling				85		
E. Testing of plant systems or components				1	21	
F. Major backfitting, refurbishment or upgrading activities with refuelling				1		
H. Nuclear regulatory requirements					7	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related		93			8	
Z. Other				1	41	
Subtotal		209		971	278	1
Total		**209**			**1250**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1971 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories	209	11
12. Reactor I&C Systems		18
13. Reactor Auxiliary Systems		16
14. Safety Systems		13
15. Reactor Cooling Systems		20
16. Steam generation systems		2
17. Safety I&C Systems (excluding reactor I&C)		3
31. Turbine and auxiliaries		32
32. Feedwater and Main Steam System		41
33. Circulating Water System		0
34. Miscellaneous Systems		35
35. All other I&C Systems		4
41. Main Generator Systems		12
42. Electrical Power Supply Systems		24
Total	**209**	**231**

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2024 Operating Experience

US-220 NINE MILE POINT-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXE/EDF (Exelon Nuclear, Électricité de France)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-2 (Mark 1)
Thermal power	:	1850 MWth
Gross electrical power	:	642 MWe
Reference unit power (net)	:	613 MWe

Key Dates

Construction Date	:	1965-04-12
Grid Date	:	1969-11-09
Commercial Date	:	1969-12-01
Age at end of year	:	55 years

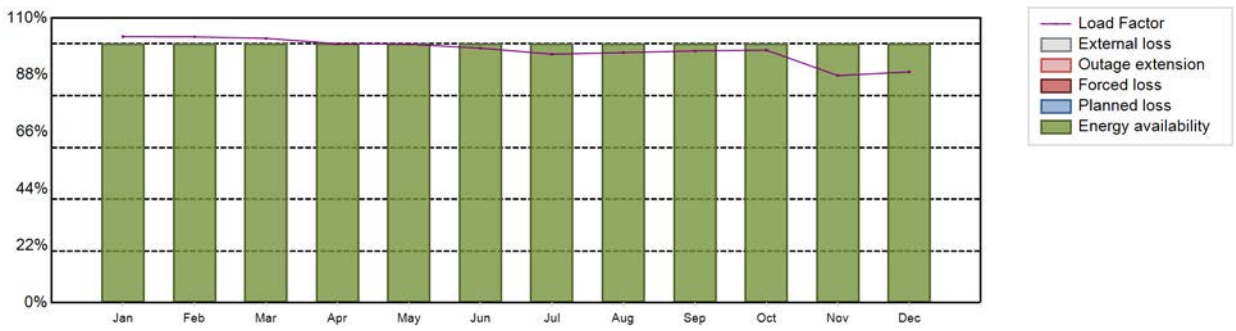
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.13
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	285
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.436
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	34	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	26000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4	HP cylinder inlet steam pressure [MPa]	:	6.79
Active core height/length [m]	:	3.7	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	532	Primary means of condenser cooling	:	Lake (once-through)
Fuel linear heat generation rate [kW/m]	:	15.5	Number of main condensate pumps	:	-
Number of control rod assemblies	:	129	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	5	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	97.54 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



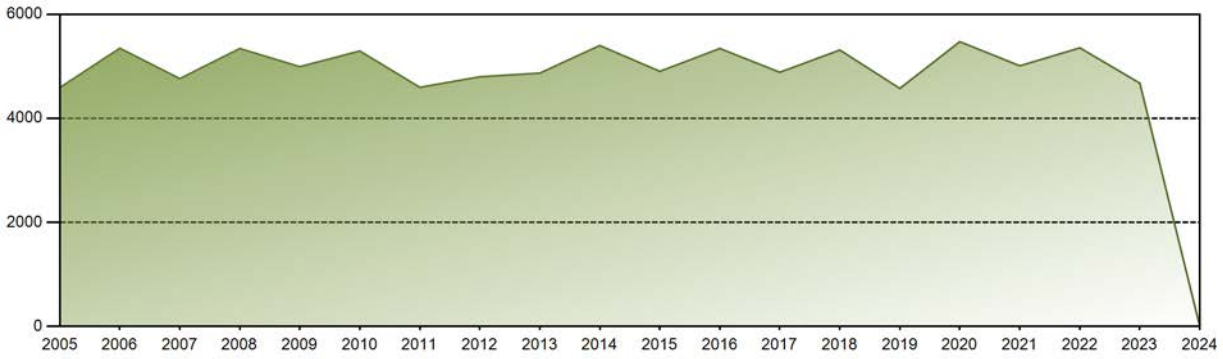
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	468.96	438.24	465.27	441.70	455.55	434.14	437.98	440.77	429.52	445.12	387.94	406.71	5251.90
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	102.83	102.72	102.15	100.08	99.89	98.37	96.03	96.64	97.32	97.60	87.77	89.18	97.54
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	8.59 %
Cumulative Energy Availability Factor (EAF)	:	80.18 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	7.54 %
Cumulative Unit Capability Factor (UCF)	:	80.18 %	Cumulative Planned Unavailability Factor (PUF)	:	12.29 %
Cumulative Load Factor (LF)	:	76.37 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	79.07 %			

Electricity Production (net) [GWh]

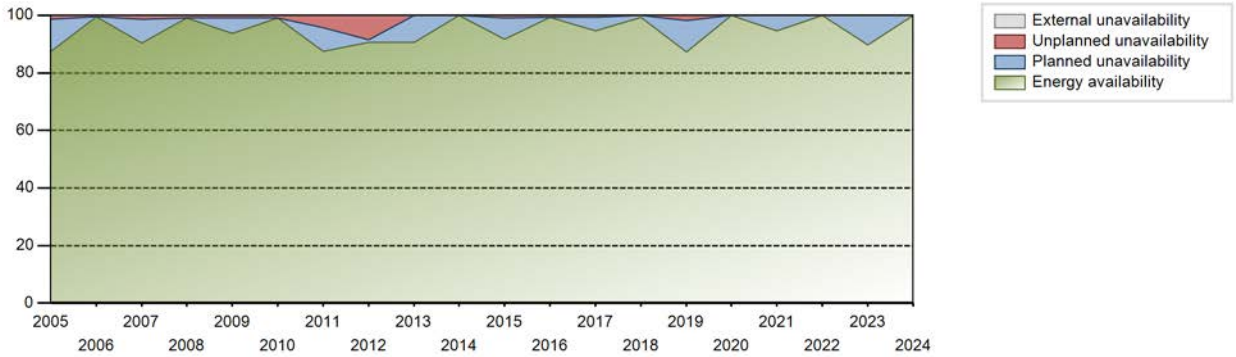


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1969	Data not provided										
1970	1581.00	3443	525	100.00	100.00	34.38	39.30	0.00	0.00	0.00	0.00
1971	3033.10	5963	592	100.00	100.00	58.49	68.07	0.00	0.00	0.00	0.00
1972	3344.80	6101	630	100.00	100.00	60.44	69.46	0.00	0.00	0.00	0.00
1973	3494.20	6682	610	76.41	76.41	65.39	76.28	7.94	6.59	17.00	0.00
1974	3278.70	6177	610	70.50	70.50	61.36	70.51	4.91	3.64	25.86	0.00
1975	3044.90	6235	610	57.03	57.03	56.98	71.18	17.76	12.32	30.66	0.00
1976	4112.80	7724	610	76.79	76.79	76.76	87.93	18.88	17.88	5.33	0.00
1977	2956.80	5171	610	55.39	55.39	55.33	59.03	2.16	1.22	43.39	0.00
1978	4467.40	8329	610	83.60	83.60	83.60	95.08	4.41	3.86	12.54	0.00
1979	3005.40	5785	610	56.24	56.24	56.24	66.04	5.91	3.53	40.23	0.00
1980	4537.30	8097	610	92.16	92.16	84.68	92.18	4.77	4.61	3.22	0.00
1981	3270.30	5780	610	65.61	65.61	61.20	65.98	1.79	1.20	33.19	0.00
1982	1134.80	1872	610	21.47	21.47	21.24	21.37	78.19	76.99	1.54	0.00
1983	2802.00	4925	610	56.21	56.21	52.44	56.22	43.79	43.79	0.00	0.00
1984	3635.23	6316	610	71.61	71.61	67.84	71.90	3.95	2.94	25.45	0.00
1985	4932.30	8441	610	96.37	96.37	92.30	96.36	3.63	3.63	0.00	0.00
1986	3146.88	5722	610	64.95	64.95	58.89	65.32	8.55	6.07	28.98	0.00
1987	4615.17	8130	610	92.81	92.81	86.37	92.81	7.19	7.19	0.00	0.00
1988	0.00	0	610	0.00	0.00	0.00	0.00	100.00	5.87	94.13	0.00
1989	0.00	0	610	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1990	1316.68	3043	612	34.24	34.24	24.56	34.74	65.54	65.11	0.66	0.00
1991	3873.51	6853	615	78.22	78.22	71.90	78.23	9.02	7.75	14.03	0.00
1992	2930.09	5052	615	57.41	57.41	54.24	57.51	42.54	42.51	0.08	0.00
1993	4353.36	7370	615	84.08	84.08	80.81	84.13	0.72	0.61	15.31	0.00
1994	4917.95	8390	565	95.42	95.42	99.36	95.78	4.58	4.58	0.00	0.00
1995	4127.64	7381	565	82.86	82.86	83.40	84.26	1.76	1.48	15.66	0.00
1996	4676.17	8133	565	91.98	91.98	94.22	92.59	6.65	6.55	1.47	0.00
1997	2698.57	4620	565	51.77	51.77	54.52	52.74	36.61	29.90	18.33	0.00
1998	4845.98	8085	565	92.31	92.31	97.91	92.29	7.69	7.69	0.00	0.00
1999	3564.86	6162	565	68.37	68.37	72.03	70.34	12.16	9.47	22.17	0.00
2000	4681.85	8060	565	91.00	91.00	94.34	91.76	1.53	1.41	7.58	0.00
2001	4378.01	7376	565	83.52	83.52	88.46	84.20	2.47	2.12	14.36	0.00
2002	4904.56	8194	565	92.90	92.90	99.09	93.54	6.14	6.07	1.03	0.00
2003	4361.37	7373	565	83.61	83.61	88.12	84.17	3.65	3.17	13.22	0.00
2004	4988.21	8258	565	93.46	93.46	100.51	94.01	1.22	1.15	5.39	0.00
2005	4589.79	7667	621	87.55	87.55	84.36	87.51	1.49	1.33	11.12	0.00

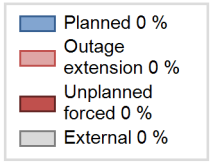
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2006	5346.94	8713	621	99.47	99.47	98.29	99.46	0.53	0.53	0.00	0.00
2007	4762.88	7910	621	90.31	90.31	87.55	90.30	1.59	1.46	8.23	0.00
2008	5341.42	8707	621	99.13	99.13	97.92	99.12	0.87	0.87	0.00	0.00
2009	4992.58	8216	621	93.81	93.81	91.78	93.79	0.87	0.82	5.37	0.00
2010	5294.08	8677	621	99.06	99.06	97.32	99.05	0.94	0.94	0.00	0.00
2011	4595.11	7671	621	87.59	87.59	84.47	87.57	4.71	4.33	8.08	0.00
2012	4798.45	7951	621	90.57	90.57	87.97	90.52	8.49	8.40	1.02	0.00
2013	4868.75	7933	621	90.56	90.56	89.49	90.55	0.00	0.00	9.44	0.00
2014	5400.06	8760	621	100.00	100.00	99.27	100.00	0.00	0.00	0.00	0.00
2015	4903.16	8039	613	91.66	91.66	91.31	91.77	1.10	1.02	7.32	0.00
2016	5342.98	8721	613	99.28	99.28	99.23	99.28	0.72	0.72	0.00	0.00
2017	4885.28	8290	613	94.64	94.64	90.98	94.63	0.70	0.67	4.69	0.00
2018	5313.34	8684	613	99.20	99.20	98.95	99.13	0.00	0.00	0.80	0.00
2019	4574.14	7646	613	87.30	87.30	85.18	87.28	1.94	1.73	10.98	0.00
2020	5473.00	8783	613	100.00	100.00	101.64	99.99	0.00	0.00	0.00	0.00
2021	5009.29	8280	613	94.52	94.52	93.28	94.52	0.00	0.00	5.48	0.00
2022	5355.41	8760	613	100.00	100.00	99.73	100.00	0.00	0.00	0.00	0.00
2023	4675.61	7795	613	89.78	89.78	87.07	88.98	0.02	0.02	10.20	0.00
2024	Data not provided										

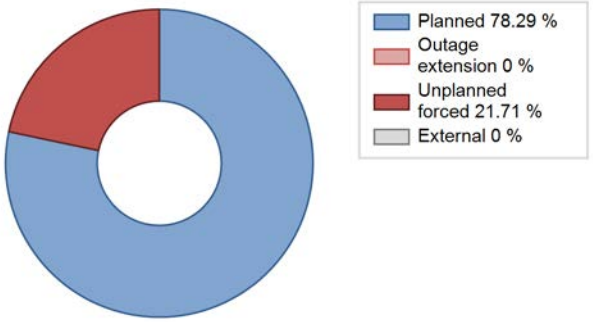
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1969 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					544	
B. Refuelling without maintenance				9		
C. Inspection, maintenance or repair combined with refuelling				972		
D. Inspection, maintenance or repair without refuelling				103		
E. Testing of plant systems or components				2	1	
F. Major backfitting, refurbishment or upgrading activities with refuelling				2		
H. Nuclear regulatory requirements					7	
L. Human factor related					21	
Z. Other				4	99	
Subtotal				1092	672	
Total		**0**			**1764**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1969 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		15
12. Reactor I&C Systems		27
13. Reactor Auxiliary Systems		22
14. Safety Systems		89
15. Reactor Cooling Systems		238
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		8
31. Turbine and auxiliaries		66
32. Feedwater and Main Steam System		44
34. Miscellaneous Systems		2
35. All other I&C Systems		2
41. Main Generator Systems		13
42. Electrical Power Supply Systems		23
Total		**550**

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2024 Operating Experience

US-410 NINE MILE POINT-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXE/EDF (Exelon Nuclear, Électricité de France)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-5 (Mark 2)
Thermal power	:	3988 MWth
Gross electrical power	:	1320 MWe
Reference unit power (net)	:	1277 MWe

Key Dates

Construction Date	:	1975-08-01
Grid Date	:	1987-08-08
Commercial Date	:	1988-03-11
Age at end of year	:	37 years

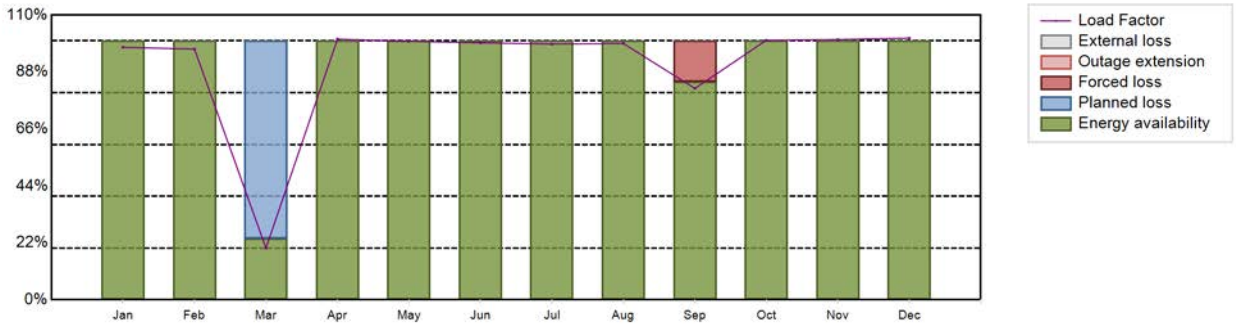
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	26
Average discharge burnup [MWd/t]	:	32300
Active core diameter [m]	:	4.75
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	764
Fuel linear heat generation rate [kW/m]	:	17.68
Number of control rod assemblies	:	185
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7.17
Reactor outlet temperature [°C]	:	287
Number of SG	:	NA
Containment type	:	-
Containment design pressure [MPa]	:	0.316
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.78
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	10232.64 GW(e).h	Forced Loss Rate (FLR)	:	1.39 %
Energy Availability Factor (EAF)	:	92.25 %	Unplanned Capability Loss Factor (UCL)	:	1.3 %
Unit Capability Factor (UCF)	:	92.25 %	Planned Unavailability Factor (PUF)	:	6.45 %
Load Factor (LF)	:	91.22 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	92.24 %	Total off-line time	:	682 hours

Annual Summary



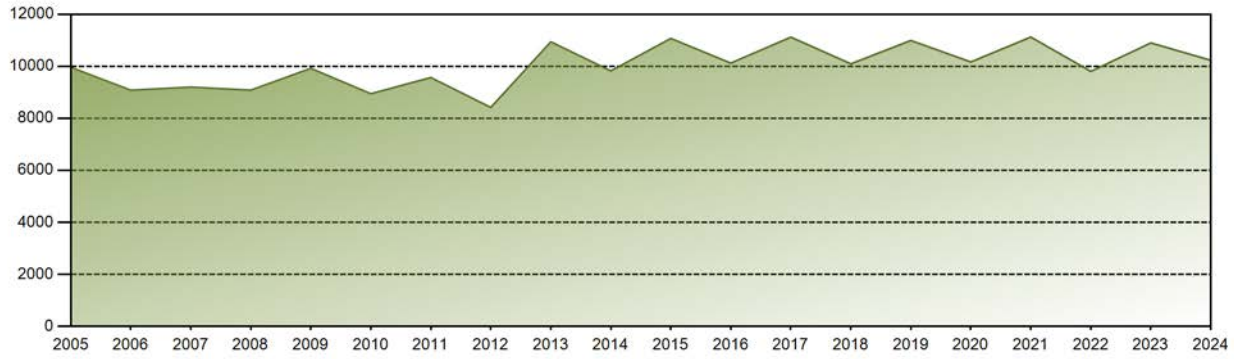
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	926.56	860.79	189.74	925.63	948.61	913.02	938.51	940.58	750.77	952.64	925.53	960.27	10232.64
EAF [%]	100.00	100.00	23.79	100.00	100.00	100.00	100.00	100.00	84.11	100.00	100.00	100.00	92.25
UCF [%]	100.00	100.00	23.79	100.00	100.00	100.00	100.00	100.00	84.11	100.00	100.00	100.00	92.25
LF [%]	97.52	96.85	20.00	100.67	99.84	99.30	98.78	99.00	81.66	100.27	100.52	101.07	91.22
OF [%]	100.00	100.00	23.69	100.00	100.00	100.00	100.00	100.00	84.03	100.00	100.00	100.00	92.24
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.89	0.00	0.00	0.00	1.39
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.89	0.00	0.00	0.00	1.30
PUF [%]	0.00	0.00	76.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.45
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	323389.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.68 %
Cumulative Energy Availability Factor (EAF)	:	88.19 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.37 %
Cumulative Unit Capability Factor (UCF)	:	88.19 %	Cumulative Planned Unavailability Factor (PUF)	:	8.44 %
Cumulative Load Factor (LF)	:	86.15 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	87.18 %			

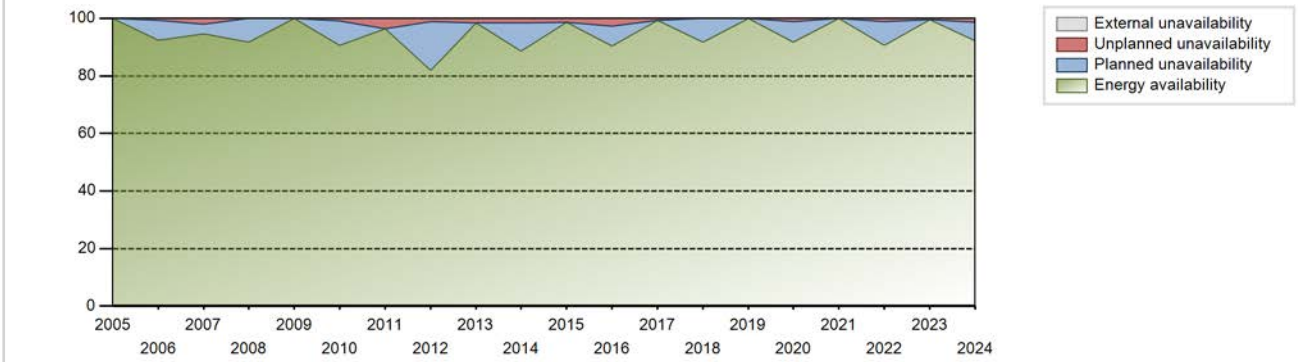
Electricity Production (net) [GWh]



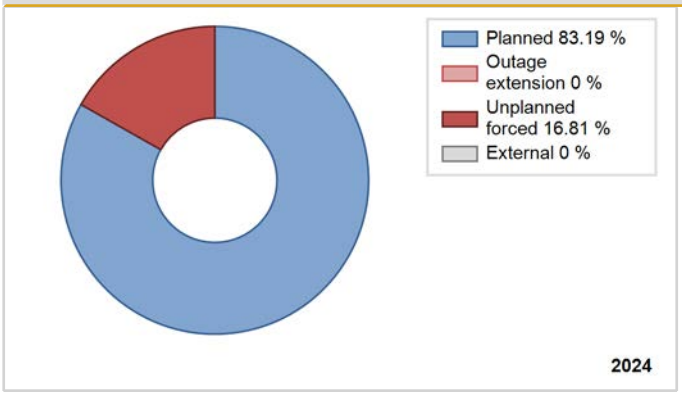
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	2540.56	2800	1040	49.12	49.12	33.61	38.64	17.46	10.39	40.48	0.00
1989	4288.28	4824	1068	56.45	56.45	45.81	55.07	20.46	14.52	29.03	0.00
1990	4140.41	4697	1082	54.42	54.42	43.66	53.62	20.59	14.11	31.47	0.00
1991	6562.93	6484	1092	75.10	75.10	68.57	74.02	18.31	16.83	8.07	0.00
1992	5144.97	5169	1075	61.85	61.85	54.48	58.85	12.58	8.90	29.26	0.00
1993	7191.09	7195	1048	82.22	82.22	78.28	82.13	2.06	1.73	16.05	0.00
1994	8355.90	8243	994	93.93	93.93	95.96	94.10	6.07	6.07	0.00	0.00
1995	7253.68	6848	1061	78.91	78.91	77.99	78.17	7.60	6.49	14.59	0.00
1996	8698.50	7811	1106	89.75	89.75	89.50	88.92	1.23	1.12	9.13	0.00
1997	8877.99	8279	1105	94.93	94.93	91.72	94.51	3.22	3.16	1.91	0.00
1998	7307.16	7028	1105	80.84	80.84	75.49	80.23	2.37	1.96	17.20	0.00
1999	8782.30	7810	1128	89.06	89.06	88.86	89.16	10.94	10.94	0.00	0.00
2000	8001.52	7204	1123	81.73	81.73	81.11	82.01	3.35	2.83	15.43	0.00
2001	8858.85	7964	1119	90.66	90.66	90.37	90.91	4.01	3.78	5.56	0.00
2002	8417.50	7473	1119	85.14	85.14	85.87	85.31	6.47	5.89	8.97	0.00
2003	9566.87	8448	1119	96.40	96.40	97.60	96.44	3.60	3.60	0.00	0.00
2004	8643.48	7788	1119	88.52	88.52	87.94	88.66	0.00	0.00	11.48	0.00
2005	9961.02	8760	1135	100.00	100.00	100.17	99.99	0.00	0.00	0.00	0.00
2006	9081.58	8100	1135	92.48	92.48	91.34	92.47	0.69	0.64	6.88	0.00
2007	9201.14	8286	1140	94.60	94.60	92.14	94.59	2.00	1.93	3.46	0.00
2008	9082.39	8063	1140	91.81	91.81	90.70	91.79	0.00	0.00	8.19	0.00
2009	9921.92	8760	1142	100.00	100.00	99.18	100.00	0.00	0.00	0.00	0.00
2010	8944.98	7934	1143	90.61	90.61	89.34	90.57	0.95	0.87	8.52	0.00
2011	9568.30	8450	1119	96.40	96.40	97.61	96.46	3.60	3.60	0.00	0.00
2012	8418.34	7119	1276	81.94	81.94	80.26	81.05	1.34	1.11	16.95	0.00
2013	10942.30	8622	1277	98.42	98.42	97.81	98.41	1.58	1.58	0.00	0.00
2014	9822.73	7755	1276	88.53	88.53	87.88	88.53	1.76	1.59	9.88	0.00
2015	11072.56	8647	1277	98.72	98.72	98.98	98.71	1.28	1.28	0.00	0.00
2016	10123.11	7935	1277	90.34	90.34	90.25	90.33	3.01	2.80	6.86	0.00
2017	11122.23	8695	1277	99.26	99.26	99.43	99.26	0.74	0.74	0.00	0.00
2018	10094.77	7988	1277	91.80	91.80	90.24	91.19	0.00	0.00	8.20	0.00
2019	10993.81	8760	1277	100.00	100.00	98.28	100.00	0.00	0.00	0.00	0.00
2020	10167.61	8059	1277	91.75	91.75	90.64	91.75	1.31	1.22	7.03	0.00
2021	11124.49	8760	1277	100.00	100.00	99.45	100.00	0.00	0.00	0.00	0.00
2022	9804.76	7935	1277	90.59	90.59	87.65	90.58	1.24	1.13	8.28	0.00
2023	10899.53	8632	1277	99.55	99.55	97.43	98.54	0.39	0.39	0.06	0.00
2024	10232.64	8102	1277	92.25	92.25	91.22	92.24	1.39	1.30	6.45	0.00

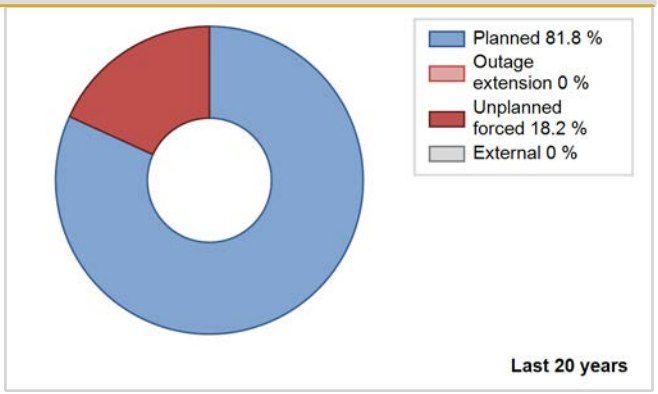
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		115			278	
B. Refuelling without maintenance				30		
C. Inspection, maintenance or repair combined with refuelling	567			551		
D. Inspection, maintenance or repair without refuelling				196		
E. Testing of plant systems or components				2	3	
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					16	
Z. Other					18	
Subtotal	567	115		779	315	3
Total		**682**			**1097**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1988 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		7
12. Reactor I&C Systems		22
13. Reactor Auxiliary Systems		9
14. Safety Systems		7
15. Reactor Cooling Systems		42
16. Steam generation systems		8
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		24
32. Feedwater and Main Steam System		42
33. Circulating Water System		9
34. Miscellaneous Systems		16
35. All other I&C Systems		29
41. Main Generator Systems	115	25
42. Electrical Power Supply Systems		43
Total	**115**	**285**

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2024 Operating Experience

US-338 NORTH ANNA-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	DOMINION (Dominion Energy)
Owner	:	VEPCO (Virginia Electric Power Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYSUB)
Thermal power	:	2940 MWth
Gross electrical power	:	990 MWe
Reference unit power (net)	:	948 MWe

Key Dates

Construction Date	:	1971-02-19
Grid Date	:	1978-04-17
Commercial Date	:	1978-06-06
Age at end of year	:	46 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	39000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.59
Number of control rod assemblies	:	32
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

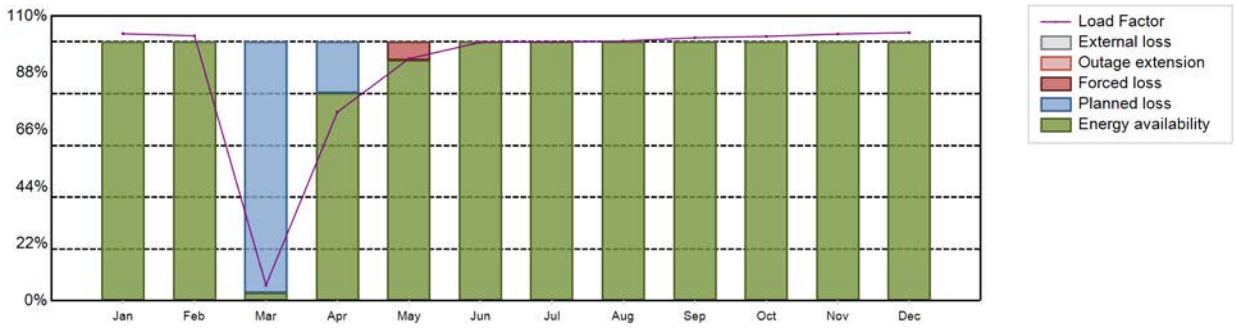
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	327
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.316
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.82
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7546.01 GW(e).h
Energy Availability Factor (EAF)	:	89.57 %
Unit Capability Factor (UCF)	:	89.57 %
Load Factor (LF)	:	90.62 %
Operating Factor (OF)	:	89.58 %

Forced Loss Rate (FLR)	:	0.67 %
Unplanned Capability Loss Factor (UCL)	:	0.61 %
Planned Unavailability Factor (PUF)	:	9.82 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	915 hours

Annual Summary



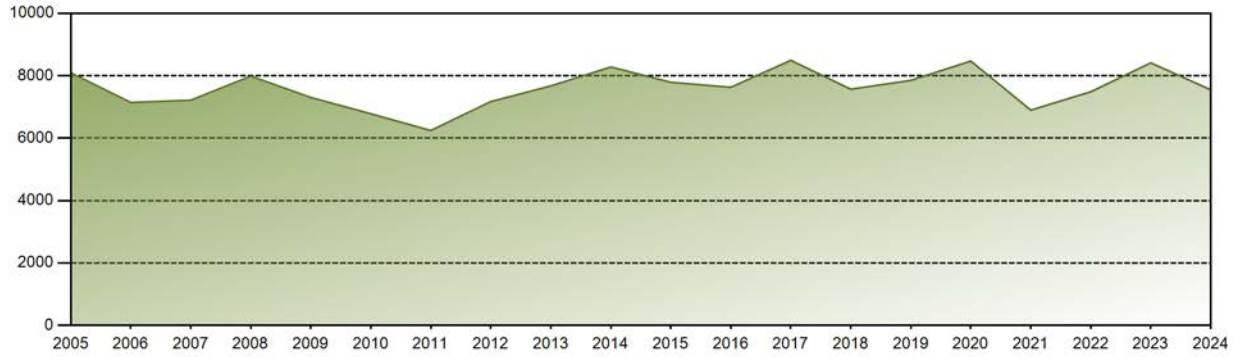
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	727.74	675.38	42.53	497.73	659.67	681.47	705.01	707.71	693.50	720.38	704.36	730.54	7546.01
EAF [%]	100.00	100.00	3.10	80.21	92.83	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.57
UCF [%]	100.00	100.00	3.10	80.21	92.83	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.57
LF [%]	103.18	102.36	6.04	72.92	93.53	99.84	99.96	100.34	101.60	102.14	103.05	103.58	90.62
OF [%]	100.00	100.00	6.33	76.94	92.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.58
FLR [%]	0.00	0.00	0.00	0.00	7.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67
UCL [%]	0.00	0.00	0.00	0.00	7.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61
PUF [%]	0.00	0.00	96.90	19.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.82
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	312947.76 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.03 %
Cumulative Energy Availability Factor (EAF)	:	85.16 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.6 %
Cumulative Unit Capability Factor (UCF)	:	85.65 %	Cumulative Planned Unavailability Factor (PUF)	:	10.75 %
Cumulative Load Factor (LF)	:	83.95 %	Cumulative Externally cause unavailability (XUF)	:	0.49 %
Cumulative Operating Factor (OF)	:	85.2 %			

Electricity Production (net) [GWh]

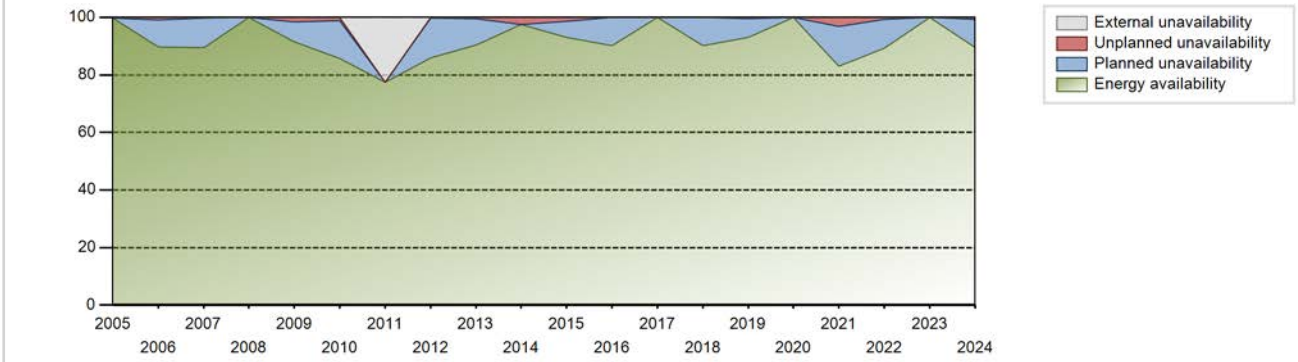


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1978	3971.50	5420	896	81.39	81.39	79.45	92.85	13.69	12.91	5.70	0.00
1979	4188.70	5399	898	53.25	53.25	53.25	61.63	21.68	14.74	32.02	0.00
1980	5631.00	7589	878	87.25	87.25	73.01	86.40	6.30	5.87	6.89	0.00
1981	4637.90	5703	860	65.62	65.62	61.56	65.10	0.38	0.25	34.13	0.00
1982	2397.90	3027	865	34.73	34.73	31.65	34.55	22.49	10.08	55.19	0.00
1983	5310.40	6277	872	71.62	71.62	69.52	71.66	23.75	22.30	6.08	0.00
1984	3784.80	4425	883	50.31	50.31	48.80	50.38	19.28	12.01	37.68	0.00
1985	5798.93	6820	892	77.88	77.88	74.21	77.85	5.14	4.22	17.90	0.00
1986	6310.74	7327	893	83.70	83.70	80.67	83.64	16.10	16.06	0.24	0.00
1987	3568.91	4523	913	52.09	52.09	44.61	51.63	35.37	28.50	19.41	0.00
1988	6897.30	7760	915	88.61	88.61	85.82	88.34	10.25	10.12	1.26	0.00
1989	4303.32	4978	915	57.80	57.80	53.69	56.83	9.68	6.20	36.01	0.00
1990	7233.54	8726	912	99.62	99.62	90.54	99.61	0.38	0.38	0.00	0.00
1991	5625.82	6549	911	75.16	75.16	70.50	74.76	11.49	9.75	15.08	0.00
1992	5358.08	7225	858	81.53	81.53	71.07	82.25	3.04	2.56	15.91	0.00
1993	5692.65	6444	890	73.49	73.49	72.99	73.56	0.00	0.00	26.51	0.00
1994	6795.70	8012	900	91.55	91.55	86.20	91.46	0.00	0.00	8.45	0.00
1995	7839.17	8733	896	99.70	99.70	99.82	99.69	0.30	0.30	0.00	0.00
1996	6945.50	7985	893	90.96	90.96	88.54	90.90	0.84	0.77	8.27	0.00
1997	7157.53	7992	893	91.26	91.26	91.50	91.23	0.00	0.00	8.74	0.00
1998	7217.05	8091	893	92.39	92.39	92.26	92.36	0.71	0.66	6.95	0.00
1999	8124.46	8760	893	100.00	100.00	103.86	100.00	0.00	0.00	0.00	0.00
2000	7213.08	7997	893	91.06	91.06	91.96	91.04	1.45	1.34	7.59	0.00
2001	7120.79	8010	925	91.46	91.46	87.88	91.44	0.00	0.00	8.54	0.00
2002	8164.34	8760	925	100.00	100.00	100.76	100.00	0.00	0.00	0.00	0.00
2003	6519.92	7200	925	82.21	82.21	80.46	82.19	3.41	2.90	14.89	0.00
2004	7418.35	8023	925	91.35	91.35	91.30	91.34	0.00	0.00	8.65	0.00
2005	8091.86	8744	925	99.82	99.82	99.85	99.81	0.18	0.18	0.00	0.00
2006	7142.74	7861	924	89.77	89.77	88.24	89.74	1.01	0.91	9.32	0.00
2007	7215.14	7854	903	89.45	89.45	91.21	89.66	0.32	0.28	10.27	0.00
2008	7986.83	8784	903	100.00	100.00	100.69	100.00	0.00	0.00	0.00	0.00
2009	7302.50	8017	903	91.53	91.53	92.32	91.52	1.70	1.58	6.88	0.00
2010	6779.93	7496	903	85.60	85.60	85.71	85.57	1.40	1.21	13.18	0.00
2011	6243.13	6746	920	77.45	100.00	77.47	77.01	0.00	0.00	0.00	22.55
2012	7170.90	7531	943	86.00	86.00	87.27	85.74	0.23	0.20	13.81	0.00
2013	7672.82	7922	943	90.44	90.44	92.87	90.42	0.65	0.59	8.97	0.00
2014	8279.47	8546	943	97.56	97.56	100.23	97.56	2.44	2.44	0.00	0.00

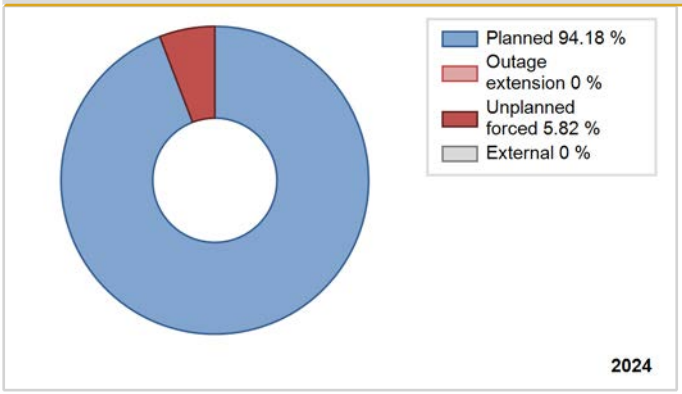
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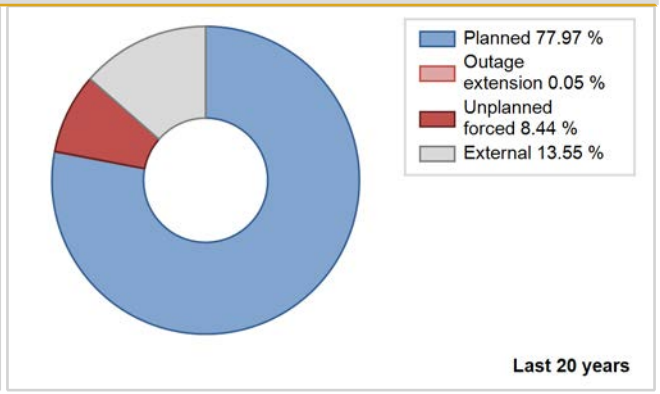
2015	7789.98	8141	948	92.96	92.96	93.80	92.93	1.54	1.46	5.58	0.00
2016	7629.40	7925	948	90.22	90.22	91.62	90.22	0.00	0.00	9.78	0.00
2017	8492.34	8760	948	100.00	100.00	102.26	100.00	0.00	0.00	0.00	0.00
2018	7568.38	7893	948	90.10	90.10	91.14	90.10	0.00	0.00	9.90	0.00
2019	7850.41	8159	948	93.16	93.16	94.53	93.14	0.46	0.43	6.40	0.00
2020	8468.83	8783	948	100.00	100.00	101.70	99.99	0.00	0.00	0.00	0.00
2021	6896.85	7276	948	83.06	83.06	83.05	83.06	3.65	3.14	13.80	0.00
2022	7485.98	7812	948	89.17	89.17	90.14	89.18	0.86	0.77	10.06	0.00
2023	8412.10	8720	948	99.91	99.91	101.30	99.54	0.00	0.08	0.01	0.00
2024	7546.01	7869	948	89.57	89.57	90.62	89.58	0.67	0.61	9.82	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1978 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		53			289	
B. Refuelling without maintenance				41		
C. Inspection, maintenance or repair combined with refuelling	863			829		
D. Inspection, maintenance or repair without refuelling				77		
E. Testing of plant systems or components				6	3	
L. Human factor related					3	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						43
Z. Other				0	7	
Subtotal	863	53		953	302	43
Total	**916**			**1298**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1978 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	53	11
12. Reactor I&C Systems		3
13. Reactor Auxiliary Systems		8
14. Safety Systems		14
15. Reactor Cooling Systems		37
16. Steam generation systems		78
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		37
32. Feedwater and Main Steam System		15
33. Circulating Water System		3
34. Miscellaneous Systems		16
41. Main Generator Systems		9
42. Electrical Power Supply Systems		61
Total	**53**	**293**

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2024 Operating Experience

US-339 NORTH ANNA-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	DOMINION (Dominion Energy)
Owner	:	VEPCO (Virginia Electric Power Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYSUB)
Thermal power	:	2940 MWth
Gross electrical power	:	1011 MWe
Reference unit power (net)	:	944 MWe

Key Dates

Construction Date	:	1971-02-19
Grid Date	:	1980-08-25
Commercial Date	:	1980-12-14
Age at end of year	:	44 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	39000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18.59
Number of control rod assemblies	:	32
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

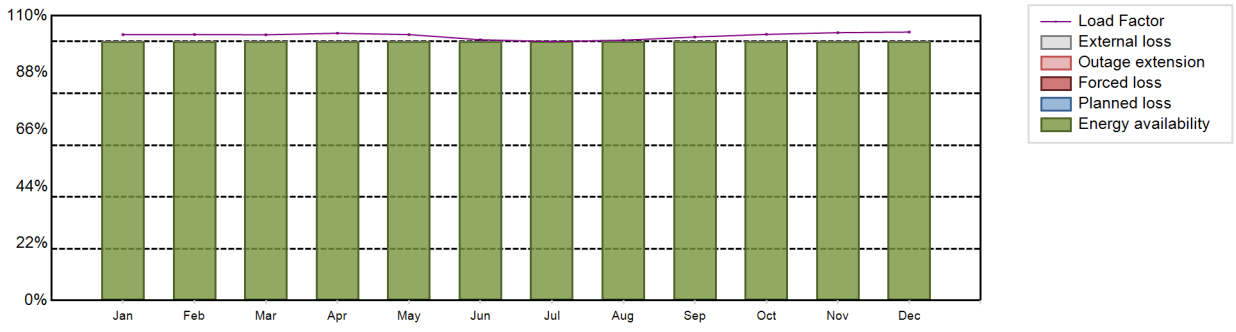
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	327
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.316
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.82
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	102.24 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



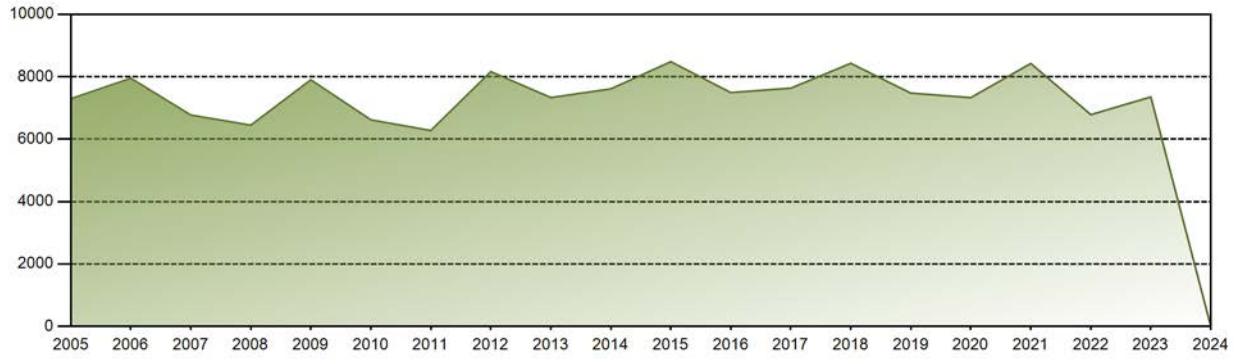
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	721.22	674.92	719.87	701.61	721.35	684.45	702.45	706.14	691.66	721.85	704.14	728.11	8477.77
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	102.69	102.72	102.64	103.23	102.71	100.70	100.02	100.54	101.76	102.78	103.45	103.67	102.24
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.27 %
Cumulative Energy Availability Factor (EAF)	:	87.43 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.98 %
Cumulative Unit Capability Factor (UCF)	:	88.03 %	Cumulative Planned Unavailability Factor (PUF)	:	8.99 %
Cumulative Load Factor (LF)	:	86.25 %	Cumulative Externally cause unavailability (XUF)	:	0.6 %
Cumulative Operating Factor (OF)	:	87.24 %			

Electricity Production (net) [GWh]

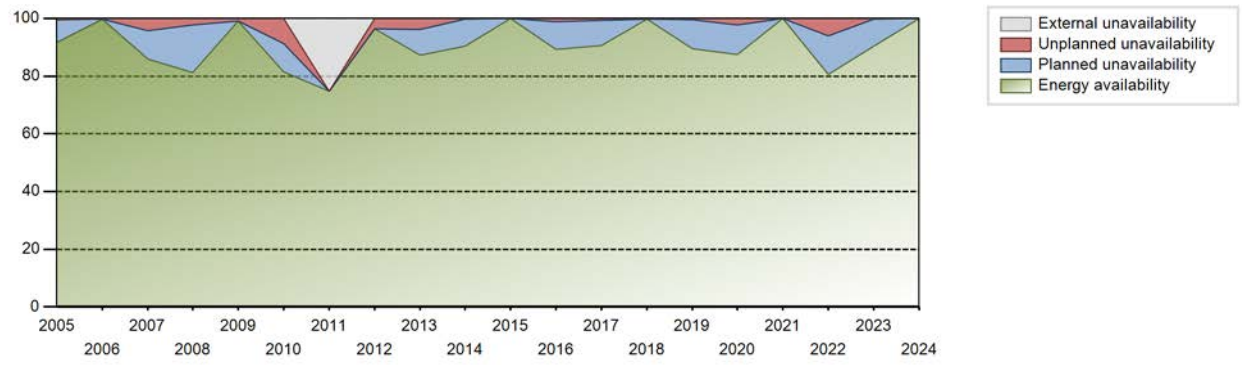


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1980	1082.50	1701	897	97.50	97.50	90.12	95.37	2.50	2.50	0.00	0.00
1981	5652.70	6813	883	78.35	78.35	73.08	77.77	19.06	18.46	3.19	0.00
1982	4047.20	4990	890	57.35	57.35	51.91	56.96	22.01	16.18	26.47	0.00
1983	5802.50	7052	890	80.75	80.75	74.43	80.50	4.16	3.51	15.74	0.00
1984	4717.19	5896	890	67.14	67.14	60.34	67.12	5.29	3.75	29.11	0.00
1985	6813.59	8252	892	94.22	94.22	87.17	94.20	5.78	5.78	0.00	0.00
1986	6022.05	7208	893	82.25	82.25	76.98	82.28	6.38	5.60	12.15	0.00
1987	5653.45	6783	905	77.42	77.42	71.24	77.43	0.00	0.00	22.58	0.00
1988	7883.98	8708	915	99.15	99.15	98.09	99.13	0.00	0.00	0.85	0.00
1989	5896.51	6887	915	80.17	80.17	73.56	78.62	0.00	0.00	19.83	0.00
1990	5976.65	6982	910	80.01	80.01	74.93	79.70	19.96	19.95	0.03	0.00
1991	7684.26	8539	909	97.52	97.52	96.50	97.48	2.48	2.48	0.00	0.00
1992	6324.75	7237	909	82.63	82.63	79.21	82.39	0.94	0.78	16.59	0.00
1993	6225.22	7303	909	83.60	83.60	78.18	83.37	3.16	2.73	13.68	0.00
1994	7490.27	8517	887	97.19	97.19	96.40	97.23	2.81	2.81	0.00	0.00
1995	6031.67	7086	892	80.82	80.82	77.19	80.89	0.42	0.34	18.84	0.00
1996	6121.54	6859	897	78.13	78.13	77.69	78.09	13.48	12.17	9.70	0.00
1997	7834.79	8738	897	99.75	99.75	99.71	99.75	0.25	0.25	0.00	0.00
1998	7086.10	8049	897	91.91	92.15	90.18	91.88	0.00	0.00	7.85	0.23
1999	7185.14	8034	897	91.73	91.73	91.44	91.71	0.49	0.45	7.82	0.00
2000	8018.85	8729	897	99.38	99.38	101.77	99.37	0.62	0.62	0.00	0.00
2001	5975.80	6776	917	77.40	77.40	74.39	77.35	1.24	0.97	21.63	0.00
2002	5509.69	6000	917	68.48	68.48	68.59	68.49	0.00	0.00	31.52	0.00
2003	7262.75	7950	917	90.77	90.77	90.41	90.75	0.26	0.24	9.00	0.00
2004	7388.14	8077	917	91.97	91.97	91.72	91.95	0.28	0.26	7.78	0.00
2005	7293.54	8034	917	91.72	92.14	90.80	91.71	0.00	0.00	7.86	0.42
2006	7950.42	8732	910	99.68	99.68	99.73	99.68	0.32	0.32	0.00	0.00
2007	6771.79	7524	903	85.81	85.81	85.61	85.89	4.66	4.20	9.99	0.00
2008	6446.59	7132	903	81.21	81.21	81.27	81.19	2.84	2.37	16.42	0.00
2009	7900.11	8688	903	99.18	99.18	99.87	99.18	0.82	0.82	0.00	0.00
2010	6619.53	7093	943	81.56	81.56	81.27	80.97	9.72	8.78	9.66	0.00
2011	6275.39	6570	943	74.77	100.00	75.97	75.00	0.00	0.00	0.00	25.23
2012	8162.29	8474	943	96.48	96.48	98.54	96.47	3.52	3.52	0.00	0.00
2013	7332.46	7642	943	87.24	87.24	88.75	87.23	4.24	3.86	8.90	0.00
2014	7609.18	7913	943	90.33	90.33	92.11	90.33	0.41	0.37	9.31	0.00
2015	8480.65	8760	943	100.00	100.00	102.66	100.00	0.00	0.00	0.00	0.00
2016	7491.97	7835	943	89.18	89.18	90.45	89.20	1.30	1.18	9.64	0.00

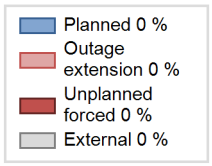
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2017	7633.75	7937	944	90.62	90.62	92.31	90.61	0.70	0.64	8.75	0.00
2018	8428.87	8732	944	99.68	99.68	101.93	99.68	0.32	0.32	0.00	0.00
2019	7474.13	7828	944	89.38	89.38	90.38	89.36	0.46	0.41	10.21	0.00
2020	7331.07	7689	944	87.54	87.54	88.41	87.53	2.53	2.27	10.18	0.00
2021	8423.95	8760	944	100.00	100.00	101.87	100.00	0.00	0.00	0.00	0.00
2022	6784.90	7066	944	80.67	80.67	82.05	80.66	6.97	6.04	13.29	0.00
2023	7352.87	7802	944	90.41	90.41	88.92	89.06	0.30	0.27	9.32	0.00
2024	Data not provided										

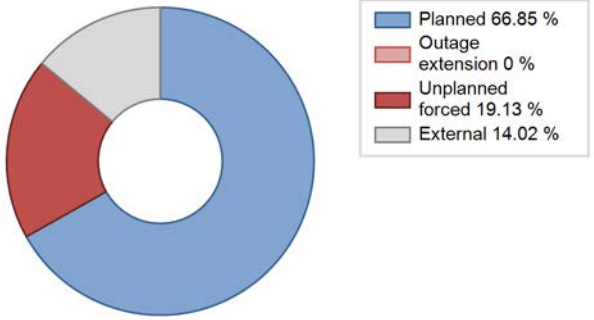
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1980 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					203	
B. Refuelling without maintenance				39		
C. Inspection, maintenance or repair combined with refuelling				695		
D. Inspection, maintenance or repair without refuelling				57		
E. Testing of plant systems or components				2		
H. Nuclear regulatory requirements					3	
L. Human factor related					9	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						56
Z. Other					45	
Subtotal				793	260	56
Total	**0**			**1109**		

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1980 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		3
13. Reactor Auxiliary Systems		2
14. Safety Systems		14
15. Reactor Cooling Systems		24
16. Steam generation systems		65
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		6
32. Feedwater and Main Steam System		17
33. Circulating Water System		0
34. Miscellaneous Systems		11
41. Main Generator Systems		49
42. Electrical Power Supply Systems		52
Total		**244**

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2024 Operating Experience

US-269 OCONEE-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	DUKEENER (Duke Energy Corp.)
Owner	:	DUKEENER (Duke Energy Corp.)
Reactor Supplier	:	B&W (BABCOCK & WILCOX CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / B&W LLP (DRYAMB)
Thermal power	:	2568 MWth
Gross electrical power	:	891 MWe
Reference unit power (net)	:	847 MWe

Key Dates

Construction Date	:	1967-11-06
Grid Date	:	1973-05-06
Commercial Date	:	1973-07-15
Age at end of year	:	51 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	34
Average discharge burnup [MWd/t]	:	30000
Active core diameter [m]	:	3.27
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	19
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

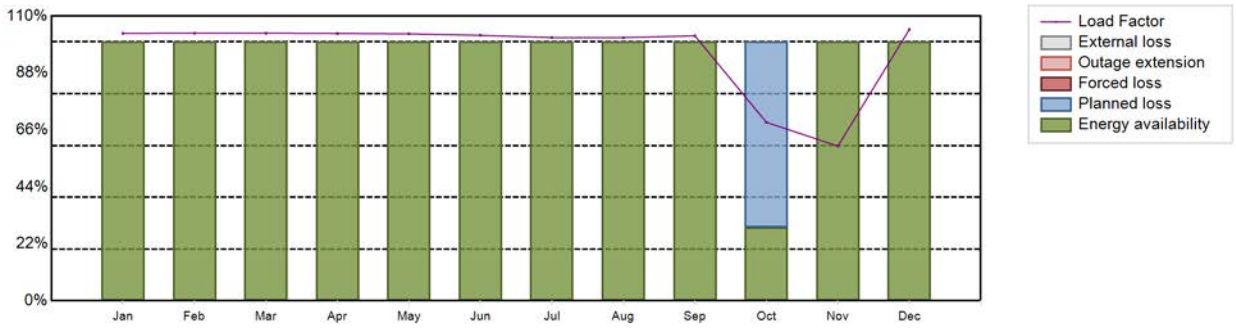
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	318
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.513
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.33
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7181.31 GW(e).h
Energy Availability Factor (EAF)	:	93.94 %
Unit Capability Factor (UCF)	:	93.94 %
Load Factor (LF)	:	96.52 %
Operating Factor (OF)	:	93.94 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	6.06 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	532 hours

Annual Summary



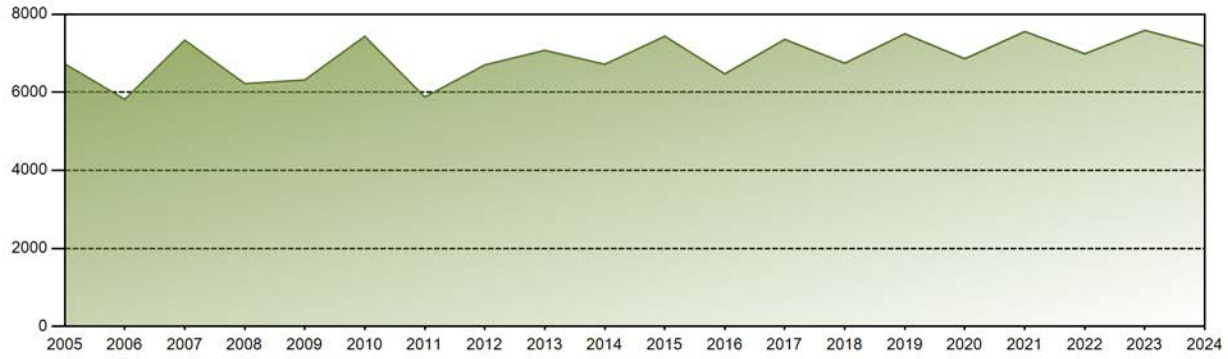
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	651.00	609.49	650.63	629.77	649.75	625.27	640.69	640.62	624.15	434.52	365.04	660.37	7181.31
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	28.45	100.00	100.00	93.94
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	28.45	100.00	100.00	93.94
LF [%]	103.31	103.39	103.39	103.27	103.11	102.53	101.67	101.66	102.35	68.95	59.77	104.79	96.52
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	67.47	59.78	100.00	93.94
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71.55	0.00	0.00	6.06
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	313295.27 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.77 %
Cumulative Energy Availability Factor (EAF)	:	83.73 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.17 %
Cumulative Unit Capability Factor (UCF)	:	83.93 %	Cumulative Planned Unavailability Factor (PUF)	:	10.9 %
Cumulative Load Factor (LF)	:	81.76 %	Cumulative Externally cause unavailability (XUF)	:	0.2 %
Cumulative Operating Factor (OF)	:	83.41 %			

Electricity Production (net) [GWh]

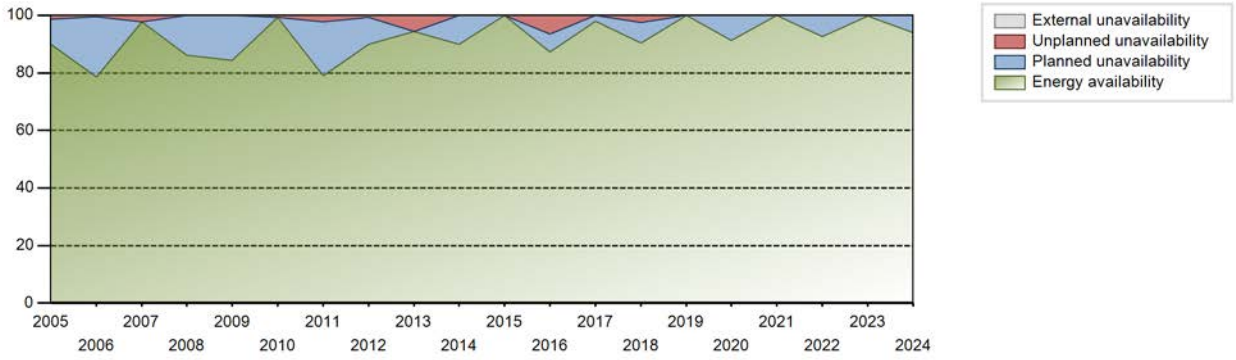


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1973	2200.00	4226	721	70.52	70.52	67.32	75.86	11.34	9.02	20.46	0.00
1974	4230.30	5141	920	100.00	100.00	52.49	58.69	0.00	0.00	0.00	0.00
1975	5299.30	6672	871	69.51	69.51	69.45	76.16	27.02	25.73	4.75	0.00
1976	4003.50	5029	871	52.38	52.38	52.33	57.25	25.57	18.00	29.62	0.00
1977	3949.00	5455	860	52.47	52.47	52.42	62.27	30.19	22.69	24.84	0.00
1978	5054.40	6299	860	67.07	67.07	67.09	71.91	20.04	16.81	16.12	0.00
1979	5003.10	6220	860	66.41	66.41	66.41	71.00	22.11	18.86	14.73	0.00
1980	5118.30	6634	860	76.23	86.33	67.75	75.52	8.70	8.22	5.45	10.10
1981	3023.20	3657	860	42.94	42.94	40.13	41.75	13.04	6.44	50.62	0.00
1982	5152.80	6335	860	73.50	73.50	68.40	72.32	24.78	24.22	2.29	0.00
1983	5672.00	6804	860	78.43	78.43	75.29	77.67	0.46	0.37	21.20	0.00
1984	6173.71	7312	860	83.55	83.55	81.73	83.24	2.07	1.76	14.68	0.00
1985	7065.96	8424	860	96.25	96.25	93.79	96.16	3.75	3.75	0.00	0.00
1986	4793.94	5870	860	70.22	70.22	63.63	67.01	13.19	10.67	19.11	0.00
1987	5031.13	6693	860	76.82	76.82	66.78	76.40	4.83	3.90	19.28	0.00
1988	7192.19	8742	846	99.53	99.53	96.78	99.52	0.47	0.47	0.00	0.00
1989	5943.13	7264	846	82.95	82.95	80.19	82.92	3.54	3.04	14.01	0.00
1990	6454.83	7751	846	88.49	88.49	87.10	88.48	0.24	0.22	11.29	0.00
1991	6022.45	7245	846	82.73	82.73	81.26	82.71	2.59	2.20	15.07	0.00
1992	6277.69	7494	846	85.31	85.31	84.48	85.31	7.36	6.77	7.91	0.00
1993	6525.05	7833	846	89.42	89.42	88.05	89.42	2.19	2.00	8.58	0.00
1994	6088.71	7302	846	83.39	83.39	82.16	83.36	0.46	0.39	16.22	0.00
1995	6360.47	7537	846	86.07	86.07	85.83	86.04	3.88	3.47	10.46	0.00
1996	5566.97	6606	846	75.23	75.23	74.91	75.20	0.60	0.46	24.32	0.00
1997	3194.22	4482	846	51.28	51.28	43.10	51.16	25.69	17.73	30.99	0.00
1998	5996.40	7255	846	82.83	82.83	80.91	82.82	17.17	17.17	0.00	0.00
1999	6212.59	7383	846	85.11	85.11	83.83	84.28	3.81	3.37	11.52	0.00
2000	6312.68	7445	846	84.76	84.76	84.95	84.76	5.13	4.59	10.66	0.00
2001	6962.62	8210	846	94.03	94.03	93.95	93.72	5.71	5.70	0.28	0.00
2002	6607.46	7788	846	88.93	88.93	89.16	88.90	1.09	0.98	10.09	0.00
2003	5258.63	6288	846	71.77	71.77	70.96	71.78	7.75	6.03	22.20	0.00
2004	7260.23	8549	846	97.33	97.33	97.70	97.32	2.07	2.06	0.61	0.00
2005	6728.57	7879	846	89.96	89.96	90.78	89.93	0.00	1.27	8.77	0.00
2006	5819.36	6884	846	78.62	78.62	78.52	78.58	0.68	0.53	20.85	0.00
2007	7335.72	8562	846	97.74	97.74	98.98	97.74	2.26	2.26	0.00	0.00
2008	6222.80	7564	846	86.12	86.12	83.74	86.11	0.00	0.00	13.88	0.00
2009	6316.65	7393	846	84.41	84.41	85.23	84.39	0.00	0.00	15.59	0.00

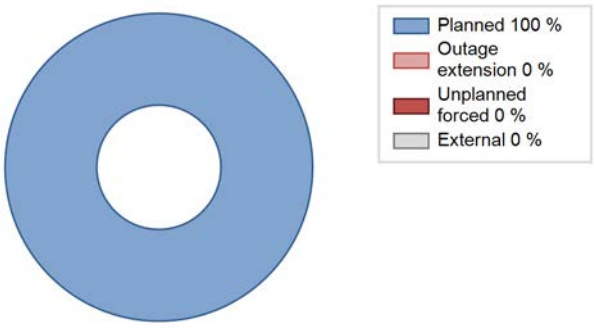
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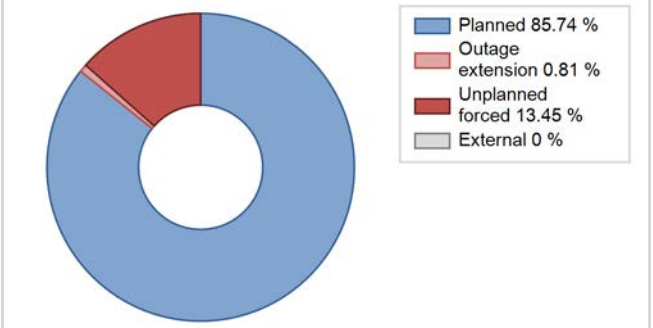
2010	7433.77	8695	846	99.27	99.27	100.31	99.26	0.73	0.73	0.00	0.00
2011	5876.33	6917	846	78.98	78.98	79.29	78.96	2.70	2.19	18.82	0.00
2012	6701.97	7902	846	89.98	89.98	90.19	89.96	0.77	0.70	9.32	0.00
2013	7075.28	8260	846	94.29	94.29	95.46	94.28	5.71	5.71	0.00	0.00
2014	6718.01	7880	846	89.95	89.95	90.65	89.95	0.00	0.00	10.05	0.00
2015	7436.93	8760	846	100.00	100.00	100.35	100.00	0.00	0.00	0.00	0.00
2016	6472.06	7669	846	87.31	87.31	87.09	87.31	6.98	6.55	6.13	0.00
2017	7356.78	8583	847	97.98	97.98	99.15	97.98	0.00	0.00	2.02	0.00
2018	6745.64	7918	847	90.39	90.39	90.91	90.39	2.68	2.49	7.12	0.00
2019	7498.64	8760	847	100.00	100.00	101.06	100.00	0.00	0.00	0.00	0.00
2020	6859.97	8011	847	91.19	91.19	92.20	91.20	0.00	0.00	8.81	0.00
2021	7558.02	8760	847	100.00	100.00	101.86	100.00	0.00	0.00	0.00	0.00
2022	6988.17	8116	847	92.66	92.66	94.18	92.65	0.00	0.00	7.34	0.00
2023	7589.74	8760	847	99.84	99.84	102.29	100.00	0.00	0.00	0.16	0.00
2024	7181.31	8252	847	93.94	93.94	96.52	93.94	0.00	0.00	6.06	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1973 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					414	
B. Refuelling without maintenance				28		
C. Inspection, maintenance or repair combined with refuelling	532			761		
D. Inspection, maintenance or repair without refuelling				114		
E. Testing of plant systems or components				16	3	
F. Major backfitting, refurbishment or upgrading activities with refuelling				1		
H. Nuclear regulatory requirements					27	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L. Human factor related					1	
P. Fire					11	
Z. Other					1	
Subtotal	532			920	457	0
Total		**532**			**1377**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1973 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		31
12. Reactor I&C Systems		45
13. Reactor Auxiliary Systems		2
14. Safety Systems		37
15. Reactor Cooling Systems		89
16. Steam generation systems		116
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		4
31. Turbine and auxiliaries		34
32. Feedwater and Main Steam System		15
34. Miscellaneous Systems		28
41. Main Generator Systems		12
42. Electrical Power Supply Systems		29
Total		**443**

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2024 Operating Experience

US-270 OCONEE-2 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	DUKEENER (Duke Energy Corp.)
Owner	:	DUKEENER (Duke Energy Corp.)
Reactor Supplier	:	B&W (BABCOCK & WILCOX CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	PWR / B&W LLP (DRYAMB)
Thermal power	:	2568 MWth
Gross electrical power	:	891 MWe
Reference unit power (net)	:	848 MWe

Key Dates

Construction Date	:	1967-11-06
Grid Date	:	1973-12-05
Commercial Date	:	1974-09-09
Age at end of year	:	51 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	34
Average discharge burnup [MWd/t]	:	30000
Active core diameter [m]	:	3.27
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	19.06
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

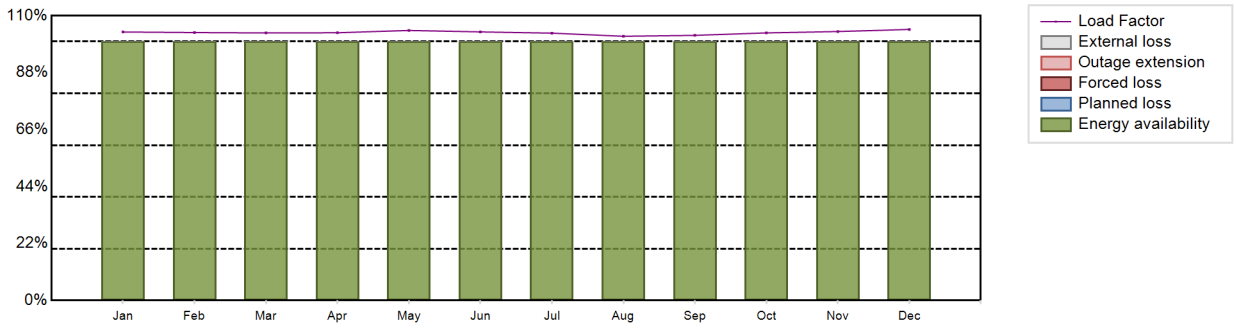
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	318
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.513
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.33
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	103.48 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	654.36	610.87	651.11	631.46	658.13	633.47	651.55	643.91	625.34	652.12	635.15	660.51	7707.97
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	103.72	103.50	103.34	103.42	104.31	103.75	103.27	102.06	102.42	103.36	103.88	104.69	103.48
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.44 %
Cumulative Energy Availability Factor (EAF)	:	85.37 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.92 %
Cumulative Unit Capability Factor (UCF)	:	85.53 %	Cumulative Planned Unavailability Factor (PUF)	:	9.55 %
Cumulative Load Factor (LF)	:	84.22 %	Cumulative Externally cause unavailability (XUF)	:	0.15 %
Cumulative Operating Factor (OF)	:	85.86 %			

Electricity Production (net) [GWh]

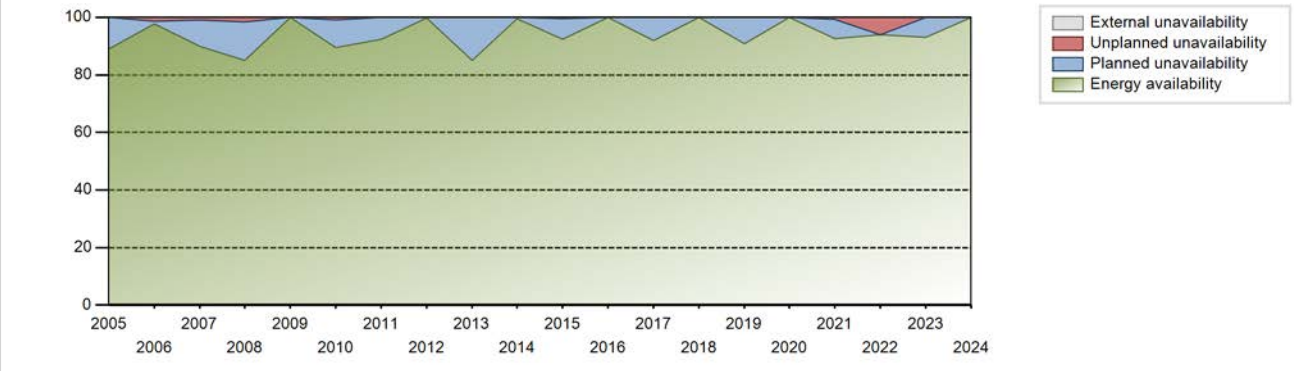


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1974	2115.50	2786	920	100.00	100.00	54.57	61.89	0.00	0.00	0.00	0.00
1975	4970.60	6398	871	65.21	65.21	65.15	73.04	29.64	27.47	7.32	0.00
1976	4232.60	5483	871	55.38	55.38	55.32	62.42	32.45	26.61	18.02	0.00
1977	3830.00	5315	860	50.88	50.88	50.84	60.67	30.19	22.00	27.12	0.00
1978	4786.20	6155	860	63.54	63.54	63.53	70.26	25.09	21.28	15.17	0.00
1979	5968.20	7532	860	79.22	79.22	79.22	85.98	13.54	12.41	8.37	0.00
1980	3882.00	5397	860	62.03	69.65	51.39	61.44	0.20	0.14	30.21	7.62
1981	5198.90	7050	860	81.03	81.03	69.01	80.48	15.40	14.75	4.22	0.00
1982	3447.70	4580	860	53.48	53.48	45.76	52.28	17.17	11.09	35.44	0.00
1983	5147.00	6348	860	73.25	73.25	68.32	72.47	8.09	6.45	20.30	0.00
1984	7297.96	8784	860	100.00	100.00	96.61	100.00	0.00	0.00	0.00	0.00
1985	5059.95	6654	860	76.28	76.28	67.17	75.96	4.92	3.95	19.77	0.00
1986	5803.10	7169	860	81.37	81.37	77.03	81.84	1.33	1.10	17.53	0.00
1987	6228.69	8565	860	98.02	98.02	82.68	97.77	1.98	1.98	0.00	0.00
1988	5539.98	6880	846	78.35	78.35	74.55	78.32	1.01	0.80	20.85	0.00
1989	6013.10	7272	846	83.06	83.06	81.14	83.01	4.79	4.18	12.76	0.00
1990	6269.36	7469	846	85.26	85.26	84.60	85.26	2.95	2.59	12.15	0.00
1991	7427.94	8760	846	100.00	100.00	100.23	100.00	0.00	0.00	0.00	0.00
1992	5946.93	7103	846	80.89	80.89	80.03	80.86	4.00	3.37	15.74	0.00
1993	6236.28	7352	846	83.95	83.95	84.15	83.93	0.66	0.56	15.49	0.00
1994	6148.50	7292	846	83.33	83.33	82.96	83.24	5.53	4.87	11.79	0.00
1995	6973.94	8263	846	94.35	94.35	94.10	94.33	5.65	5.65	0.00	0.00
1996	4431.97	5304	846	60.42	60.42	59.64	60.38	32.36	28.90	10.68	0.00
1997	5876.79	6974	846	79.67	79.67	79.30	79.61	20.33	20.33	0.00	0.00
1998	5654.70	6776	846	77.39	77.39	76.30	77.35	4.49	3.64	18.97	0.00
1999	6257.60	7374	846	84.20	84.20	84.44	84.18	4.67	4.13	11.67	0.00
2000	7499.52	8784	846	100.00	100.00	100.92	100.00	0.00	0.00	0.00	0.00
2001	6688.42	7836	846	89.45	89.45	90.25	89.45	0.00	0.00	10.55	0.00
2002	6611.11	7743	846	88.40	88.40	89.20	88.38	3.37	3.08	8.52	0.00
2003	7568.72	8760	846	100.00	100.00	102.13	100.00	0.00	0.00	0.00	0.00
2004	5676.11	6652	846	75.76	75.76	76.38	75.73	3.40	2.67	21.57	0.00
2005	6672.33	7808	846	89.14	89.14	90.03	89.13	0.00	0.00	10.86	0.00
2006	7391.88	8552	846	97.65	97.65	99.74	97.63	1.36	1.35	1.01	0.00
2007	6768.99	7878	846	89.95	89.95	91.34	89.93	1.13	1.03	9.02	0.00
2008	6392.52	7470	846	85.06	85.06	86.02	85.04	1.88	1.63	13.31	0.00
2009	7606.99	8760	846	100.00	100.00	102.65	100.00	0.00	0.00	0.00	0.00
2010	6734.26	7829	846	89.41	89.41	90.87	89.37	1.05	0.95	9.65	0.00

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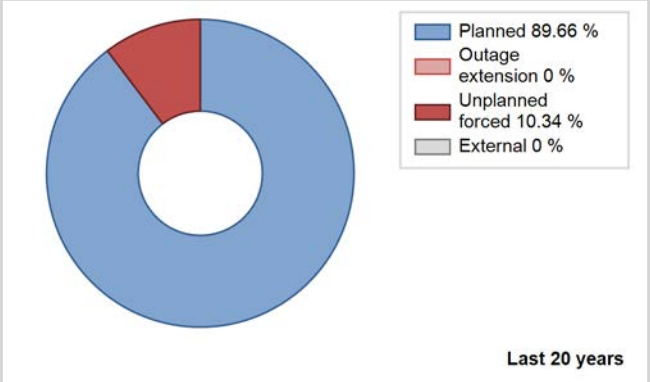
2011	6858.68	8097	846	92.45	92.45	92.55	92.43	0.00	0.00	7.55	0.00
2012	7537.01	8756	846	99.69	99.69	101.42	99.68	0.00	0.00	0.31	0.00
2013	6396.65	7455	846	85.11	85.11	86.30	85.09	0.00	0.00	14.89	0.00
2014	7539.58	8711	846	99.44	99.44	101.74	99.44	0.00	0.00	0.56	0.00
2015	6949.48	8082	848	92.28	92.28	93.55	92.26	0.57	0.52	7.19	0.00
2016	7609.83	8784	848	100.00	100.00	102.16	100.00	0.00	0.00	0.00	0.00
2017	6869.61	8045	848	91.83	91.83	92.48	91.84	0.00	0.00	8.17	0.00
2018	7581.17	8760	848	100.00	100.00	102.06	100.00	0.00	0.00	0.00	0.00
2019	6798.42	7955	848	90.82	90.82	91.52	90.81	0.00	0.00	9.18	0.00
2020	7670.16	8783	848	100.00	100.00	102.97	99.99	0.00	0.00	0.00	0.00
2021	6786.82	8106	848	92.53	92.53	91.36	92.53	0.74	0.69	6.78	0.00
2022	7123.87	8236	848	94.02	94.02	95.90	94.02	5.98	5.98	0.00	0.00
2023	7068.01	8159	848	93.15	93.15	95.15	93.14	0.00	0.00	6.85	0.00
2024	Data not provided										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1974 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					395	
B. Refuelling without maintenance				12		
C. Inspection, maintenance or repair combined with refuelling				734		
D. Inspection, maintenance or repair without refuelling				47		
E. Testing of plant systems or components				4	2	
H. Nuclear regulatory requirements					21	
L. Human factor related					1	
Z. Other					1	
Subtotal				797	420	
Total	**0**			**1217**		

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1974 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		28
12. Reactor I&C Systems		42
13. Reactor Auxiliary Systems		8
14. Safety Systems		31
15. Reactor Cooling Systems		72
16. Steam generation systems		77
31. Turbine and auxiliaries		104
32. Feedwater and Main Steam System		6
33. Circulating Water System		1
34. Miscellaneous Systems		2
41. Main Generator Systems		15
42. Electrical Power Supply Systems		12
Total		**398**

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2024 Operating Experience

US-287 OCONEE-3 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	DUKEENER (Duke Energy Corp.)
Owner	:	DUKEENER (Duke Energy Corp.)
Reactor Supplier	:	B&W (BABCOCK & WILCOX CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / B&W LLP (DRYAMB)
Thermal power	:	2568 MWth
Gross electrical power	:	900 MWe
Reference unit power (net)	:	859 MWe

Key Dates

Construction Date	:	1967-11-06
Grid Date	:	1974-09-18
Commercial Date	:	1974-12-16
Age at end of year	:	50 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	34
Average discharge burnup [MWd/t]	:	30000
Active core diameter [m]	:	3.27
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	177
Fuel linear heat generation rate [kW/m]	:	19.06
Number of control rod assemblies	:	28
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

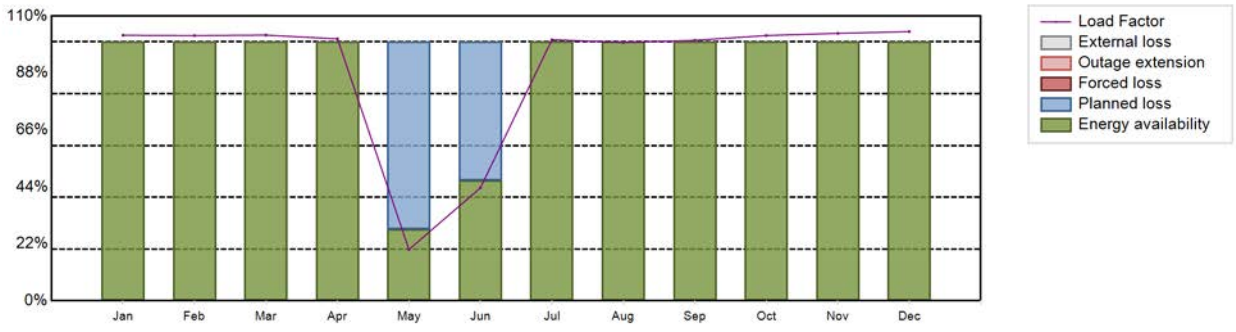
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	318
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.513
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.33
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6809.06 GW(e).h
Energy Availability Factor (EAF)	:	89.5 %
Unit Capability Factor (UCF)	:	89.5 %
Load Factor (LF)	:	90.24 %
Operating Factor (OF)	:	89.5 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	10.5 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	922 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	655.50	612.46	655.05	625.77	126.79	269.85	644.50	637.76	622.30	654.78	639.84	664.46	6809.06
EAF [%]	100.00	100.00	100.00	100.00	27.67	46.60	100.00	100.00	100.00	100.00	100.00	100.00	89.50
UCF [%]	100.00	100.00	100.00	100.00	27.67	46.60	100.00	100.00	100.00	100.00	100.00	100.00	89.50
LF [%]	102.57	102.44	102.63	101.18	19.84	43.63	100.84	99.79	100.62	102.45	103.31	103.97	90.24
OF [%]	100.00	100.00	100.00	100.00	27.69	46.67	100.00	100.00	100.00	100.00	100.00	100.00	89.50
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	72.33	53.40	0.00	0.00	0.00	0.00	0.00	0.00	10.50
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	314019.28 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.79 %
Cumulative Energy Availability Factor (EAF)	:	84.5 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.21 %
Cumulative Unit Capability Factor (UCF)	:	84.72 %	Cumulative Planned Unavailability Factor (PUF)	:	10.07 %
Cumulative Load Factor (LF)	:	84.02 %	Cumulative Externally cause unavailability (XUF)	:	0.22 %
Cumulative Operating Factor (OF)	:	84.8 %			

Electricity Production (net) [GWh]

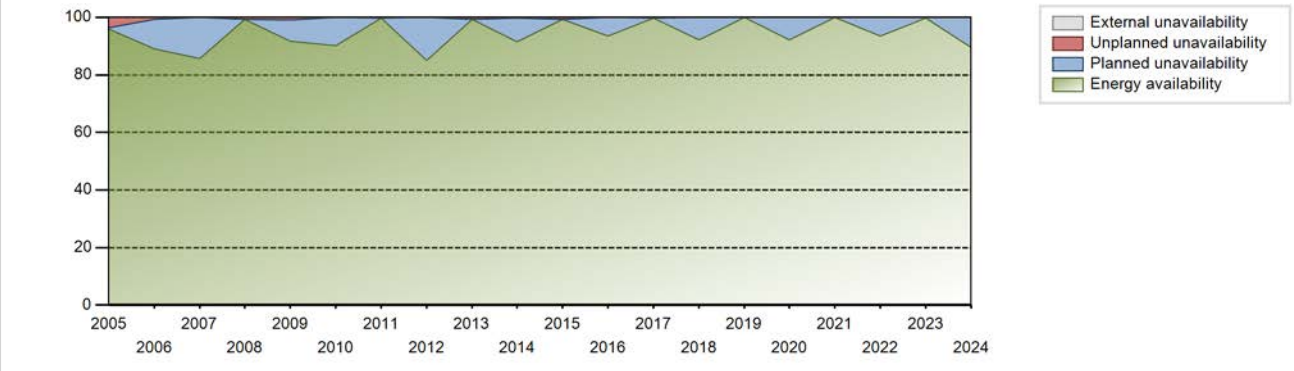


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1974	Data not provided										
1975	5037.40	6761	871	66.09	66.09	66.02	77.18	22.28	18.95	14.96	0.00
1976	4758.00	6072	871	62.25	62.25	62.19	69.13	22.10	17.66	20.09	0.00
1977	5268.70	6545	860	69.90	69.90	69.94	74.71	19.50	16.94	13.16	0.00
1978	6064.30	7444	860	80.47	80.47	80.50	84.98	8.17	7.16	12.37	0.00
1979	3278.90	4038	860	43.53	43.53	43.52	46.10	47.13	38.81	17.67	0.00
1980	5224.60	6414	860	73.84	84.77	69.16	73.02	8.74	8.12	7.12	10.93
1981	5641.40	6835	860	78.63	78.63	74.88	78.03	2.19	1.76	19.61	0.00
1982	2128.40	2826	860	33.51	33.51	28.25	32.26	40.34	22.65	43.84	0.00
1983	7099.10	8436	860	96.52	96.52	94.23	96.30	3.48	3.48	0.00	0.00
1984	5355.51	6474	860	74.15	74.15	70.89	73.70	5.77	4.54	21.31	0.00
1985	4860.76	6071	860	69.67	69.67	64.52	69.30	16.59	13.85	16.47	0.00
1986	6064.31	7781	860	89.99	89.99	80.50	88.82	7.45	7.24	2.77	0.00
1987	5094.42	6068	860	69.81	69.81	67.62	69.27	3.48	2.52	27.67	0.00
1988	5965.75	7190	846	81.87	81.87	80.28	81.85	7.09	6.24	11.88	0.00
1989	6337.39	7585	846	86.61	86.61	85.51	86.59	2.39	2.12	11.27	0.00
1990	7427.84	8712	846	99.45	99.45	100.23	99.45	0.55	0.55	0.00	0.00
1991	5594.62	6691	846	86.59	86.59	75.49	76.38	9.61	9.20	4.21	0.00
1992	5448.23	6634	846	75.52	75.52	73.31	75.52	7.37	6.01	18.47	0.00
1993	7393.76	8647	846	98.72	98.72	99.77	98.71	0.20	0.19	1.08	0.00
1994	5670.82	6781	846	77.47	77.47	76.52	77.41	8.35	7.05	15.48	0.00
1995	6467.84	7625	846	87.09	87.09	87.27	87.04	3.09	2.77	10.14	0.00
1996	5454.03	6429	846	73.22	73.22	73.39	73.19	3.45	2.62	24.16	0.00
1997	4652.64	5633	846	64.65	64.65	62.78	64.30	19.58	15.74	19.61	0.00
1998	5786.35	7026	846	80.06	80.06	78.08	80.21	7.91	6.88	13.06	0.00
1999	7369.54	8676	846	99.05	99.05	99.44	99.04	0.40	0.40	0.56	0.00
2000	6577.84	7729	846	88.02	88.02	88.52	87.99	1.51	1.35	10.63	0.00
2001	5398.55	6355	846	72.57	72.57	72.85	72.55	21.17	19.48	7.95	0.00
2002	7465.52	8688	846	99.18	99.18	100.74	99.18	0.82	0.82	0.00	0.00
2003	6318.01	7467	846	85.25	85.25	85.25	85.24	5.72	5.17	9.58	0.00
2004	5747.05	6698	846	76.27	76.27	77.34	76.25	1.01	0.78	22.95	0.00
2005	7236.99	8395	846	95.87	95.87	97.64	95.82	3.62	3.60	0.53	0.00
2006	6716.23	7804	846	89.11	89.11	90.63	89.09	0.69	0.62	10.27	0.00
2007	6461.88	7498	846	85.60	85.60	87.19	85.59	0.00	0.00	14.40	0.00
2008	7575.11	8717	846	99.24	99.24	101.94	99.24	0.76	0.76	0.00	0.00
2009	6974.69	8041	846	91.81	91.81	94.11	91.79	0.96	0.89	7.31	0.00
2010	6778.51	7889	846	90.08	90.08	91.47	90.06	0.00	0.00	9.92	0.00

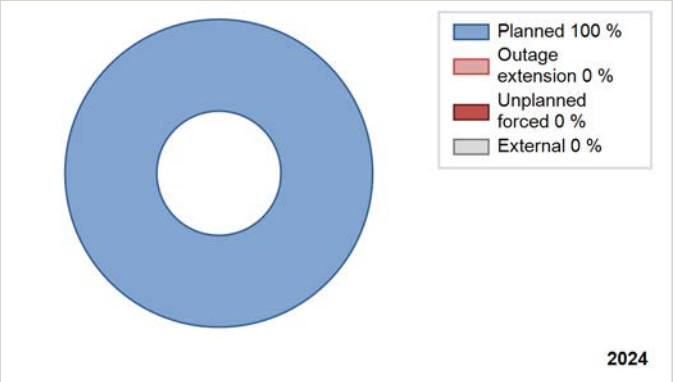
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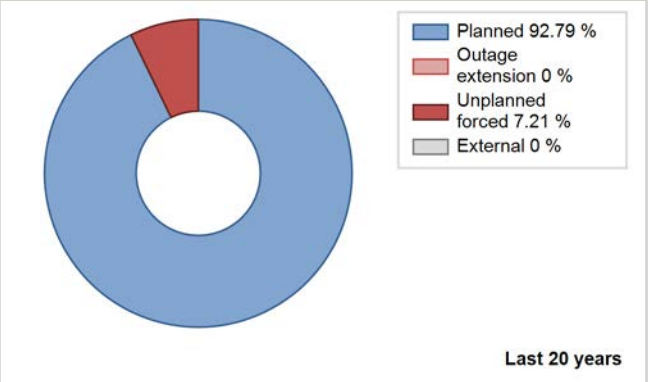
2011	7602.37	8730	846	99.66	99.66	102.58	99.66	0.34	0.34	0.00	0.00
2012	6411.91	7469	846	85.05	85.05	86.28	85.03	0.00	0.00	14.95	0.00
2013	7553.22	8700	846	99.31	99.31	101.91	99.30	0.69	0.69	0.00	0.00
2014	6935.79	8022	846	91.57	91.57	93.59	91.58	0.30	0.28	8.15	0.00
2015	7553.32	8701	859	99.33	99.33	100.38	99.33	0.67	0.67	0.00	0.00
2016	7095.22	8216	859	93.53	93.53	94.03	93.53	0.00	0.00	6.47	0.00
2017	7572.35	8730	859	99.66	99.66	100.63	99.66	0.34	0.34	0.00	0.00
2018	6967.44	8083	859	92.26	92.26	92.59	92.27	0.00	0.00	7.74	0.00
2019	7587.62	8760	859	100.00	100.00	100.83	100.00	0.00	0.00	0.00	0.00
2020	7012.14	8087	859	92.09	92.09	92.93	92.07	0.00	0.00	7.91	0.00
2021	7621.40	8760	859	100.00	100.00	101.28	100.00	0.00	0.00	0.00	0.00
2022	7013.09	8193	859	93.53	93.53	93.20	93.53	0.00	0.00	6.47	0.00
2023	7588.99	8709	859	99.78	99.78	100.85	99.42	0.00	0.00	0.22	0.00
2024	6809.06	7862	859	89.50	89.50	90.24	89.50	0.00	0.00	10.50	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1974 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					359	
B. Refuelling without maintenance				25		
C. Inspection, maintenance or repair combined with refuelling	538			728		
D. Inspection, maintenance or repair without refuelling	384			93	0	
E. Testing of plant systems or components				8	3	
H. Nuclear regulatory requirements					75	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						0
L. Human factor related					3	
Z. Other				0	10	
Subtotal	922			854	450	0
Total	**922**			**1304**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1974 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		12
12. Reactor I&C Systems		63
13. Reactor Auxiliary Systems		25
14. Safety Systems		17
15. Reactor Cooling Systems		48
16. Steam generation systems		93
21. Fuel Handling and Storage Facilities		3
31. Turbine and auxiliaries		49
32. Feedwater and Main Steam System		21
34. Miscellaneous Systems		26
41. Main Generator Systems		6
42. Electrical Power Supply Systems		5
Total		**368**

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2024 Operating Experience

US-528 PALO VERDE-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	APS (ARIZONA PUBLIC SERVICE CO.)
Owner	:	APS (ARIZONA PUBLIC SERVICE CO.)
Reactor Supplier	:	CE (COMBUSTION ENGINEERING CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / CE80 2LP (DRYAMB)
Thermal power	:	3990 MWth
Gross electrical power	:	1414 MWe
Reference unit power (net)	:	1311 MWe

Key Dates

Construction Date	:	1976-05-25
Grid Date	:	1985-06-10
Commercial Date	:	1986-01-28
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	38000
Active core diameter [m]	:	3.65
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	241
Fuel linear heat generation rate [kW/m]	:	18.14
Number of control rod assemblies	:	76
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

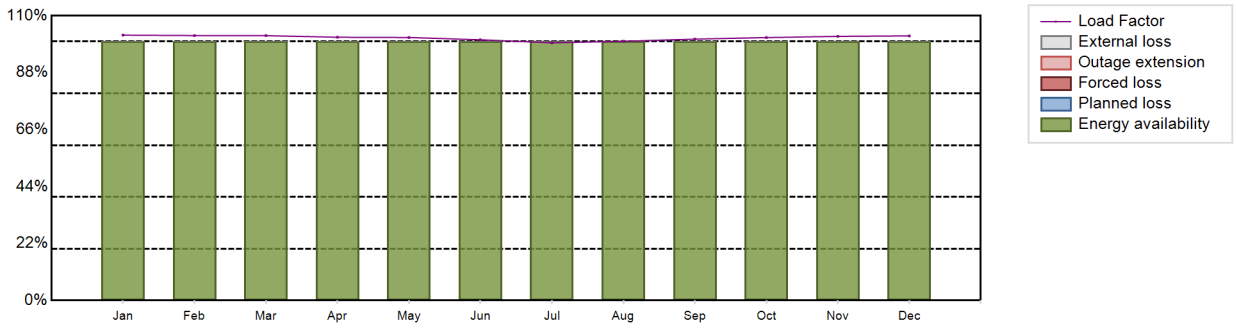
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	327
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.45
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	7
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	101.46 %
Operating Factor (OF)	:	99.99 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



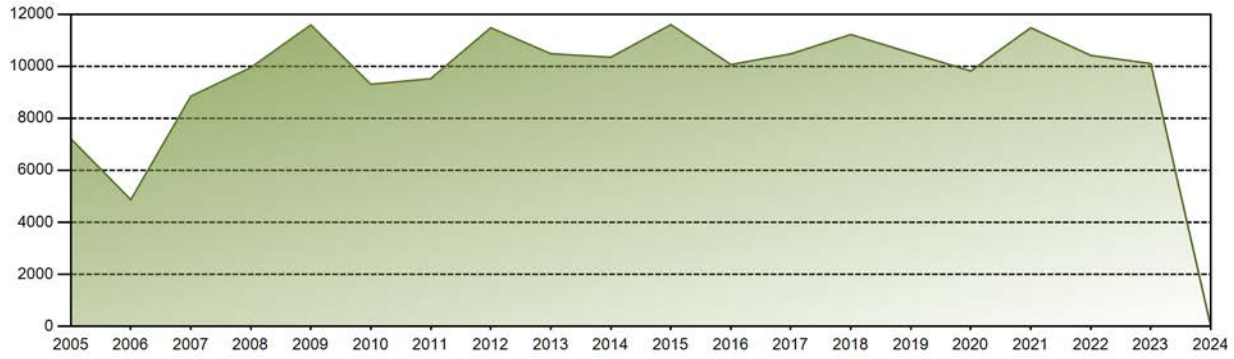
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	999.75	933.72	996.40	959.84	990.86	950.49	971.00	976.48	952.96	990.67	964.26	997.02	11683.46
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	102.50	102.33	102.29	101.69	101.59	100.70	99.55	100.11	100.96	101.57	102.01	102.22	101.46
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.86	100.00	99.99
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.15 %
Cumulative Energy Availability Factor (EAF)	:	83.52 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.62 %
Cumulative Unit Capability Factor (UCF)	:	83.64 %	Cumulative Planned Unavailability Factor (PUF)	:	12.73 %
Cumulative Load Factor (LF)	:	82.28 %	Cumulative Externally cause unavailability (XUF)	:	0.12 %
Cumulative Operating Factor (OF)	:	83.51 %			

Electricity Production (net) [GWh]

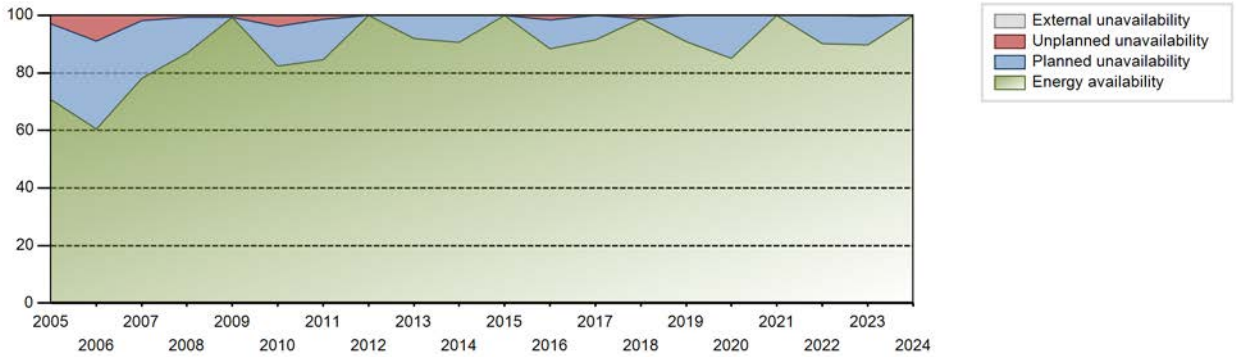


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	6264.75	5349	1221	63.26	63.26	62.16	64.51	36.74	36.74	0.00	0.00
1987	5268.27	4500	1221	50.89	50.89	49.26	51.38	32.44	24.43	24.67	0.00
1988	6668.69	5585	1221	62.81	62.81	62.18	63.58	35.00	33.82	3.37	0.00
1989	1796.57	1522	1221	14.06	14.06	16.80	17.37	40.50	9.57	76.37	0.00
1990	4719.46	3925	1221	42.61	42.61	44.12	44.81	9.64	4.55	52.84	0.00
1991	9312.14	7567	1221	85.85	87.09	87.06	86.38	1.56	1.38	11.53	1.25
1992	7118.80	6010	1221	67.16	67.16	66.37	68.42	6.70	4.82	28.02	0.00
1993	7514.76	6665	1221	76.06	76.06	70.26	76.08	1.41	1.09	22.85	0.00
1994	9772.54	8656	1221	98.78	98.78	91.37	98.81	1.22	1.22	0.00	0.00
1995	8526.82	7244	1224	82.10	82.10	79.52	82.69	2.15	1.80	16.10	0.00
1996	8713.00	7246	1227	81.97	84.39	80.84	82.49	0.01	0.01	15.60	2.42
1997	10737.71	8658	1244	98.82	98.82	98.47	98.82	1.18	1.18	0.00	0.00
1998	9575.01	7819	1243	89.04	89.04	87.94	89.26	0.76	0.68	10.28	0.00
1999	9653.94	7774	1243	88.76	88.76	88.66	88.74	0.76	0.68	10.56	0.00
2000	10966.60	8770	1243	99.84	99.84	100.44	99.84	0.16	0.16	0.00	0.00
2001	9559.58	7712	1243	88.04	88.04	87.79	88.04	0.00	0.00	11.96	0.00
2002	9705.03	7890	1243	90.14	90.14	89.13	90.07	0.90	0.82	9.04	0.00
2003	10587.11	8604	1243	98.24	98.24	97.23	98.22	1.76	1.76	0.00	0.00
2004	9235.80	7669	1243	87.33	88.53	84.59	87.31	1.33	1.19	10.28	1.20
2005	7212.30	6194	1243	70.73	70.73	66.24	70.71	3.95	2.91	26.36	0.00
2006	4868.23	5292	1314	60.44	60.44	42.29	60.41	12.90	8.95	30.61	0.00
2007	8844.90	6834	1311	78.04	78.04	77.02	78.01	2.23	1.78	20.18	0.00
2008	9953.15	7616	1311	86.71	86.71	86.43	86.70	0.88	0.77	12.52	0.00
2009	11589.72	8707	1311	99.40	99.40	100.92	99.39	0.60	0.60	0.00	0.00
2010	9307.97	7217	1311	82.41	82.41	81.05	82.39	4.46	3.85	13.74	0.00
2011	9525.07	7400	1311	84.50	84.50	82.94	84.47	1.69	1.46	14.05	0.00
2012	11482.17	8784	1311	100.00	100.00	99.71	100.00	0.00	0.00	0.00	0.00
2013	10481.92	8044	1311	91.83	91.83	91.27	91.83	0.00	0.00	8.17	0.00
2014	10350.31	7943	1311	90.68	90.68	90.13	90.67	0.00	0.00	9.32	0.00
2015	11600.88	8760	1311	100.00	100.00	101.01	100.00	0.00	0.00	0.00	0.00
2016	10068.74	7763	1311	88.37	88.37	87.43	88.38	1.67	1.50	10.13	0.00
2017	10477.95	8012	1311	91.46	91.46	91.24	91.46	0.00	0.00	8.54	0.00
2018	11220.88	8655	1311	98.80	98.80	97.71	98.80	1.20	1.20	0.00	0.00
2019	10515.17	7956	1311	90.83	90.83	91.56	90.82	0.00	0.00	9.17	0.00
2020	9818.48	7460	1311	84.93	84.93	85.26	84.93	0.00	0.00	15.07	0.00
2021	11482.05	8760	1311	100.00	100.00	99.98	100.00	0.00	0.00	0.00	0.00
2022	10418.48	7907	1311	90.26	90.26	90.72	90.26	0.00	0.00	9.74	0.00

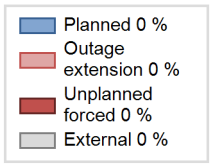
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2023	10105.43	7757	1311	89.66	89.66	87.99	88.55	0.30	0.36	9.98	0.00
2024	Data not provided										

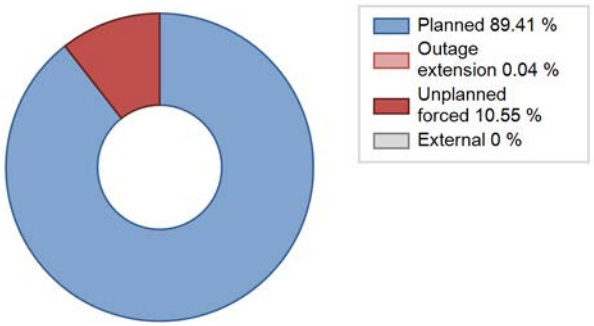
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					364	
B. Refuelling without maintenance				56		
C. Inspection, maintenance or repair combined with refuelling				928		
D. Inspection, maintenance or repair without refuelling				124		
E. Testing of plant systems or components				2	7	
J. Grid limitation, failure or grid unavailability						4
L. Human factor related					5	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						7
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					2	
Z. Other					13	
Subtotal				1110	391	11
Total		**0**			**1512**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		66
13. Reactor Auxiliary Systems		3
14. Safety Systems		11
15. Reactor Cooling Systems		55
16. Steam generation systems		30
31. Turbine and auxiliaries		4
32. Feedwater and Main Steam System		80
33. Circulating Water System		22
34. Miscellaneous Systems		34
35. All other I&C Systems		1
41. Main Generator Systems		10
42. Electrical Power Supply Systems		52
Total		**370**

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2024 Operating Experience

US-529 PALO VERDE-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	APS (ARIZONA PUBLIC SERVICE CO.)
Owner	:	APS (ARIZONA PUBLIC SERVICE CO.)
Reactor Supplier	:	CE (COMBUSTION ENGINEERING CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / CE80 2LP (DRYAMB)
Thermal power	:	3990 MWth
Gross electrical power	:	1414 MWe
Reference unit power (net)	:	1314 MWe

Key Dates

Construction Date	:	1976-06-01
Grid Date	:	1986-05-20
Commercial Date	:	1986-09-19
Age at end of year	:	38 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	38000
Active core diameter [m]	:	3.65
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	241
Fuel linear heat generation rate [kW/m]	:	18.21
Number of control rod assemblies	:	76
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

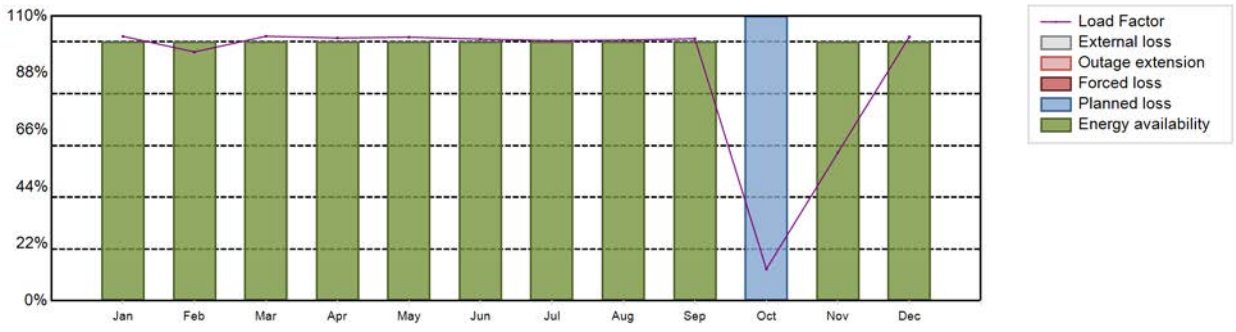
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	327
Number of SG	:	2
Containment type	:	Single
Containment design pressure [MPa]	:	0.45
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	7
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	10371.33 GW(e).h
Energy Availability Factor (EAF)	:	89.51 %
Unit Capability Factor (UCF)	:	89.51 %
Load Factor (LF)	:	89.86 %
Operating Factor (OF)	:	89.5 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	10.49 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	922 hours

Annual Summary



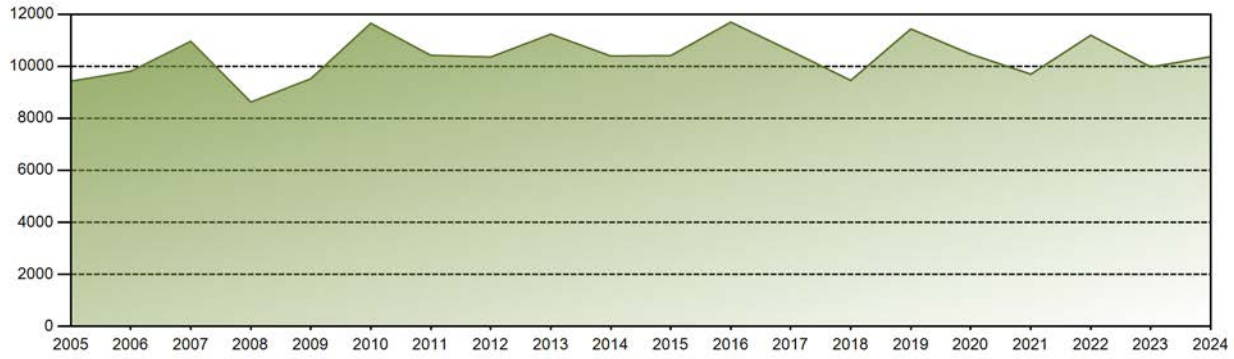
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	998.66	879.10	997.64	960.46	995.45	956.23	982.60	984.34	957.72	120.33	541.97	996.84	10371.33
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-23.85	100.00	100.00	89.51
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-23.85	100.00	100.00	89.51
LF [%]	102.15	96.12	102.19	101.52	101.82	101.07	100.51	100.69	101.23	12.31	57.21	101.97	89.86
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	12.90	62.00	100.00	89.50
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	123.85	0.00	0.00	10.49
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	363727.32 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.14 %
Cumulative Energy Availability Factor (EAF)	:	85.11 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.9 %
Cumulative Unit Capability Factor (UCF)	:	85.17 %	Cumulative Planned Unavailability Factor (PUF)	:	12.93 %
Cumulative Load Factor (LF)	:	84.83 %	Cumulative Externally cause unavailability (XUF)	:	0.06 %
Cumulative Operating Factor (OF)	:	85.13 %			

Electricity Production (net) [GWh]

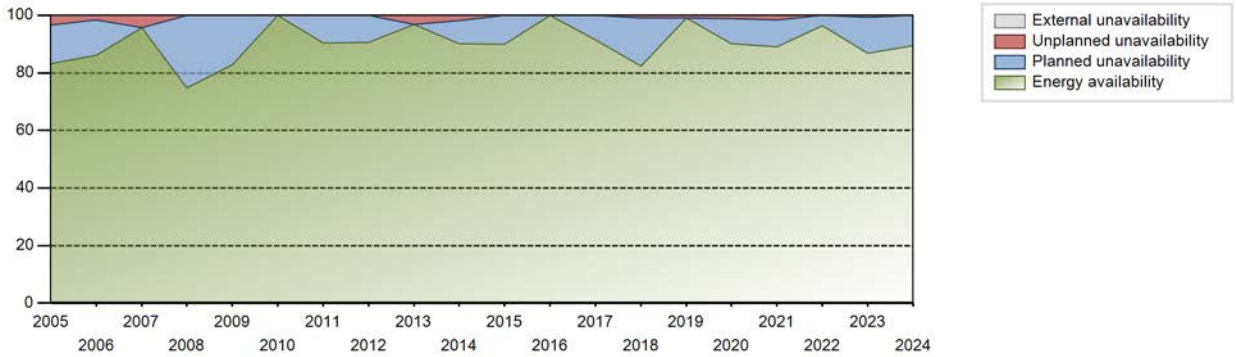


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	Data not provided										
1987	8190.04	6860	1221	77.59	77.59	76.57	78.31	6.73	5.60	16.81	0.00
1988	6747.17	5613	1221	62.56	62.56	62.91	63.90	3.50	2.27	35.17	0.00
1989	4698.76	4003	1221	44.31	44.31	43.93	45.70	25.08	14.83	40.86	0.00
1990	6242.22	5276	1221	58.63	58.63	58.36	60.23	0.00	0.00	41.37	0.00
1991	8265.19	6690	1221	76.27	76.27	77.27	76.37	3.69	2.92	20.81	0.00
1992	10104.51	8341	1221	94.85	94.85	94.21	94.96	2.94	2.87	2.27	0.00
1993	5125.31	4621	1221	50.91	50.91	47.92	52.75	3.50	1.84	47.25	0.00
1994	6573.86	5919	1221	66.82	66.82	61.46	67.57	5.45	3.85	29.33	0.00
1995	9070.86	7420	1224	84.16	84.16	84.60	84.70	0.53	0.45	15.39	0.00
1996	9346.14	7548	1227	85.46	85.46	86.72	85.93	0.73	0.62	13.92	0.00
1997	9322.67	7661	1244	87.22	87.22	85.49	87.44	2.65	2.38	10.40	0.00
1998	11084.83	8760	1243	100.00	100.00	101.80	100.00	0.00	0.00	0.00	0.00
1999	9797.35	7857	1243	89.71	89.71	89.98	89.69	0.45	0.41	9.89	0.00
2000	9525.26	7743	1243	88.17	88.17	87.24	88.15	1.24	1.11	10.73	0.00
2001	10083.52	8002	1243	91.36	91.36	92.61	91.35	8.64	8.64	0.00	0.00
2002	10019.17	7981	1243	91.12	91.12	92.01	91.11	0.00	0.00	8.88	0.00
2003	8444.41	6809	1243	77.74	77.74	77.55	77.73	0.78	0.61	21.65	0.00
2004	10662.06	8138	1335	92.60	94.90	91.96	92.65	5.10	5.10	0.00	2.30
2005	9427.24	7284	1335	83.18	83.18	80.61	83.15	3.96	3.43	13.39	0.00
2006	9808.17	7535	1314	86.05	86.05	85.21	86.02	1.76	1.55	12.41	0.00
2007	10957.60	8384	1314	95.71	95.71	95.20	95.71	4.29	4.29	0.00	0.00
2008	8624.08	6577	1314	74.88	74.88	74.72	74.87	0.00	0.00	25.12	0.00
2009	9521.55	7254	1314	82.82	82.82	82.72	82.81	0.00	0.00	17.18	0.00
2010	11652.97	8760	1314	100.00	100.00	101.24	100.00	0.00	0.00	0.00	0.00
2011	10421.32	7921	1314	90.43	90.43	90.54	90.42	0.00	0.10	9.47	0.00
2012	10358.07	7957	1314	90.59	90.59	89.74	90.59	0.00	0.00	9.41	0.00
2013	11235.03	8488	1314	96.90	96.90	97.61	96.89	3.10	3.10	0.00	0.00
2014	10394.10	7904	1314	90.22	90.22	90.30	90.23	2.00	1.84	7.94	0.00
2015	10410.84	7883	1314	89.98	89.98	90.45	89.99	0.00	0.00	10.02	0.00
2016	11696.95	8784	1314	100.00	100.00	101.34	100.00	0.00	0.00	0.00	0.00
2017	10588.60	8011	1314	91.44	91.44	91.99	91.45	0.00	0.00	8.56	0.00
2018	9458.03	7216	1314	82.38	82.38	82.17	82.37	1.14	0.95	16.68	0.00
2019	11434.51	8670	1314	98.98	98.98	99.34	98.97	1.02	1.02	0.00	0.00
2020	10466.37	7929	1314	90.26	90.26	90.68	90.27	0.00	1.11	8.62	0.00
2021	9697.05	7802	1314	89.06	89.06	84.24	89.06	1.78	1.61	9.33	0.00
2022	11192.86	8437	1314	96.31	96.31	97.24	96.31	0.00	0.00	3.69	0.00

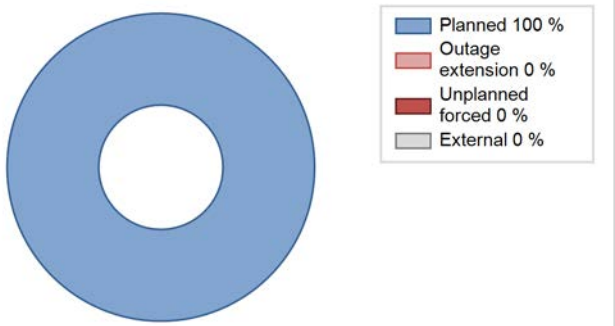
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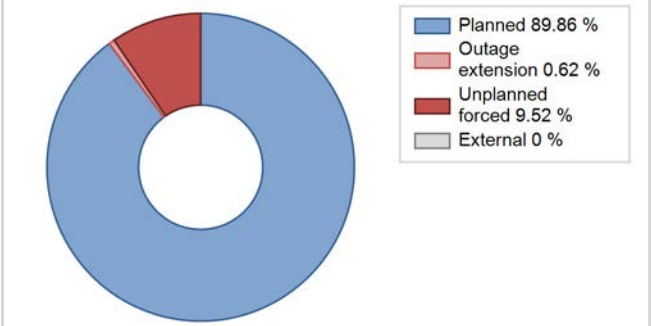
2023	9972.52	7672	1314	86.87	86.87	86.64	87.58	0.80	0.70	12.43	0.00
2024	10371.33	7862	1314	89.51	89.51	89.86	89.50	0.00	0.00	10.49	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					127	
B. Refuelling without maintenance				41		
C. Inspection, maintenance or repair combined with refuelling	921			861		
D. Inspection, maintenance or repair without refuelling				154		
E. Testing of plant systems or components				0		
H. Nuclear regulatory requirements					19	
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					9	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
Z. Other				69	9	3
Subtotal	921			1125	164	8
Total	**921**			**1297**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		1
12. Reactor I&C Systems		19
13. Reactor Auxiliary Systems		4
14. Safety Systems		18
15. Reactor Cooling Systems		13
16. Steam generation systems		19
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		14
32. Feedwater and Main Steam System		13
34. Miscellaneous Systems		29
35. All other I&C Systems		1
41. Main Generator Systems		3
42. Electrical Power Supply Systems		13
Total		**149**

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2024 Operating Experience

US-530 PALO VERDE-3 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	APS (ARIZONA PUBLIC SERVICE CO.)
Owner	:	APS (ARIZONA PUBLIC SERVICE CO.)
Reactor Supplier	:	CE (COMBUSTION ENGINEERING CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	PWR / CE80 2LP (DRYAMB)
Thermal power	:	3990 MWth
Gross electrical power	:	1414 MWe
Reference unit power (net)	:	1312 MWe

Key Dates

Construction Date	:	1976-06-01
Grid Date	:	1987-11-28
Commercial Date	:	1988-01-08
Age at end of year	:	37 years

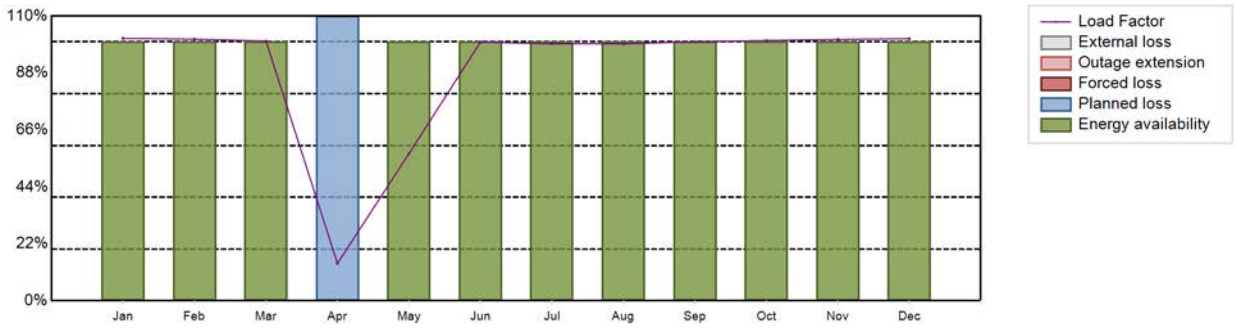
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.8
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	327
Fuel material	:	UO2	Number of SG	:	2
Refuelling type	:	OFF-line	Containment type	:	Single
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.45
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	33.3	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	38000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.65	HP cylinder inlet steam pressure [MPa]	:	7
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	241	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	18.37	Number of main condensate pumps	:	-
Number of control rod assemblies	:	76	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10333.33 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	89.89 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	89.89 %	Planned Unavailability Factor (PUF)	:	10.11 %
Load Factor (LF)	:	89.66 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	89.88 %	Total off-line time	:	889 hours

Annual Summary



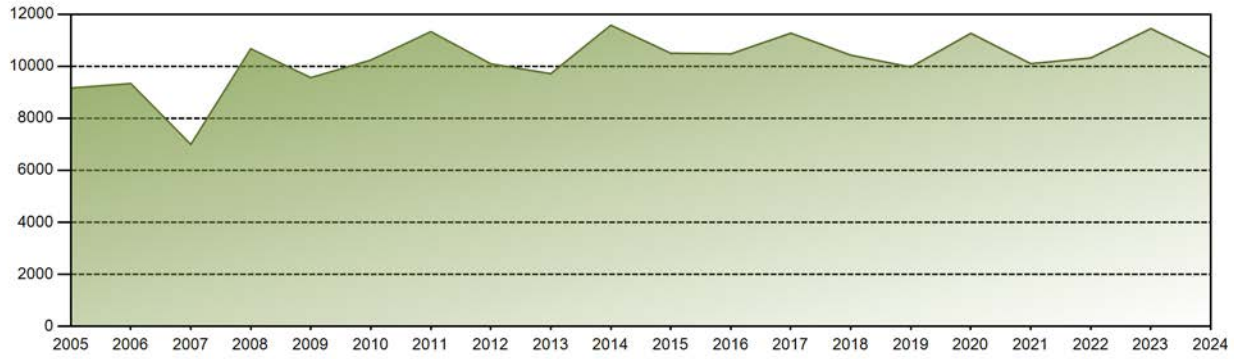
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	989.36	922.82	978.11	136.58	554.79	943.76	969.32	968.90	945.11	981.40	954.95	988.23	10333.33
EAF [%]	100.00	100.00	100.00	-23.28	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.89
UCF [%]	100.00	100.00	100.00	-23.28	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	89.89
LF [%]	101.36	101.06	100.34	14.46	56.84	99.91	99.30	99.26	100.05	100.54	100.95	101.24	89.66
OF [%]	100.00	100.00	100.00	16.67	61.29	100.00	100.00	100.00	100.00	100.00	99.86	100.00	89.88
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	123.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.11
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	356096.76 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.77 %
Cumulative Energy Availability Factor (EAF)	:	86.92 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.57 %
Cumulative Unit Capability Factor (UCF)	:	87.1 %	Cumulative Planned Unavailability Factor (PUF)	:	11.33 %
Cumulative Load Factor (LF)	:	86.4 %	Cumulative Externally cause unavailability (XUF)	:	0.18 %
Cumulative Operating Factor (OF)	:	86.91 %			

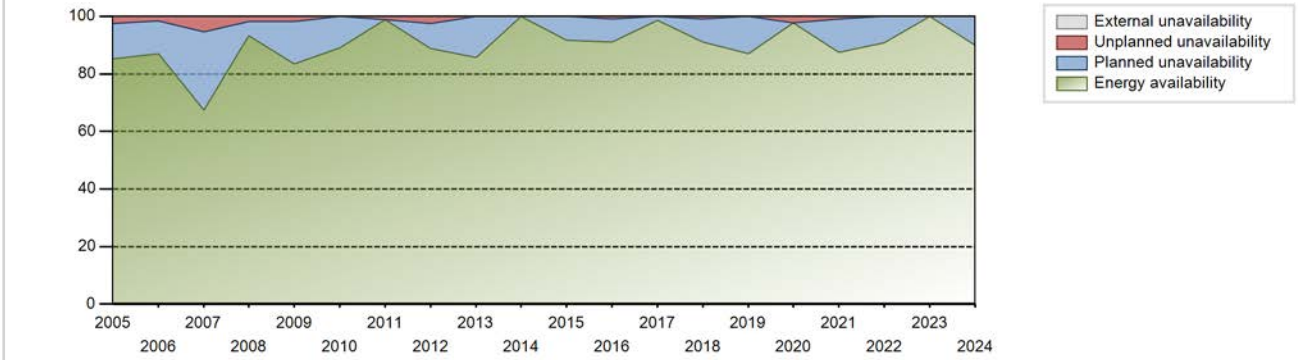
Electricity Production (net) [GWh]



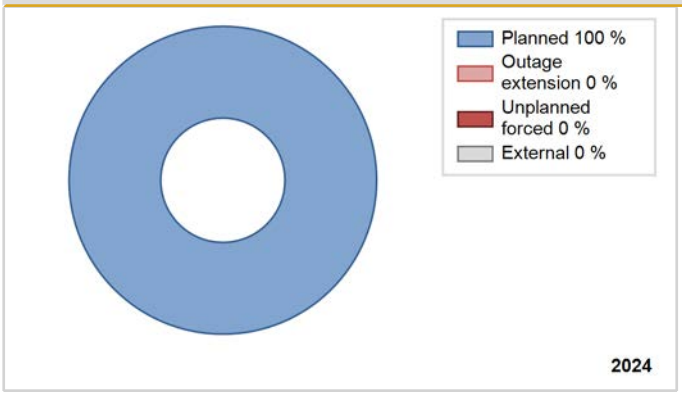
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	10035.48	8177	1221	94.92	94.92	95.39	94.90	5.08	5.08	0.00	0.00
1989	1327.99	1096	1221	9.01	9.01	12.42	12.51	40.97	6.25	84.74	0.00
1990	9636.01	8048	1221	91.58	91.58	90.09	91.87	8.36	8.35	0.07	0.00
1991	7518.45	6272	1221	70.78	75.30	70.29	71.60	2.63	2.03	22.67	4.52
1992	8386.20	6923	1221	78.72	78.72	78.19	78.81	3.48	2.84	18.44	0.00
1993	9393.90	7898	1221	90.12	90.12	87.83	90.16	2.69	2.49	7.39	0.00
1994	6824.49	5920	1221	66.35	66.35	63.80	67.58	1.29	0.87	32.78	0.00
1995	9386.83	7628	1225	86.63	86.63	87.44	87.08	0.00	0.00	13.37	0.00
1996	10789.60	8699	1230	99.04	99.52	99.86	99.03	0.48	0.48	0.00	0.48
1997	9456.06	7820	1247	89.13	89.13	86.50	89.26	0.38	0.34	10.54	0.00
1998	9600.91	7835	1247	89.26	89.26	87.89	89.44	0.00	0.00	10.74	0.00
1999	10956.48	8760	1247	100.00	100.00	100.30	100.00	0.00	0.00	0.00	0.00
2000	9888.71	7898	1247	89.94	89.94	90.28	89.91	1.59	1.46	8.61	0.00
2001	9170.39	7439	1247	84.96	84.96	83.95	84.92	1.60	1.38	13.65	0.00
2002	11137.71	8760	1247	100.00	100.00	101.96	100.00	0.00	0.00	0.00	0.00
2003	9554.71	7712	1247	88.05	88.05	87.47	88.04	2.18	1.96	9.99	0.00
2004	8223.32	6729	1247	76.65	78.41	75.07	76.61	4.32	3.54	18.06	1.76
2005	9163.97	7471	1247	85.31	85.31	83.89	85.29	2.88	2.53	12.16	0.00
2006	9335.83	7625	1247	87.07	87.07	85.46	87.04	1.70	1.51	11.43	0.00
2007	6993.69	5903	1247	67.42	67.42	64.02	67.39	7.47	5.45	27.13	0.00
2008	10673.28	8197	1317	93.32	93.32	92.26	93.32	1.90	1.81	4.87	0.00
2009	9562.61	7310	1317	83.46	83.46	82.89	83.45	2.11	1.80	14.74	0.00
2010	10238.99	7801	1317	89.06	89.06	88.75	89.05	0.00	0.00	10.94	0.00
2011	11331.50	8657	1312	98.84	98.84	98.59	98.82	1.16	1.16	0.00	0.00
2012	10093.67	7797	1312	88.78	88.78	87.58	88.76	2.82	2.58	8.64	0.00
2013	9714.13	7506	1312	85.68	85.68	84.52	85.68	0.00	0.00	14.32	0.00
2014	11579.13	8760	1312	100.00	100.00	100.75	100.00	0.00	0.00	0.00	0.00
2015	10502.98	8037	1312	91.74	91.74	91.38	91.75	0.00	0.00	8.26	0.00
2016	10477.43	8001	1312	91.09	91.09	90.91	91.09	1.04	0.96	7.95	0.00
2017	11273.58	8626	1312	98.63	98.63	98.09	98.47	0.00	0.00	1.37	0.00
2018	10427.45	7983	1312	91.13	91.13	90.73	91.13	1.04	0.96	7.91	0.00
2019	9969.69	7619	1312	86.99	86.99	86.74	86.97	0.00	0.00	13.01	0.00
2020	11267.58	8587	1312	97.76	97.76	97.77	97.76	2.24	2.24	0.00	0.00
2021	10101.41	7663	1312	87.47	87.47	87.89	87.48	1.14	1.01	11.51	0.00
2022	10321.36	7952	1312	90.77	90.77	89.80	90.78	0.00	0.00	9.23	0.00
2023	11449.96	8741	1312	99.96	99.96	99.62	99.78	0.04	0.04	0.00	0.00
2024	10333.33	7895	1312	89.89	89.89	89.66	89.88	0.00	0.00	10.11	0.00

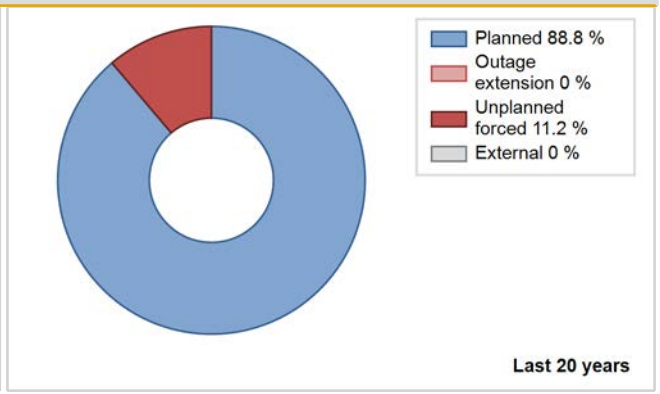
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					109	
B. Refuelling without maintenance				49		
C. Inspection, maintenance or repair combined with refuelling	888			862		
D. Inspection, maintenance or repair without refuelling				77		
E. Testing of plant systems or components				3	5	
H. Nuclear regulatory requirements					2	
J. Grid limitation, failure or grid unavailability						5
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						23
Z. Other					9	0
Subtotal	888			991	126	28
Total	**888**			**1145**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1988 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		9
13. Reactor Auxiliary Systems		3
14. Safety Systems		16
16. Steam generation systems		2
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		24
32. Feedwater and Main Steam System		13
34. Miscellaneous Systems		18
41. Main Generator Systems		8
42. Electrical Power Supply Systems		40
Total		**134**

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2024 Operating Experience

US-277 PEACH BOTTOM-2 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXE/PSEG (EXELON Corp. (50%)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	3951 MWth
Gross electrical power	:	1412 MWe
Reference unit power (net)	:	1300 MWe

Key Dates

Construction Date	:	1968-01-31
Grid Date	:	1974-02-18
Commercial Date	:	1974-07-05
Age at end of year	:	50 years

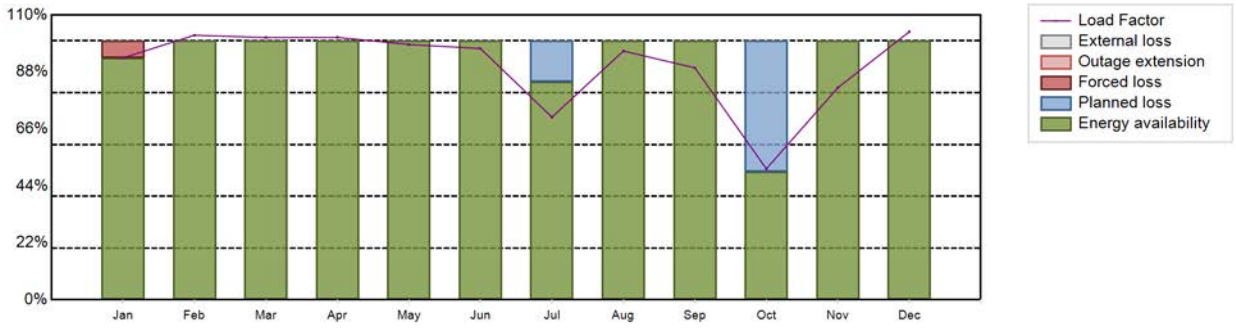
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.1
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	287
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.16
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	40	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	48000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.57	HP cylinder inlet steam pressure [MPa]	:	6.65
Active core height/length [m]	:	3.71	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	764	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	16.37	Number of main condensate pumps	:	-
Number of control rod assemblies	:	185	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	10327.54 GW(e).h	Forced Loss Rate (FLR)	:	0.59 %
Energy Availability Factor (EAF)	:	93.83 %	Unplanned Capability Loss Factor (UCL)	:	0.56 %
Unit Capability Factor (UCF)	:	93.83 %	Planned Unavailability Factor (PUF)	:	5.62 %
Load Factor (LF)	:	90.44 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	93.66 %	Total off-line time	:	557 hours

Annual Summary



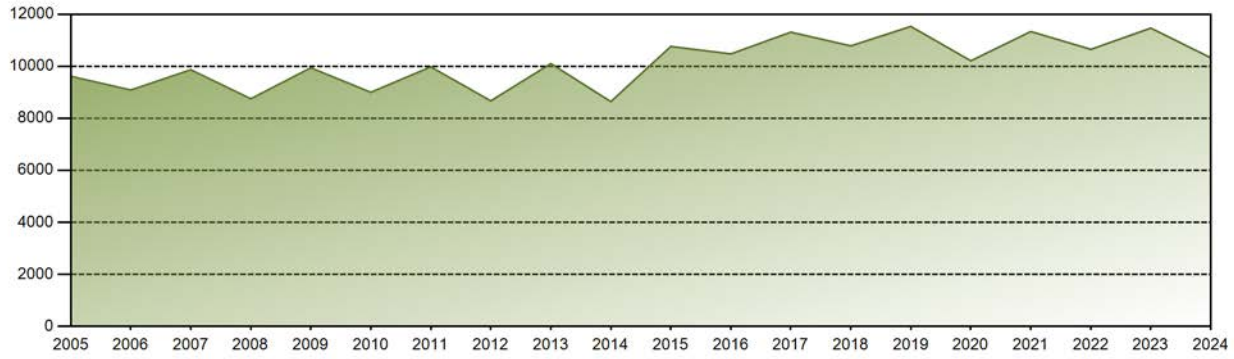
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	903.70	924.72	978.41	948.71	953.76	908.47	682.59	929.44	838.66	489.55	768.02	1001.53	10327.54
EAF [%]	93.41	100.00	100.00	100.00	100.00	100.00	84.30	100.00	100.00	49.40	100.00	100.00	93.83
UCF [%]	93.41	100.00	100.00	100.00	100.00	100.00	84.30	100.00	100.00	49.40	100.00	100.00	93.83
LF [%]	93.43	102.20	101.30	101.36	98.61	97.06	70.57	96.10	89.60	50.61	81.94	103.55	90.44
OF [%]	93.28	100.00	100.00	100.00	100.00	100.00	83.87	100.00	100.00	64.52	82.94	100.00	93.66
FLR [%]	6.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59
UCL [%]	6.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	15.70	0.00	0.00	50.60	0.00	0.00	5.62
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	394684.49 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.03 %
Cumulative Energy Availability Factor (EAF)	:	81.44 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.42 %
Cumulative Unit Capability Factor (UCF)	:	81.45 %	Cumulative Planned Unavailability Factor (PUF)	:	15.13 %
Cumulative Load Factor (LF)	:	79.52 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	81.75 %			

Electricity Production (net) [GWh]

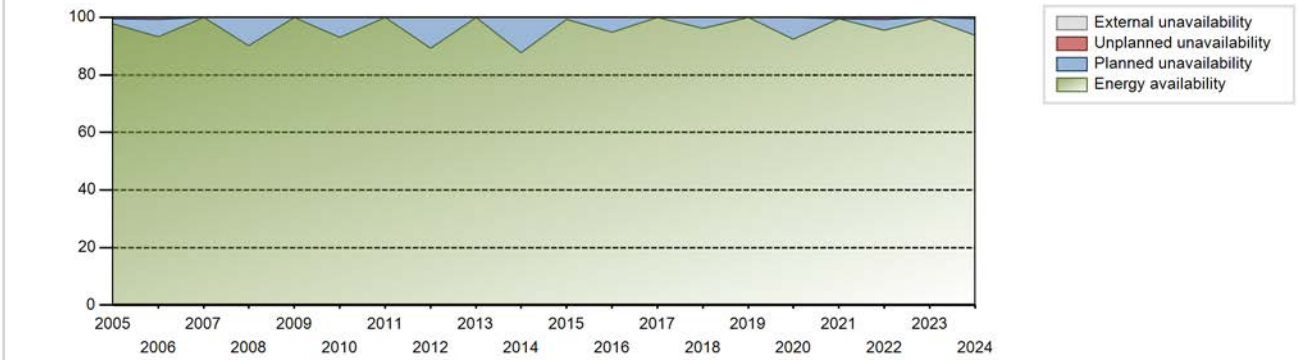


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1974	4982.70	6162	1053	90.55	90.55	78.92	90.58	7.84	7.70	1.75	0.00
1975	5082.50	6638	1051	55.26	55.26	55.20	75.78	22.93	16.44	28.31	0.00
1976	5580.40	5998	1051	60.51	60.51	60.45	68.28	13.21	9.21	30.28	0.00
1977	4051.60	4836	1051	44.04	44.04	44.01	55.21	23.10	13.23	42.73	0.00
1978	6793.60	7299	1051	73.79	73.79	73.79	83.32	7.88	6.31	19.89	0.00
1979	8574.40	8295	1051	92.91	92.91	93.13	94.69	0.92	0.86	6.23	0.00
1980	4372.60	4529	1051	49.95	49.95	47.36	51.56	4.19	2.18	47.87	0.00
1981	6635.30	6938	1051	78.53	78.53	72.07	79.20	19.56	19.10	2.37	0.00
1982	4816.80	5089	1051	56.46	56.46	52.32	58.09	3.36	1.96	41.57	0.00
1983	4481.10	4461	1051	49.03	49.56	48.67	50.92	11.53	6.46	43.98	0.53
1984	2465.82	2544	1051	28.85	28.85	26.71	28.96	4.54	1.37	69.77	0.00
1985	2378.20	2570	1051	28.67	28.67	25.83	29.34	24.48	9.30	62.03	0.00
1986	6896.57	7010	1051	79.76	79.76	74.91	80.02	18.80	18.46	1.77	0.00
1987	1599.91	1724	1051	16.48	16.48	17.38	19.68	48.28	15.39	68.13	0.00
1988	0.00	0	1051	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1989	3880.86	4735	1051	52.26	52.26	42.15	54.05	12.44	7.42	40.32	0.00
1990	6699.80	6977	1055	78.92	78.92	72.49	79.65	8.26	7.11	13.97	0.00
1991	5120.97	5277	1055	58.82	58.82	55.41	60.24	18.91	13.72	27.46	0.00
1992	5677.94	5811	1055	64.94	64.94	61.27	66.15	13.16	9.84	25.23	0.00
1993	7704.08	7571	1053	85.92	85.92	83.47	86.43	5.53	5.03	9.05	0.00
1994	7450.65	7783	1055	88.80	88.80	80.60	88.85	1.59	1.43	9.77	0.00
1995	9363.44	8598	1093	98.15	98.15	97.79	98.15	0.00	0.00	1.85	0.00
1996	7660.56	8176	1093	93.09	93.09	79.79	93.08	1.75	1.66	5.25	0.00
1997	9570.35	8663	1093	98.89	98.89	99.95	98.89	0.43	0.42	0.68	0.00
1998	7658.77	7923	1093	90.45	90.45	79.99	90.45	0.00	0.00	9.55	0.00
1999	9462.31	8635	1093	98.58	98.58	98.83	98.57	1.42	1.42	0.00	0.00
2000	8523.01	8169	1093	93.01	93.01	88.77	93.00	0.00	0.00	6.99	0.00
2001	9369.24	8563	1093	97.76	97.76	97.85	97.75	2.24	2.24	0.00	0.00
2002	8838.93	8149	1093	93.03	93.03	92.32	93.03	0.81	0.76	6.21	0.00
2003	9265.77	8430	1112	96.32	96.32	94.86	96.23	3.68	3.68	0.00	0.00
2004	8886.06	8066	1112	91.85	91.85	90.97	91.83	1.61	1.51	6.65	0.00
2005	9615.14	8569	1112	97.83	97.83	98.70	97.81	0.40	0.40	1.78	0.00
2006	9088.33	8172	1112	93.30	93.30	93.30	93.29	0.72	0.68	6.02	0.00
2007	9867.90	8737	1112	100.00	100.00	101.57	100.00	0.00	0.00	0.00	0.00
2008	8750.03	7914	1112	90.11	90.11	89.58	90.10	0.00	0.00	9.89	0.00
2009	9941.74	8760	1112	100.00	100.00	102.06	100.00	0.00	0.00	0.00	0.00
2010	9000.11	8139	1122	92.99	92.99	91.57	92.91	0.00	0.00	7.01	0.00

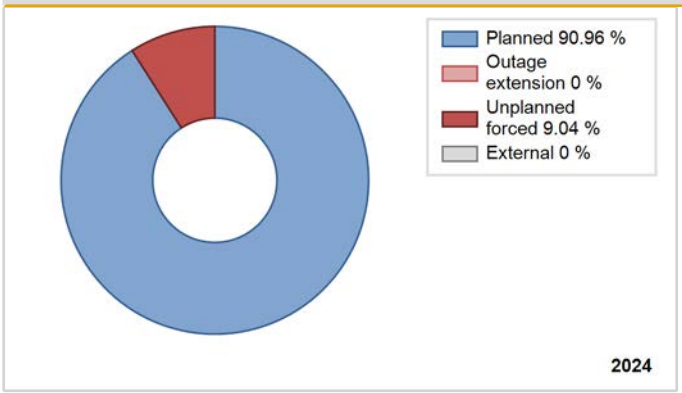
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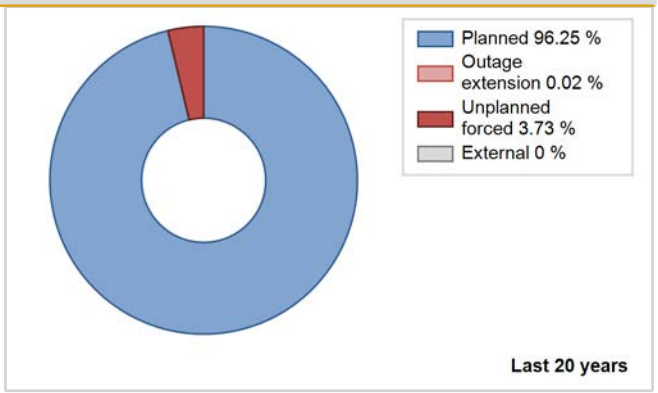
2011	9978.33	8760	1122	100.00	100.00	101.52	100.00	0.00	0.00	0.00	0.00
2012	8671.08	7832	1125	89.18	89.18	87.94	89.16	0.00	0.00	10.82	0.00
2013	10103.52	8760	1125	100.00	100.00	102.51	99.99	0.00	0.00	0.00	0.00
2014	8641.88	7685	1125	87.74	87.74	87.69	87.73	0.00	0.00	12.26	0.00
2015	10762.56	8692	1308	99.29	99.29	99.70	99.22	0.00	0.00	0.71	0.00
2016	10476.69	8322	1308	94.74	94.74	91.19	94.74	0.00	0.00	5.26	0.00
2017	11313.07	8760	1308	100.00	100.00	98.73	100.00	0.00	0.00	0.00	0.00
2018	10784.58	8395	1308	96.07	96.07	94.12	95.83	0.00	0.00	3.93	0.00
2019	11534.21	8760	1300	100.00	100.00	101.28	100.00	0.00	0.00	0.00	0.00
2020	10211.82	8111	1300	92.34	92.34	89.43	92.34	0.00	0.00	7.66	0.00
2021	11337.91	8724	1300	99.59	99.59	99.56	99.59	0.41	0.41	0.00	0.00
2022	10652.64	8362	1300	95.46	95.46	93.54	95.46	0.80	0.77	3.77	0.00
2023	11469.21	8760	1300	99.55	99.55	100.71	100.00	0.00	0.01	0.44	0.00
2024	10327.54	8227	1300	93.83	93.83	90.44	93.66	0.59	0.56	5.62	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1974 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		81			287	
B. Refuelling without maintenance				27		
C. Inspection, maintenance or repair combined with refuelling	387			970		
D. Inspection, maintenance or repair without refuelling	90			174		
E. Testing of plant systems or components				4	0	
F. Major backfitting, refurbishment or upgrading activities with refuelling				1		
H. Nuclear regulatory requirements					107	
J. Grid limitation, failure or grid unavailability						4
L. Human factor related					5	
Z. Other				23	6	1
Subtotal	477	81		1199	405	5
Total	**558**			**1609**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1974 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	50	1
12. Reactor I&C Systems		17
13. Reactor Auxiliary Systems		11
14. Safety Systems		36
15. Reactor Cooling Systems		73
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		46
31. Turbine and auxiliaries		36
32. Feedwater and Main Steam System	30	22
34. Miscellaneous Systems		4
35. All other I&C Systems		1
41. Main Generator Systems		6
42. Electrical Power Supply Systems		47
Total	**80**	**301**

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2024 Operating Experience

US-278 PEACH BOTTOM-3 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXE/PSEG (EXELON Corp. (50%)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 1)
Thermal power	:	3951 MWth
Gross electrical power	:	1412 MWe
Reference unit power (net)	:	1331 MWe

Key Dates

Construction Date	:	1968-01-31
Grid Date	:	1974-09-01
Commercial Date	:	1974-12-23
Age at end of year	:	50 years

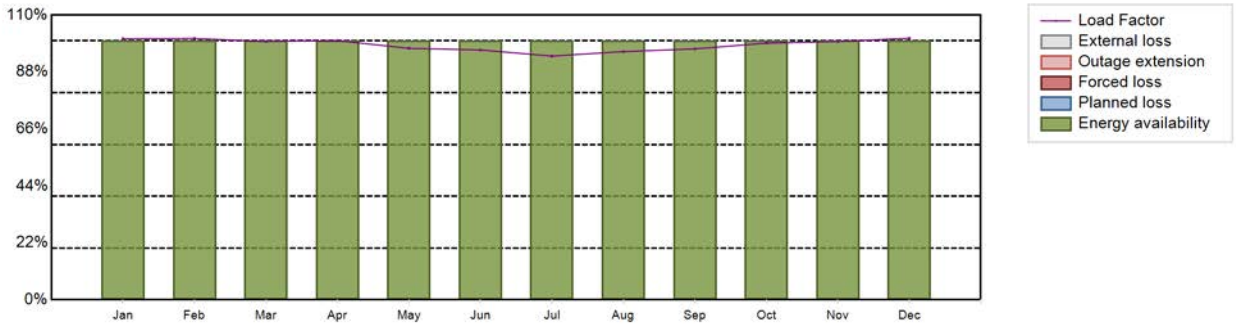
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.1
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	287
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.16
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	40	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	48000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.75	HP cylinder inlet steam pressure [MPa]	:	6.65
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	764	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	18.24	Number of main condensate pumps	:	-
Number of control rod assemblies	:	185	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	98.51 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



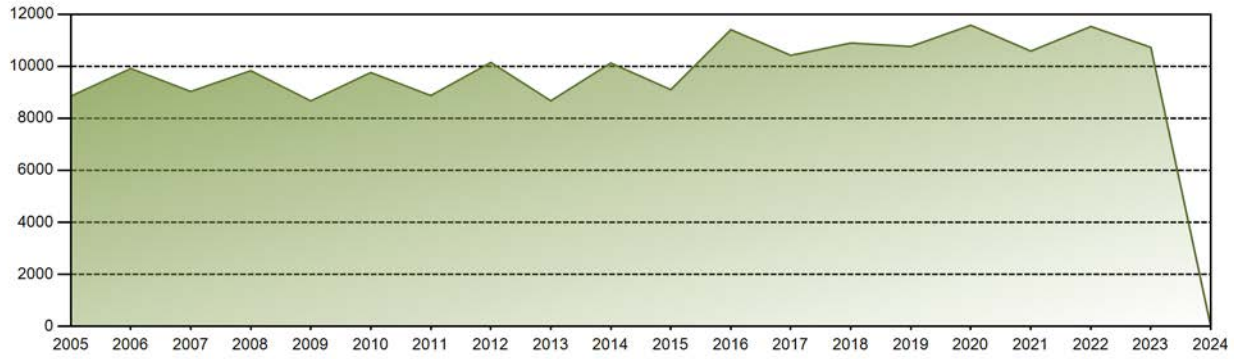
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	998.59	935.01	986.83	959.38	961.92	924.76	932.32	949.54	928.83	981.63	957.47	1000.54	11516.83
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	100.84	100.93	99.79	100.11	97.14	96.50	94.15	95.89	96.92	99.13	99.77	101.04	98.51
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.31 %
Cumulative Energy Availability Factor (EAF)	:	81.89 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.6 %
Cumulative Unit Capability Factor (UCF)	:	81.95 %	Cumulative Planned Unavailability Factor (PUF)	:	13.45 %
Cumulative Load Factor (LF)	:	80.44 %	Cumulative Externally cause unavailability (XUF)	:	0.07 %
Cumulative Operating Factor (OF)	:	82.5 %			

Electricity Production (net) [GWh]

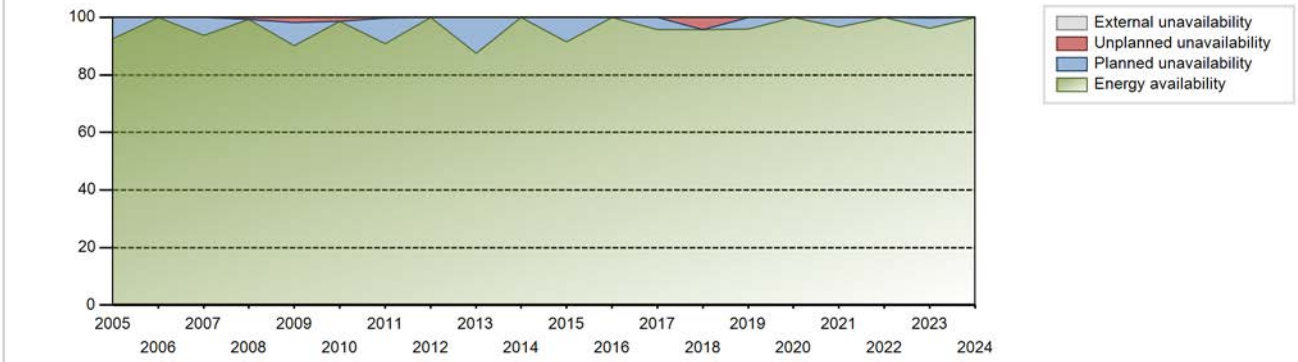


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1974	1095.30	1902	1073	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1975	5282.40	7520	1035	58.19	58.19	58.26	85.84	24.55	18.94	22.87	0.00
1976	6056.80	6829	1035	66.68	66.68	66.62	77.74	18.98	15.62	17.70	0.00
1977	4787.80	5450	1035	52.84	52.84	52.81	62.21	14.35	8.85	38.30	0.00
1978	6973.60	7412	1035	76.91	76.91	76.92	84.61	6.53	5.37	17.71	0.00
1979	6110.40	6500	1035	67.21	67.21	67.39	74.20	5.73	4.09	28.71	0.00
1980	7233.40	7089	1035	79.70	80.12	79.56	80.70	11.47	10.38	9.49	0.43
1981	3171.10	3201	1035	33.00	33.00	34.98	36.54	13.97	5.36	61.64	0.00
1982	8532.30	8372	1035	95.35	95.35	94.11	95.57	4.65	4.65	0.00	0.00
1983	2465.70	2714	1035	27.14	27.50	27.20	30.98	4.64	1.34	71.16	0.36
1984	7445.52	7545	1035	85.15	86.21	81.90	85.89	13.79	13.79	0.00	1.06
1985	3320.84	3988	1035	45.11	45.11	36.63	45.53	0.83	0.38	54.51	0.00
1986	4858.84	5542	1035	60.94	60.94	53.59	63.26	20.95	16.15	22.91	0.00
1987	1507.72	1658	1035	14.41	14.41	16.63	18.93	85.59	85.59	0.00	0.00
1988	0.00	0	1035	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
1989	247.31	472	1035	0.10	0.10	2.73	5.39	47.89	0.09	99.81	0.00
1990	7534.10	7684	1035	87.08	87.08	83.10	87.72	5.30	4.87	8.05	0.00
1991	5118.92	5212	1035	57.26	59.14	56.46	59.50	13.61	9.32	31.54	1.88
1992	7180.95	7391	1035	83.65	83.65	78.99	84.14	12.72	12.19	4.16	0.00
1993	6314.03	6594	1035	73.89	73.89	69.64	75.27	7.25	5.77	20.34	0.00
1994	8867.35	8588	1035	97.93	97.93	97.80	98.04	2.07	2.07	0.00	0.00
1995	7172.49	7929	1049	90.12	90.12	78.01	90.51	3.20	2.98	6.89	0.00
1996	9424.69	8627	1093	98.21	98.21	98.16	98.21	1.79	1.79	0.00	0.00
1997	7566.58	7909	1093	90.29	90.29	79.03	90.29	1.75	1.61	8.11	0.00
1998	8823.63	8172	1093	93.30	93.30	92.16	93.29	1.41	1.34	5.36	0.00
1999	8558.61	8100	1093	92.48	92.48	89.39	92.47	0.00	0.00	7.52	0.00
2000	9556.78	8722	1093	99.30	99.30	99.54	99.29	0.70	0.70	0.00	0.00
2001	8524.44	8153	1093	93.09	93.09	89.03	93.07	0.00	0.00	6.91	0.00
2002	9647.38	8740	1093	99.78	99.78	100.76	99.77	0.00	0.00	0.22	0.00
2003	8937.81	8089	1112	92.38	92.38	92.94	92.34	4.49	4.35	3.27	0.00
2004	9989.10	8784	1112	100.00	100.00	102.27	100.00	0.00	0.00	0.00	0.00
2005	8848.91	8105	1112	92.55	92.55	90.84	92.52	0.00	0.00	7.45	0.00
2006	9912.75	8760	1112	100.00	100.00	101.76	100.00	0.00	0.00	0.00	0.00
2007	9030.82	8207	1112	93.70	93.70	92.71	93.69	0.00	0.00	6.30	0.00
2008	9830.48	8729	1112	99.38	99.38	100.64	99.37	0.62	0.62	0.00	0.00
2009	8668.09	7888	1112	90.09	90.09	88.98	90.05	2.04	1.88	8.04	0.00
2010	9759.27	8640	1112	98.64	98.64	100.19	98.63	1.36	1.36	0.00	0.00

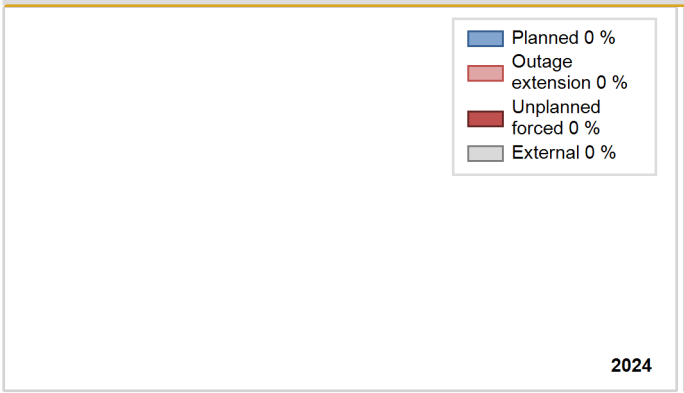
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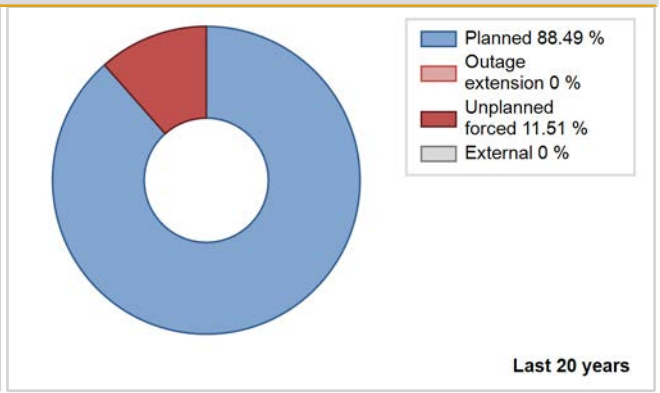
2011	8873.28	7952	1122	90.81	90.81	90.95	90.78	0.33	0.30	8.89	0.00
2012	10148.35	8784	1138	100.00	100.00	101.52	100.00	0.00	0.00	0.00	0.00
2013	8673.15	7656	1138	87.40	87.40	86.99	87.39	0.00	0.00	12.60	0.00
2014	10124.97	8757	1138	99.96	99.96	101.57	99.97	0.04	0.04	0.00	0.00
2015	9101.27	8006	1308	91.50	91.50	90.15	91.39	0.00	0.00	8.50	0.00
2016	11406.74	8784	1309	100.00	100.00	99.20	100.00	0.00	0.00	0.00	0.00
2017	10421.37	8378	1309	95.64	95.64	90.88	95.64	0.00	0.00	4.36	0.00
2018	10895.50	8384	1251	95.70	95.70	99.54	95.71	4.30	4.30	0.00	0.00
2019	10761.63	8377	1331	95.90	95.90	92.30	95.63	0.00	0.00	4.10	0.00
2020	11580.51	8783	1331	100.00	100.00	99.05	99.99	0.00	0.00	0.00	0.00
2021	10584.21	8458	1331	96.55	96.55	90.78	96.55	0.00	0.00	3.45	0.00
2022	11531.32	8760	1331	100.00	100.00	98.90	100.00	0.00	0.00	0.00	0.00
2023	10727.42	8435	1331	96.21	96.21	92.01	96.29	0.16	0.15	3.64	0.00
2024	Data not provided										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1974 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					269	
B. Refuelling without maintenance				6		
C. Inspection, maintenance or repair combined with refuelling				1026		
D. Inspection, maintenance or repair without refuelling				61		
E. Testing of plant systems or components				12	1	
H. Nuclear regulatory requirements					136	
J. Grid limitation, failure or grid unavailability						8
L. Human factor related					13	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						7
Z. Other				16	0	1
Subtotal				1121	419	16
Total		**0**			**1556**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1974 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		18
13. Reactor Auxiliary Systems		9
14. Safety Systems		32
15. Reactor Cooling Systems		75
31. Turbine and auxiliaries		35
32. Feedwater and Main Steam System		46
33. Circulating Water System		2
34. Miscellaneous Systems		0
41. Main Generator Systems		13
42. Electrical Power Supply Systems		50
Total		**280**

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2024 Operating Experience

US-440 PERRY-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	FENOC (FIRST ENERGY NUCLEAR OPERATING CO.)
Owner	:	CEI (CLEVELAND ELECTRIC ILLUMINATING CO.)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-6 (Mark 3)
Thermal power	:	3758 MWth
Gross electrical power	:	1303 MWe
Reference unit power (net)	:	1240 MWe

Key Dates

Construction Date	:	1974-10-01
Grid Date	:	1986-12-19
Commercial Date	:	1987-11-18
Age at end of year	:	38 years

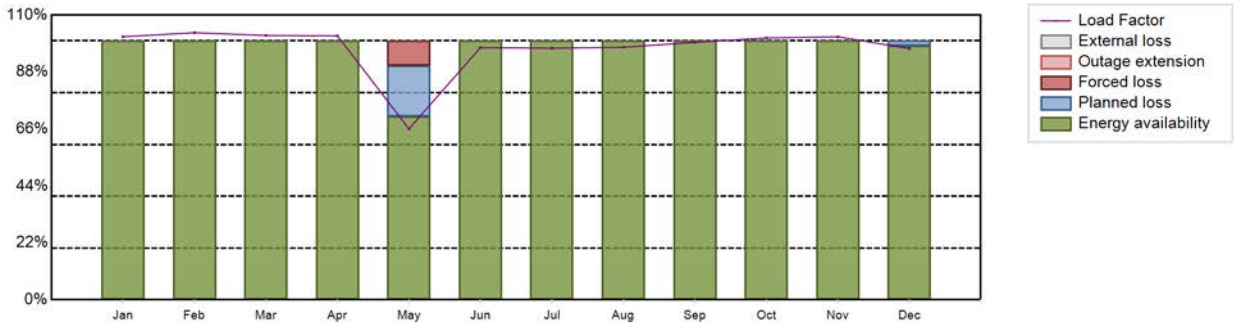
Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	24
Part of the core refuelled [%]	:	25
Average discharge burnup [MWd/t]	:	7614
Active core diameter [m]	:	4.65
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	748
Fuel linear heat generation rate [kW/m]	:	19.85
Number of control rod assemblies	:	177
Number of external reactor coolant loops	:	2
Coolant type	:	H2O
Operating coolant pressure [MPa]	:	7.31
Reactor outlet temperature [°C]	:	285.5
Number of SG	:	NA
Containment type	:	Confinement
Containment design pressure [MPa]	:	0.105
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.78
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	10578.86 GW(e).h
Energy Availability Factor (EAF)	:	97.37 %
Unit Capability Factor (UCF)	:	97.37 %
Load Factor (LF)	:	97.12 %
Operating Factor (OF)	:	97.37 %
Forced Loss Rate (FLR)	:	0.81 %
Unplanned Capability Loss Factor (UCL)	:	0.8 %
Planned Unavailability Factor (PUF)	:	1.83 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	231 hours

Annual Summary



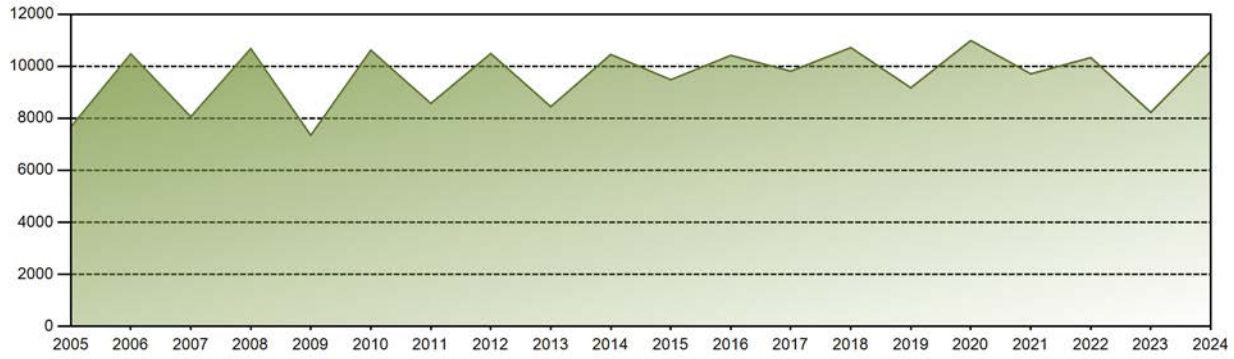
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	937.40	890.43	940.75	910.39	609.33	869.59	896.59	899.84	887.95	932.96	908.32	895.31	10578.86
EAF [%]	100.00	100.00	100.00	100.00	70.85	100.00	100.00	100.00	100.00	100.00	100.00	98.12	97.37
UCF [%]	100.00	100.00	100.00	100.00	70.85	100.00	100.00	100.00	100.00	100.00	100.00	98.12	97.37
LF [%]	101.61	103.17	102.11	101.97	66.05	97.40	97.19	97.54	99.46	101.13	101.60	97.05	97.12
OF [%]	100.00	100.00	100.00	100.00	70.83	100.00	100.00	100.00	100.00	100.00	100.00	98.12	97.37
FLR [%]	0.00	0.00	0.00	0.00	11.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81
UCL [%]	0.00	0.00	0.00	0.00	9.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80
PUF [%]	0.00	0.00	0.00	0.00	19.70	0.00	0.00	0.00	0.00	0.00	0.00	1.88	1.83
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	327901.77 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.69 %
Cumulative Energy Availability Factor (EAF)	:	85.28 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.2 %
Cumulative Unit Capability Factor (UCF)	:	85.28 %	Cumulative Planned Unavailability Factor (PUF)	:	10.52 %
Cumulative Load Factor (LF)	:	82.91 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	84.8 %			

Electricity Production (net) [GWh]

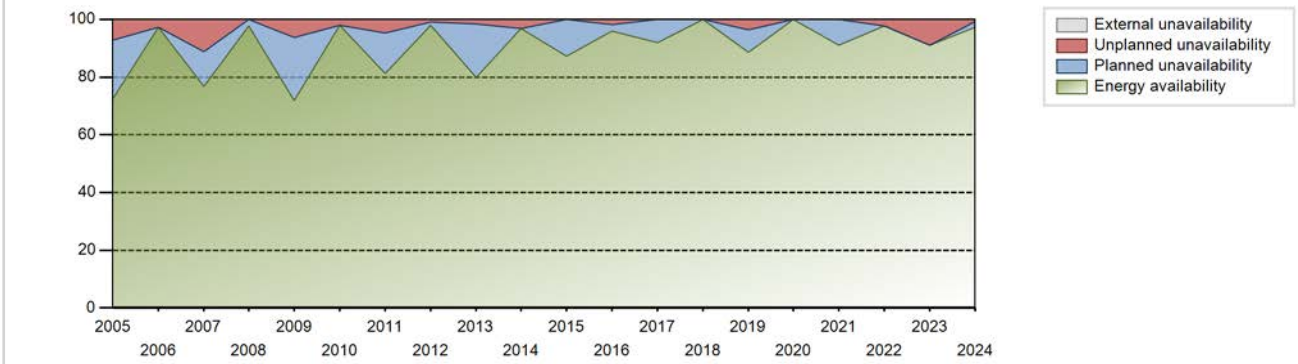


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	Data not provided										
1988	7233.82	6664	1203	76.34	76.34	68.44	75.87	14.72	13.18	10.48	0.00
1989	5357.58	4776	1141	53.43	53.43	53.60	54.52	0.80	0.43	46.14	0.00
1990	6638.89	5723	1141	65.27	65.27	66.42	65.33	1.27	0.84	33.89	0.00
1991	8975.67	7949	1166	90.74	90.74	87.87	90.74	8.38	8.30	0.96	0.00
1992	7168.56	6383	1166	72.62	72.62	69.99	72.67	7.41	5.81	21.57	0.00
1993	3973.21	3853	1166	43.86	43.86	38.90	43.98	37.99	26.87	29.26	0.00
1994	4591.90	4151	1166	47.28	47.28	44.96	47.39	1.34	0.64	52.07	0.00
1995	9112.12	8174	1166	93.36	93.36	89.21	93.31	6.64	6.64	0.00	0.00
1996	7481.95	6673	1164	75.92	75.92	73.18	75.97	4.60	3.66	20.42	0.00
1997	8151.83	7178	1160	81.88	81.88	80.22	81.94	7.35	6.50	11.62	0.00
1998	10188.94	8684	1160	99.14	99.14	100.27	99.13	0.86	0.86	0.00	0.00
1999	9124.91	7850	1160	89.62	89.62	89.80	89.61	0.00	0.00	10.38	0.00
2000	10085.68	8506	1191	96.90	96.90	96.35	96.84	0.00	0.00	3.10	0.00
2001	7781.77	6708	1241	77.89	77.89	71.84	76.58	14.30	12.99	9.12	0.00
2002	9974.81	8196	1235	93.56	93.56	92.20	93.56	6.44	6.44	0.00	0.00
2003	8553.20	7217	1235	82.36	82.36	79.06	82.39	2.38	2.00	15.63	0.00
2004	10227.34	8378	1235	95.41	95.41	94.28	95.38	4.59	4.59	0.00	0.00
2005	7667.52	6363	1235	72.65	72.65	70.87	72.63	8.93	7.12	20.23	0.00
2006	10475.37	8521	1235	97.27	97.27	96.83	97.27	2.73	2.73	0.00	0.00
2007	8058.25	6704	1245	76.84	76.84	73.89	76.53	12.74	11.22	11.95	0.00
2008	10680.58	8580	1245	97.68	97.68	97.66	97.68	0.00	0.00	2.32	0.00
2009	7345.14	6284	1245	71.77	71.77	67.35	71.74	7.95	6.20	22.03	0.00
2010	10619.71	8590	1240	98.06	98.06	97.77	98.06	1.94	1.94	0.00	0.00
2011	8569.09	7115	1240	81.24	81.24	78.89	81.22	5.41	4.64	14.12	0.00
2012	10490.30	8607	1240	98.00	98.00	96.31	97.98	0.94	0.93	1.07	0.00
2013	8448.62	6981	1256	79.88	79.88	77.10	79.68	1.84	1.50	18.63	0.00
2014	10455.27	8490	1256	96.92	96.92	95.03	96.92	3.08	3.08	0.00	0.00
2015	9482.84	7639	1256	87.20	87.20	86.19	87.20	0.00	0.00	12.80	0.00
2016	10420.29	8434	1256	96.02	96.02	94.45	96.02	1.84	1.80	2.18	0.00
2017	9812.38	8054	1256	91.92	91.92	89.18	91.94	0.00	0.00	8.08	0.00
2018	10718.96	8760	1240	100.00	100.00	98.68	100.00	0.00	0.00	0.00	0.00
2019	9173.10	7763	1240	88.64	88.64	84.45	88.62	3.79	3.49	7.86	0.00
2020	10990.96	8783	1240	100.00	100.00	100.91	99.99	0.00	0.00	0.00	0.00
2021	9709.68	7975	1240	91.04	91.04	89.39	91.04	0.00	0.00	8.96	0.00
2022	10334.45	8553	1240	97.64	97.64	95.14	97.64	2.36	2.36	0.00	0.00
2023	8227.22	7239	1240	91.10	91.10	75.74	82.64	8.78	8.85	0.04	0.00

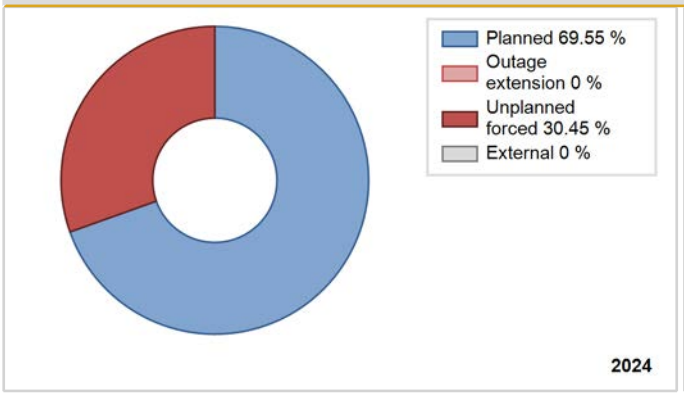
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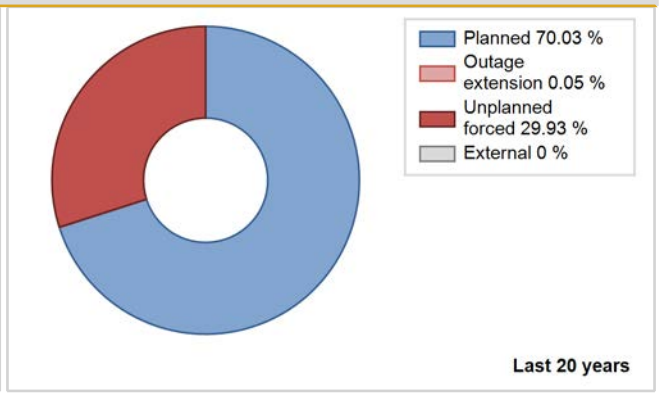
2024	10578.86	8553	1240	97.37	97.37	97.12	97.37	0.81	0.80	1.83	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1987 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		70			322	
B. Refuelling without maintenance				21		
C. Inspection, maintenance or repair combined with refuelling				817		
D. Inspection, maintenance or repair without refuelling	161			134		
E. Testing of plant systems or components				0		
H. Nuclear regulatory requirements					6	
L. Human factor related					10	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					1	
Z. Other					5	
Subtotal	161	70		972	344	
Total	**231**			**1316**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	70	6
12. Reactor I&C Systems		30
13. Reactor Auxiliary Systems		2
14. Safety Systems		0
15. Reactor Cooling Systems		45
17. Safety I&C Systems (excluding reactor I&C)		4
31. Turbine and auxiliaries		44
32. Feedwater and Main Steam System		23
33. Circulating Water System		9
34. Miscellaneous Systems		76
35. All other I&C Systems		16
41. Main Generator Systems		27
42. Electrical Power Supply Systems		55
Total	**70**	**337**

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2024 Operating Experience

US-266 POINT BEACH-1 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	NEXTERA (NextEra Energy Resources, LLC
Owner	:	NEXTERA (NextEra Energy Resources, LLC
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)



Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP (DRYAMB)
Thermal power	:	1800 MWth
Gross electrical power	:	640 MWe
Reference unit power (net)	:	591 MWe

Key Dates

Construction Date	:	1967-07-19
Grid Date	:	1970-11-06
Commercial Date	:	1970-12-21
Age at end of year	:	54 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	74
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	2.46
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	18.7
Number of control rod assemblies	:	21
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

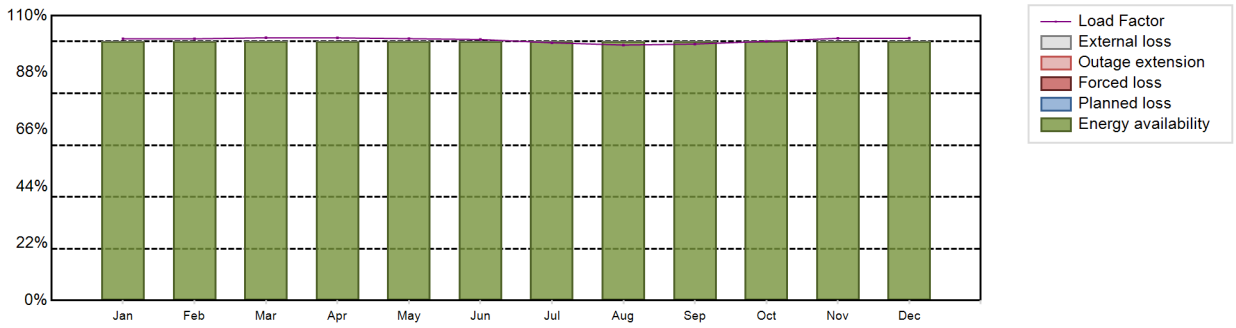
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	316
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.422
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.55
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	100.57 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



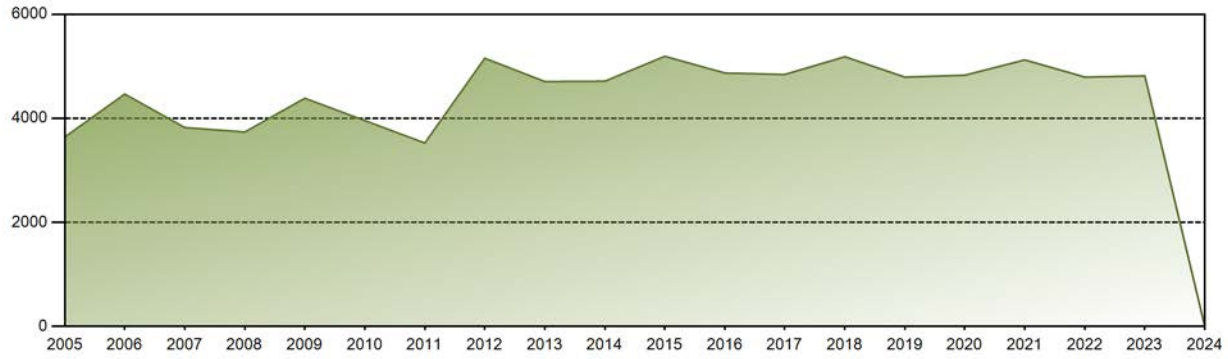
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	444.47	415.69	445.61	431.66	444.65	428.96	437.72	433.78	421.49	440.18	431.52	445.37	5221.10
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	101.08	101.06	101.48	101.44	101.12	100.81	99.55	98.65	99.05	100.11	101.27	101.29	100.57
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.07 %
Cumulative Energy Availability Factor (EAF)	:	86.49 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.74 %
Cumulative Unit Capability Factor (UCF)	:	86.74 %	Cumulative Planned Unavailability Factor (PUF)	:	10.51 %
Cumulative Load Factor (LF)	:	83.49 %	Cumulative Externally cause unavailability (XUF)	:	0.26 %
Cumulative Operating Factor (OF)	:	85.75 %			

Electricity Production (net) [GWh]

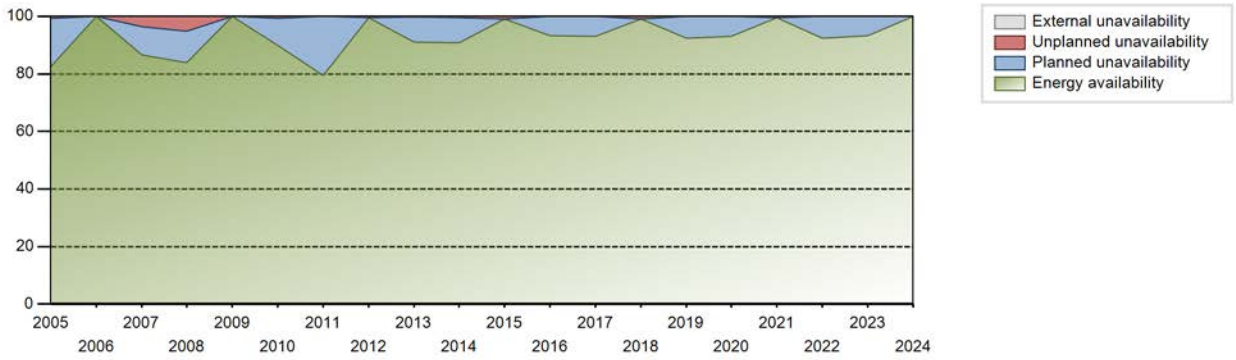


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1970	Data not provided										
1971	3446.20	7699	524	100.00	100.00	75.08	87.89	0.00	0.00	0.00	0.00
1972	3085.50	6349	524	100.00	100.00	67.04	72.28	0.00	0.00	0.00	0.00
1973	2742.30	6867	497	67.61	67.61	62.99	78.39	15.83	12.72	19.67	0.00
1974	3144.30	7136	497	81.45	81.45	72.22	81.46	4.61	3.93	14.62	0.00
1975	2924.90	6297	480	69.52	69.52	69.56	71.88	17.11	14.35	16.14	0.00
1976	3392.50	7239	492	78.43	78.43	78.50	82.41	0.08	0.06	21.52	0.00
1977	3687.10	7733	495	85.08	85.08	85.03	88.28	3.92	3.47	11.45	0.00
1978	3794.50	7864	495	87.50	87.50	87.51	89.77	2.83	2.55	9.95	0.00
1979	3059.60	6455	495	70.56	70.56	70.56	73.69	12.40	9.99	19.45	0.00
1980	2479.30	6739	495	76.96	91.02	57.02	76.72	0.40	0.37	8.62	14.06
1981	2614.90	6834	495	78.30	78.30	60.30	78.01	0.22	0.18	21.52	0.00
1982	2701.70	7134	495	81.51	81.51	62.31	81.44	0.18	0.15	18.34	0.00
1983	2384.90	6498	495	74.26	74.26	55.00	74.18	0.00	0.00	25.74	0.00
1984	3109.21	6379	485	72.63	72.63	72.98	72.62	0.00	0.00	27.37	0.00
1985	3354.18	6917	485	78.65	78.65	78.95	78.96	0.10	0.08	21.27	0.00
1986	3770.07	7786	485	88.73	88.73	88.74	88.88	0.40	0.36	10.92	0.00
1987	3567.09	7348	485	83.64	83.64	83.96	83.88	0.28	0.23	16.12	0.00
1988	3830.95	7787	485	88.48	88.48	89.92	88.65	0.00	0.00	11.52	0.00
1989	3606.22	7706	485	87.78	87.78	84.88	87.97	0.00	0.00	12.22	0.00
1990	3531.73	7362	485	83.80	83.80	83.13	84.04	0.00	0.00	16.20	0.00
1991	3628.73	7524	485	85.68	85.68	85.41	85.89	1.33	1.16	13.17	0.00
1992	3605.64	7409	485	84.10	84.10	84.63	84.35	0.66	0.56	15.34	0.00
1993	3804.79	7799	485	88.85	88.85	89.55	89.03	0.00	0.00	11.15	0.00
1994	3905.06	8071	485	92.04	92.04	91.91	92.13	0.00	0.00	7.96	0.00
1995	3792.43	7768	485	88.52	88.52	89.26	88.68	1.28	1.15	10.33	0.00
1996	4003.33	8173	485	92.95	92.95	93.97	93.04	0.00	0.00	7.05	0.00
1997	853.50	1872	485	21.33	21.33	20.09	21.37	78.67	78.67	0.00	0.00
1998	2584.22	5489	485	62.69	62.69	60.83	62.66	0.00	0.00	37.31	0.00
1999	3489.33	7070	489	80.02	80.02	81.43	80.71	3.79	3.15	16.83	0.00
2000	4134.62	8391	510	95.59	96.10	92.29	95.53	3.90	3.90	0.00	0.51
2001	3702.10	7611	510	87.04	87.04	82.87	86.88	3.35	3.01	9.95	0.00
2002	3975.79	7964	510	91.01	91.01	88.99	90.91	0.00	0.00	8.99	0.00
2003	4343.00	8538	516	97.52	97.52	96.18	97.47	2.48	2.48	0.00	0.00
2004	3631.04	7186	516	81.89	81.89	80.11	81.81	0.00	0.00	18.11	0.00
2005	3641.04	7232	512	82.58	82.58	81.18	82.56	0.76	0.63	16.79	0.00
2006	4465.63	8760	512	100.00	100.00	99.57	100.00	0.00	0.00	0.00	0.00

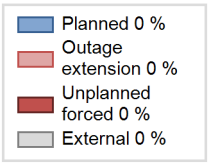
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2007	3822.30	7582	512	86.57	86.57	85.22	86.55	3.89	3.51	9.92	0.00
2008	3737.01	7365	512	83.87	83.87	83.09	83.85	5.89	5.24	10.89	0.00
2009	4385.38	8760	512	100.00	100.00	97.78	100.00	0.00	0.00	0.00	0.00
2010	3956.14	7870	512	89.89	89.89	88.21	89.84	0.83	0.75	9.36	0.00
2011	3525.04	6954	512	79.39	79.39	78.59	79.38	0.00	0.00	20.61	0.00
2012	5154.43	8737	591	99.47	99.47	99.29	99.46	0.53	0.53	0.00	0.00
2013	4707.21	7981	591	91.11	91.11	90.91	91.10	0.40	0.36	8.53	0.00
2014	4713.10	7956	591	90.82	90.82	91.04	90.82	0.49	0.45	8.73	0.00
2015	5191.57	8671	591	98.99	98.99	100.28	98.98	1.01	1.01	0.00	0.00
2016	4871.11	8196	591	93.30	93.30	93.83	93.31	0.00	0.00	6.70	0.00
2017	4842.86	8158	591	93.13	93.13	93.54	93.13	0.00	0.00	6.87	0.00
2018	5184.30	8675	591	99.06	99.06	100.14	99.03	0.94	0.94	0.00	0.00
2019	4792.60	8098	591	92.45	92.45	92.57	92.44	0.00	0.00	7.55	0.00
2020	4828.77	8181	591	93.15	93.15	93.02	93.14	0.00	0.00	6.85	0.00
2021	5123.07	8719	591	99.53	99.53	98.96	99.53	0.47	0.47	0.00	0.00
2022	4793.10	8097	591	92.43	92.43	92.58	92.43	0.00	0.00	7.57	0.00
2023	4815.15	8147	591	93.18	93.18	93.01	93.00	0.00	0.00	6.82	0.00
2024	Data not provided										

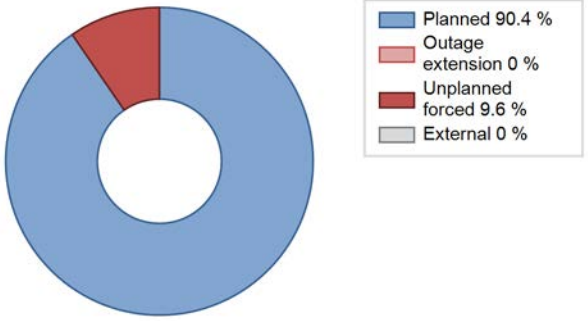
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

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Full Outages, Analysis by Cause

Outage Cause	2024			1970 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					113	
B. Refuelling without maintenance				23		
C. Inspection, maintenance or repair combined with refuelling				914		
D. Inspection, maintenance or repair without refuelling				42		
E. Testing of plant systems or components				2		
F. Major backfitting, refurbishment or upgrading activities with refuelling				1		
H. Nuclear regulatory requirements					23	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						128
Z. Other				1	3	
Subtotal				983	140	129
Total		**0**			**1252**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1970 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		3
12. Reactor I&C Systems		1
15. Reactor Cooling Systems		7
16. Steam generation systems		68
31. Turbine and auxiliaries		14
32. Feedwater and Main Steam System		19
33. Circulating Water System		1
34. Miscellaneous Systems		135
41. Main Generator Systems		8
42. Electrical Power Supply Systems		12
Total		**268**

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2024 Operating Experience

US-301 POINT BEACH-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	NEXTERA (NextEra Energy Resources, LLC
Owner	:	NEXTERA (NextEra Energy Resources, LLC
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP (DRYAMB)
Thermal power	:	1800 MWth
Gross electrical power	:	640 MWe
Reference unit power (net)	:	591 MWe

Key Dates

Construction Date	:	1968-07-25
Grid Date	:	1972-08-02
Commercial Date	:	1972-10-01
Age at end of year	:	52 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	74
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	2.44
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	18.7
Number of control rod assemblies	:	21
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

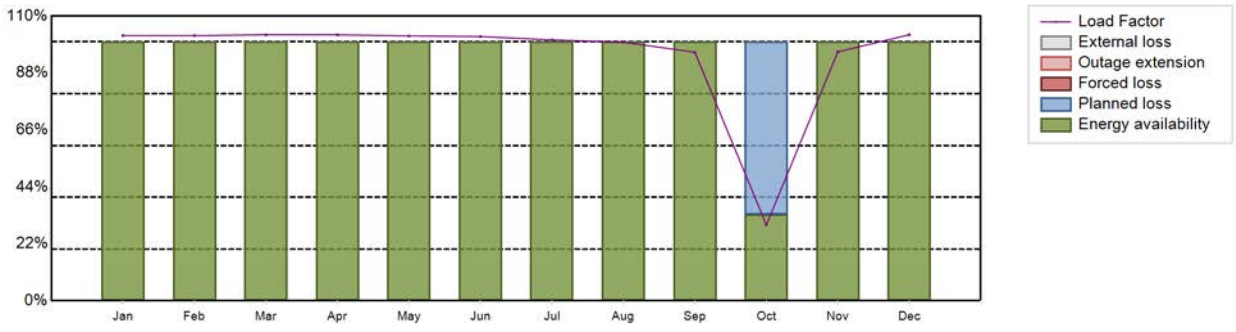
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	316
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.422
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.55
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	4925.77 GW(e).h
Energy Availability Factor (EAF)	:	94.36 %
Unit Capability Factor (UCF)	:	94.36 %
Load Factor (LF)	:	94.88 %
Operating Factor (OF)	:	94.41 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	5.64 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	491 hours

Annual Summary



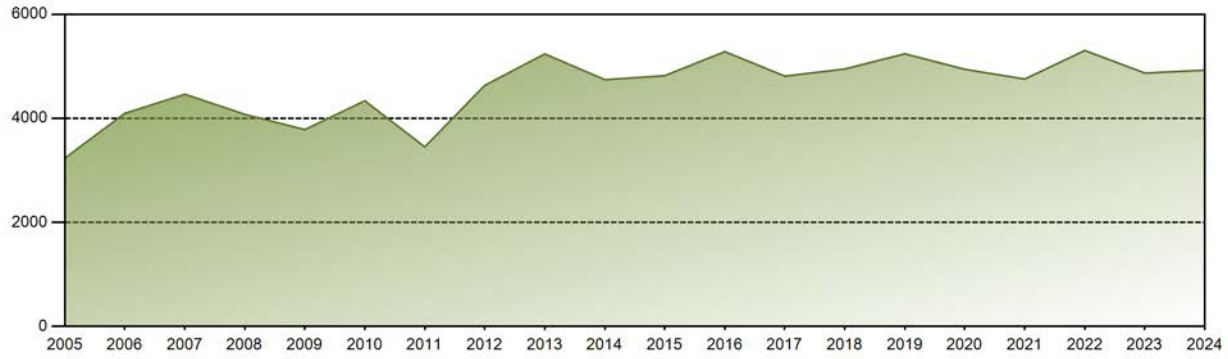
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	450.50	421.24	451.27	437.09	449.98	434.31	443.07	439.23	408.49	128.94	409.72	451.91	4925.77
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	33.41	100.00	100.00	94.36
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	33.41	100.00	100.00	94.36
LF [%]	102.46	102.41	102.77	102.72	102.34	102.07	100.77	99.89	96.00	29.32	96.15	102.78	94.88
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	35.62	98.34	100.00	94.41
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.59	0.00	0.00	5.64
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	204957.56 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.55 %
Cumulative Energy Availability Factor (EAF)	:	87.48 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.38 %
Cumulative Unit Capability Factor (UCF)	:	87.48 %	Cumulative Planned Unavailability Factor (PUF)	:	11.14 %
Cumulative Load Factor (LF)	:	86.09 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	87.1 %			

Electricity Production (net) [GWh]

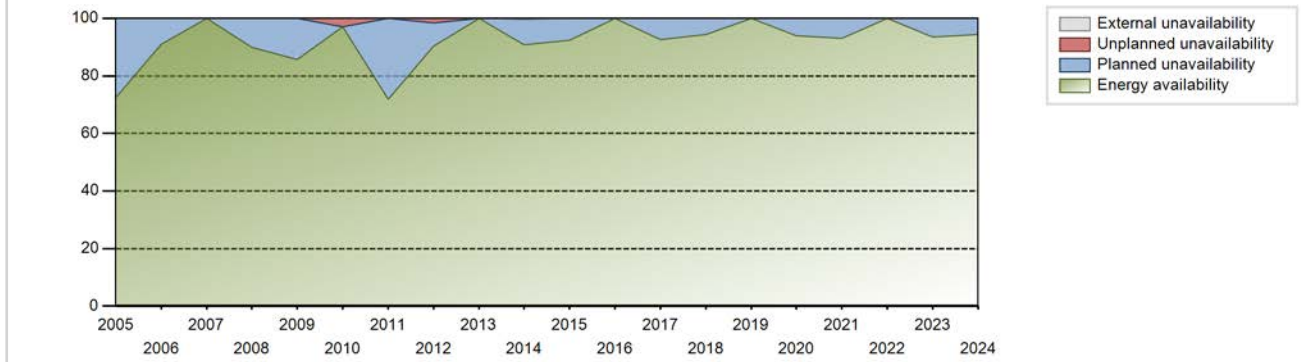


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1972	225.70	2987	288	100.00	100.00	84.78	81.48	0.00	0.00	0.00	0.00
1973	2991.00	8192	497	80.16	80.16	68.70	93.52	16.63	15.99	3.85	0.00
1974	3179.30	7100	497	81.05	81.05	73.02	81.05	1.22	1.00	17.95	0.00
1975	3741.40	8224	485	87.92	87.92	88.06	93.88	3.19	2.89	9.19	0.00
1976	3749.20	7959	491	86.80	86.80	86.93	90.61	0.78	0.68	12.52	0.00
1977	3622.30	7496	495	83.51	83.51	83.54	85.57	0.54	0.45	16.05	0.00
1978	3858.90	8039	495	88.99	88.99	88.99	91.77	0.64	0.58	10.43	0.00
1979	3707.50	7728	495	85.50	85.50	85.50	88.22	0.52	0.44	14.06	0.00
1980	3587.90	7569	495	88.03	88.03	82.52	86.17	3.86	3.54	8.44	0.00
1981	3720.30	7757	495	89.89	89.89	85.80	88.55	0.00	0.00	10.11	0.00
1982	3605.40	7595	495	88.22	88.22	83.15	86.70	0.00	0.00	11.78	0.00
1983	3016.30	6245	495	74.47	74.47	69.56	71.29	0.49	0.37	25.16	0.00
1984	3512.37	7405	495	86.04	86.04	80.78	84.30	0.06	0.05	13.91	0.00
1985	3603.08	7491	485	86.84	86.84	84.81	85.51	0.57	0.50	12.66	0.00
1986	3417.55	7186	485	82.12	82.12	80.44	82.03	0.30	0.25	17.64	0.00
1987	3606.15	7478	485	85.50	85.90	84.88	85.37	0.58	0.50	13.60	0.39
1988	3718.68	7626	485	88.02	88.02	87.29	86.82	0.28	0.24	11.74	0.00
1989	3485.10	7107	485	82.87	82.87	82.03	81.13	1.57	1.32	15.81	0.00
1990	3793.46	7713	485	89.14	89.14	89.29	88.05	0.00	0.00	10.86	0.00
1991	3689.18	7569	485	87.60	87.60	86.83	86.40	0.61	0.54	11.86	0.00
1992	3668.19	7492	485	86.63	86.63	86.10	85.29	0.00	0.00	13.37	0.00
1993	3844.50	7883	485	90.91	90.91	90.49	89.99	0.24	0.22	8.87	0.00
1994	3752.30	7827	485	90.34	90.34	88.32	89.35	0.00	0.00	9.66	0.00
1995	3385.96	7158	485	83.41	83.41	79.70	81.71	0.17	0.15	16.44	0.00
1996	2950.35	6653	485	77.95	77.95	69.25	75.74	0.25	0.20	21.85	0.00
1997	825.49	1788	485	21.45	21.45	19.43	20.41	43.40	16.44	62.11	0.00
1998	3123.75	6609	485	75.46	75.46	73.52	75.45	18.52	17.15	7.40	0.00
1999	3578.50	7195	498	82.57	82.57	81.93	82.13	0.00	0.00	17.43	0.00
2000	3527.45	7094	512	80.89	80.89	78.43	80.76	0.81	0.66	18.45	0.00
2001	4342.97	8631	512	98.55	98.55	96.83	98.53	1.45	1.45	0.00	0.00
2002	4004.30	7934	512	90.69	90.69	89.28	90.57	0.89	0.81	8.50	0.00
2003	3713.28	7469	518	85.59	85.59	81.91	85.26	2.00	1.75	12.66	0.00
2004	4384.88	8559	518	97.47	97.47	96.37	97.44	2.53	2.53	0.00	0.00
2005	3232.63	6355	514	72.57	72.57	71.79	72.54	0.00	0.00	27.43	0.00
2006	4094.78	7972	514	91.03	91.03	90.94	91.00	0.00	0.00	8.97	0.00
2007	4462.21	8760	514	100.00	100.00	99.10	100.00	0.00	0.00	0.00	0.00
2008	4075.91	7904	514	89.99	89.99	90.28	89.98	0.00	0.00	10.01	0.00

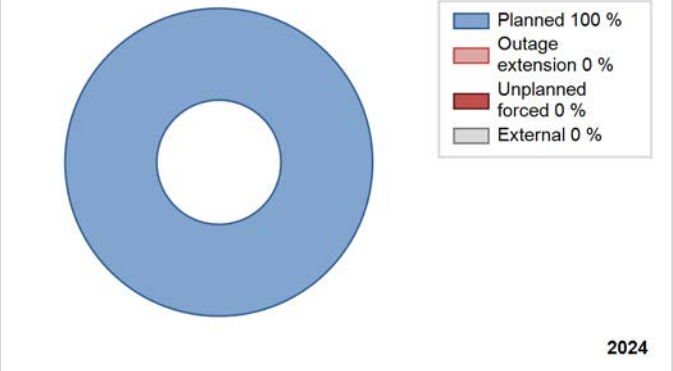
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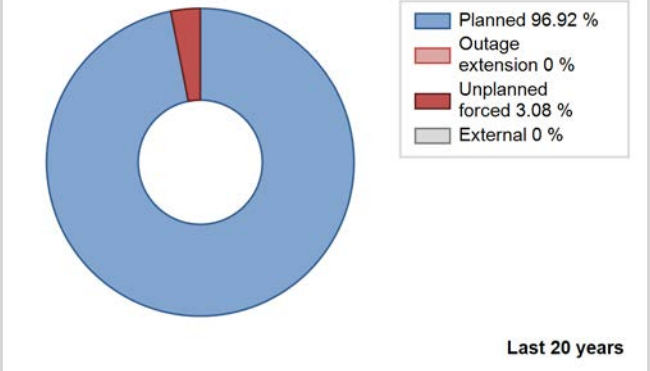
2009	3782.45	7501	516	85.69	85.69	83.68	85.63	0.00	0.00	14.31	0.00
2010	4336.29	8495	515	96.99	96.99	96.12	96.97	3.01	3.01	0.00	0.00
2011	3450.08	6098	586	71.91	71.91	70.75	69.61	0.00	0.00	28.09	0.00
2012	4633.79	7935	591	90.36	90.36	89.26	90.33	1.68	1.55	8.09	0.00
2013	5237.69	8760	591	100.00	100.00	101.16	99.99	0.00	0.00	0.00	0.00
2014	4742.28	7962	591	90.89	90.89	91.60	90.89	0.36	0.33	8.78	0.00
2015	4819.90	8095	591	92.40	92.40	93.10	92.41	0.00	0.00	7.60	0.00
2016	5282.17	8784	591	100.00	100.00	101.75	100.00	0.00	0.00	0.00	0.00
2017	4810.70	8113	591	92.61	92.61	92.92	92.61	0.00	0.00	7.39	0.00
2018	4948.38	8267	591	94.49	94.49	95.58	94.37	0.00	0.00	5.51	0.00
2019	5239.90	8760	591	100.00	100.00	101.21	100.00	0.00	0.00	0.00	0.00
2020	4942.57	8244	591	93.87	93.87	95.21	93.85	0.00	0.00	6.13	0.00
2021	4754.72	8145	591	92.98	92.98	91.84	92.98	0.00	0.00	7.02	0.00
2022	5303.96	8760	591	100.00	100.00	102.45	100.00	0.00	0.00	0.00	0.00
2023	4870.22	8172	591	93.44	93.44	94.07	93.29	0.00	0.00	6.56	0.00
2024	4925.77	8293	591	94.36	94.36	94.88	94.41	0.00	0.00	5.64	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1972 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					82	
B. Refuelling without maintenance				32		
C. Inspection, maintenance or repair combined with refuelling	491			941		
D. Inspection, maintenance or repair without refuelling				32		
E. Testing of plant systems or components				1	18	
F. Major backfitting, refurbishment or upgrading activities with refuelling				2		
H. Nuclear regulatory requirements					3	
L. Human factor related					5	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z. Other					13	
Subtotal	491			1008	121	1
Total	**491**			**1130**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1972 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		4
12. Reactor I&C Systems		40
13. Reactor Auxiliary Systems		1
14. Safety Systems		0
15. Reactor Cooling Systems		25
16. Steam generation systems		12
31. Turbine and auxiliaries		8
32. Feedwater and Main Steam System		6
41. Main Generator Systems		1
42. Electrical Power Supply Systems		14
Total		**111**

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2024 Operating Experience

US-282 PRAIRIE ISLAND-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	NSP (Northern States Power Co. (subsidiary of Xcel Energy))
Owner	:	XCEL (Xcel Energy)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP (DRYAMB)
Thermal power	:	1677 MWth
Gross electrical power	:	566 MWe
Reference unit power (net)	:	522 MWe

Key Dates

Construction Date	:	1968-06-25
Grid Date	:	1973-12-04
Commercial Date	:	1973-12-16
Age at end of year	:	51 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	40
Average discharge burnup [MWd/t]	:	51000
Active core diameter [m]	:	2.45
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	20.3
Number of control rod assemblies	:	21
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

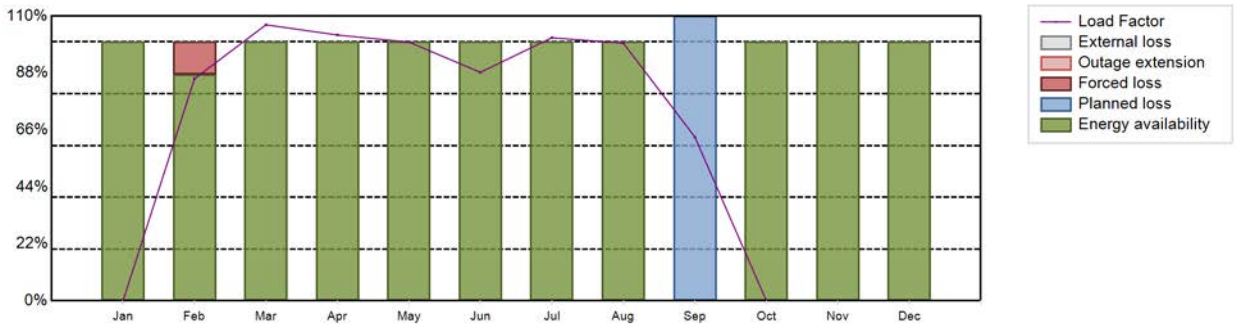
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	315
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.291
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.06
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	2849.83 GW(e).h
Energy Availability Factor (EAF)	:	71.04 %
Unit Capability Factor (UCF)	:	71.04 %
Load Factor (LF)	:	62.15 %
Operating Factor (OF)	:	63.63 %

Forced Loss Rate (FLR)	:	1.38 %
Unplanned Capability Loss Factor (UCL)	:	1 %
Planned Unavailability Factor (PUF)	:	27.96 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	3195 hours

Annual Summary



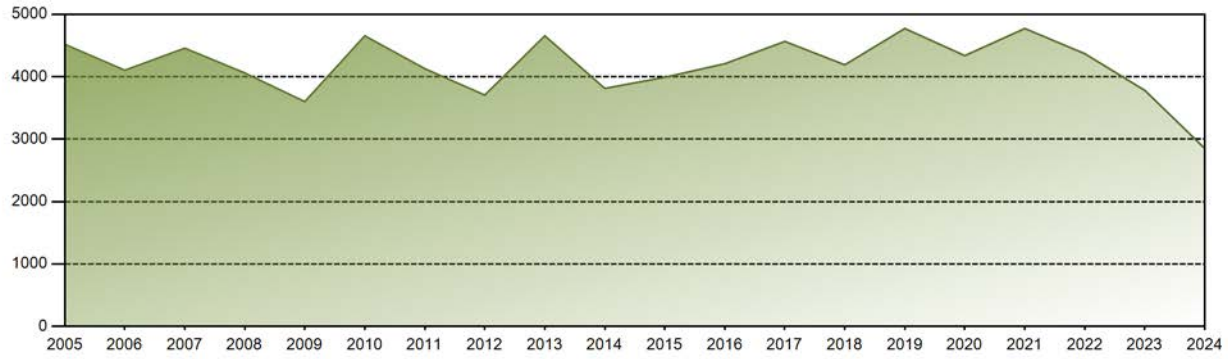
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	311.67	413.52	385.87	388.12	331.69	394.68	386.40	237.87	0.00	0.00	0.00	2849.83
EAF [%]	100.00	87.44	100.00	100.00	100.00	100.00	100.00	100.00	-241.15	100.00	100.00	100.00	71.04
UCF [%]	100.00	87.44	100.00	100.00	100.00	100.00	100.00	100.00	-241.15	100.00	100.00	100.00	71.04
LF [%]	0.00	85.79	106.62	102.67	99.94	88.25	101.63	99.49	63.29	0.00	0.00	0.00	62.15
OF [%]	13.17	87.36	100.00	100.00	100.00	100.00	100.00	100.00	65.00	0.00	0.00	0.00	63.63
FLR [%]	0.00	12.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.38
UCL [%]	0.00	12.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	341.15	0.00	0.00	0.00	27.96
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	200759.66 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.7 %
Cumulative Energy Availability Factor (EAF)	:	87.5 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.37 %
Cumulative Unit Capability Factor (UCF)	:	87.52 %	Cumulative Planned Unavailability Factor (PUF)	:	9.11 %
Cumulative Load Factor (LF)	:	86.77 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	87.47 %			

Electricity Production (net) [GWh]

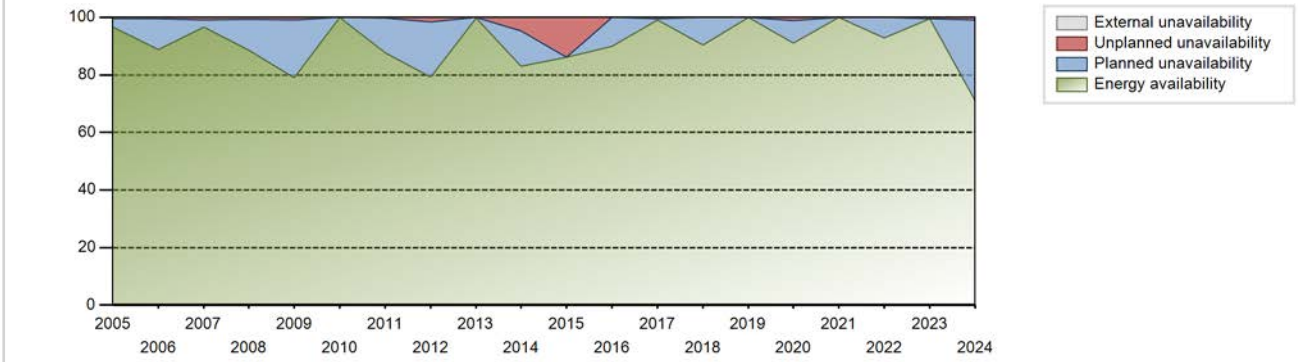


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1973	7.20	312	514	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1974	1452.20	3848	520	43.95	43.95	31.88	43.93	51.66	46.97	9.08	0.00
1975	3694.20	7560	520	81.18	81.18	81.10	86.30	6.61	5.75	13.07	0.00
1976	3268.70	6801	520	71.55	71.55	71.56	77.42	11.20	9.03	19.43	0.00
1977	3714.50	7453	511	82.93	82.93	82.98	85.08	0.92	0.77	16.29	0.00
1978	3810.70	8012	507	85.86	85.86	85.80	91.46	4.44	3.99	10.14	0.00
1979	2910.90	6402	503	65.84	65.84	66.06	73.08	24.15	20.96	13.20	0.00
1980	3105.70	6863	503	77.80	77.80	70.29	78.13	2.56	2.05	20.15	0.00
1981	3838.60	7803	503	88.87	88.87	87.12	89.08	0.27	0.24	10.88	0.00
1982	3918.00	7960	503	90.90	90.90	88.92	90.87	0.20	0.18	8.92	0.00
1983	3888.90	7621	503	87.20	87.20	88.26	87.00	4.99	4.58	8.22	0.00
1984	4159.39	8285	503	94.34	94.34	94.14	94.32	4.95	4.91	0.75	0.00
1985	3678.45	7333	503	83.39	83.39	83.48	83.71	0.60	0.51	16.11	0.00
1986	3819.56	7870	503	89.64	89.64	86.68	89.84	0.31	0.28	10.08	0.00
1987	3590.27	7232	503	82.22	82.22	81.48	82.56	4.08	3.50	14.29	0.00
1988	3823.39	7800	503	89.26	89.26	86.53	88.80	0.11	0.10	10.65	0.00
1989	4392.28	8737	503	99.75	99.75	99.68	99.74	0.25	0.25	0.00	0.00
1990	3829.68	7764	503	81.66	81.66	86.91	88.63	8.30	7.39	10.94	0.00
1991	3987.08	7943	505	90.51	90.51	90.09	90.67	1.27	1.16	8.33	0.00
1992	3497.78	6844	503	77.44	77.44	79.16	77.91	4.38	3.55	19.01	0.00
1993	4377.99	8480	505	96.83	96.83	98.86	96.80	0.18	0.17	3.00	0.00
1994	3718.20	7258	513	82.84	82.84	82.74	82.85	2.23	1.89	15.27	0.00
1995	4519.04	8752	513	99.91	99.91	100.56	99.91	0.00	0.00	0.09	0.00
1996	3741.65	7327	513	92.18	92.86	83.03	83.41	0.00	0.00	7.14	0.68
1997	3522.80	6965	513	79.53	79.53	78.39	79.51	4.83	4.04	16.43	0.00
1998	4209.16	7948	514	90.78	90.78	93.46	90.73	8.98	8.96	0.27	0.00
1999	4068.78	7643	522	87.17	87.17	88.98	87.25	2.02	1.80	11.02	0.00
2000	4536.51	8499	522	96.74	96.74	98.94	96.76	0.00	0.00	3.26	0.00
2001	3641.74	6890	522	78.77	78.77	79.64	78.65	12.28	11.02	10.21	0.00
2002	4373.23	8268	522	94.36	94.36	95.64	94.38	0.00	0.00	5.64	0.00
2003	4596.35	8619	522	98.38	98.38	100.96	98.39	1.62	1.62	0.00	0.00
2004	3602.14	7017	522	79.89	79.89	78.56	79.88	0.00	0.00	20.11	0.00
2005	4518.40	8465	522	96.66	96.66	98.80	96.62	0.44	0.43	2.91	0.00
2006	4103.24	7785	523	88.88	88.88	89.56	88.87	0.57	0.51	10.62	0.00
2007	4457.09	8472	551	96.72	96.72	92.34	96.71	0.98	0.96	2.32	0.00
2008	4059.45	7780	551	88.58	88.58	83.87	88.57	0.83	0.74	10.67	0.00
2009	3600.15	6923	551	79.04	79.04	74.59	79.03	1.20	0.96	20.00	0.00

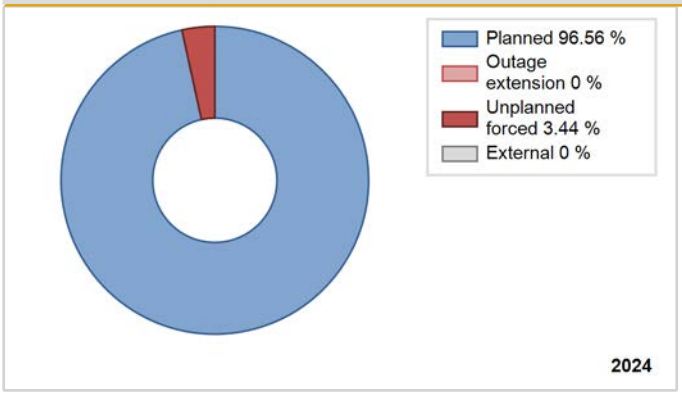
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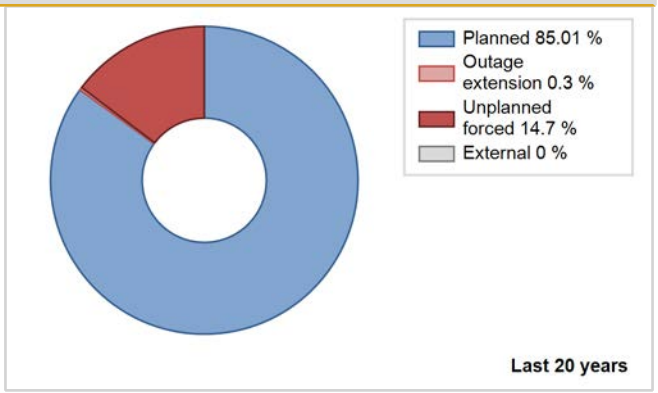
2010	4654.86	8760	560	100.00	100.00	96.04	100.00	0.00	0.00	0.00	0.00
2011	4128.39	7717	521	87.69	87.69	87.22	88.09	0.39	0.34	11.96	0.00
2012	3705.98	6961	522	79.26	79.26	80.82	79.25	1.99	1.61	19.13	0.00
2013	4654.69	8732	522	99.68	99.68	101.78	99.67	0.00	0.00	0.32	0.00
2014	3812.46	7264	522	82.92	82.92	83.37	82.92	5.28	4.62	12.45	0.00
2015	3991.22	7539	522	86.06	86.06	87.28	86.06	13.94	13.94	0.00	0.00
2016	4207.70	7903	522	89.97	89.97	91.77	89.97	0.00	0.00	10.03	0.00
2017	4565.00	8689	522	99.18	99.18	99.83	99.19	0.54	0.54	0.28	0.00
2018	4190.47	7916	522	90.36	90.36	91.64	90.37	0.00	0.00	9.64	0.00
2019	4772.56	8760	522	100.00	100.00	104.37	100.00	0.00	0.00	0.00	0.00
2020	4337.58	8092	522	91.02	91.02	94.60	92.12	1.21	1.12	7.86	0.00
2021	4772.37	8760	522	100.00	100.00	104.37	100.00	0.00	0.00	0.00	0.00
2022	4368.70	8137	522	92.88	92.88	95.54	92.89	0.00	0.00	7.12	0.00
2023	3780.99	6994	522	99.46	99.46	82.69	79.84	0.00	0.54	0.00	0.00
2024	2849.83	5589	522	71.04	71.04	62.15	63.63	1.38	1.00	27.96	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1973 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		88			248	
B. Refuelling without maintenance				24		
C. Inspection, maintenance or repair combined with refuelling	2461			677		
D. Inspection, maintenance or repair without refuelling				62		
E. Testing of plant systems or components				5	1	
F. Major backfitting, refurbishment or upgrading activities with refuelling				0		
H. Nuclear regulatory requirements					3	
L. Human factor related					1	
P. Fire					18	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					0	
Z. Other					2	1
Subtotal	2461	88		768	273	1
Total		**2549**			**1042**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1973 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		11
12. Reactor I&C Systems		39
14. Safety Systems		7
15. Reactor Cooling Systems		29
16. Steam generation systems		27
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		90
32. Feedwater and Main Steam System	88	29
33. Circulating Water System		2
34. Miscellaneous Systems		3
35. All other I&C Systems		6
41. Main Generator Systems		15
42. Electrical Power Supply Systems		11
Total	**88**	**270**

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2024 Operating Experience

US-306 PRAIRIE ISLAND-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	NSP (Northern States Power Co. (subsidiary of Xcel Energy))
Owner	:	XCEL (Xcel Energy)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 2LP (DRYAMB)
Thermal power	:	1677 MWth
Gross electrical power	:	560 MWe
Reference unit power (net)	:	519 MWe

Key Dates

Construction Date	:	1969-06-25
Grid Date	:	1974-12-21
Commercial Date	:	1974-12-21
Age at end of year	:	50 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	40
Average discharge burnup [MWd/t]	:	51000
Active core diameter [m]	:	2.45
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	121
Fuel linear heat generation rate [kW/m]	:	20.3
Number of control rod assemblies	:	21
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

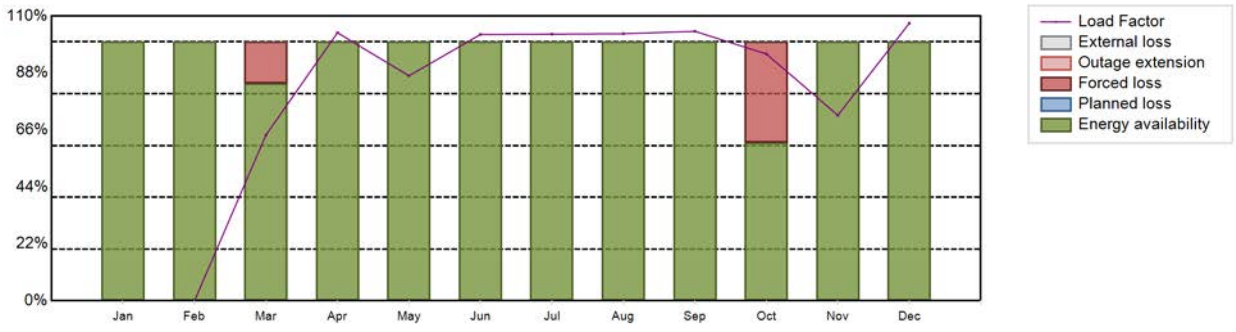
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	315
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.291
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.06
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	3589.21 GW(e).h
Energy Availability Factor (EAF)	:	95.36 %
Unit Capability Factor (UCF)	:	95.36 %
Load Factor (LF)	:	78.73 %
Operating Factor (OF)	:	78.7 %

Forced Loss Rate (FLR)	:	4.64 %
Unplanned Capability Loss Factor (UCL)	:	4.64 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1871 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	0.00	246.98	386.94	335.61	384.30	397.74	398.31	388.94	368.24	268.13	414.01	3589.21
EAF [%]	100.00	100.00	84.06	100.00	100.00	100.00	100.00	100.00	100.00	61.13	100.00	100.00	95.36
UCF [%]	100.00	100.00	84.06	100.00	100.00	100.00	100.00	100.00	100.00	61.13	100.00	100.00	95.36
LF [%]	0.00	0.00	64.05	103.55	86.92	102.84	103.01	103.15	104.08	95.37	71.65	107.22	78.73
OF [%]	0.00	0.00	81.02	100.00	100.00	100.00	100.00	100.00	100.00	91.67	68.38	100.00	78.70
FLR [%]	0.00	0.00	15.94	0.00	0.00	0.00	0.00	0.00	0.00	38.87	0.00	0.00	4.64
UCL [%]	0.00	0.00	15.94	0.00	0.00	0.00	0.00	0.00	0.00	38.87	0.00	0.00	4.64
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	199220.81 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.15 %
Cumulative Energy Availability Factor (EAF)	:	88.44 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.88 %
Cumulative Unit Capability Factor (UCF)	:	88.45 %	Cumulative Planned Unavailability Factor (PUF)	:	8.67 %
Cumulative Load Factor (LF)	:	88.3 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	88.55 %			

Electricity Production (net) [GWh]

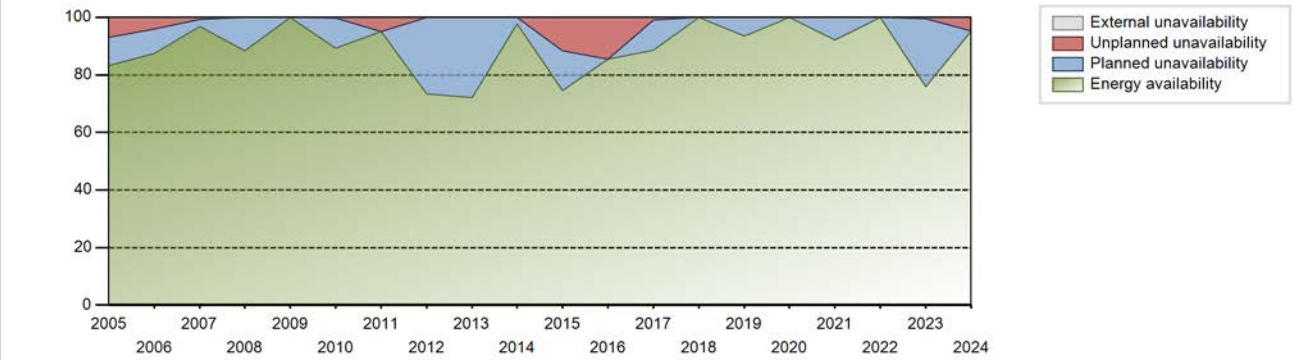


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1974	7.40	104	513	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1975	3176.20	7035	520	69.91	69.91	69.92	80.53	22.79	20.63	9.46	0.00
1976	2660.60	6657	520	58.24	58.24	58.25	75.79	16.48	11.50	30.27	0.00
1977	3882.30	7807	511	86.68	86.68	86.73	89.12	1.79	1.58	11.74	0.00
1978	3924.40	8126	507	88.16	88.16	88.36	92.76	2.09	1.88	9.96	0.00
1979	4193.00	8661	500	94.61	94.61	95.73	98.87	3.46	3.39	2.00	0.00
1980	3468.70	7167	500	81.41	81.54	78.98	81.59	0.24	0.20	18.26	0.13
1981	3092.90	6292	500	71.40	71.40	70.61	71.83	15.28	12.88	15.72	0.00
1982	3857.70	7844	500	89.85	89.99	88.08	89.54	0.26	0.24	9.77	0.15
1983	3716.30	7574	500	86.51	86.51	84.85	86.46	2.88	2.56	10.93	0.00
1984	3905.96	7830	500	89.16	89.16	88.93	89.14	0.00	0.00	10.84	0.00
1985	3612.47	7378	500	92.95	92.95	82.48	84.22	0.00	0.00	7.05	0.00
1986	3853.98	7930	500	90.55	90.55	87.99	90.53	0.55	0.50	8.95	0.00
1987	4462.19	8760	500	100.00	100.00	101.88	100.00	0.00	0.00	0.00	0.00
1988	3886.16	7773	500	88.24	88.24	88.48	88.49	1.19	1.07	10.70	0.00
1989	3887.19	7798	500	96.86	96.86	88.75	89.02	2.30	2.28	0.86	0.00
1990	3803.70	7602	500	83.31	83.31	86.84	86.78	8.79	8.03	8.65	0.00
1991	4480.40	8760	502	100.00	100.00	101.82	100.00	0.00	0.00	0.00	0.00
1992	3223.51	6516	500	73.51	73.51	73.40	74.18	0.00	0.00	26.49	0.00
1993	3746.24	7338	503	83.53	83.53	85.02	83.77	0.00	0.00	16.47	0.00
1994	4552.96	8734	512	99.71	99.71	101.51	99.70	0.23	0.23	0.06	0.00
1995	3968.17	7666	512	87.51	87.51	88.47	87.51	0.00	0.00	12.49	0.00
1996	4485.11	8653	512	98.55	99.20	99.73	98.51	0.80	0.80	0.00	0.65
1997	3642.86	7180	512	82.00	82.00	81.22	81.96	7.91	7.05	10.95	0.00
1998	3333.71	6555	512	74.84	74.84	74.33	74.83	12.44	10.64	14.52	0.00
1999	4597.44	8690	522	99.21	99.21	100.48	99.20	0.00	0.00	0.79	0.00
2000	4182.26	7820	522	89.03	89.03	91.21	89.03	0.00	0.00	10.97	0.00
2001	4270.96	8031	522	91.67	91.67	93.40	91.68	8.33	8.33	0.00	0.00
2002	4296.03	8082	522	92.43	92.43	93.95	92.26	0.00	0.00	7.57	0.00
2003	4240.97	8058	522	91.97	91.97	92.75	91.99	0.55	0.51	7.52	0.00
2004	4660.26	8737	522	99.47	99.47	101.64	99.46	0.53	0.53	0.00	0.00
2005	3848.63	7296	522	83.30	83.30	84.16	83.28	7.72	6.97	9.73	0.00
2006	4012.40	7665	522	87.52	87.52	87.75	87.50	4.53	4.15	8.33	0.00
2007	4456.64	8488	545	96.91	96.91	93.35	96.89	0.82	0.81	2.28	0.00
2008	4059.36	7768	545	88.45	88.45	84.79	88.43	0.00	0.00	11.55	0.00
2009	4653.35	8760	545	100.00	100.00	97.47	100.00	0.00	0.00	0.00	0.00
2010	4128.07	7817	554	89.30	89.30	86.11	89.24	0.35	0.31	10.39	0.00

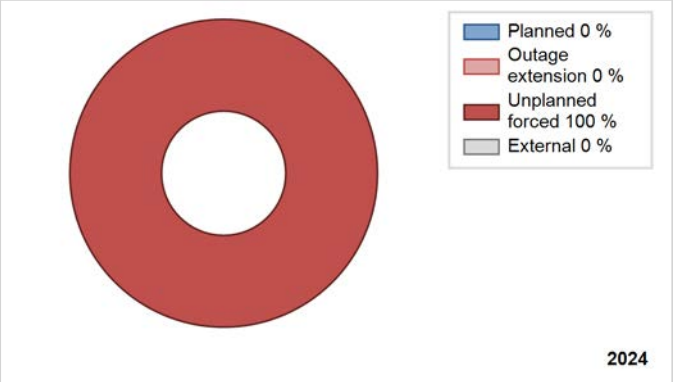
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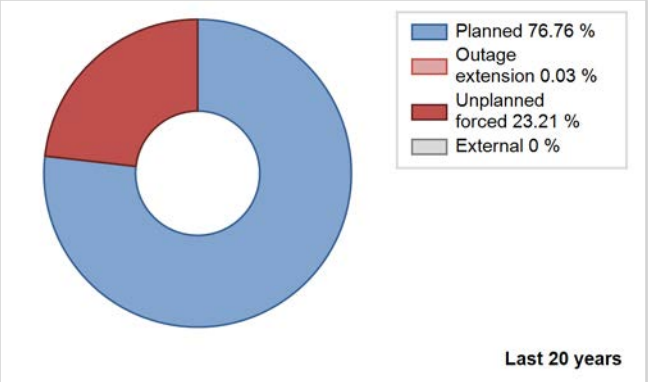
2011	4477.65	8354	519	95.07	95.07	98.49	95.37	4.93	4.93	0.00	0.00
2012	3354.75	6453	518	73.49	73.49	73.73	73.46	0.00	0.00	26.51	0.00
2013	3069.71	6311	519	72.11	72.11	67.51	72.04	0.00	0.00	27.89	0.00
2014	4570.74	8556	518	97.67	97.67	100.73	97.67	0.00	0.00	2.33	0.00
2015	3386.74	6531	518	74.56	74.56	74.64	74.55	13.40	11.54	13.91	0.00
2016	4066.08	7500	518	85.38	85.38	89.36	85.38	14.62	14.62	0.00	0.00
2017	4179.73	7767	519	88.68	88.68	91.93	88.66	0.91	0.82	10.50	0.00
2018	4792.83	8760	519	100.00	100.00	105.42	100.00	0.00	0.00	0.00	0.00
2019	4367.41	8183	519	93.42	93.42	96.06	93.41	0.00	0.00	6.58	0.00
2020	4746.40	8783	519	100.00	100.00	104.11	99.99	0.00	0.00	0.00	0.00
2021	4299.59	8066	519	92.08	92.08	94.57	92.08	0.00	0.00	7.92	0.00
2022	4782.23	8760	519	100.00	100.00	105.19	100.00	0.00	0.00	0.00	0.00
2023	3349.16	6326	519	75.85	75.85	73.67	72.21	0.51	0.45	23.70	0.00
2024	3589.21	6913	519	95.36	95.36	78.73	78.70	4.64	4.64	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1974 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		408			208	
B. Refuelling without maintenance				14		
C. Inspection, maintenance or repair combined with refuelling				639		
D. Inspection, maintenance or repair without refuelling				64		
E. Testing of plant systems or components				3		
H. Nuclear regulatory requirements					10	
J. Grid limitation, failure or grid unavailability						0
L. Human factor related					1	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						10
Z. Other					2	1
Subtotal		408		720	221	11
Total		**408**			**952**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1974 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	289	7
12. Reactor I&C Systems		30
13. Reactor Auxiliary Systems		3
14. Safety Systems		1
15. Reactor Cooling Systems		34
16. Steam generation systems		4
17. Safety I&C Systems (excluding reactor I&C)		10
31. Turbine and auxiliaries	118	61
32. Feedwater and Main Steam System		4
33. Circulating Water System		12
34. Miscellaneous Systems		4
35. All other I&C Systems		1
41. Main Generator Systems		37
42. Electrical Power Supply Systems		21
Total	**407**	**229**

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2024 Operating Experience

US-254 QUAD CITIES-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXE/MIDA (Exelon (75%), MidAmerican Energy (25%)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-3 (Mark 1)
Thermal power	:	2957 MWth
Gross electrical power	:	940 MWe
Reference unit power (net)	:	908 MWe

Key Dates

Construction Date	:	1967-02-15
Grid Date	:	1972-04-12
Commercial Date	:	1973-02-18
Age at end of year	:	52 years

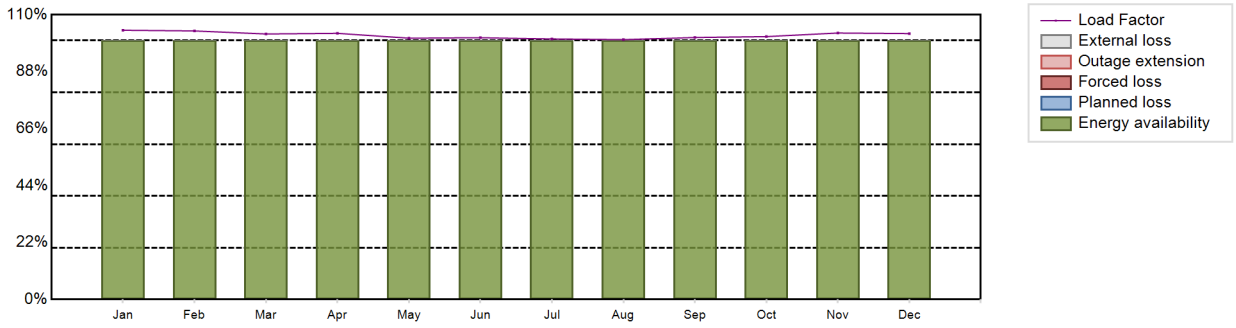
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.1
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	286
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.43
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	35	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	47000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.55	HP cylinder inlet steam pressure [MPa]	:	6.57
Active core height/length [m]	:	3.6	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	724	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	43.96	Number of main condensate pumps	:	-
Number of control rod assemblies	:	177	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	102.03 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



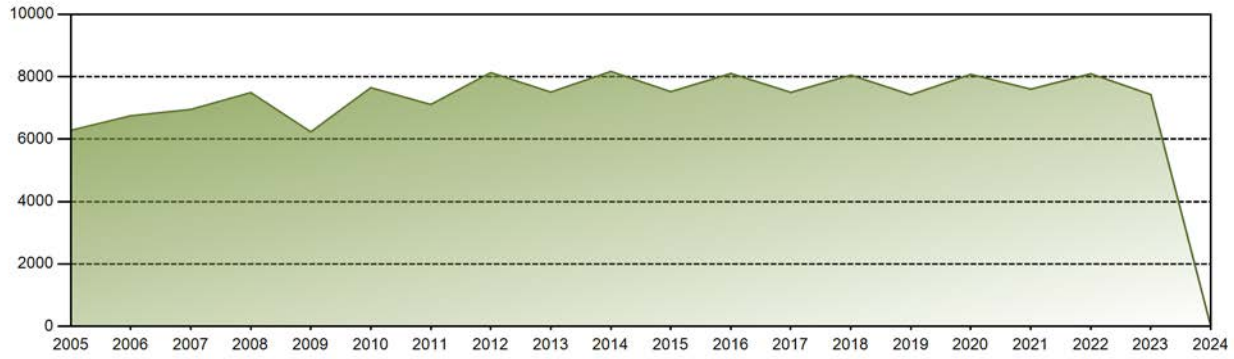
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	702.59	655.55	691.84	672.10	681.89	661.06	679.82	677.98	661.49	685.98	673.83	693.86	8137.98
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	104.00	103.73	102.55	102.81	100.94	101.12	100.63	100.36	101.18	101.54	102.93	102.71	102.03
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.23 %
Cumulative Energy Availability Factor (EAF)	:	83.57 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.65 %
Cumulative Unit Capability Factor (UCF)	:	83.6 %	Cumulative Planned Unavailability Factor (PUF)	:	11.75 %
Cumulative Load Factor (LF)	:	80.35 %	Cumulative Externally cause unavailability (XUF)	:	0.03 %
Cumulative Operating Factor (OF)	:	84.37 %			

Electricity Production (net) [GWh]

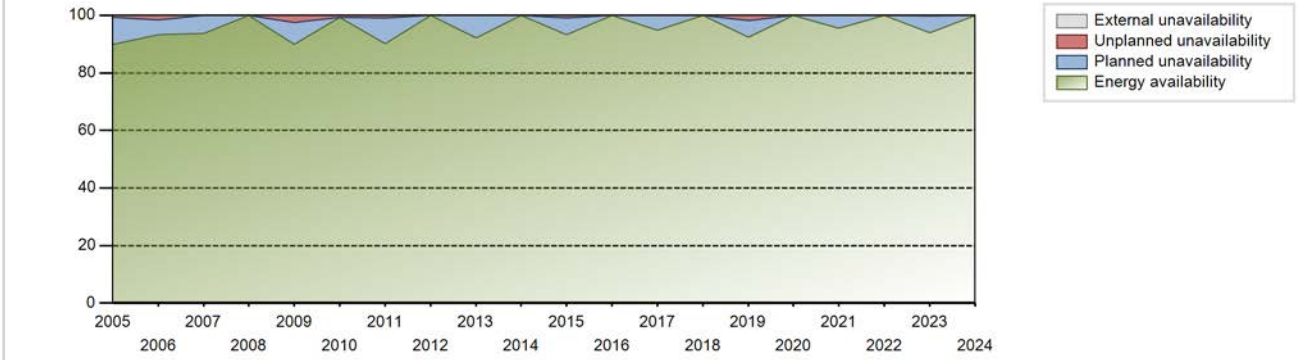


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1973	4908.50	7382	800	86.81	86.81	69.05	82.79	4.33	3.93	9.26	0.00
1974	3464.10	5365	800	61.37	61.37	49.43	61.24	17.84	13.33	25.31	0.00
1975	4413.40	7531	800	61.04	61.04	62.98	85.97	38.96	38.96	0.00	0.00
1976	3401.70	5699	769	50.44	50.44	50.36	64.88	14.61	8.63	40.92	0.00
1977	3527.40	6176	769	52.42	52.42	52.36	70.50	21.19	14.10	33.49	0.00
1978	4782.00	8315	769	71.04	71.04	70.99	94.92	11.08	8.85	20.11	0.00
1979	4786.50	7096	769	71.05	71.05	71.05	81.00	9.44	7.41	21.54	0.00
1980	3468.80	5840	769	66.68	67.43	51.35	66.48	2.92	2.03	30.54	0.75
1981	5726.80	8244	769	94.33	94.33	85.01	94.11	2.05	1.97	3.70	0.00
1982	3258.00	5951	769	68.48	68.48	48.36	67.93	1.18	0.82	30.70	0.00
1983	5776.40	8258	769	94.65	94.65	85.75	94.27	1.00	0.96	4.39	0.00
1984	3358.48	4687	769	53.37	53.37	49.72	53.36	2.65	1.45	45.17	0.00
1985	6072.32	8242	769	94.11	94.11	90.14	94.09	3.80	3.72	2.17	0.00
1986	4426.18	6035	769	68.92	68.92	65.71	68.89	3.37	2.40	28.67	0.00
1987	4456.09	6141	769	70.11	70.11	66.15	70.10	0.71	0.50	29.38	0.00
1988	5661.98	8199	769	93.36	93.36	83.82	93.34	4.22	4.11	2.53	0.00
1989	4280.44	6428	769	73.43	73.43	63.54	73.38	6.13	4.79	21.78	0.00
1990	5345.56	7276	769	83.08	83.08	79.35	83.06	1.48	1.24	15.67	0.00
1991	3549.53	4882	769	55.79	56.61	52.69	55.73	16.08	10.84	32.55	0.82
1992	4166.14	6158	769	70.12	70.12	61.68	70.10	7.88	6.00	23.88	0.00
1993	5042.49	6902	769	78.81	78.81	74.85	78.79	15.10	14.02	7.17	0.00
1994	1670.17	2526	769	28.87	28.87	24.79	28.84	46.41	25.00	46.13	0.00
1995	5886.21	7934	769	90.59	90.59	87.38	90.57	9.41	9.41	0.00	0.00
1996	2680.59	3769	769	42.94	42.94	39.68	42.91	2.98	1.32	55.74	0.00
1997	5565.46	7764	769	88.69	88.69	82.62	88.63	11.31	11.31	0.00	0.00
1998	3142.88	4299	769	49.12	49.12	46.65	49.08	41.59	34.98	15.90	0.00
1999	6337.59	8210	769	93.72	93.72	94.08	93.72	0.55	0.52	5.75	0.00
2000	6168.07	8242	769	93.83	93.83	91.31	93.83	0.56	0.52	5.65	0.00
2001	6710.87	8691	769	99.22	99.22	99.62	99.21	0.00	0.00	0.78	0.00
2002	5709.52	7564	855	86.60	86.60	83.96	86.35	7.61	7.14	6.26	0.00
2003	6810.25	8013	855	92.41	92.41	90.93	91.47	4.96	4.82	2.77	0.00
2004	6502.77	8784	855	100.00	100.00	86.58	100.00	0.00	0.00	0.00	0.00
2005	6281.05	7875	864	89.92	89.92	82.98	89.89	0.69	0.62	9.46	0.00
2006	6747.25	8161	867	93.18	93.18	88.84	93.16	1.77	1.68	5.14	0.00
2007	6951.04	8212	867	93.75	93.75	91.52	93.74	0.00	0.00	6.25	0.00
2008	7490.09	8784	867	100.00	100.00	98.35	100.00	0.00	0.00	0.00	0.00
2009	6230.78	7879	867	89.96	89.96	82.04	89.94	0.98	2.53	7.52	0.00

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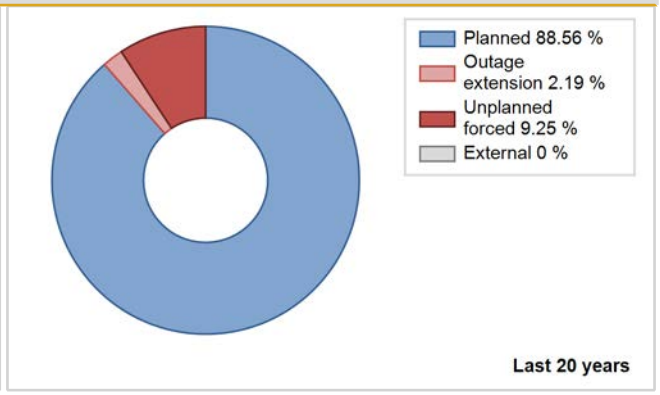
2010	7646.11	8698	882	99.31	99.31	98.96	99.29	0.69	0.69	0.00	0.00
2011	7109.23	7898	882	90.18	90.18	92.01	90.16	1.13	1.03	8.79	0.00
2012	8130.41	8784	908	100.00	100.00	101.94	100.00	0.00	0.00	0.00	0.00
2013	7505.99	8073	908	92.16	92.16	94.36	92.15	0.00	0.00	7.84	0.00
2014	8168.26	8760	908	100.00	100.00	102.69	100.00	0.00	0.00	0.00	0.00
2015	7519.60	8170	908	93.26	93.26	94.54	93.26	0.87	0.82	5.91	0.00
2016	8104.18	8784	908	100.00	100.00	101.61	100.00	0.00	0.00	0.00	0.00
2017	7498.16	8305	908	94.81	94.81	94.27	94.81	0.00	0.00	5.19	0.00
2018	8051.91	8668	908	100.00	100.00	101.23	98.95	0.00	0.00	0.00	0.00
2019	7421.05	8101	908	92.49	92.49	93.30	92.48	1.95	1.84	5.67	0.00
2020	8075.97	8783	908	100.00	100.00	101.25	99.99	0.00	0.00	0.00	0.00
2021	7601.76	8360	908	95.44	95.44	95.57	95.43	0.00	0.00	4.56	0.00
2022	8095.80	8760	908	100.00	100.00	101.78	100.00	0.00	0.00	0.00	0.00
2023	7425.73	8241	908	93.95	93.95	93.36	94.08	0.00	0.18	5.87	0.00
2024	Data not provided										

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1973 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					243	
B. Refuelling without maintenance				8		
C. Inspection, maintenance or repair combined with refuelling				856		
D. Inspection, maintenance or repair without refuelling				115	56	
E. Testing of plant systems or components				7	6	
H. Nuclear regulatory requirements					6	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						10
L. Human factor related					50	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						2
P. Fire					6	
Z. Other				2	6	1
Subtotal				988	373	13
Total		**0**			**1374**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1973 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		6
12. Reactor I&C Systems		16
13. Reactor Auxiliary Systems		2
14. Safety Systems		6
15. Reactor Cooling Systems		72
31. Turbine and auxiliaries		67
32. Feedwater and Main Steam System		18
34. Miscellaneous Systems		21
41. Main Generator Systems		15
42. Electrical Power Supply Systems		30
Total		**253**

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2024 Operating Experience

US-265 QUAD CITIES-2 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	EXELON (Exelon Generation Co., LLC)
Owner	:	EXE/MIDA (Exelon (75%), MidAmerican Energy (25%)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)



Reactor Unit Details

Reactor type and model	:	BWR / BWR-3 (Mark 1)
Thermal power	:	2957 MWth
Gross electrical power	:	940 MWe
Reference unit power (net)	:	911 MWe

Key Dates

Construction Date	:	1967-02-15
Grid Date	:	1972-05-23
Commercial Date	:	1973-03-10
Age at end of year	:	52 years

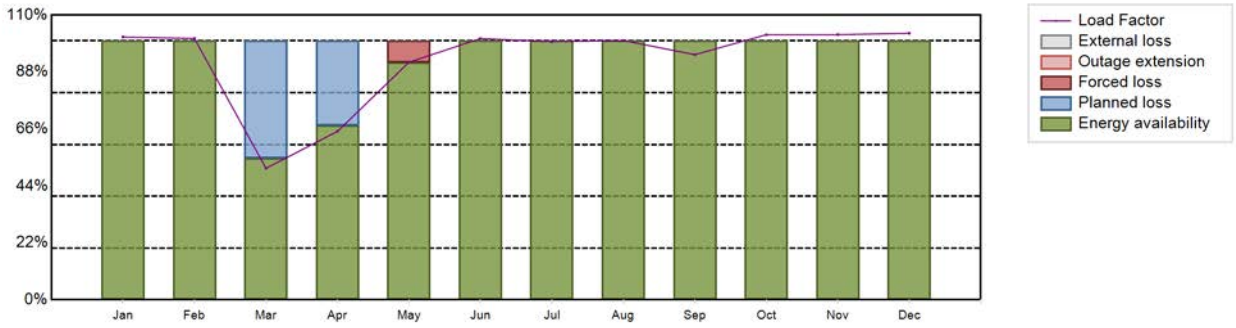
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.1
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	286
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	Confinement
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.43
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	35	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	47000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.55	HP cylinder inlet steam pressure [MPa]	:	6.57
Active core height/length [m]	:	3.6	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	724	Primary means of condenser cooling	:	River (once-through)
Fuel linear heat generation rate [kW/m]	:	43.96	Number of main condensate pumps	:	-
Number of control rod assemblies	:	177	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7422.39 GW(e).h	Forced Loss Rate (FLR)	:	0.75 %
Energy Availability Factor (EAF)	:	92.8 %	Unplanned Capability Loss Factor (UCL)	:	0.7 %
Unit Capability Factor (UCF)	:	92.8 %	Planned Unavailability Factor (PUF)	:	6.5 %
Load Factor (LF)	:	92.75 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	92.79 %	Total off-line time	:	633 hours

Annual Summary



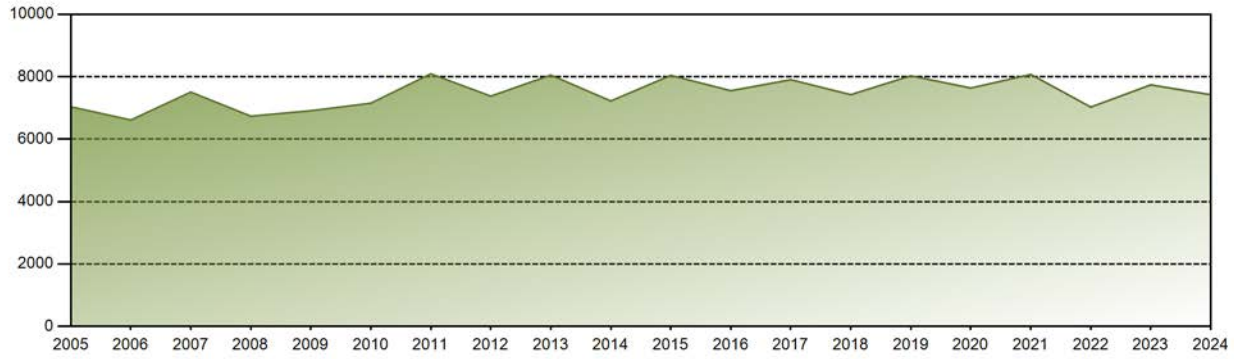
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	688.01	639.97	343.79	426.76	621.81	661.86	675.88	678.72	621.10	694.08	672.66	697.75	7422.39
EAF [%]	100.00	100.00	54.78	67.42	91.73	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.80
UCF [%]	100.00	100.00	54.78	67.42	91.73	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.80
LF [%]	101.51	100.93	50.79	65.06	91.74	100.91	99.72	100.14	94.69	102.40	102.41	102.95	92.75
OF [%]	100.00	100.00	54.78	67.36	91.67	100.00	100.00	100.00	100.00	100.00	100.00	100.00	92.79
FLR [%]	0.00	0.00	0.00	0.00	8.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75
UCL [%]	0.00	0.00	0.00	0.00	8.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70
PUF [%]	0.00	0.00	45.22	32.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.50
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	298910.29 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.87 %
Cumulative Energy Availability Factor (EAF)	:	82.27 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.18 %
Cumulative Unit Capability Factor (UCF)	:	82.76 %	Cumulative Planned Unavailability Factor (PUF)	:	12.05 %
Cumulative Load Factor (LF)	:	78.86 %	Cumulative Externally cause unavailability (XUF)	:	0.5 %
Cumulative Operating Factor (OF)	:	83.04 %			

Electricity Production (net) [GWh]

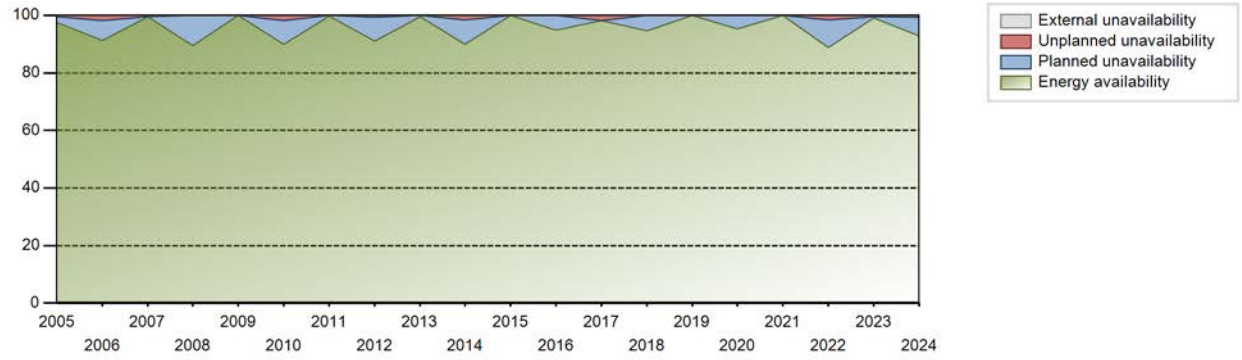


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1973	5208.90	7405	800	86.42	86.42	74.76	84.94	4.05	3.64	9.94	0.00
1974	4643.80	7232	800	82.56	82.56	66.26	82.56	11.84	11.08	6.36	0.00
1975	2490.90	4555	798	35.73	35.73	35.63	52.00	31.66	16.55	47.72	0.00
1976	4320.00	7143	769	64.02	64.02	63.95	81.32	9.71	6.88	29.10	0.00
1977	4369.30	7118	769	64.92	64.92	64.86	81.26	12.32	9.12	25.96	0.00
1978	4429.10	7022	769	65.74	65.74	65.75	80.16	6.60	4.64	29.62	0.00
1979	3993.60	7686	769	59.28	59.28	59.28	87.74	13.92	9.59	31.13	0.00
1980	3651.60	5486	769	62.47	62.79	54.06	62.45	8.26	5.65	31.56	0.32
1981	3770.70	5957	769	68.07	68.07	55.97	68.00	1.08	0.74	31.19	0.00
1982	5062.30	7343	769	83.98	83.98	75.15	83.82	14.50	14.24	1.78	0.00
1983	3158.50	5620	769	64.18	64.18	46.89	64.16	0.50	0.32	35.50	0.00
1984	4984.45	6837	769	77.87	77.87	73.79	77.83	10.15	8.79	13.34	0.00
1985	4560.69	6247	769	71.33	71.33	67.70	71.31	2.97	2.19	26.49	0.00
1986	4727.96	6399	769	74.24	74.24	70.18	73.05	0.88	0.66	25.10	0.00
1987	4952.99	6832	769	78.06	78.06	73.53	77.99	17.05	16.05	5.90	0.00
1988	4178.87	6193	769	70.55	70.55	61.86	70.50	10.03	7.86	21.59	0.00
1989	5743.07	8363	769	95.51	95.51	85.25	95.47	3.85	3.82	0.67	0.00
1990	4373.60	6186	769	70.38	70.38	64.92	70.62	27.74	27.02	2.60	0.00
1991	5285.18	7731	769	88.26	88.26	78.46	88.25	11.74	11.74	0.00	0.00
1992	3464.19	5621	769	63.99	63.99	51.28	63.99	0.00	0.00	36.01	0.00
1993	3111.82	4538	769	51.84	51.84	46.19	51.80	26.46	18.65	29.51	0.00
1994	4013.35	5745	769	65.66	65.66	59.58	65.58	34.26	34.21	0.13	0.00
1995	2496.98	3966	769	45.33	45.33	37.07	45.27	22.14	12.89	41.78	0.00
1996	4666.84	6348	769	72.31	98.78	69.09	72.27	1.22	1.22	0.00	26.47
1997	2627.74	3718	769	42.34	42.34	39.01	42.44	38.44	26.44	31.22	0.00
1998	3819.59	5095	769	58.20	59.00	56.70	58.16	2.12	1.28	39.73	0.79
1999	6596.69	8537	769	97.47	97.47	97.93	97.45	0.00	0.00	2.53	0.00
2000	6220.62	8156	769	92.87	92.87	92.09	92.85	1.21	1.14	5.99	0.00
2001	6273.82	8058	769	91.92	91.92	93.13	91.99	7.30	7.24	0.84	0.00
2002	6556.83	7852	855	90.37	90.37	89.77	89.63	3.56	3.33	6.30	0.00
2003	6975.11	8181	855	94.01	94.01	93.13	93.39	5.99	5.99	0.00	0.00
2004	6179.39	7955	855	90.48	90.48	82.28	90.56	0.32	0.29	9.23	0.00
2005	7036.91	8533	864	97.42	97.42	92.96	97.40	0.44	0.43	2.15	0.00
2006	6611.02	8000	867	91.34	91.34	87.05	91.32	1.84	1.71	6.94	0.00
2007	7505.84	8720	867	99.55	99.55	98.83	99.54	0.45	0.45	0.00	0.00
2008	6734.60	7852	867	89.40	89.40	88.43	89.39	0.00	0.00	10.60	0.00
2009	6909.37	8760	867	100.00	100.00	90.97	100.00	0.00	0.00	0.00	0.00

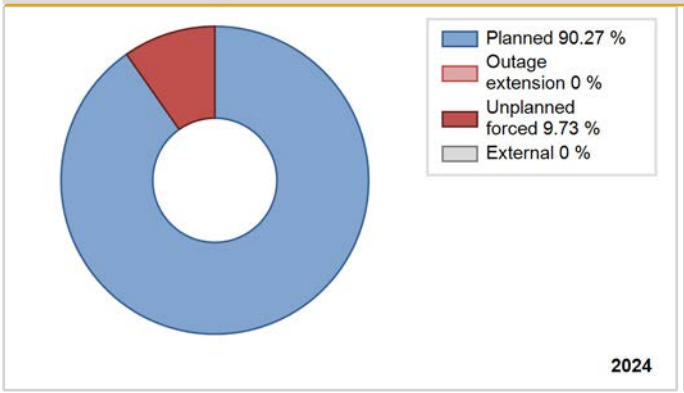
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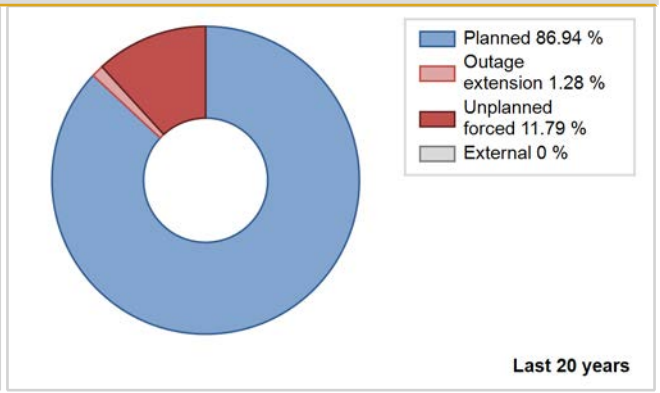
2010	7150.14	7849	892	89.90	89.90	91.51	89.60	0.88	1.93	8.17	0.00
2011	8092.34	8743	892	99.81	99.81	103.56	99.81	0.00	0.00	0.19	0.00
2012	7375.56	8004	911	91.14	91.14	92.17	91.12	0.67	0.61	8.25	0.00
2013	8051.85	8723	911	99.58	99.58	100.88	99.57	0.00	0.00	0.42	0.00
2014	7220.77	7886	911	90.03	90.03	90.48	90.02	1.84	1.69	8.28	0.00
2015	8042.55	8760	911	100.00	100.00	100.78	100.00	0.00	0.00	0.00	0.00
2016	7550.87	8336	911	94.90	94.90	94.36	94.90	0.00	0.00	5.10	0.00
2017	7903.72	8604	911	98.22	98.22	99.04	98.22	1.78	1.78	0.00	0.00
2018	7424.55	8282	911	94.68	94.68	93.04	94.54	0.00	0.00	5.32	0.00
2019	8029.05	8760	911	100.00	100.00	100.61	100.00	0.00	0.00	0.00	0.00
2020	7636.48	8376	911	95.37	95.37	95.43	95.36	0.00	0.00	4.63	0.00
2021	8073.93	8760	911	100.00	100.00	101.17	100.00	0.00	0.00	0.00	0.00
2022	7026.45	7782	911	88.84	88.84	88.05	88.84	1.84	1.66	9.50	0.00
2023	7739.24	8512	911	99.15	99.15	96.98	97.17	0.53	0.53	0.32	0.00
2024	7422.39	8151	911	92.80	92.80	92.75	92.79	0.75	0.70	6.50	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1973 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		62			373	
B. Refuelling without maintenance				33		
C. Inspection, maintenance or repair combined with refuelling	571			812		
D. Inspection, maintenance or repair without refuelling				103		
E. Testing of plant systems or components				3	1	
H. Nuclear regulatory requirements					8	
K. Load-following (frequency control, reserve shutdown due to reduced energy demand, reactive power)						11
L. Human factor related					10	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
P. Fire					6	
Z. Other				68	32	45
Subtotal	571	62		1019	430	57
Total		**633**			**1506**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1973 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	62	21
12. Reactor I&C Systems		11
13. Reactor Auxiliary Systems		3
14. Safety Systems		13
15. Reactor Cooling Systems		52
16. Steam generation systems		8
17. Safety I&C Systems (excluding reactor I&C)		5
31. Turbine and auxiliaries		66
32. Feedwater and Main Steam System		37
33. Circulating Water System		6
34. Miscellaneous Systems		67
35. All other I&C Systems		1
41. Main Generator Systems		28
42. Electrical Power Supply Systems		60
Total	**62**	**378**

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2024 Operating Experience

US-458 RIVER BEND-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	ENTERGY (Entergy Nuclear Operations, Inc.)
Owner	:	ENTGS (ENTERGY GULF STATES, INC.)
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-6 (Mark 3)
Thermal power	:	3091 MWth
Gross electrical power	:	1016 MWe
Reference unit power (net)	:	967 MWe

Key Dates

Construction Date	:	1977-03-25
Grid Date	:	1985-12-03
Commercial Date	:	1986-06-16
Age at end of year	:	39 years

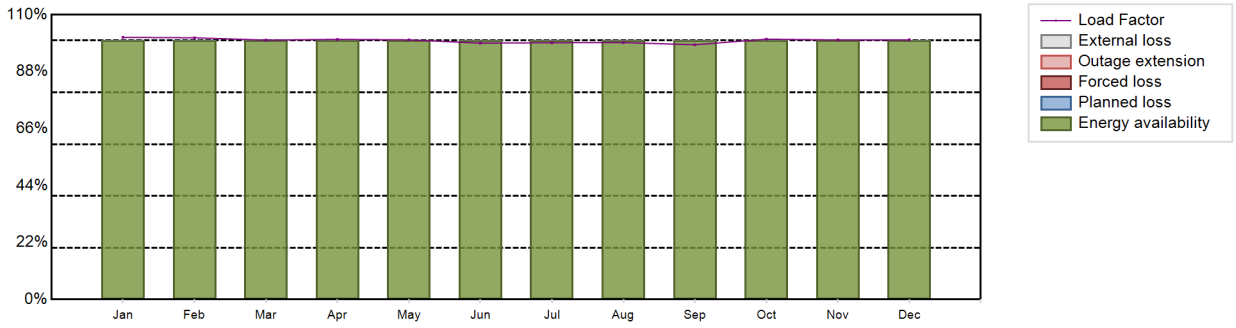
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.56
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	288
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.105
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	25	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	29600	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.29	HP cylinder inlet steam pressure [MPa]	:	6.78
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	624	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	18.86	Number of main condensate pumps	:	-
Number of control rod assemblies	:	145	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	100.01 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



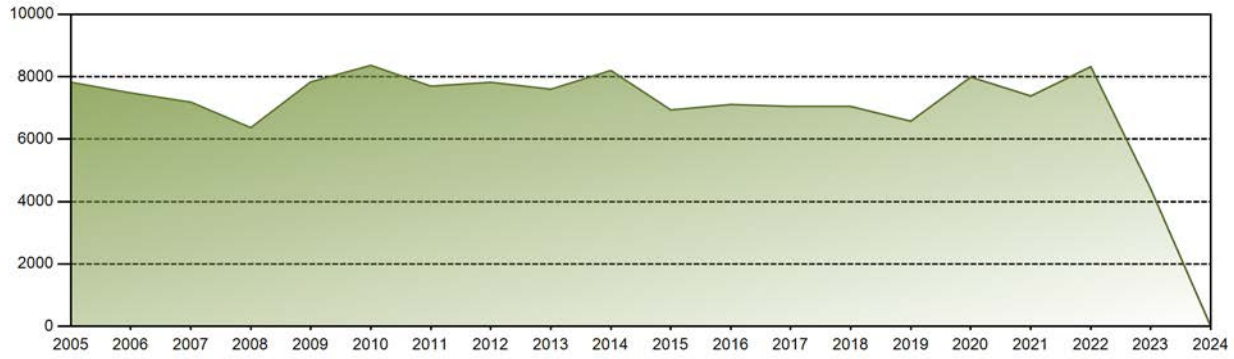
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	728.34	680.26	719.88	699.57	721.48	689.43	713.44	713.99	685.02	723.42	698.89	721.60	8495.31
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	101.24	101.07	100.19	100.48	100.28	99.02	99.16	99.24	98.39	100.55	100.24	100.30	100.01
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.23 %
Cumulative Energy Availability Factor (EAF)	:	85.22 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.72 %
Cumulative Unit Capability Factor (UCF)	:	85.37 %	Cumulative Planned Unavailability Factor (PUF)	:	9.91 %
Cumulative Load Factor (LF)	:	82.39 %	Cumulative Externally cause unavailability (XUF)	:	0.16 %
Cumulative Operating Factor (OF)	:	84.93 %			

Electricity Production (net) [GWh]

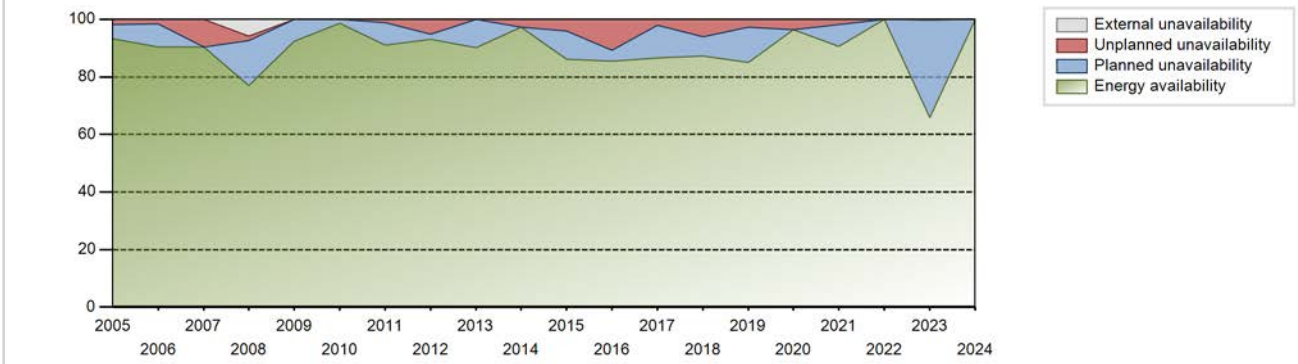


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1986	2995.44	4221	936	51.92	51.92	47.08	51.73	18.86	12.07	36.01	0.00
1987	4964.44	5836	936	66.65	66.65	60.55	66.62	5.69	4.02	29.33	0.00
1988	7248.98	8149	936	92.80	92.80	88.17	92.77	4.26	4.13	3.06	0.00
1989	4785.01	5853	936	66.88	66.88	58.36	66.82	11.31	8.53	24.60	0.00
1990	5592.55	6642	936	75.83	75.83	68.21	75.82	2.27	1.76	22.41	0.00
1991	6687.20	7507	936	85.72	85.72	81.56	85.70	11.54	11.19	3.09	0.00
1992	2762.68	3210	936	36.54	36.54	33.60	36.54	25.78	12.69	50.76	0.00
1993	5257.87	6076	936	69.37	69.37	64.13	69.36	28.70	27.92	2.71	0.00
1994	4886.23	5455	936	62.34	62.34	59.59	62.27	19.70	15.30	22.36	0.00
1995	7930.81	8704	936	99.37	99.37	96.72	99.36	0.63	0.63	0.00	0.00
1996	6860.33	7391	936	84.20	84.20	83.44	84.14	5.65	5.04	10.76	0.00
1997	6822.66	7427	936	84.82	84.82	83.21	84.78	5.08	4.54	10.64	0.00
1998	7833.50	8404	936	95.94	95.94	95.54	95.94	4.06	4.06	0.00	0.00
1999	5704.78	6476	936	74.01	74.01	69.58	73.93	16.83	14.98	11.02	0.00
2000	7352.74	7795	936	88.76	88.76	89.43	88.74	1.65	1.49	9.76	0.00
2001	7811.78	8120	936	92.36	92.36	95.27	92.69	0.77	0.72	6.92	0.00
2002	8472.43	8579	966	97.92	97.92	100.12	97.93	1.03	1.01	1.06	0.00
2003	7653.23	8050	966	91.81	91.81	90.44	91.89	1.24	1.16	7.03	0.00
2004	7427.37	7758	966	88.20	88.20	87.53	88.32	3.27	2.98	8.83	0.00
2005	7822.48	8162	978	93.21	93.21	91.30	93.16	2.03	1.93	4.86	0.00
2006	7478.26	7921	966	90.44	90.44	88.37	90.42	1.71	1.58	7.98	0.00
2007	7184.57	7916	970	90.46	90.46	84.55	90.37	9.54	9.54	0.00	0.00
2008	6366.63	6771	970	77.09	82.99	74.72	77.08	1.74	1.47	15.54	5.90
2009	7833.37	8085	978	92.39	92.39	91.43	92.29	0.00	0.00	7.61	0.00
2010	8363.16	8642	974	98.67	98.67	98.02	98.65	0.00	0.00	1.33	0.00
2011	7696.44	7988	967	91.15	91.15	90.86	91.19	1.21	1.12	7.73	0.00
2012	7819.86	8172	967	93.06	93.06	92.06	93.03	5.19	5.09	1.85	0.00
2013	7599.84	7898	967	90.16	90.16	89.71	90.15	0.09	0.08	9.76	0.00
2014	8197.47	8525	967	97.31	97.31	96.77	97.32	2.69	2.69	0.00	0.00
2015	6934.81	7556	967	86.24	86.24	81.87	86.26	4.42	3.99	9.77	0.00
2016	7108.86	7501	967	85.39	85.39	83.69	85.39	11.23	10.80	3.81	0.00
2017	7047.56	7586	967	86.61	86.61	83.20	86.60	2.39	2.12	11.27	0.00
2018	7045.93	7650	967	87.34	87.34	83.18	87.33	6.53	6.10	6.56	0.00
2019	6574.77	7448	967	85.04	85.04	77.62	85.02	3.17	2.78	12.17	0.00
2020	7988.37	8467	967	96.40	96.40	94.05	96.39	3.54	3.60	0.00	0.00
2021	7381.59	7933	967	90.56	90.56	87.14	90.56	1.96	1.81	7.63	0.00
2022	8321.81	8760	967	100.00	100.00	98.24	100.00	0.00	0.00	0.00	0.00

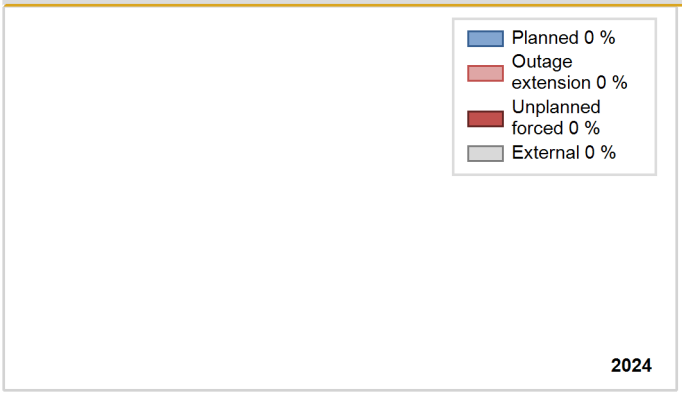
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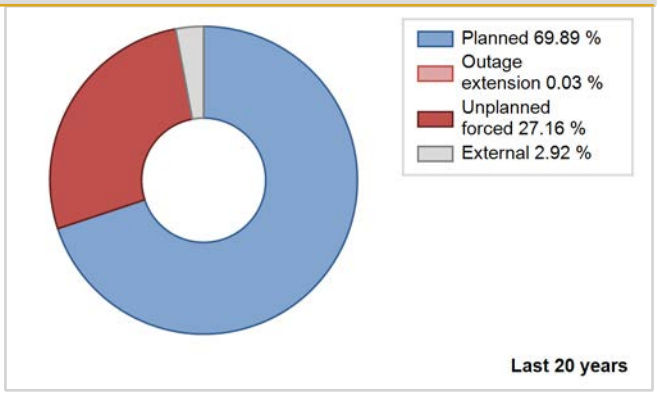
2023	4398.62	5196	967	65.92	65.92	51.93	59.32	0.56	0.37	33.71	0.00
2024	Data not provided										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1986 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					323	
B. Refuelling without maintenance				17		
C. Inspection, maintenance or repair combined with refuelling				716		
D. Inspection, maintenance or repair without refuelling				137		
E. Testing of plant systems or components				8	14	
L. Human factor related					15	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						13
P. Fire					0	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				9		
Z. Other				7	90	0
Subtotal				894	442	13
Total		**0**			**1349**	

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1986 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		32
12. Reactor I&C Systems		53
13. Reactor Auxiliary Systems		2
14. Safety Systems		7
15. Reactor Cooling Systems		64
17. Safety I&C Systems (excluding reactor I&C)		13
31. Turbine and auxiliaries		60
32. Feedwater and Main Steam System		60
33. Circulating Water System		2
34. Miscellaneous Systems		13
35. All other I&C Systems		7
41. Main Generator Systems		38
42. Electrical Power Supply Systems		30
Total		**381**

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2024 Operating Experience

US-261 ROBINSON-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	PROGRESS (Progress Energy)
Owner	:	PROG_E_C (PROGRESS ENERGY Carolinas, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYAMB)
Thermal power	:	2339 MWth
Gross electrical power	:	780 MWe
Reference unit power (net)	:	741 MWe

Key Dates

Construction Date	:	1967-04-13
Grid Date	:	1970-09-26
Commercial Date	:	1971-03-07
Age at end of year	:	54 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	30000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	43.96
Number of control rod assemblies	:	45
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

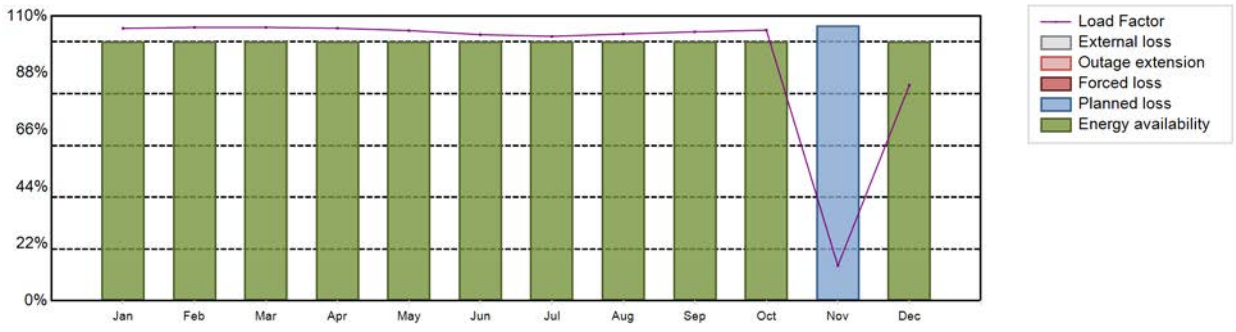
Operating coolant pressure [MPa]	:	15.71
Reactor outlet temperature [°C]	:	318
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.295
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.4
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6185.31 GW(e).h
Energy Availability Factor (EAF)	:	91.28 %
Unit Capability Factor (UCF)	:	91.28 %
Load Factor (LF)	:	95.03 %
Operating Factor (OF)	:	91.48 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	8.72 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	748 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	580.12	544.67	581.49	561.61	575.50	548.47	563.17	568.19	554.24	576.38	72.47	459.00	6185.31
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-6.29	100.00	91.28
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-6.29	100.00	91.28
LF [%]	105.23	105.61	105.62	105.26	104.39	102.80	102.15	103.06	103.88	104.55	13.56	83.26	95.03
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	13.73	83.06	91.48
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	106.29	0.00	8.72
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	265981.12 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.3 %
Cumulative Energy Availability Factor (EAF)	:	81.85 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.52 %
Cumulative Unit Capability Factor (UCF)	:	82 %	Cumulative Planned Unavailability Factor (PUF)	:	12.48 %
Cumulative Load Factor (LF)	:	80.68 %	Cumulative Externally cause unavailability (XUF)	:	0.15 %
Cumulative Operating Factor (OF)	:	80.68 %			

Electricity Production (net) [GWh]

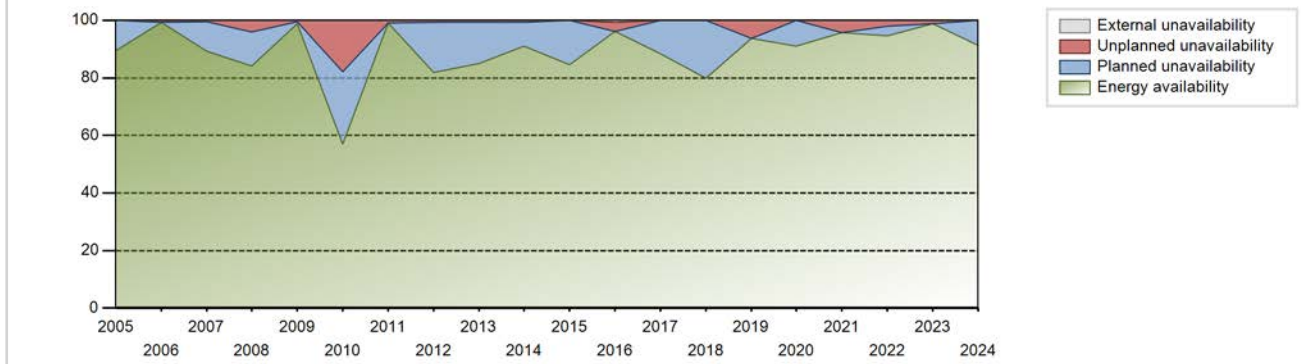


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1971	2538.60	4078	739	100.00	100.00	43.07	48.12	0.00	0.00	0.00	0.00
1972	5082.40	7487	739	100.00	100.00	78.29	85.23	0.00	0.00	0.00	0.00
1973	3765.50	6591	715	75.70	75.70	60.12	75.24	9.44	7.89	16.41	0.00
1974	4813.10	7297	700	83.30	83.30	78.49	83.30	3.03	2.60	14.10	0.00
1975	4170.90	6316	665	71.05	71.05	71.60	72.10	13.68	11.26	17.69	0.00
1976	4874.20	7435	667	82.54	82.54	83.19	84.64	3.46	2.95	14.50	0.00
1977	4130.20	7462	665	70.81	70.81	70.90	85.18	23.86	22.18	7.01	0.00
1978	3980.00	6307	665	68.21	68.21	68.32	72.00	9.62	7.26	24.53	0.00
1979	4005.10	6172	665	68.72	68.72	68.75	70.46	5.18	3.75	27.53	0.00
1980	3210.90	5464	665	61.85	61.85	54.97	62.20	21.08	16.52	21.63	0.00
1981	3510.80	6391	665	73.41	81.06	60.27	72.96	18.94	18.94	0.00	7.65
1982	2268.40	4278	665	47.89	47.89	38.94	48.84	7.11	3.66	48.44	0.00
1983	3347.50	6609	665	75.54	75.54	57.46	75.45	17.74	16.30	8.16	0.00
1984	224.28	615	665	6.97	6.97	3.84	7.00	17.70	1.50	91.53	0.00
1985	5239.91	7697	665	87.64	87.64	89.95	87.87	9.76	9.48	2.89	0.00
1986	4799.60	7028	665	79.72	79.72	82.39	80.23	20.23	20.22	0.06	0.00
1987	4235.47	6224	665	70.31	70.31	72.71	71.05	9.25	7.17	22.52	0.00
1988	3182.43	5717	665	64.23	64.23	54.48	65.08	25.18	21.62	14.15	0.00
1989	2790.53	4107	665	45.49	45.49	47.90	46.88	46.11	38.93	15.58	0.00
1990	3319.19	5614	665	63.15	63.15	56.98	64.09	1.77	1.14	35.71	0.00
1991	4792.24	7048	672	80.15	80.15	81.34	80.46	1.30	1.05	18.79	0.00
1992	4062.91	5812	683	66.17	66.17	67.72	66.17	12.75	9.67	24.17	0.00
1993	4193.27	6137	683	70.07	70.07	70.09	70.06	14.94	12.31	17.63	0.00
1994	4655.06	6845	683	78.20	78.20	77.80	78.14	21.80	21.80	0.00	0.00
1995	5033.83	7356	683	84.01	84.01	84.13	83.97	1.64	1.40	14.59	0.00
1996	5460.10	7745	683	88.19	88.19	91.01	88.17	0.21	0.18	11.62	0.00
1997	6197.59	8662	683	98.89	98.89	103.59	98.88	1.11	1.11	0.00	0.00
1998	5505.56	7751	683	88.50	88.50	92.02	88.48	0.99	0.88	10.62	0.00
1999	5684.48	8009	683	91.45	91.45	95.01	91.43	0.00	0.00	8.55	0.00
2000	6237.08	8750	683	99.62	99.62	103.96	99.61	0.38	0.38	0.00	0.00
2001	5515.04	7919	683	90.41	90.41	92.18	90.40	0.00	0.00	9.59	0.00
2002	5606.11	7960	683	90.88	90.88	93.70	90.87	0.00	0.00	9.12	0.00
2003	6439.90	8760	710	100.00	100.00	103.54	100.00	0.00	0.00	0.00	0.00
2004	5742.21	7811	710	88.94	88.94	92.07	88.92	0.60	0.54	10.52	0.00
2005	5770.14	7839	710	89.50	89.50	92.77	89.49	0.00	0.00	10.50	0.00
2006	6442.70	8705	710	99.38	99.38	103.59	99.37	0.62	0.62	0.00	0.00
2007	5737.92	7825	710	89.34	89.34	92.26	89.33	0.62	0.56	10.10	0.00

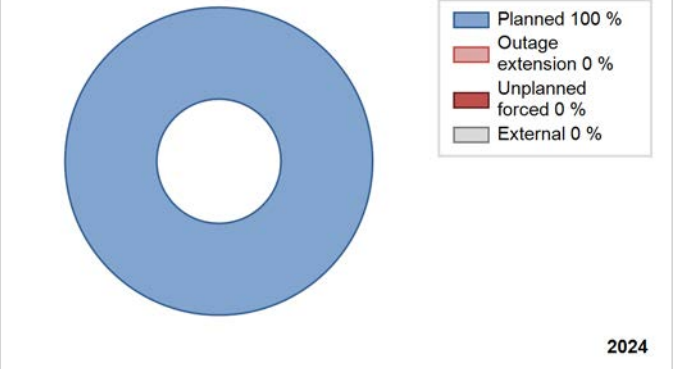
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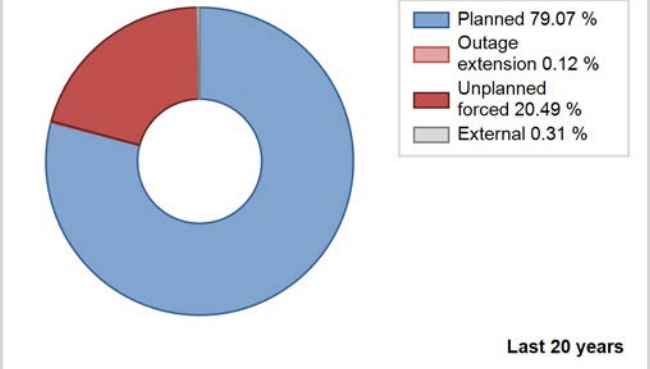
2008	5429.26	7380	710	84.03	84.03	87.05	84.02	4.50	3.96	12.01	0.00
2009	6473.19	8667	710	98.95	98.95	104.08	98.94	0.52	0.52	0.54	0.00
2010	3598.36	4902	724	56.85	56.85	56.74	55.96	23.96	17.91	25.24	0.00
2011	6363.80	8677	724	99.06	99.06	100.34	99.05	0.94	0.94	0.00	0.00
2012	5388.11	7165	741	81.90	81.90	83.25	81.57	0.93	0.77	17.33	0.00
2013	5696.46	7446	741	85.00	85.00	87.75	84.99	0.70	0.60	14.40	0.00
2014	6159.41	7975	741	91.03	91.03	94.89	91.04	0.66	0.60	8.37	0.00
2015	5723.72	7413	741	84.62	84.62	88.18	84.62	0.00	0.00	15.38	0.00
2016	6432.19	8441	741	96.09	96.73	98.82	96.10	3.27	3.27	0.00	0.64
2017	5930.08	7752	741	88.48	88.48	91.36	88.49	0.00	0.00	11.52	0.00
2018	5278.14	7009	741	80.01	80.01	81.31	80.01	0.00	0.00	19.99	0.00
2019	6376.32	8207	741	93.70	93.70	98.23	93.69	6.30	6.30	0.00	0.00
2020	6124.63	8001	741	91.08	91.08	94.10	91.09	0.00	0.00	8.92	0.00
2021	6361.89	8395	741	95.83	95.83	98.01	95.83	4.17	4.17	0.00	0.00
2022	5695.94	7339	741	94.64	94.64	87.75	83.78	2.17	2.10	3.26	0.00
2023	6693.97	8689	741	98.81	98.81	103.12	99.19	0.93	1.19	0.01	0.00
2024	6185.31	8036	741	91.28	91.28	95.03	91.48	0.00	0.00	8.72	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1971 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					417	
B. Refuelling without maintenance				33		
C. Inspection, maintenance or repair combined with refuelling	748			1010		
D. Inspection, maintenance or repair without refuelling				52		
E. Testing of plant systems or components				0	0	
F. Major backfitting, refurbishment or upgrading activities with refuelling				1		
H. Nuclear regulatory requirements					92	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					46	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z. Other					33	
Subtotal	748			1096	588	2
Total	**748**			**1686**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1971 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		1
12. Reactor I&C Systems		47
13. Reactor Auxiliary Systems		2
14. Safety Systems		41
15. Reactor Cooling Systems		65
16. Steam generation systems		96
31. Turbine and auxiliaries		79
32. Feedwater and Main Steam System		31
34. Miscellaneous Systems		68
35. All other I&C Systems		0
41. Main Generator Systems		19
42. Electrical Power Supply Systems		81
Total		**530**

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2024 Operating Experience

US-272 SALEM-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	PSEG (PSEG Nuclear, LLC)
Owner	:	PSEGPOWR (PSEG Power, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3459 MWth
Gross electrical power	:	1254 MWe
Reference unit power (net)	:	1169 MWe

Key Dates

Construction Date	:	1968-09-25
Grid Date	:	1976-12-25
Commercial Date	:	1977-06-30
Age at end of year	:	48 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.4
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.85
Number of control rod assemblies	:	29
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

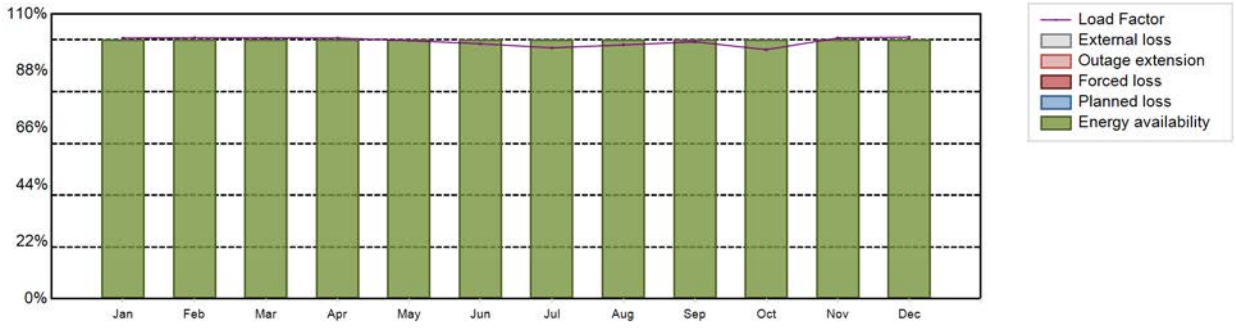
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.42
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.38
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	99.45 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



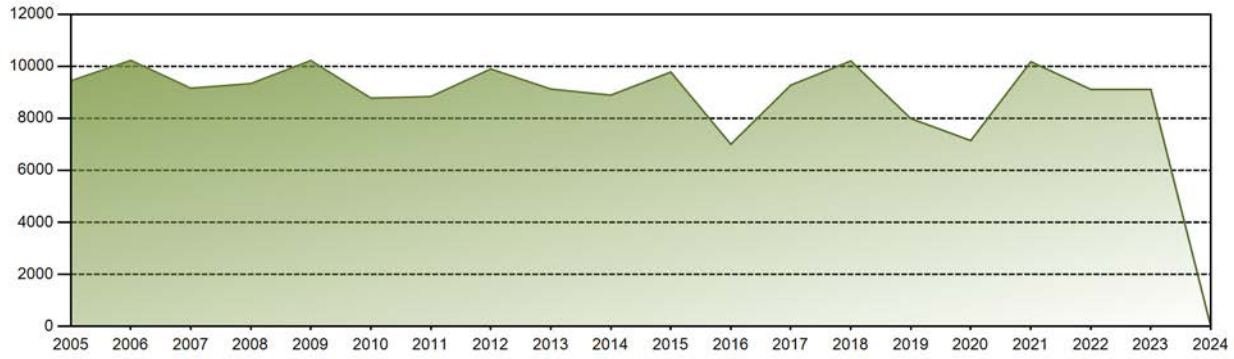
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	876.03	820.25	875.05	847.82	867.47	829.19	843.05	852.91	835.41	836.99	849.27	879.05	10212.50
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	100.72	100.81	100.75	100.73	99.74	98.52	96.93	98.07	99.26	96.24	100.76	101.07	99.45
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	14.99 %
Cumulative Energy Availability Factor (EAF)	:	74.95 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	13.24 %
Cumulative Unit Capability Factor (UCF)	:	75.09 %	Cumulative Planned Unavailability Factor (PUF)	:	11.67 %
Cumulative Load Factor (LF)	:	72.65 %	Cumulative Externally cause unavailability (XUF)	:	0.14 %
Cumulative Operating Factor (OF)	:	74.87 %			

Electricity Production (net) [GWh]

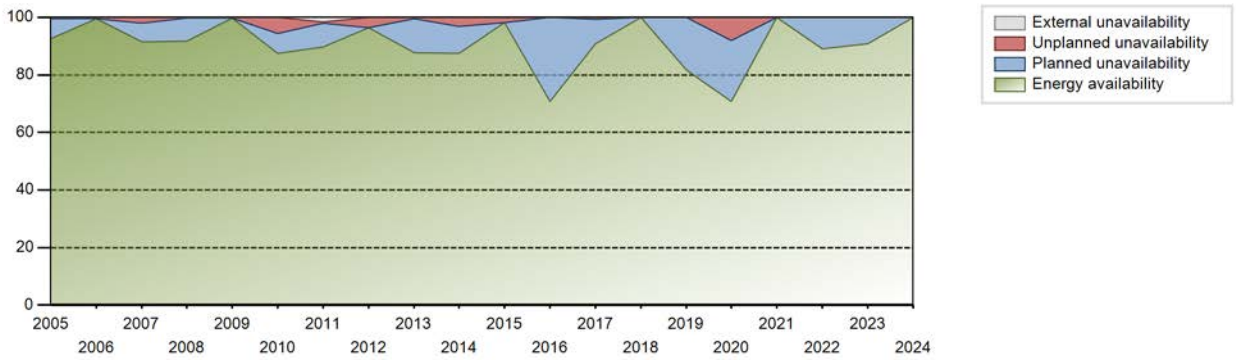


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1977	3398.20	2432	1079	42.77	42.77	42.79	54.53	56.99	56.66	0.57	0.00
1978	4537.00	4862	1079	48.00	48.00	48.00	55.50	51.90	51.80	0.20	0.00
1979	2084.30	2231	1079	22.05	22.05	22.05	25.47	65.71	42.25	35.70	0.00
1980	5689.80	6075	1079	69.47	74.22	60.03	69.16	5.09	3.98	21.81	4.74
1981	6191.30	6839	1079	78.47	78.47	65.50	78.07	21.53	21.53	0.00	0.00
1982	4107.40	4192	1079	46.96	46.96	43.46	47.85	6.50	3.27	49.78	0.00
1983	5408.80	5127	1079	57.61	57.61	57.22	58.53	42.39	42.39	0.00	0.00
1984	2160.15	2378	1079	27.08	27.08	22.79	27.07	61.84	43.88	29.05	0.00
1985	9007.51	8345	1079	95.16	95.16	95.30	95.26	4.84	4.84	0.00	0.00
1986	7084.01	6921	1083	78.61	78.61	74.63	79.01	9.85	8.59	12.81	0.00
1987	6216.61	6362	1106	72.64	73.08	64.16	72.63	2.96	2.23	24.69	0.44
1988	7418.56	6841	1106	77.92	77.92	76.36	77.88	3.06	2.46	19.62	0.00
1989	6213.35	6059	1106	69.18	69.18	64.13	69.17	10.69	8.28	22.53	0.00
1990	5999.21	5868	1106	67.01	67.01	61.92	66.99	32.99	32.99	0.00	0.00
1991	6810.28	6479	1106	73.96	73.96	70.29	73.96	4.23	3.26	22.77	0.00
1992	5307.84	5090	1106	57.99	57.99	54.63	57.95	24.21	18.52	23.49	0.00
1993	5870.60	5746	1106	65.61	65.61	60.59	65.59	12.61	9.46	24.93	0.00
1994	5779.31	5865	1106	67.04	67.04	59.65	66.95	25.86	23.38	9.58	0.00
1995	2554.43	2632	1106	30.07	30.07	26.37	30.05	59.80	44.73	25.21	0.00
1996	0.00	0	1106	0.01	0.01	0.00	0.00	99.98	66.94	33.05	0.00
1997	0.00	0	1106	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1998	6475.62	6199	1106	70.76	70.76	66.84	70.76	29.24	29.24	0.00	0.00
1999	8009.17	7663	1106	87.48	87.48	82.67	87.48	2.21	1.97	10.55	0.00
2000	8952.64	8328	1106	94.81	94.81	92.15	94.81	4.84	4.83	0.36	0.00
2001	7709.42	7116	1096	80.94	80.94	80.83	81.23	8.04	7.07	11.99	0.00
2002	8620.57	7855	1096	89.53	89.53	89.79	89.67	3.23	2.99	7.49	0.00
2003	9096.68	8401	1096	95.85	95.85	94.75	95.90	4.15	4.15	0.00	0.00
2004	7452.71	6766	1159	77.61	77.61	75.24	77.03	5.21	4.27	18.13	0.00
2005	9440.58	8105	1111	92.52	92.52	97.00	92.52	0.60	0.56	6.92	0.00
2006	10228.09	8725	1174	99.60	99.60	99.45	99.60	0.40	0.40	0.00	0.00
2007	9158.51	8013	1174	91.51	91.51	89.05	91.47	2.15	2.01	6.48	0.00
2008	9333.79	8053	1174	91.69	91.69	90.51	91.68	0.17	0.16	8.15	0.00
2009	10221.76	8735	1174	99.72	99.72	99.39	99.71	0.28	0.28	0.00	0.00
2010	8776.60	7653	1174	87.37	87.37	85.34	87.36	6.06	5.63	6.99	0.00
2011	8835.77	7847	1174	89.61	91.30	85.92	89.58	0.46	0.43	8.28	1.69
2012	9896.78	8472	1168	96.48	96.48	96.46	96.45	3.52	3.52	0.00	0.00
2013	9124.16	7692	1168	87.80	87.80	89.17	87.80	0.58	0.52	11.68	0.00

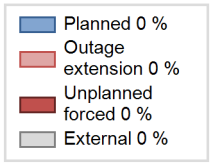
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2014	8891.48	7657	1168	87.40	87.40	86.90	87.41	3.51	3.17	9.42	0.00
2015	9778.02	8593	1169	98.09	98.09	95.48	98.09	1.91	1.91	0.00	0.00
2016	7002.31	6214	1169	70.74	70.74	68.19	70.74	0.00	0.00	29.26	0.00
2017	9275.70	7964	1169	90.92	90.92	90.58	90.91	0.67	0.62	8.47	0.00
2018	10204.37	8760	1169	100.00	100.00	99.65	100.00	0.00	0.00	0.00	0.00
2019	7990.30	7153	1169	81.66	81.66	78.03	81.66	0.00	0.00	18.34	0.00
2020	7142.17	6225	1169	70.87	70.87	69.55	70.87	10.22	8.07	21.05	0.00
2021	10176.69	8760	1169	100.00	100.00	99.38	100.00	0.00	0.00	0.00	0.00
2022	9112.71	7806	1169	89.12	89.12	88.99	89.11	0.00	0.00	10.88	0.00
2023	9112.43	7909	1169	90.73	90.73	88.98	90.29	0.00	0.00	9.27	0.00
2024	Data not provided										

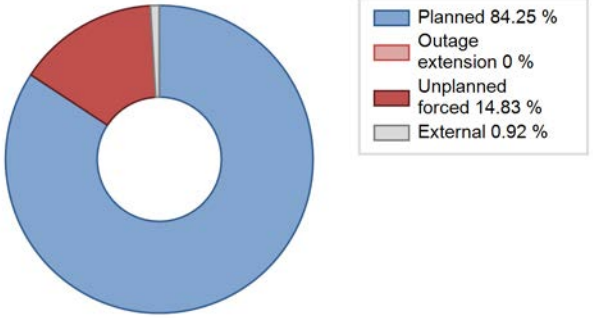
Key Factors in Last 20 Years [%]



Energy Losses by Type



2024



Last 20 years

Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1977 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					960	
B. Refuelling without maintenance				59		
C. Inspection, maintenance or repair combined with refuelling				891		
D. Inspection, maintenance or repair without refuelling				69		
E. Testing of plant systems or components				1	1	
H. Nuclear regulatory requirements					103	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					7	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						7
Z. Other				9	89	
Subtotal				1029	1160	8
Total	**0**			**2197**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1977 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		16
12. Reactor I&C Systems		64
13. Reactor Auxiliary Systems		8
14. Safety Systems		81
15. Reactor Cooling Systems		62
16. Steam generation systems		396
17. Safety I&C Systems (excluding reactor I&C)		3
31. Turbine and auxiliaries		168
32. Feedwater and Main Steam System		81
33. Circulating Water System		42
34. Miscellaneous Systems		61
35. All other I&C Systems		4
41. Main Generator Systems		78
42. Electrical Power Supply Systems		45
Total		**1109**

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2024 Operating Experience

US-311 SALEM-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	PSEG (PSEG Nuclear, LLC)
Owner	:	PSEGPOWR (PSEG Power, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3459 MWth
Gross electrical power	:	1200 MWe
Reference unit power (net)	:	1158 MWe

Key Dates

Construction Date	:	1968-09-25
Grid Date	:	1981-06-03
Commercial Date	:	1981-10-13
Age at end of year	:	43 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	40000
Active core diameter [m]	:	3.4
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.85
Number of control rod assemblies	:	29
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

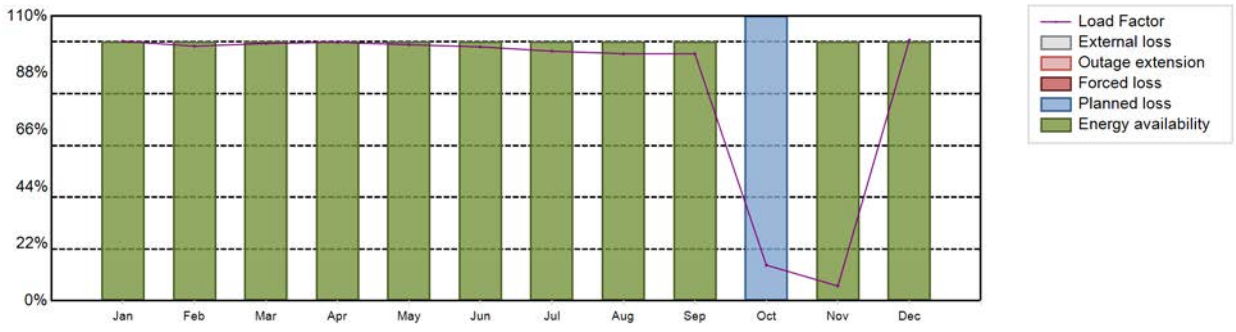
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	322
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.42
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.38
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	8497.22 GW(e).h
Energy Availability Factor (EAF)	:	86.13 %
Unit Capability Factor (UCF)	:	86.13 %
Load Factor (LF)	:	83.54 %
Operating Factor (OF)	:	85.89 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	13.87 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1239 hours

Annual Summary



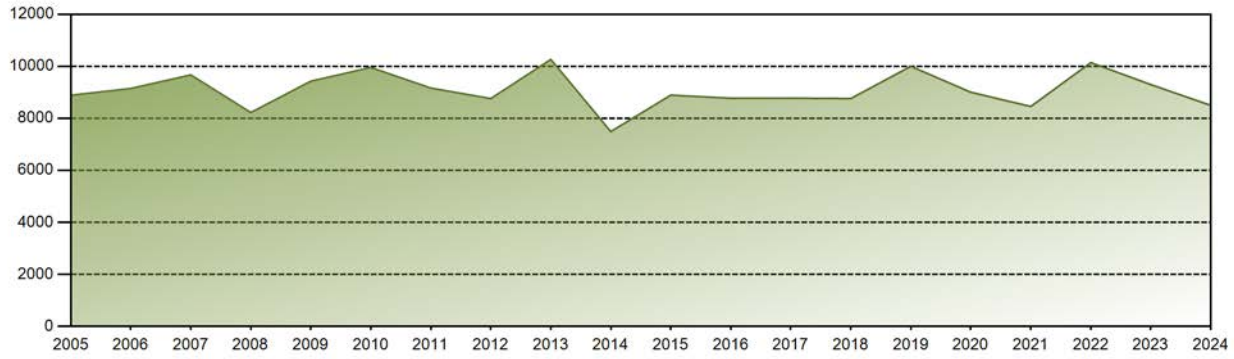
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	863.70	792.69	855.38	832.48	852.11	817.79	830.75	822.30	795.56	118.95	47.90	867.60	8497.22
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-63.79	100.00	100.00	86.13
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-63.79	100.00	100.00	86.13
LF [%]	100.25	98.35	99.42	99.85	98.90	98.08	96.42	95.44	95.42	13.81	5.74	100.70	83.54
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	16.13	14.70	100.00	85.89
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	163.79	0.00	0.00	13.87
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	317806.47 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	12.97 %
Cumulative Energy Availability Factor (EAF)	:	77.48 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	11.97 %
Cumulative Unit Capability Factor (UCF)	:	77.49 %	Cumulative Planned Unavailability Factor (PUF)	:	10.54 %
Cumulative Load Factor (LF)	:	74.49 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	76.88 %			

Electricity Production (net) [GWh]

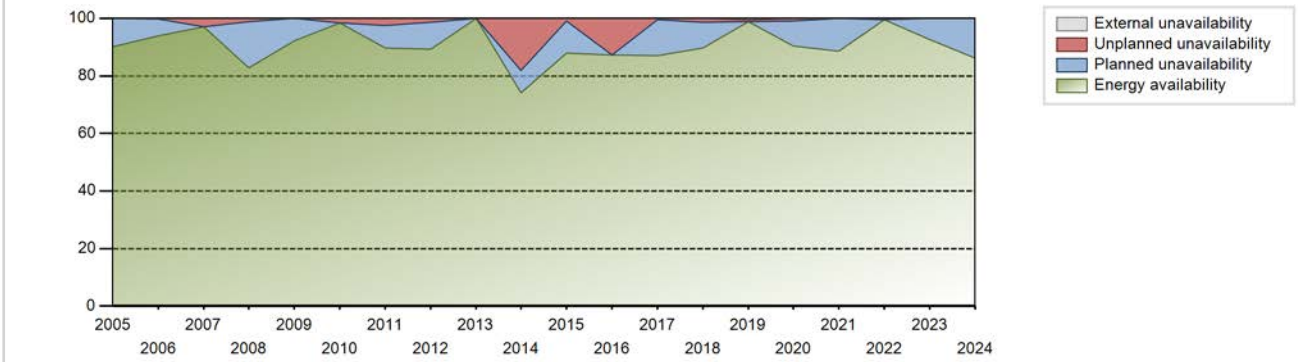


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	3009.57	3253	1105	96.27	96.27	76.89	94.59	3.73	3.73	0.00	0.00
1982	7941.70	8517	1106	97.54	97.54	81.97	97.23	2.46	2.46	0.00	0.00
1983	775.20	1078	1106	12.65	12.65	8.00	12.31	73.49	35.06	52.29	0.00
1984	3225.70	3192	1106	36.40	36.40	33.20	36.34	56.61	47.48	16.12	0.00
1985	5033.76	4923	1106	56.22	56.22	51.96	56.20	41.70	40.21	3.56	0.00
1986	5317.72	5388	1106	61.59	61.59	54.89	61.51	20.69	16.06	22.35	0.00
1987	6176.55	6338	1106	72.42	72.42	63.75	72.35	9.33	7.45	20.12	0.00
1988	5982.17	5838	1106	66.50	66.50	61.58	66.46	33.47	33.45	0.05	0.00
1989	7824.60	7419	1106	84.74	84.74	80.76	84.69	9.76	9.17	6.10	0.00
1990	5446.10	5163	1106	72.16	72.16	56.21	58.94	5.68	4.35	23.49	0.00
1991	7662.34	7188	1106	82.05	82.05	79.09	82.05	15.40	14.93	3.01	0.00
1992	4744.64	4657	1106	53.05	53.05	48.84	53.02	16.80	10.71	36.24	0.00
1993	5575.50	5328	1106	60.87	60.87	57.55	60.82	20.37	15.57	23.56	0.00
1994	5606.78	6076	1106	69.43	69.43	57.87	69.36	5.75	4.24	26.34	0.00
1995	2071.74	2261	1106	25.83	25.83	21.38	25.81	65.33	48.69	25.48	0.00
1996	0.00	0	1106	0.00	0.00	0.00	0.00	100.00	91.53	8.47	0.00
1997	2564.28	2834	1106	32.37	32.37	26.47	32.35	67.63	67.63	0.00	0.00
1998	7797.25	7287	1106	83.18	83.18	80.48	83.18	15.42	15.17	1.64	0.00
1999	7949.39	7431	1106	84.83	84.83	82.05	84.83	0.00	0.00	15.17	0.00
2000	8381.72	7819	1106	89.01	89.01	86.28	89.01	0.00	0.00	10.99	0.00
2001	9517.60	8736	1092	99.72	99.72	99.97	99.73	0.28	0.28	0.00	0.00
2002	8367.43	7620	1092	86.77	86.77	87.47	86.99	1.68	1.49	11.74	0.00
2003	8095.61	7355	1116	83.73	83.73	84.47	83.96	3.24	2.80	13.47	0.00
2004	8799.76	7945	1116	90.34	90.34	89.77	90.45	9.60	9.59	0.07	0.00
2005	8886.03	7897	1129	90.15	90.15	89.84	90.14	0.00	0.00	9.85	0.00
2006	9147.38	8220	1130	93.86	93.86	92.41	93.84	0.29	0.28	5.87	0.00
2007	9669.39	8506	1130	97.12	97.12	97.68	97.10	2.88	2.88	0.00	0.00
2008	8222.00	7285	1156	82.82	82.82	81.58	82.93	1.50	1.26	15.92	0.00
2009	9427.50	8069	1158	92.15	92.15	92.94	92.11	0.00	0.00	7.85	0.00
2010	9954.77	8620	1158	98.41	98.41	98.13	98.40	1.59	1.59	0.00	0.00
2011	9162.79	7863	1158	89.78	89.78	90.33	89.76	2.62	2.41	7.81	0.00
2012	8758.57	7813	1158	89.19	89.19	86.11	88.95	1.49	1.35	9.46	0.00
2013	10262.83	8760	1158	100.00	100.00	101.16	99.99	0.00	0.00	0.00	0.00
2014	7490.46	6488	1158	74.06	74.06	73.84	74.06	0.74	18.14	7.80	0.00
2015	8892.07	7710	1158	88.02	88.02	87.66	88.01	1.13	1.00	10.98	0.00
2016	8773.17	7661	1158	87.22	87.22	86.25	87.22	12.78	12.78	0.00	0.00
2017	8774.68	7617	1158	86.96	86.96	86.50	86.95	0.45	0.40	12.64	0.00

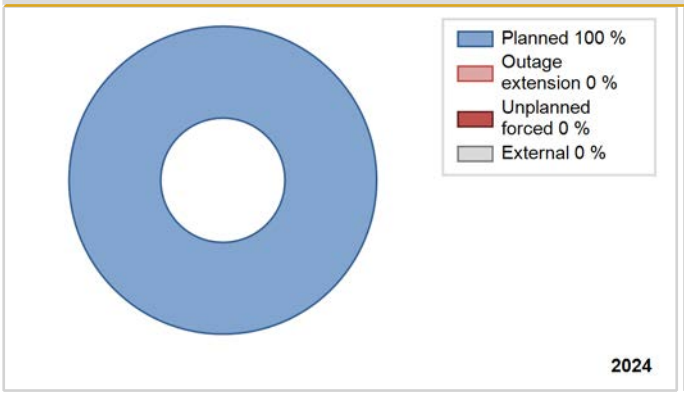
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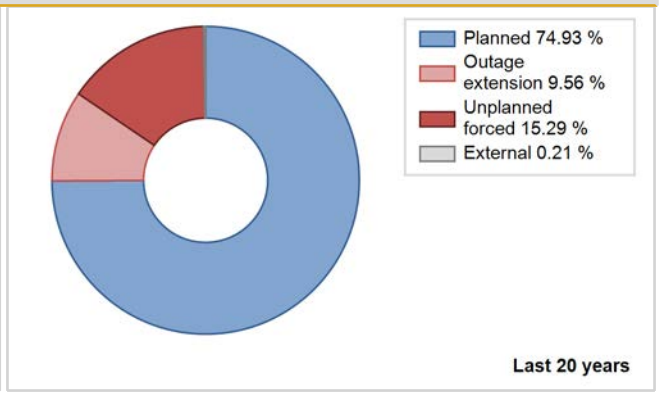
2018	8761.52	7844	1158	89.75	89.75	86.37	89.54	1.54	1.40	8.85	0.00
2019	9999.01	8649	1158	98.75	99.13	98.57	98.73	0.87	0.87	0.00	0.38
2020	9003.39	7941	1158	90.41	90.41	88.51	90.40	1.05	0.96	8.63	0.00
2021	8454.84	7764	1158	88.63	88.63	83.35	88.63	0.00	0.00	11.37	0.00
2022	10142.84	8720	1158	99.55	99.55	99.99	99.54	0.45	0.45	0.00	0.00
2023	9296.43	8103	1158	92.66	92.66	91.64	92.50	0.00	0.00	7.34	0.00
2024	8497.22	7545	1158	86.13	86.13	83.54	85.89	0.00	0.00	13.87	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1981 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure					820	
B.	Refuelling without maintenance				41		
C.	Inspection, maintenance or repair combined with refuelling	1239			813		
D.	Inspection, maintenance or repair without refuelling				73		
E.	Testing of plant systems or components				0	0	
H.	Nuclear regulatory requirements					199	
L.	Human factor related					6	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
Z.	Other				3	20	
Subtotal		1239			930	1045	4
Total		**1239**			**1979**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		185
12. Reactor I&C Systems		43
13. Reactor Auxiliary Systems		4
14. Safety Systems		36
15. Reactor Cooling Systems		95
16. Steam generation systems		136
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		72
32. Feedwater and Main Steam System		90
33. Circulating Water System		14
34. Miscellaneous Systems		8
35. All other I&C Systems		2
41. Main Generator Systems		190
42. Electrical Power Supply Systems		149
Total		**1025**

Highlights (2024)

NA

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2024 Operating Experience

US-443 SEABROOK-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	NEXTERA (NextEra Energy Resources, LLC
Owner	:	NEXTERA (NextEra Energy Resources, LLC
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3648 MWth
Gross electrical power	:	1296 MWe
Reference unit power (net)	:	1246 MWe

Key Dates

Construction Date	:	1976-07-07
Grid Date	:	1990-05-29
Commercial Date	:	1990-08-19
Age at end of year	:	34 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.18
Number of control rod assemblies	:	57
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

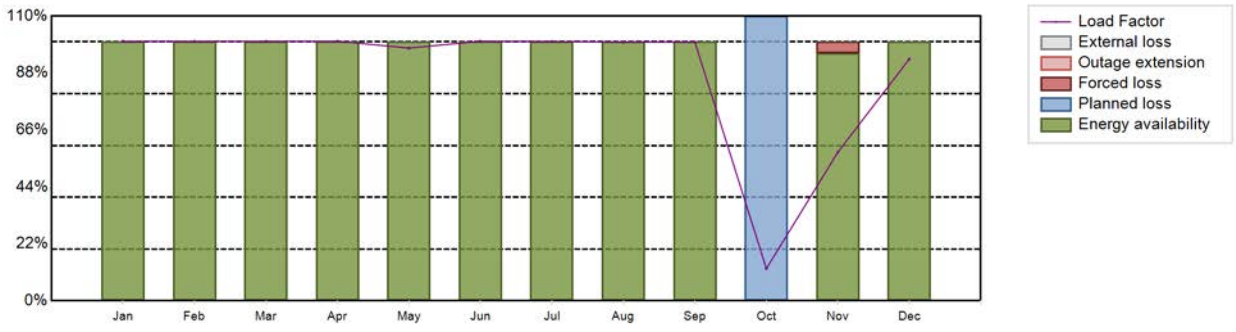
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	326
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.37
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	7.14
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9676.41 GW(e).h
Energy Availability Factor (EAF)	:	89.52 %
Unit Capability Factor (UCF)	:	89.52 %
Load Factor (LF)	:	88.41 %
Operating Factor (OF)	:	89.55 %

Forced Loss Rate (FLR)	:	0.4 %
Unplanned Capability Loss Factor (UCL)	:	0.36 %
Planned Unavailability Factor (PUF)	:	10.12 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	918 hours

Annual Summary



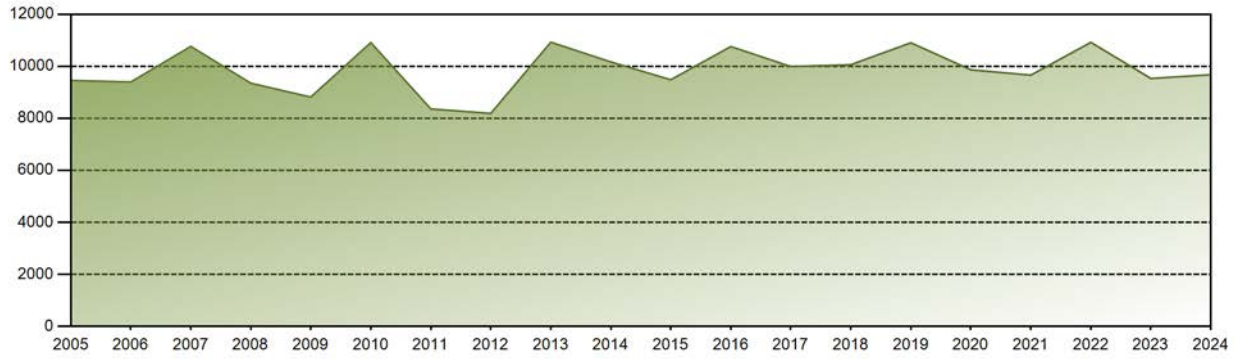
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	928.64	868.77	927.40	899.58	904.95	899.45	928.20	925.87	896.57	115.44	515.74	865.79	9676.41
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-19.44	95.59	100.00	89.52
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	-19.44	95.59	100.00	89.52
LF [%]	100.17	100.18	100.18	100.27	97.62	100.26	100.13	99.88	99.94	12.45	57.41	93.39	88.41
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	12.90	62.55	100.00	89.55
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.41	0.00	0.40
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.41	0.00	0.36
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	119.44	0.00	0.00	10.12
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	319826.11 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.26 %
Cumulative Energy Availability Factor (EAF)	:	89.28 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.07 %
Cumulative Unit Capability Factor (UCF)	:	89.36 %	Cumulative Planned Unavailability Factor (PUF)	:	8.57 %
Cumulative Load Factor (LF)	:	87.86 %	Cumulative Externally cause unavailability (XUF)	:	0.08 %
Cumulative Operating Factor (OF)	:	89.09 %			

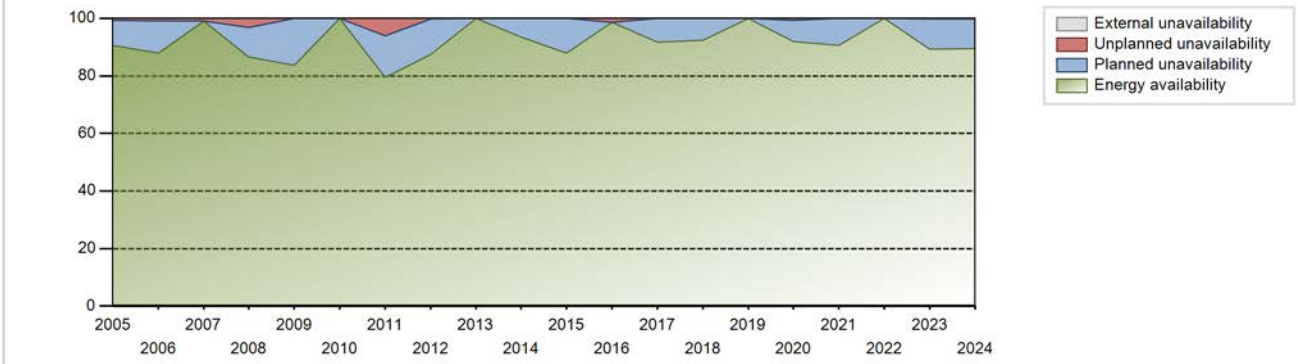
Electricity Production (net) [GWh]



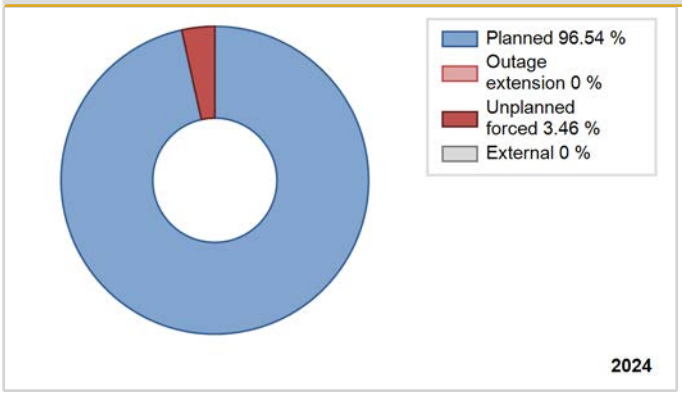
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1990	4094.00	4125	1151	84.94	84.94	82.11	84.94	15.06	15.06	0.00	0.00
1991	6814.38	6394	1150	73.00	73.00	67.64	72.99	6.00	4.66	22.34	0.00
1992	7868.44	7056	1150	80.26	80.26	77.89	80.33	1.29	1.05	18.69	0.00
1993	9046.81	8094	1150	92.39	92.39	89.80	92.40	7.61	7.61	0.00	0.00
1994	6203.50	5466	1150	62.28	62.28	61.58	62.40	9.22	6.33	31.39	0.00
1995	8380.64	7465	1150	85.18	85.18	83.14	85.22	5.01	4.49	10.32	0.00
1996	9844.19	8690	1158	98.96	98.96	96.78	98.93	1.04	1.04	0.00	0.00
1997	7945.70	6929	1158	79.18	79.18	78.33	79.10	8.32	7.18	13.64	0.00
1998	8388.43	7294	1158	83.33	83.33	82.69	83.26	16.67	16.67	0.00	0.00
1999	8685.71	7564	1156	86.33	86.33	85.77	86.35	0.62	0.54	13.13	0.00
2000	7921.49	6910	1155	78.66	78.66	78.08	78.67	2.05	1.64	19.69	0.00
2001	8692.24	7703	1155	87.89	90.59	85.91	87.93	1.82	1.68	7.73	2.70
2002	9293.37	8083	1155	92.24	92.24	91.85	92.27	0.00	0.00	7.76	0.00
2003	9275.43	8121	1155	92.68	92.68	91.67	92.71	0.48	0.45	6.88	0.00
2004	10176.97	8784	1155	100.00	100.00	100.31	100.00	0.00	0.00	0.00	0.00
2005	9455.21	7928	1159	90.52	90.52	93.12	90.49	0.72	0.65	8.83	0.00
2006	9397.40	7718	1244	87.94	87.94	87.58	88.11	1.02	0.90	11.16	0.00
2007	10763.88	8669	1245	99.00	99.00	98.70	98.96	1.00	1.00	0.00	0.00
2008	9349.64	7596	1245	86.49	86.49	85.49	86.48	3.62	3.25	10.26	0.00
2009	8816.67	7326	1245	83.65	83.65	80.84	83.63	0.00	0.00	16.35	0.00
2010	10910.05	8760	1247	100.00	100.00	99.87	100.00	0.00	0.00	0.00	0.00
2011	8361.74	6959	1247	79.46	79.46	76.55	79.44	7.19	6.15	14.38	0.00
2012	8188.86	7689	1246	87.55	87.55	74.82	87.53	0.18	0.15	12.30	0.00
2013	10926.11	8760	1246	100.00	100.00	100.09	99.99	0.00	0.00	0.00	0.00
2014	10167.58	8190	1246	93.49	93.49	93.15	93.49	0.00	0.00	6.51	0.00
2015	9483.63	7705	1246	87.96	87.96	86.89	87.96	0.00	0.00	12.04	0.00
2016	10760.55	8667	1246	98.67	98.67	98.32	98.67	1.33	1.33	0.00	0.00
2017	9990.27	8033	1246	91.70	91.70	91.53	91.70	0.00	0.00	8.30	0.00
2018	10061.27	8093	1246	92.38	92.38	92.18	92.39	0.00	0.00	7.62	0.00
2019	10906.28	8760	1246	100.00	100.00	99.92	100.00	0.00	0.00	0.00	0.00
2020	9865.20	7961	1246	91.96	91.96	90.14	90.63	0.72	0.67	7.36	0.00
2021	9660.02	7932	1246	90.55	90.55	88.50	90.55	0.00	0.00	9.45	0.00
2022	10921.11	8760	1246	100.00	100.00	100.06	100.00	0.00	0.00	0.00	0.00
2023	9534.37	7726	1246	89.30	89.30	87.35	88.20	0.31	0.30	10.40	0.00
2024	9676.41	7866	1246	89.52	89.52	88.41	89.55	0.40	0.36	10.12	0.00

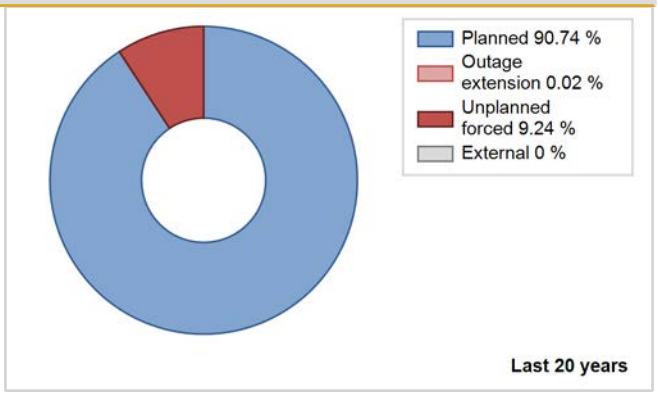
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1990 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		32			192	
B. Refuelling without maintenance				43		
C. Inspection, maintenance or repair combined with refuelling	886			698		
D. Inspection, maintenance or repair without refuelling				20		
E. Testing of plant systems or components				1	3	
J. Grid limitation, failure or grid unavailability						0
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						7
Z. Other				0	7	
Subtotal	886	32		762	202	7
Total	**918**			**971**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1990 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories	32	2
12. Reactor I&C Systems		3
13. Reactor Auxiliary Systems		50
15. Reactor Cooling Systems		25
16. Steam generation systems		0
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		23
32. Feedwater and Main Steam System		26
35. All other I&C Systems		11
41. Main Generator Systems		26
42. Electrical Power Supply Systems		23
Total	**32**	**191**

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Highlights (2024)

NA

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2024 Operating Experience

US-327 SEQUOYAH-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	TVA (Tennessee Valley Authority)
Owner	:	TVA (Tennessee Valley Authority)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (ICECND)
Thermal power	:	3455 MWth
Gross electrical power	:	1221 MWe
Reference unit power (net)	:	1152 MWe

Key Dates

Construction Date	:	1970-05-27
Grid Date	:	1980-07-22
Commercial Date	:	1981-07-01
Age at end of year	:	44 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	37
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.65
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.85
Number of control rod assemblies	:	29
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

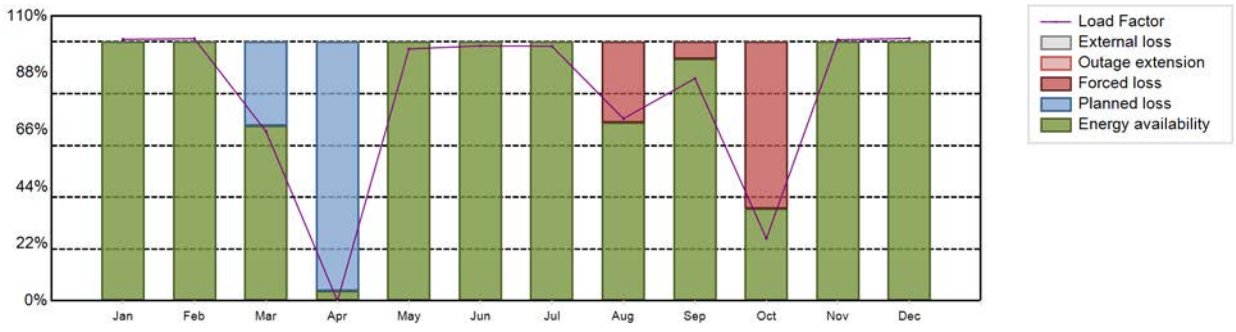
Operating coolant pressure [MPa]	:	15.82
Reactor outlet temperature [°C]	:	322.4
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	0.84
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.85
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7958.84 GW(e).h
Energy Availability Factor (EAF)	:	80.77 %
Unit Capability Factor (UCF)	:	80.77 %
Load Factor (LF)	:	78.65 %
Operating Factor (OF)	:	80.76 %

Forced Loss Rate (FLR)	:	9.65 %
Unplanned Capability Loss Factor (UCL)	:	8.63 %
Planned Unavailability Factor (PUF)	:	10.61 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1690 hours

Annual Summary



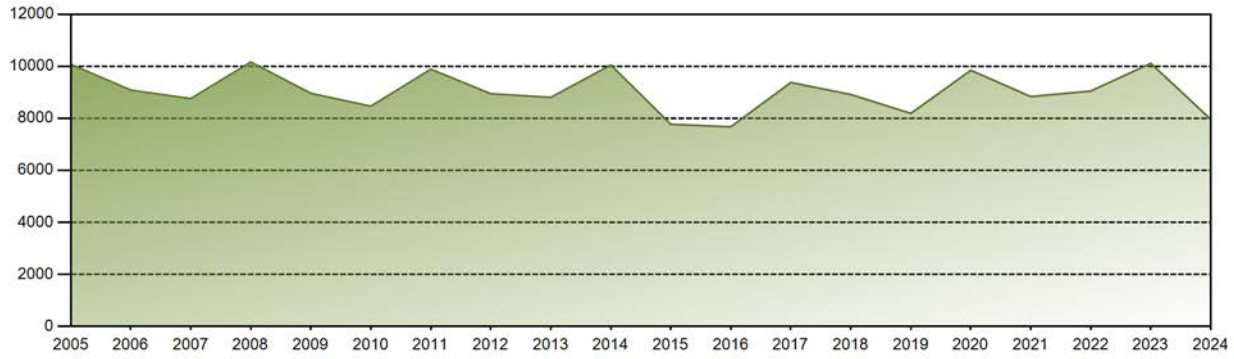
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	865.68	811.74	560.43	0.00	833.97	816.72	842.92	602.90	712.36	206.28	837.33	868.51	7958.84
EAF [%]	100.00	100.00	67.70	3.93	100.00	100.00	100.00	68.92	93.33	35.69	100.00	100.00	80.77
UCF [%]	100.00	100.00	67.70	3.93	100.00	100.00	100.00	68.92	93.33	35.69	100.00	100.00	80.77
LF [%]	101.00	101.24	65.48	0.00	97.30	98.47	98.35	70.34	85.89	24.07	100.81	101.33	78.65
OF [%]	100.00	100.00	70.52	0.97	100.00	100.00	100.00	72.58	90.28	34.95	100.00	100.00	80.76
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.08	6.67	64.31	0.00	0.00	9.65
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.08	6.67	64.31	0.00	0.00	8.63
PUF [%]	0.00	0.00	32.30	96.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.61
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	331858.89 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	13.55 %
Cumulative Energy Availability Factor (EAF)	:	78.28 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	12.28 %
Cumulative Unit Capability Factor (UCF)	:	78.31 %	Cumulative Planned Unavailability Factor (PUF)	:	9.41 %
Cumulative Load Factor (LF)	:	76.4 %	Cumulative Externally cause unavailability (XUF)	:	0.04 %
Cumulative Operating Factor (OF)	:	78.02 %			

Electricity Production (net) [GWh]

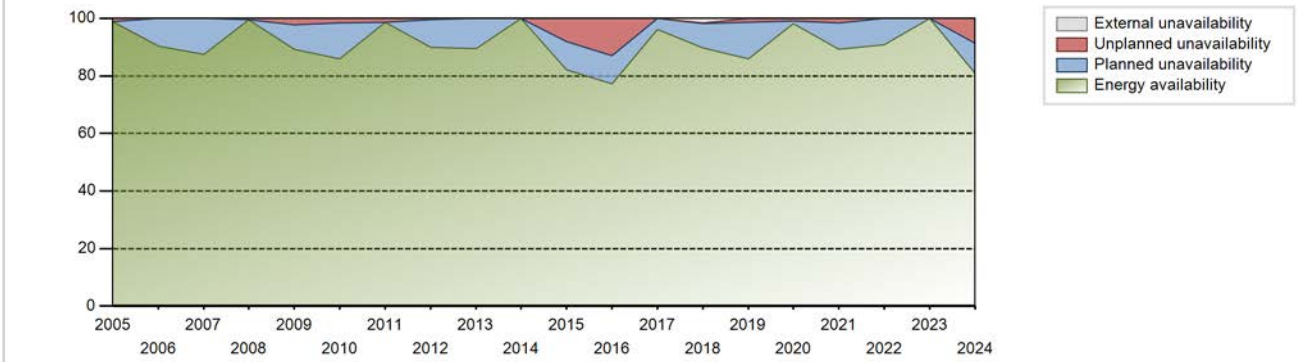


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1981	4806.21	4984	1128	62.10	62.10	50.72	60.86	17.60	13.26	24.64	0.00
1982	4909.70	4626	1128	53.36	53.36	49.69	52.81	23.05	15.99	30.65	0.00
1983	7340.90	6791	1139	78.25	78.25	73.57	77.52	17.49	16.58	5.17	0.00
1984	6104.70	5992	1148	69.06	69.06	60.54	68.21	18.75	15.94	15.00	0.00
1985	4076.07	3760	1148	44.68	44.68	40.53	42.92	17.01	9.16	46.16	0.00
1986	0.00	0	1148	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1987	0.00	0	1148	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1988	127.69	282	1148	6.35	6.35	1.27	3.21	93.58	92.57	1.09	0.00
1989	9550.60	8624	1148	98.52	98.52	94.97	98.45	1.48	1.48	0.00	0.00
1990	6840.68	6406	1148	73.99	73.99	68.02	73.13	7.02	5.59	20.42	0.00
1991	7270.13	6774	1122	77.56	77.56	73.97	77.33	2.14	1.70	20.74	0.00
1992	8402.49	7734	1122	88.20	88.20	85.26	88.05	11.80	11.80	0.00	0.00
1993	1290.51	1219	1122	14.77	14.77	13.13	13.92	85.23	85.23	0.00	0.00
1994	6111.64	5774	1111	65.97	65.97	62.80	65.91	5.91	4.14	29.89	0.00
1995	6829.49	6620	1111	75.64	75.64	70.17	75.57	8.20	6.76	17.60	0.00
1996	9293.49	8344	1112	95.07	95.07	95.10	94.99	1.05	1.01	3.92	0.00
1997	8324.30	7486	1117	85.54	85.54	85.07	85.46	0.44	0.37	14.09	0.00
1998	8905.68	7966	1118	91.02	91.02	90.91	90.94	1.08	0.99	7.99	0.00
1999	9986.98	8760	1122	100.00	100.00	101.61	100.00	0.00	0.00	0.00	0.00
2000	7720.48	6988	1122	79.53	79.53	78.34	79.55	14.83	13.85	6.63	0.00
2001	9018.99	7988	1122	91.21	91.21	91.76	91.19	0.00	0.00	8.79	0.00
2002	9953.53	8760	1125	100.00	100.00	101.07	100.00	0.00	0.00	0.00	0.00
2003	7351.13	6443	1125	73.61	73.61	74.59	73.55	1.46	1.09	25.30	0.00
2004	9290.48	8027	1148	91.39	91.39	92.13	91.38	1.42	1.32	7.30	0.00
2005	10076.53	8658	1150	98.84	98.84	100.01	98.82	1.16	1.16	0.00	0.00
2006	9086.03	7915	1150	90.37	90.37	90.19	90.35	0.00	0.00	9.63	0.00
2007	8758.29	7668	1148	87.52	87.52	87.09	87.53	0.00	0.00	12.48	0.00
2008	10164.80	8738	1148	99.49	99.49	100.80	99.48	0.51	0.51	0.00	0.00
2009	8962.17	7820	1148	89.29	89.29	89.12	89.27	2.49	2.28	8.42	0.00
2010	8464.09	7524	1152	85.95	85.95	83.87	85.89	1.83	1.60	12.45	0.00
2011	9888.54	8636	1152	98.61	98.61	97.99	98.58	1.39	1.39	0.00	0.00
2012	8945.17	7907	1152	90.04	90.04	88.40	90.02	0.49	0.45	9.52	0.00
2013	8805.63	7834	1152	89.43	89.43	87.25	89.42	0.00	0.00	10.57	0.00
2014	10051.76	8760	1152	100.00	100.00	99.61	100.00	0.00	0.00	0.00	0.00
2015	7771.73	7196	1152	82.15	82.15	77.01	82.15	9.05	8.17	9.68	0.00
2016	7673.62	6783	1152	77.22	77.22	75.83	77.22	14.35	12.94	9.84	0.00
2017	9378.86	8420	1152	96.11	96.11	92.94	96.12	0.00	0.00	3.89	0.00

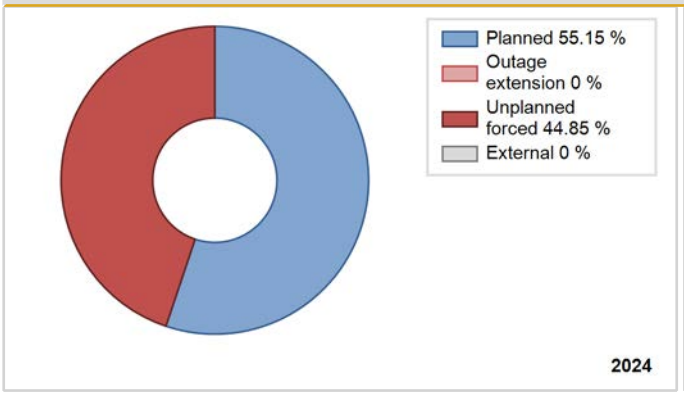
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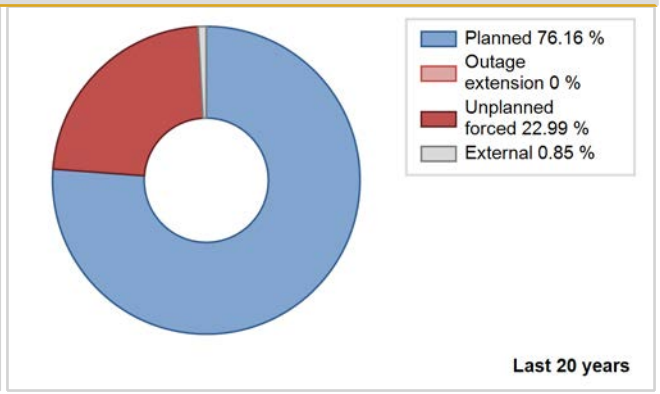
2018	8916.87	7858	1152	89.70	91.23	88.36	89.70	0.33	0.30	8.46	1.53
2019	8189.64	7523	1152	85.90	85.90	81.15	85.88	1.58	1.38	12.72	0.00
2020	9846.77	8627	1152	98.22	98.22	97.31	98.21	0.99	0.98	0.79	0.00
2021	8836.62	7810	1152	89.16	89.16	87.56	89.16	1.80	1.64	9.21	0.00
2022	9049.98	7956	1152	90.82	90.82	89.68	90.82	0.00	0.00	9.18	0.00
2023	10112.90	8760	1152	99.99	99.99	100.21	100.00	0.00	0.00	0.01	0.00
2024	7958.84	7094	1152	80.77	80.77	78.65	80.76	9.65	8.63	10.61	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1981 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		758			477	
B. Refuelling without maintenance				35		
C. Inspection, maintenance or repair combined with refuelling	932			725		
D. Inspection, maintenance or repair without refuelling				41		
E. Testing of plant systems or components				1		
H. Nuclear regulatory requirements					210	
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					16	
P. Fire					3	
Z. Other				32	380	
Subtotal	932	758		834	1086	3
Total	**1690**			**1923**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1981 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		16
13. Reactor Auxiliary Systems		10
14. Safety Systems		26
15. Reactor Cooling Systems		39
16. Steam generation systems		5
31. Turbine and auxiliaries		32
32. Feedwater and Main Steam System		202
34. Miscellaneous Systems		1
35. All other I&C Systems		4
41. Main Generator Systems	758	119
42. Electrical Power Supply Systems		27
Total	**758**	**481**

Highlights (2024)

NA

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2024 Operating Experience

US-328 SEQUOYAH-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	TVA (Tennessee Valley Authority)
Owner	:	TVA (Tennessee Valley Authority)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (ICECND)
Thermal power	:	3455 MWth
Gross electrical power	:	1200 MWe
Reference unit power (net)	:	1139 MWe

Key Dates

Construction Date	:	1970-05-27
Grid Date	:	1981-12-23
Commercial Date	:	1982-06-01
Age at end of year	:	43 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	37
Average discharge burnup [MWd/t]	:	45000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.65
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.85
Number of control rod assemblies	:	29
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

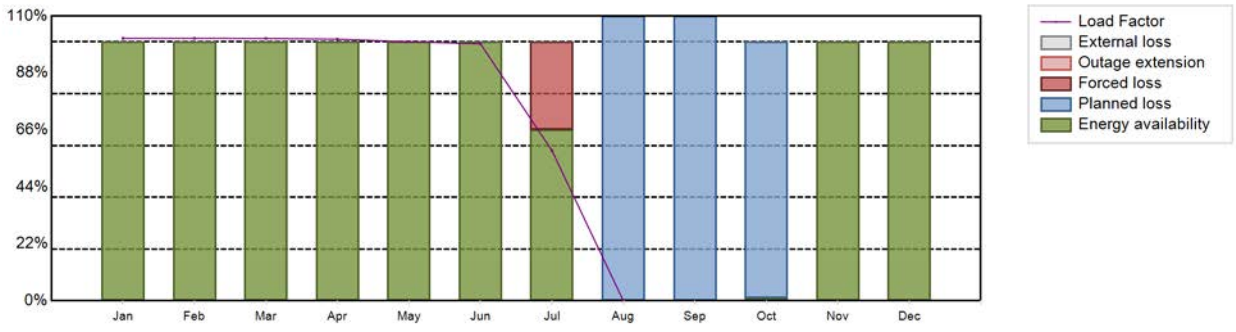
Operating coolant pressure [MPa]	:	15.82
Reactor outlet temperature [°C]	:	322.4
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	0.84
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.85
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	5503.26 GW(e).h
Energy Availability Factor (EAF)	:	56.19 %
Unit Capability Factor (UCF)	:	56.19 %
Load Factor (LF)	:	55.01 %
Operating Factor (OF)	:	55.46 %

Forced Loss Rate (FLR)	:	9.26 %
Unplanned Capability Loss Factor (UCL)	:	5.73 %
Planned Unavailability Factor (PUF)	:	38.07 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	3912 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	859.01	803.87	857.44	828.84	847.85	814.28	491.97	0.00	0.00	0.00	0.00	0.00	5503.26
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	66.10	-90.02	-100.96	1.17	100.00	100.00	56.19
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	66.10	-90.02	-100.96	1.17	100.00	100.00	56.19
LF [%]	101.37	101.40	101.32	101.07	100.05	99.29	58.06	0.00	0.00	0.00	0.00	0.00	55.01
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	67.88	0.00	0.00	0.00	0.00	0.00	55.46
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	33.90	0.00	0.00	0.00	0.00	0.00	9.26
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	33.90	33.80	0.00	0.00	0.00	0.00	5.73
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	156.22	200.96	98.83	0.00	0.00	38.07
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	331171.5 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	11.42 %
Cumulative Energy Availability Factor (EAF)	:	80.73 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	10.41 %
Cumulative Unit Capability Factor (UCF)	:	80.73 %	Cumulative Planned Unavailability Factor (PUF)	:	8.86 %
Cumulative Load Factor (LF)	:	78.62 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	80.66 %			

Electricity Production (net) [GWh]

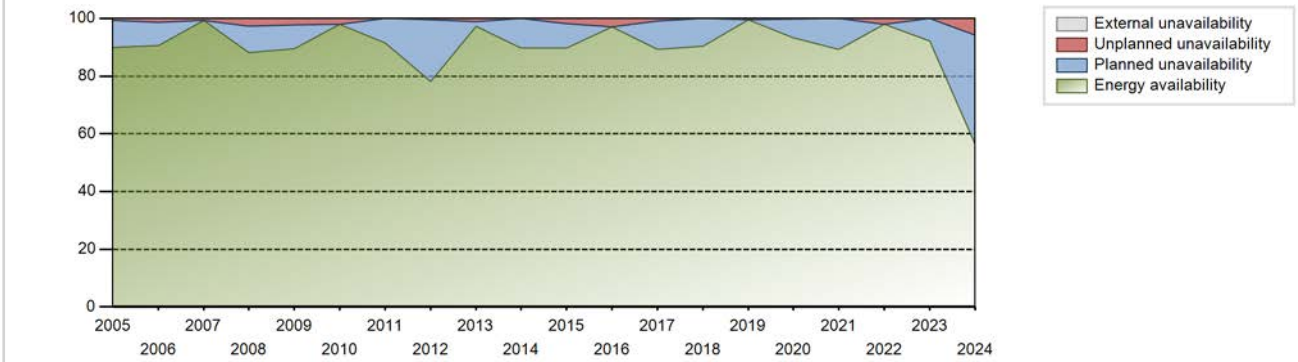


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1982	5207.56	5881	1145	75.00	75.00	66.75	74.05	17.32	15.71	9.29	0.00
1983	6691.40	6346	1133	72.76	72.76	67.42	72.44	3.72	2.81	24.42	0.00
1984	6403.27	6112	1148	69.82	69.82	63.50	69.58	7.23	5.44	24.74	0.00
1985	5624.97	5223	1148	59.80	59.80	55.93	59.62	40.16	40.13	0.07	0.00
1986	0.00	0	1148	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1987	0.00	0	1148	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00
1988	3934.70	5097	1148	59.44	59.44	39.02	58.03	40.55	40.55	0.02	0.00
1989	6067.70	6103	1148	70.71	70.71	60.34	69.67	5.97	4.49	24.80	0.00
1990	7185.46	6864	1148	79.14	79.14	71.45	78.36	1.29	1.03	19.83	0.00
1991	9318.89	8482	1122	96.88	96.88	94.81	96.83	3.12	3.12	0.00	0.00
1992	7276.08	7031	1122	80.35	80.35	73.83	80.04	2.69	2.22	17.43	0.00
1993	2094.36	2213	1122	26.32	26.32	21.31	25.26	73.68	73.68	0.00	0.00
1994	5849.36	5415	1106	61.85	61.85	60.37	61.82	2.18	1.38	36.77	0.00
1995	8887.69	8064	1106	92.15	92.15	91.73	92.05	7.85	7.85	0.00	0.00
1996	7682.50	6894	1108	78.59	78.59	78.88	78.48	8.62	7.42	13.99	0.00
1997	8725.64	8001	1117	91.45	91.45	89.17	91.34	0.30	0.27	8.27	0.00
1998	9799.59	8656	1117	98.84	98.84	100.15	98.81	1.16	1.16	0.00	0.00
1999	8978.97	8203	1117	93.65	93.65	91.76	93.64	0.00	0.00	6.35	0.00
2000	9058.27	8158	1117	92.88	92.88	92.32	92.87	0.88	0.82	6.30	0.00
2001	9939.87	8760	1117	100.00	100.00	101.58	100.00	0.00	0.00	0.00	0.00
2002	8542.04	7640	1126	87.28	87.28	87.14	87.21	3.20	2.88	9.83	0.00
2003	8258.27	7401	1126	84.64	84.64	83.72	84.49	7.37	6.74	8.63	0.00
2004	9464.89	8353	1124	95.08	95.08	95.86	95.09	2.19	2.13	2.78	0.00
2005	8922.57	7867	1127	89.83	89.83	90.37	89.80	0.77	0.70	9.47	0.00
2006	8914.65	7931	1127	90.56	90.56	90.30	90.54	1.42	1.31	8.13	0.00
2007	9892.40	8692	1126	99.23	99.23	100.29	99.22	0.77	0.77	0.00	0.00
2008	8752.56	7749	1126	88.23	88.23	88.49	88.22	2.89	2.62	9.14	0.00
2009	8792.36	7837	1126	89.49	89.49	89.14	89.46	2.46	2.26	8.25	0.00
2010	9536.67	8573	1126	97.89	97.89	96.68	97.87	2.11	2.11	0.00	0.00
2011	8799.53	8016	1126	91.52	91.52	89.21	91.51	0.00	0.00	8.48	0.00
2012	7640.46	6866	1125	78.18	78.18	77.32	78.16	0.64	0.51	21.31	0.00
2013	9661.10	8519	1126	97.25	97.25	97.93	97.24	1.18	1.16	1.59	0.00
2014	8840.63	7867	1125	89.81	89.81	89.71	89.81	0.00	0.00	10.19	0.00
2015	8739.59	7849	1125	89.60	89.60	88.68	89.60	2.11	1.93	8.47	0.00
2016	9595.60	8526	1125	97.06	97.06	97.10	97.06	2.94	2.94	0.00	0.00
2017	8848.02	7824	1125	89.32	89.32	89.78	89.32	1.08	0.98	9.71	0.00
2018	8786.87	7909	1139	90.28	90.28	88.07	90.29	0.00	0.00	9.72	0.00

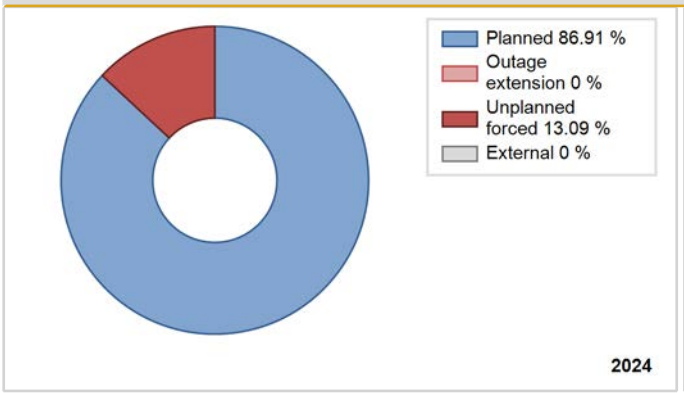
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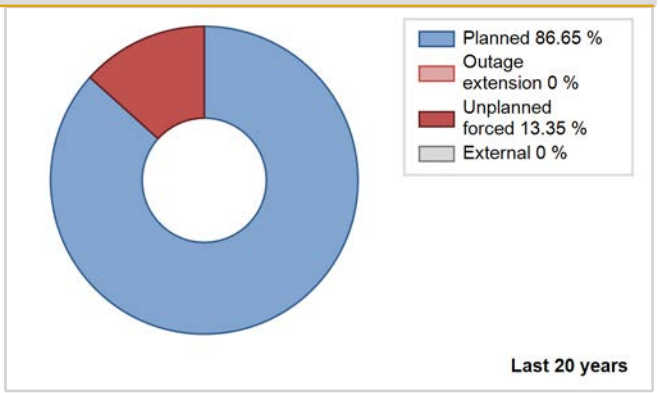
2019	9874.98	8711	1139	99.45	99.45	98.97	99.44	0.55	0.55	0.00	0.00
2020	9252.42	8190	1139	93.24	93.24	92.48	93.24	0.33	0.31	6.45	0.00
2021	8478.57	7828	1139	89.36	89.36	84.98	89.36	0.00	0.00	10.64	0.00
2022	9777.31	8590	1139	98.06	98.06	97.99	98.06	1.94	1.94	0.00	0.00
2023	9114.69	8079	1139	92.23	92.23	91.35	92.23	0.00	0.00	7.77	0.00
2024	5503.26	4872	1139	56.19	56.19	55.01	55.46	9.26	5.73	38.07	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1982 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		510			344	
B. Refuelling without maintenance				35		
C. Inspection, maintenance or repair combined with refuelling	3384			733		
D. Inspection, maintenance or repair without refuelling				25		
E. Testing of plant systems or components				1		
H. Nuclear regulatory requirements					284	
L. Human factor related					18	
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					0	
Z. Other					263	
Subtotal	3384	510		794	909	
Total	**3894**			**1703**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1982 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		1
12. Reactor I&C Systems		5
13. Reactor Auxiliary Systems		6
14. Safety Systems		1
15. Reactor Cooling Systems		33
16. Steam generation systems		17
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries	207	30
32. Feedwater and Main Steam System		42
34. Miscellaneous Systems		2
35. All other I&C Systems		1
41. Main Generator Systems	302	191
42. Electrical Power Supply Systems		18
Total	**509**	**348**

Highlights (2024)

NA

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2024 Operating Experience

US-498 SOUTH TEXAS-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	STP (STP Nuclear Operating Co.)
Owner	:	NRGENERG (NRG Energy, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3853 MWth
Gross electrical power	:	1354 MWe
Reference unit power (net)	:	1280 MWe

Key Dates

Construction Date	:	1975-12-22
Grid Date	:	1988-03-30
Commercial Date	:	1988-08-25
Age at end of year	:	36 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	16.7
Average discharge burnup [MWd/t]	:	43000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	4.27
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.03
Number of control rod assemblies	:	29
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

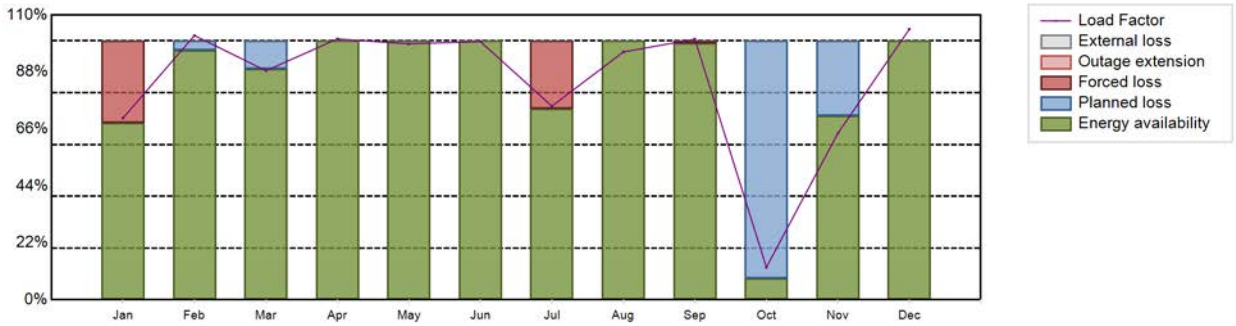
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	330
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.397
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	7.55
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Pond (closed-cycle)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9469.55 GW(e).h
Energy Availability Factor (EAF)	:	83.71 %
Unit Capability Factor (UCF)	:	83.71 %
Load Factor (LF)	:	84.22 %
Operating Factor (OF)	:	83.95 %

Forced Loss Rate (FLR)	:	5.59 %
Unplanned Capability Loss Factor (UCL)	:	4.96 %
Planned Unavailability Factor (PUF)	:	11.33 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1410 hours

Annual Summary



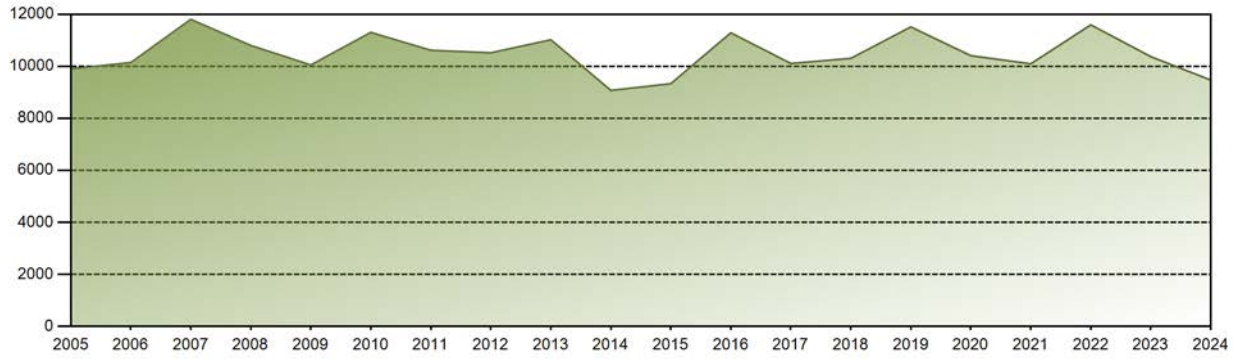
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	668.72	909.45	841.64	928.43	941.44	919.18	712.44	911.61	928.04	119.67	593.35	995.58	9469.55
EAF [%]	68.41	96.50	89.14	100.00	100.00	100.00	73.79	100.00	99.21	8.27	71.16	100.00	83.71
UCF [%]	68.41	96.50	89.14	100.00	100.00	100.00	73.79	100.00	99.21	8.27	71.16	100.00	83.71
LF [%]	70.22	102.08	88.50	100.74	98.86	99.74	74.81	95.73	100.70	12.57	64.29	104.54	84.22
OF [%]	68.95	98.28	87.62	100.00	100.00	100.00	75.13	98.25	100.00	12.63	68.52	100.00	83.95
FLR [%]	31.59	0.00	0.00	0.00	0.00	0.00	26.21	0.00	0.79	0.00	0.00	0.00	5.59
UCL [%]	31.59	0.00	0.00	0.00	0.00	0.00	26.21	0.00	0.79	0.00	0.00	0.00	4.96
PUF [%]	0.00	3.50	10.86	0.00	0.00	0.00	0.00	0.00	0.00	91.73	28.84	0.00	11.33
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	345986.44 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.35 %
Cumulative Energy Availability Factor (EAF)	:	85.12 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.79 %
Cumulative Unit Capability Factor (UCF)	:	85.12 %	Cumulative Planned Unavailability Factor (PUF)	:	9.09 %
Cumulative Load Factor (LF)	:	85.74 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	85 %			

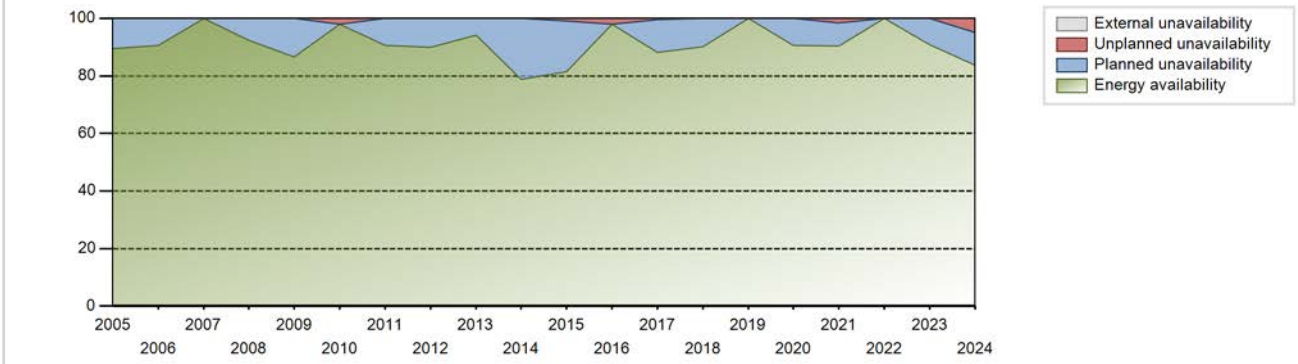
Electricity Production (net) [GWh]



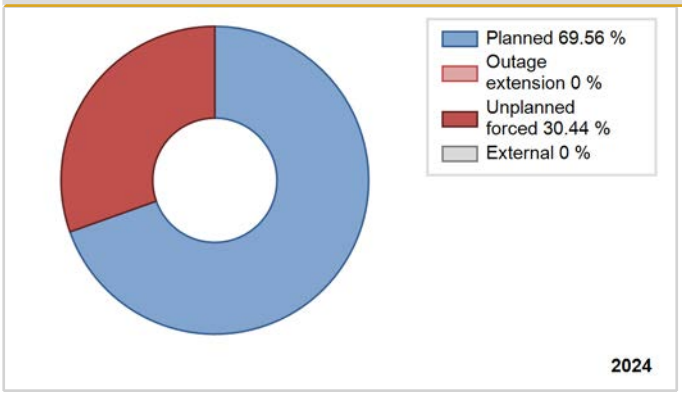
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1988	2791.49	2404	1250	80.04	80.04	74.87	79.55	7.84	6.81	13.15	0.00
1989	6307.67	5524	1250	63.09	63.09	57.60	63.06	8.17	5.62	31.29	0.00
1990	6072.87	5198	1251	59.38	59.38	55.42	59.34	23.62	18.37	22.25	0.00
1991	7239.78	6069	1251	69.29	69.29	66.06	69.28	11.39	8.90	21.80	0.00
1992	7265.14	6033	1251	68.69	68.69	66.11	68.68	14.83	11.96	19.34	0.00
1993	666.03	676	1251	7.73	7.73	6.08	7.72	92.27	92.27	0.00	0.00
1994	8251.41	6842	1251	78.15	78.15	75.30	78.11	21.80	21.79	0.06	0.00
1995	9301.77	7570	1251	86.46	86.46	84.88	86.42	2.38	2.11	11.43	0.00
1996	10226.80	8213	1251	93.53	93.53	93.07	93.50	0.00	0.00	6.47	0.00
1997	9873.23	8019	1251	91.61	91.61	90.09	91.54	1.57	1.46	6.93	0.00
1998	10859.94	8739	1250	99.77	99.77	99.11	99.76	0.00	0.00	0.23	0.00
1999	9645.37	7857	1250	89.72	89.72	88.09	89.69	1.38	1.26	9.02	0.00
2000	8591.90	6905	1250	78.64	78.64	78.25	78.61	1.22	0.97	20.39	0.00
2001	10338.16	8240	1250	94.07	94.07	94.41	94.06	0.00	0.00	5.93	0.00
2002	10867.94	8573	1250	97.85	97.85	99.01	97.87	2.15	2.15	0.00	0.00
2003	6858.78	5433	1250	62.26	62.26	62.64	62.02	33.18	30.92	6.82	0.00
2004	11103.58	8712	1250	99.17	99.17	101.13	99.18	0.83	0.83	0.00	0.00
2005	9901.85	7845	1280	89.57	89.57	88.30	89.54	0.00	0.00	10.43	0.00
2006	10144.55	7942	1280	90.67	90.67	90.47	90.66	0.00	0.00	9.33	0.00
2007	11804.80	8760	1280	100.00	100.00	105.28	100.00	0.00	0.00	0.00	0.00
2008	10800.56	8108	1280	92.31	92.31	96.06	92.30	0.00	0.00	7.69	0.00
2009	10052.23	7582	1280	86.56	86.56	89.65	86.55	0.00	0.00	13.44	0.00
2010	11304.11	8588	1280	98.05	98.05	100.81	98.04	1.95	1.95	0.00	0.00
2011	10616.20	7909	1280	90.52	90.52	94.68	90.29	0.00	0.00	9.48	0.00
2012	10520.66	7891	1280	89.85	89.85	93.57	89.83	0.00	0.00	10.15	0.00
2013	11019.47	8247	1280	94.14	94.14	98.26	94.13	0.00	0.00	5.86	0.00
2014	9075.07	6894	1280	78.70	78.70	80.93	78.70	0.00	0.00	21.30	0.00
2015	9331.90	7140	1280	81.51	81.51	83.23	81.51	1.22	1.01	17.49	0.00
2016	11288.14	8599	1280	97.89	97.89	100.40	97.89	2.11	2.11	0.00	0.00
2017	10109.92	7715	1280	88.08	88.08	90.16	88.07	0.51	0.45	11.47	0.00
2018	10306.36	7881	1280	90.20	90.20	91.92	89.97	0.00	0.00	9.80	0.00
2019	11515.33	8760	1280	100.00	100.00	102.70	100.00	0.00	0.00	0.00	0.00
2020	10409.82	7965	1280	90.69	90.69	92.59	90.68	0.00	0.00	9.31	0.00
2021	10097.71	7915	1280	90.36	90.36	90.06	90.35	0.99	1.63	8.01	0.00
2022	11593.44	8760	1280	100.00	100.00	103.39	100.00	0.00	0.00	0.00	0.00
2023	10372.14	7932	1280	90.74	90.74	92.50	90.55	0.00	0.00	9.26	0.00
2024	9469.55	7374	1280	83.71	83.71	84.22	83.95	5.59	4.96	11.33	0.00

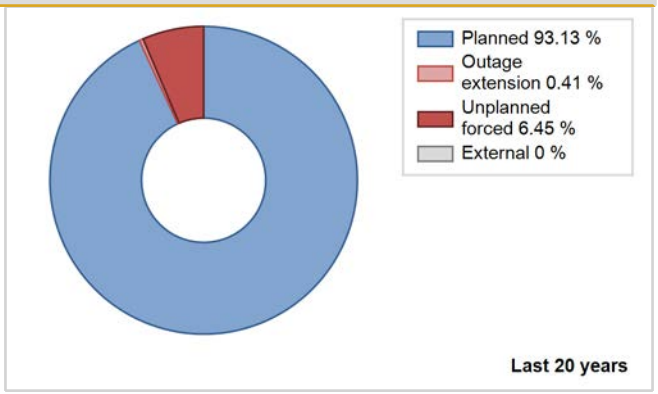
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1988 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure	103	429		3	464	
B. Refuelling without maintenance				42		
C. Inspection, maintenance or repair combined with refuelling	877			682		
D. Inspection, maintenance or repair without refuelling				58	27	
E. Testing of plant systems or components				4		
H. Nuclear regulatory requirements					10	
L. Human factor related					11	
Z. Other				0	4	
Subtotal	980	429		789	516	
Total	**1409**			**1305**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1988 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories		2
12. Reactor I&C Systems		5
13. Reactor Auxiliary Systems		5
14. Safety Systems		260
15. Reactor Cooling Systems		7
17. Safety I&C Systems (excluding reactor I&C)		89
31. Turbine and auxiliaries		14
32. Feedwater and Main Steam System	231	21
34. Miscellaneous Systems		1
35. All other I&C Systems		5
41. Main Generator Systems	198	53
42. Electrical Power Supply Systems		4
Total	**429**	**466**

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Highlights (2024)

NA

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2024 Operating Experience

US-499 SOUTH TEXAS-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	STP (STP Nuclear Operating Co.)
Owner	:	NRGENERG (NRG Energy, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3853 MWth
Gross electrical power	:	1354 MWe
Reference unit power (net)	:	1280 MWe

Key Dates

Construction Date	:	1975-12-22
Grid Date	:	1989-04-11
Commercial Date	:	1989-06-19
Age at end of year	:	35 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	16.7
Average discharge burnup [MWd/t]	:	43000
Active core diameter [m]	:	3.37
Active core height/length [m]	:	4.27
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.03
Number of control rod assemblies	:	29
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

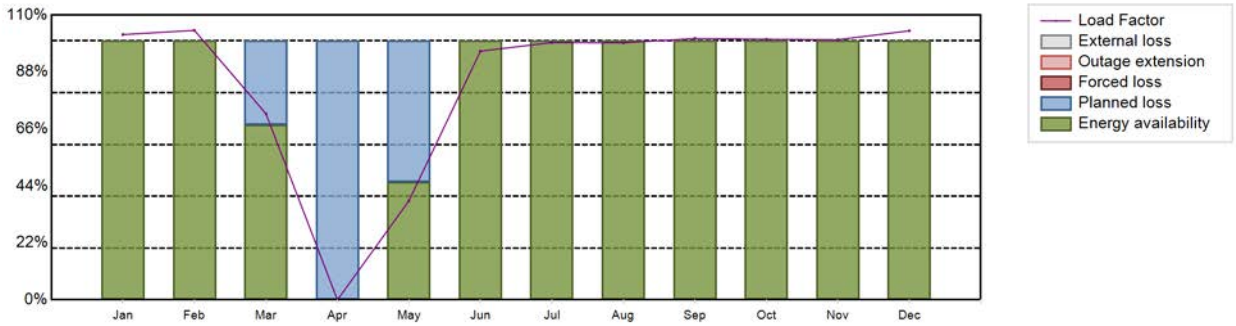
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	330
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.397
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	7.55
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Pond (closed-cycle)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9532.37 GW(e).h
Energy Availability Factor (EAF)	:	84.46 %
Unit Capability Factor (UCF)	:	84.46 %
Load Factor (LF)	:	84.78 %
Operating Factor (OF)	:	84.46 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	15.54 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1365 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	975.59	927.14	683.46	0.00	364.26	885.10	946.20	945.37	930.10	958.32	927.31	989.52	9532.37
EAF [%]	100.00	100.00	67.70	0.00	45.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	84.46
UCF [%]	100.00	100.00	67.70	0.00	45.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	84.46
LF [%]	102.44	104.07	71.86	0.00	38.25	96.04	99.36	99.27	100.92	100.63	100.48	103.91	84.78
OF [%]	100.00	100.00	70.79	0.00	42.47	100.00	100.00	100.00	100.00	100.00	100.00	100.00	84.46
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	32.30	100.00	54.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.54
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	337838.33 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	6.25 %
Cumulative Energy Availability Factor (EAF)	:	85.13 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	5.67 %
Cumulative Unit Capability Factor (UCF)	:	85.13 %	Cumulative Planned Unavailability Factor (PUF)	:	9.2 %
Cumulative Load Factor (LF)	:	85.58 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	85.06 %			

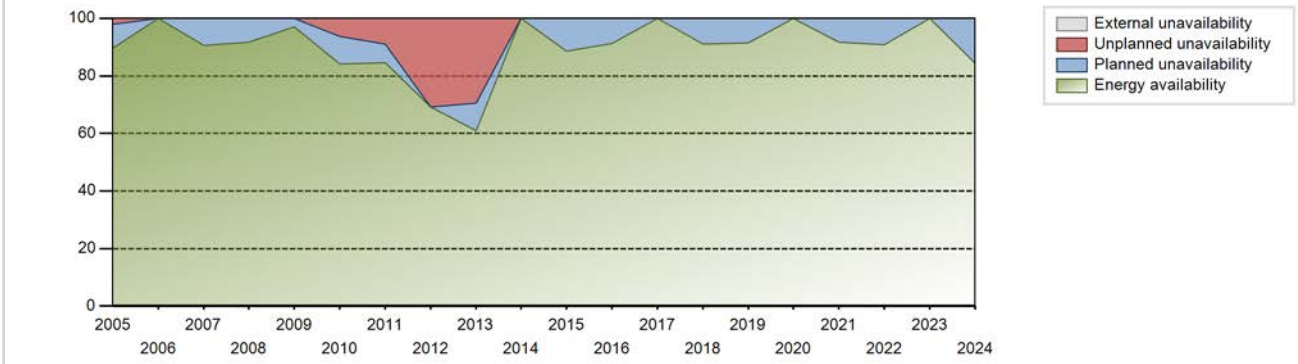
Electricity Production (net) [GWh]



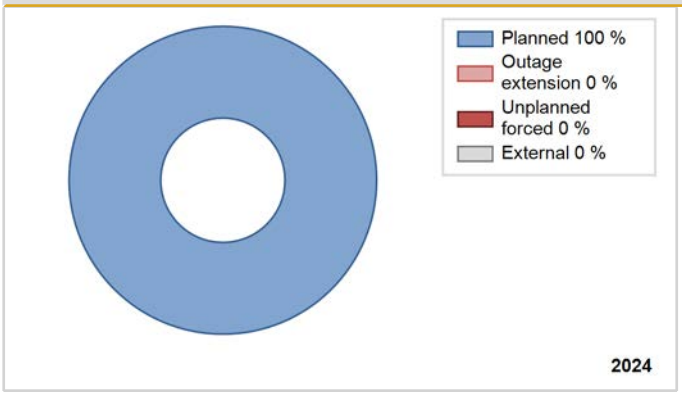
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	3026.67	2845	1250	57.92	57.92	48.32	57.89	22.68	16.99	25.09	0.00
1990	6452.17	5494	1251	62.76	62.76	58.88	62.72	21.61	17.31	19.93	0.00
1991	7267.99	6134	1251	70.03	70.03	66.32	70.02	9.37	7.24	22.73	0.00
1992	10340.97	8548	1251	97.32	97.32	94.10	97.31	2.68	2.68	0.00	0.00
1993	690.30	702	1251	8.00	8.00	6.30	8.01	51.35	8.45	83.55	0.00
1994	5990.98	5098	1251	58.23	58.23	54.67	58.20	41.72	41.68	0.09	0.00
1995	9923.09	7985	1251	91.19	91.19	90.55	91.15	1.69	1.56	7.25	0.00
1996	10457.93	8373	1251	95.34	95.34	95.17	95.32	0.68	0.65	4.01	0.00
1997	9972.90	8093	1251	92.44	92.44	91.00	92.39	2.88	2.74	4.82	0.00
1998	9983.91	8096	1250	92.46	92.46	91.11	92.42	1.33	1.25	6.29	0.00
1999	9799.26	8034	1250	91.73	91.73	89.49	91.71	0.99	0.91	7.36	0.00
2000	10557.22	8449	1250	96.20	96.20	96.15	96.19	2.08	2.04	1.75	0.00
2001	9537.56	7751	1250	88.52	88.52	87.10	88.48	4.44	4.12	7.36	0.00
2002	8219.85	6663	1250	75.89	75.89	75.07	76.06	7.57	6.22	17.89	0.00
2003	8920.21	7112	1250	81.07	81.07	81.46	81.19	18.93	18.93	0.00	0.00
2004	10304.10	8121	1250	92.28	92.28	93.84	92.45	0.50	0.46	7.26	0.00
2005	9937.18	7866	1280	89.81	89.81	88.62	89.79	2.18	2.00	8.19	0.00
2006	11225.96	8760	1280	100.00	100.00	100.12	100.00	0.00	0.00	0.00	0.00
2007	10373.70	7943	1280	90.68	90.68	92.52	90.67	0.00	0.00	9.32	0.00
2008	10739.07	8047	1280	91.61	91.61	95.51	91.61	0.00	0.00	8.39	0.00
2009	11303.91	8498	1280	97.01	97.01	100.81	97.01	0.00	0.00	2.99	0.00
2010	9822.67	7371	1280	84.16	84.16	87.60	84.14	6.86	6.20	9.63	0.00
2011	9823.15	7408	1280	84.59	84.59	87.61	84.57	9.61	9.00	6.42	0.00
2012	8122.51	6073	1280	69.15	69.15	72.24	69.14	30.85	30.85	0.00	0.00
2013	7046.84	5338	1280	60.95	60.95	62.84	60.93	32.55	29.42	9.64	0.00
2014	11628.69	8760	1280	100.00	100.00	103.71	100.00	0.00	0.00	0.00	0.00
2015	10154.98	7767	1280	88.67	88.67	90.57	88.66	0.00	0.00	11.33	0.00
2016	10452.92	8024	1280	91.35	91.35	92.97	91.35	0.00	0.00	8.65	0.00
2017	11502.22	8760	1280	100.00	100.00	102.58	100.00	0.00	0.00	0.00	0.00
2018	10434.48	7964	1280	91.12	91.12	93.06	90.91	0.00	0.00	8.88	0.00
2019	10518.90	8007	1280	91.42	91.42	93.81	91.40	0.00	0.00	8.58	0.00
2020	11548.94	8783	1280	100.00	100.00	102.72	99.99	0.00	0.00	0.00	0.00
2021	10458.96	8028	1280	91.64	91.64	93.28	91.64	0.00	0.00	8.36	0.00
2022	10360.23	7951	1280	90.75	90.75	92.40	90.76	0.00	0.00	9.25	0.00
2023	11443.58	8760	1280	99.96	99.96	102.06	100.00	0.01	0.01	0.03	0.00
2024	9532.37	7419	1280	84.46	84.46	84.78	84.46	0.00	0.00	15.54	0.00

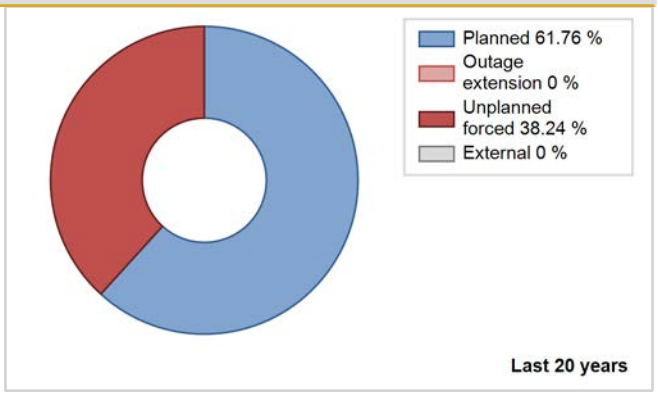
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					488	
B. Refuelling without maintenance				43		
C. Inspection, maintenance or repair combined with refuelling	1179			707		
D. Inspection, maintenance or repair without refuelling	186			58		
E. Testing of plant systems or components				1		
H. Nuclear regulatory requirements					1	
L. Human factor related					5	
Z. Other					4	
Subtotal	1365			809	498	
Total	**1365**			**1307**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1989 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		4
13. Reactor Auxiliary Systems		6
14. Safety Systems		116
15. Reactor Cooling Systems		6
16. Steam generation systems		9
17. Safety I&C Systems (excluding reactor I&C)		4
31. Turbine and auxiliaries		65
32. Feedwater and Main Steam System		30
33. Circulating Water System		1
34. Miscellaneous Systems		9
35. All other I&C Systems		5
41. Main Generator Systems		123
42. Electrical Power Supply Systems		110
Total		**488**

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Highlights (2024)

NA

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2024 Operating Experience

US-335 ST. LUCIE-1 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	FPL (Florida Power & Light Co.)
Owner	:	FPL (Florida Power & Light Co.)
Reactor Supplier	:	CE (COMBUSTION ENGINEERING CO.)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / CE 2LP (DRYAMB)
Thermal power	:	3020 MWth
Gross electrical power	:	1045 MWe
Reference unit power (net)	:	981 MWe

Key Dates

Construction Date	:	1970-07-01
Grid Date	:	1976-05-07
Commercial Date	:	1976-12-21
Age at end of year	:	48 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.45
Active core height/length [m]	:	3.47
Number of fissile fuel assemblies/bundles	:	217
Fuel linear heat generation rate [kW/m]	:	19.4
Number of control rod assemblies	:	73
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

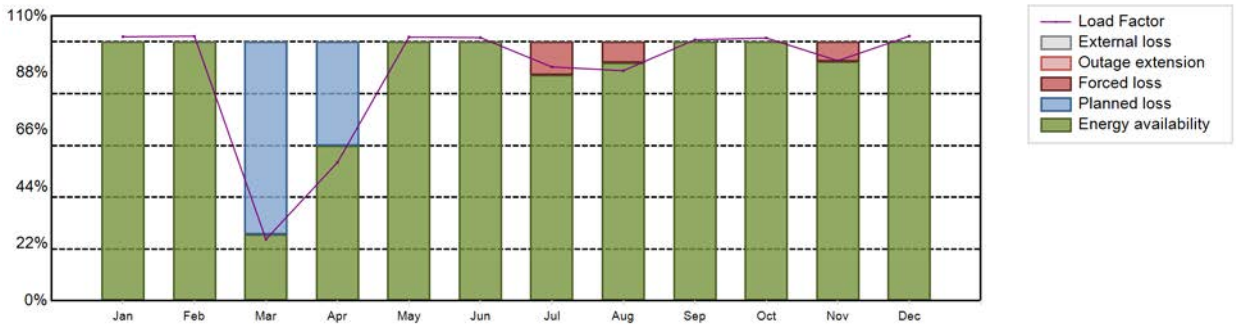
Operating coolant pressure [MPa]	:	15.5
Reactor outlet temperature [°C]	:	314
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.31
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.38
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7617.44 GW(e).h
Energy Availability Factor (EAF)	:	88.05 %
Unit Capability Factor (UCF)	:	88.05 %
Load Factor (LF)	:	88.4 %
Operating Factor (OF)	:	88.05 %

Forced Loss Rate (FLR)	:	2.63 %
Unplanned Capability Loss Factor (UCL)	:	2.38 %
Planned Unavailability Factor (PUF)	:	9.57 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1050 hours

Annual Summary



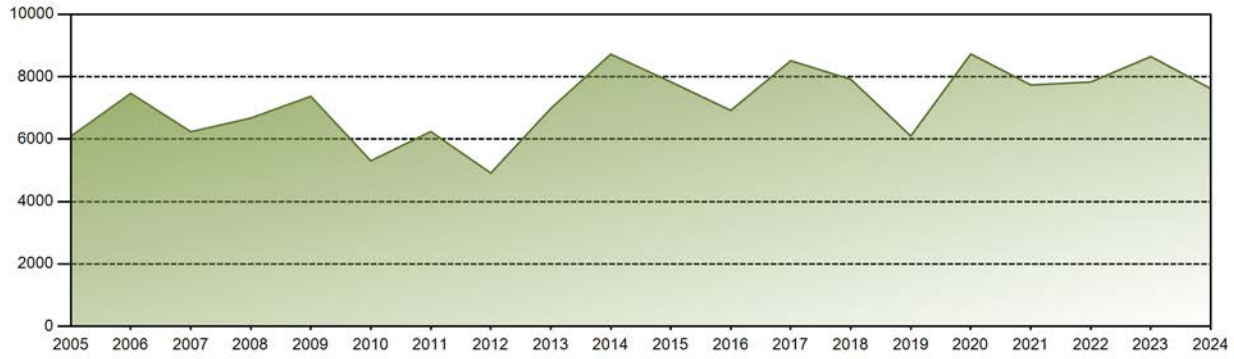
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	744.41	697.84	173.18	377.45	743.38	717.97	659.33	648.76	712.12	740.88	655.93	746.20	7617.44
EAF [%]	100.00	100.00	25.71	59.90	100.00	100.00	87.10	92.04	100.00	100.00	92.51	100.00	88.05
UCF [%]	100.00	100.00	25.71	59.90	100.00	100.00	87.10	92.04	100.00	100.00	92.51	100.00	88.05
LF [%]	101.99	102.21	23.76	53.44	101.85	101.65	90.34	88.89	100.82	101.51	92.74	102.24	88.40
OF [%]	100.00	100.00	25.84	59.72	100.00	100.00	89.65	89.52	100.00	100.00	92.51	100.00	88.05
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	12.90	7.96	0.00	0.00	7.49	0.00	2.63
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	12.90	7.96	0.00	0.00	7.49	0.00	2.38
PUF [%]	0.00	0.00	74.29	40.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.57
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	307568.52 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.69 %
Cumulative Energy Availability Factor (EAF)	:	84.26 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.24 %
Cumulative Unit Capability Factor (UCF)	:	84.45 %	Cumulative Planned Unavailability Factor (PUF)	:	12.32 %
Cumulative Load Factor (LF)	:	84.08 %	Cumulative Externally cause unavailability (XUF)	:	0.18 %
Cumulative Operating Factor (OF)	:	84.12 %			

Electricity Production (net) [GWh]

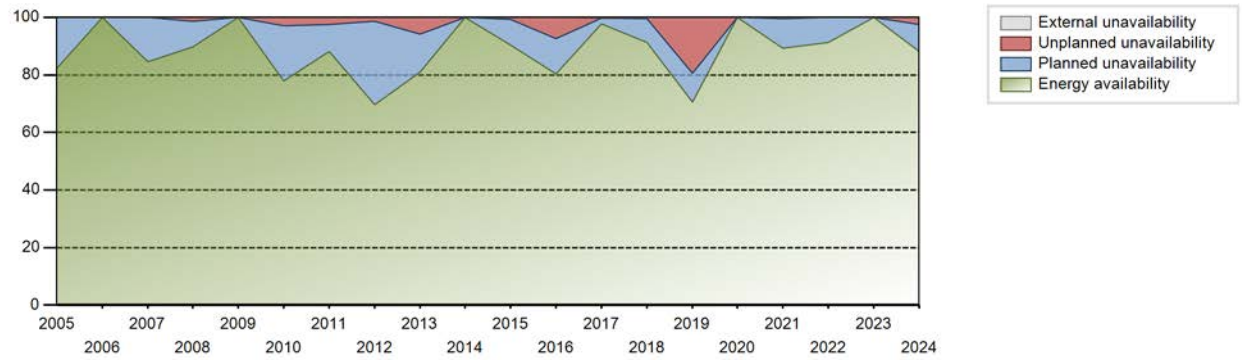


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1976	317.20	919	814	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1977	5343.70	7414	779	78.39	78.39	78.31	84.63	16.10	15.04	6.57	0.00
1978	5009.70	6674	777	73.65	73.65	73.60	76.19	3.45	2.64	23.71	0.00
1979	4889.60	6469	777	71.70	71.70	71.84	73.85	3.60	2.67	25.63	0.00
1980	5201.90	6797	777	75.98	75.98	76.22	77.38	7.26	5.95	18.07	0.00
1981	4954.70	6364	777	70.48	70.48	72.79	72.65	5.05	3.75	25.77	0.00
1982	6784.60	8227	803	94.15	94.15	96.45	93.92	0.55	0.52	5.33	0.00
1983	1099.50	1350	820	15.40	15.40	15.31	15.41	1.15	0.18	84.43	0.00
1984	4243.28	5154	822	58.64	60.77	58.77	58.67	3.05	1.91	37.31	2.13
1985	5868.61	7067	825	80.39	80.39	81.13	80.67	1.45	1.18	18.43	0.00
1986	7052.03	8351	829	95.70	95.70	97.10	95.33	0.50	0.48	3.82	0.00
1987	5719.18	6812	839	77.80	77.80	77.82	77.76	4.35	3.54	18.66	0.00
1988	6256.01	7407	839	84.36	84.36	84.89	84.32	1.56	1.34	14.31	0.00
1989	6947.34	8257	839	94.28	94.28	94.53	94.26	0.53	0.51	5.22	0.00
1990	4503.49	5463	839	64.29	64.29	61.27	62.36	33.77	32.79	2.92	0.00
1991	5793.30	7089	839	80.95	80.95	78.82	80.92	1.16	0.95	18.11	0.00
1992	7142.17	8479	839	96.54	96.54	96.91	96.53	3.46	3.46	0.00	0.00
1993	5440.51	6678	839	76.24	76.60	74.02	76.23	1.61	1.26	22.15	0.35
1994	6183.59	7600	839	86.84	86.84	84.13	86.76	5.03	4.60	8.56	0.00
1995	5519.42	6662	839	76.16	76.16	75.10	76.05	21.82	21.26	2.58	0.00
1996	5222.04	6472	839	73.76	73.76	70.86	73.68	2.99	2.28	23.96	0.00
1997	5717.75	6842	839	78.14	78.14	77.80	78.11	2.33	1.86	20.00	0.00
1998	7035.48	8393	839	95.82	95.82	95.73	95.81	0.48	0.46	3.72	0.00
1999	6532.73	7752	839	88.50	89.87	88.89	88.49	1.99	1.83	8.30	1.37
2000	7513.70	8784	839	100.00	100.00	101.95	100.00	0.00	0.00	0.00	0.00
2001	6709.77	7915	839	90.37	90.37	91.29	90.35	1.92	1.77	7.86	0.00
2002	6919.40	8163	839	93.20	93.20	94.15	93.18	0.00	0.00	6.80	0.00
2003	7504.81	8760	839	100.00	100.00	102.11	100.00	0.00	0.00	0.00	0.00
2004	6324.30	7518	839	85.62	90.45	85.81	85.59	0.00	0.00	9.55	4.83
2005	6088.09	7217	839	82.40	82.40	82.84	82.39	0.00	0.00	17.60	0.00
2006	7463.29	8760	839	100.00	100.00	101.55	100.00	0.00	0.00	0.00	0.00
2007	6235.76	7417	839	84.68	84.68	84.84	84.67	0.00	0.00	15.32	0.00
2008	6673.04	7872	839	89.63	89.63	90.55	89.62	1.62	1.47	8.90	0.00
2009	7369.21	8760	839	100.00	100.00	100.27	100.00	0.00	0.00	0.00	0.00
2010	5302.68	6813	839	77.79	77.79	72.15	77.77	3.63	2.93	19.28	0.00
2011	6240.99	7719	839	88.13	88.13	84.92	88.12	2.67	2.42	9.45	0.00
2012	4912.62	5821	982	69.71	69.71	59.09	66.27	1.83	1.30	29.00	0.00

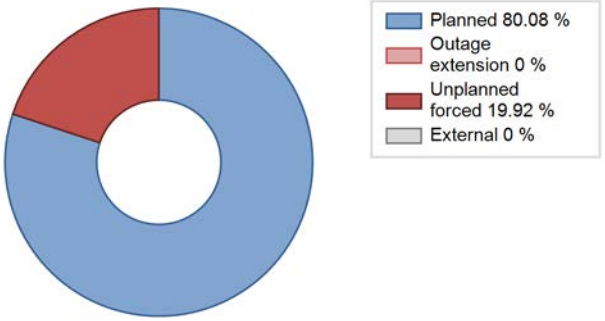
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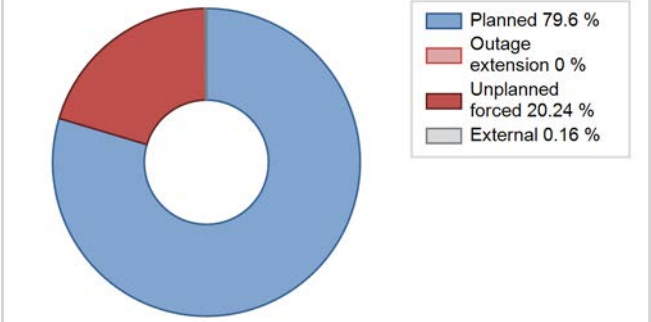
2013	6980.44	7104	982	81.09	81.09	81.14	81.09	6.68	5.80	13.11	0.00
2014	8721.17	8760	982	100.00	100.00	101.38	100.00	0.00	0.00	0.00	0.00
2015	7833.25	7927	982	90.48	90.48	91.06	90.49	0.65	0.59	8.92	0.00
2016	6918.93	7059	982	80.36	80.36	80.21	80.36	8.42	7.39	12.25	0.00
2017	8512.14	8554	981	97.64	98.00	99.05	97.65	0.00	0.00	2.00	0.35
2018	7914.55	7986	981	91.17	91.17	92.10	91.16	0.42	0.38	8.45	0.00
2019	6098.13	6182	981	70.59	70.59	70.96	70.57	21.67	19.53	9.89	0.00
2020	8726.84	8783	981	100.00	100.00	101.27	99.99	0.00	0.00	0.00	0.00
2021	7734.30	7811	981	89.17	89.17	90.00	89.17	0.49	0.44	10.38	0.00
2022	7831.28	8001	981	91.33	91.33	91.13	91.34	0.01	0.01	8.65	0.00
2023	8644.64	8760	981	99.97	99.97	100.59	100.00	0.01	0.01	0.02	0.00
2024	7617.44	7734	981	88.05	88.05	88.40	88.05	2.63	2.38	9.57	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1976 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		209			331	
B.	Refuelling without maintenance				35		
C.	Inspection, maintenance or repair combined with refuelling	841			982		
D.	Inspection, maintenance or repair without refuelling				71		
E.	Testing of plant systems or components				3		
L.	Human factor related					17	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						21
Z.	Other				0	3	
Subtotal		841	209		1091	351	21
Total		**1050**			**1463**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1976 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	209	105
12. Reactor I&C Systems		12
13. Reactor Auxiliary Systems		10
14. Safety Systems		11
15. Reactor Cooling Systems		98
16. Steam generation systems		1
17. Safety I&C Systems (excluding reactor I&C)		1
31. Turbine and auxiliaries		13
32. Feedwater and Main Steam System		20
33. Circulating Water System		6
34. Miscellaneous Systems		12
41. Main Generator Systems		43
42. Electrical Power Supply Systems		18
Total	**209**	**350**

Highlights (2024)

NA

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2024 Operating Experience

US-389 ST. LUCIE-2 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	FPL (Florida Power & Light Co.)
Owner	:	FPL (Florida Power & Light Co.)
Reactor Supplier	:	CE (COMBUSTION ENGINEERING CO.)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / CE 2LP (DRYAMB)
Thermal power	:	3020 MWth
Gross electrical power	:	1050 MWe
Reference unit power (net)	:	987 MWe

Key Dates

Construction Date	:	1977-06-02
Grid Date	:	1983-06-13
Commercial Date	:	1983-08-08
Age at end of year	:	41 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	35
Average discharge burnup [MWd/t]	:	36000
Active core diameter [m]	:	3.45
Active core height/length [m]	:	3.47
Number of fissile fuel assemblies/bundles	:	217
Fuel linear heat generation rate [kW/m]	:	14.5
Number of control rod assemblies	:	91
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

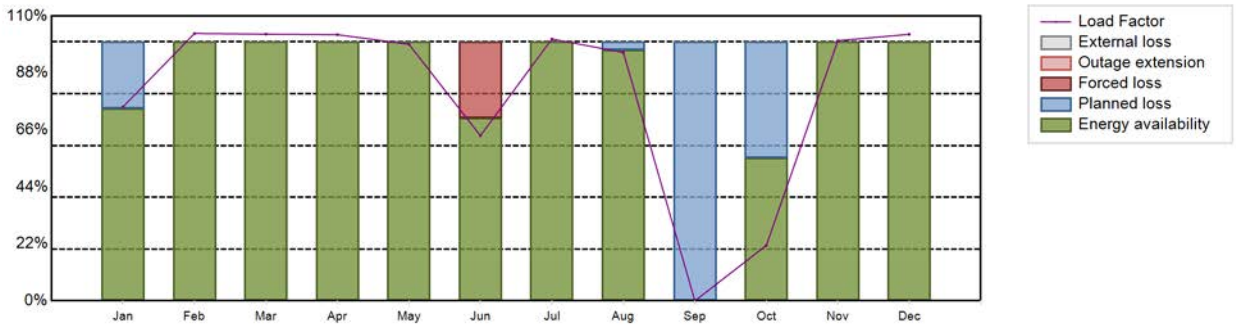
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	314
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.31
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.38
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7001.26 GW(e).h
Energy Availability Factor (EAF)	:	83.16 %
Unit Capability Factor (UCF)	:	83.16 %
Load Factor (LF)	:	80.75 %
Operating Factor (OF)	:	83.15 %

Forced Loss Rate (FLR)	:	2.82 %
Unplanned Capability Loss Factor (UCL)	:	2.41 %
Planned Unavailability Factor (PUF)	:	14.43 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1480 hours

Annual Summary



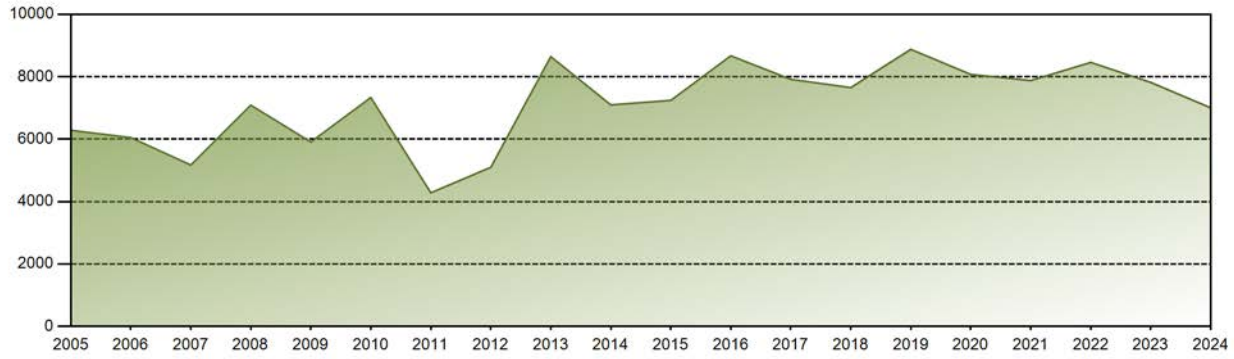
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	550.25	709.30	755.40	730.50	727.57	453.26	742.63	704.14	0.00	157.29	714.96	755.96	7001.26
EAF [%]	74.39	100.00	100.00	100.00	100.00	70.55	100.00	96.77	0.00	55.24	100.00	100.00	83.16
UCF [%]	74.39	100.00	100.00	100.00	100.00	70.55	100.00	96.77	0.00	55.24	100.00	100.00	83.16
LF [%]	74.93	103.25	103.01	102.79	99.08	63.78	101.13	95.89	0.00	21.42	100.47	102.95	80.75
OF [%]	74.33	100.00	100.00	100.00	100.00	70.56	100.00	96.77	0.00	55.24	100.00	100.00	83.15
FLR [%]	0.00	0.00	0.00	0.00	0.00	29.45	0.00	0.00	0.00	0.00	0.00	0.00	2.82
UCL [%]	0.00	0.00	0.00	0.00	0.00	29.45	0.00	0.00	0.00	0.00	0.00	0.00	2.41
PUF [%]	25.61	0.00	0.00	0.00	0.00	0.00	0.00	3.23	100.00	44.76	0.00	0.00	14.43
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	276033.97 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.29 %
Cumulative Energy Availability Factor (EAF)	:	87.02 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.11 %
Cumulative Unit Capability Factor (UCF)	:	87.34 %	Cumulative Planned Unavailability Factor (PUF)	:	9.55 %
Cumulative Load Factor (LF)	:	86.58 %	Cumulative Externally cause unavailability (XUF)	:	0.32 %
Cumulative Operating Factor (OF)	:	86.6 %			

Electricity Production (net) [GWh]

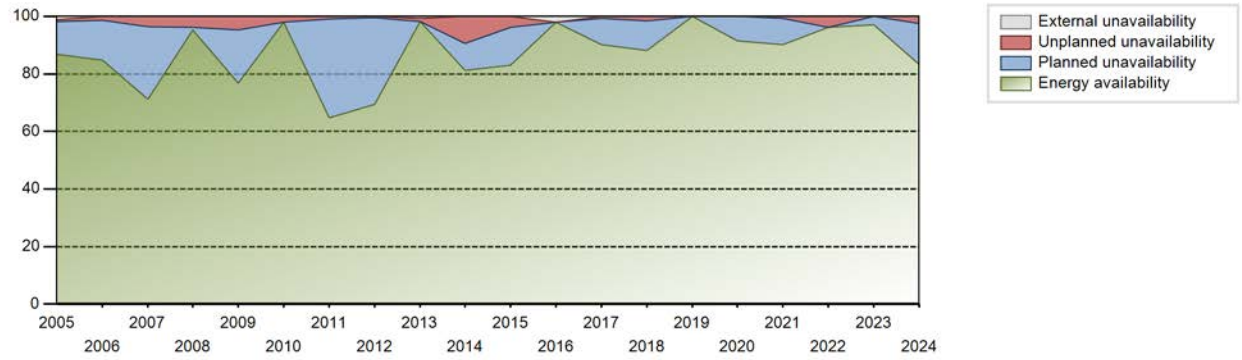


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	2575.80	3598	808	89.40	89.40	87.03	89.27	10.60	10.60	0.00	0.00
1984	5564.83	7067	786	79.49	82.85	80.60	80.45	6.88	6.13	11.02	3.36
1985	6108.63	7368	824	83.89	83.89	84.58	84.11	13.57	13.18	2.94	0.00
1986	6151.23	7253	837	82.80	82.80	83.86	82.80	1.02	0.86	16.35	0.00
1987	5950.18	7206	839	82.30	82.30	80.96	82.26	4.13	3.54	14.16	0.00
1988	7407.10	8784	839	100.00	100.00	100.51	100.00	0.00	0.00	0.00	0.00
1989	5443.45	6531	839	74.59	74.59	74.06	74.55	2.05	1.56	23.85	0.00
1990	5341.48	6487	839	74.08	74.08	72.68	74.05	10.25	8.46	17.47	0.00
1991	7428.74	8760	839	100.00	100.00	101.08	100.00	0.00	0.00	0.00	0.00
1992	5431.15	6598	839	75.15	75.15	73.69	75.11	8.10	6.63	18.23	0.00
1993	4719.91	6687	839	76.36	76.36	64.22	76.34	23.64	23.64	0.00	0.00
1994	5607.44	6971	839	79.62	79.62	76.30	79.58	2.30	1.87	18.50	0.00
1995	5295.95	6570	839	75.05	75.05	72.06	75.00	2.52	1.94	23.01	0.00
1996	6984.80	8444	839	96.16	96.16	94.78	96.13	2.75	2.72	1.12	0.00
1997	6498.92	7756	839	88.55	88.55	88.43	88.54	0.00	0.00	11.45	0.00
1998	6739.45	8009	839	91.45	91.45	91.70	91.43	0.00	0.00	8.55	0.00
1999	7212.98	8583	839	97.99	97.99	98.14	97.98	2.01	2.01	0.00	0.00
2000	6804.33	8041	839	91.56	91.56	92.33	91.54	4.79	4.61	3.83	0.00
2001	6707.49	7979	839	91.11	91.11	91.26	91.08	1.97	1.84	7.05	0.00
2002	7424.99	8742	839	99.80	99.80	101.03	99.79	0.00	0.00	0.20	0.00
2003	5891.34	7120	839	81.31	81.31	80.16	81.28	6.03	5.22	13.47	0.00
2004	6781.43	8059	839	91.77	98.17	92.02	91.75	1.83	1.83	0.00	6.40
2005	6283.15	7602	839	86.81	87.89	85.49	86.78	0.97	0.86	11.26	1.08
2006	6048.25	7434	839	84.88	84.88	82.29	84.86	1.70	1.47	13.65	0.00
2007	5170.45	6232	839	71.16	71.16	70.35	71.14	4.71	3.52	25.32	0.00
2008	7087.29	8361	839	95.19	95.19	96.17	95.18	3.83	3.79	1.02	0.00
2009	5906.55	6721	839	76.75	76.75	80.37	76.72	5.72	4.66	18.59	0.00
2010	7331.25	8589	839	98.05	98.05	99.75	98.05	1.95	1.95	0.00	0.00
2011	4279.08	5674	839	64.78	64.78	58.22	64.77	1.30	0.86	34.36	0.00
2012	5096.77	6101	839	69.47	69.47	69.16	69.46	0.78	0.54	29.99	0.00
2013	8641.77	8583	987	98.28	99.05	99.94	97.97	0.95	0.95	0.00	0.77
2014	7096.40	7121	987	81.30	81.30	82.08	81.29	5.23	9.51	9.19	0.00
2015	7242.01	7272	987	83.01	83.01	83.76	83.01	4.42	3.84	13.15	0.00
2016	8669.53	8604	987	97.95	100.00	100.00	97.95	0.00	0.00	0.00	2.05
2017	7915.78	7904	987	90.23	90.23	91.55	90.23	0.89	0.81	8.96	0.00
2018	7652.59	7723	987	88.16	88.16	88.51	88.16	1.68	1.51	10.33	0.00
2019	8876.97	8760	987	100.00	100.00	102.67	100.00	0.00	0.00	0.00	0.00

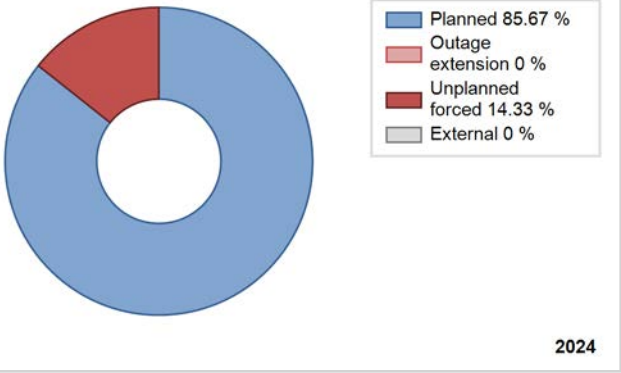
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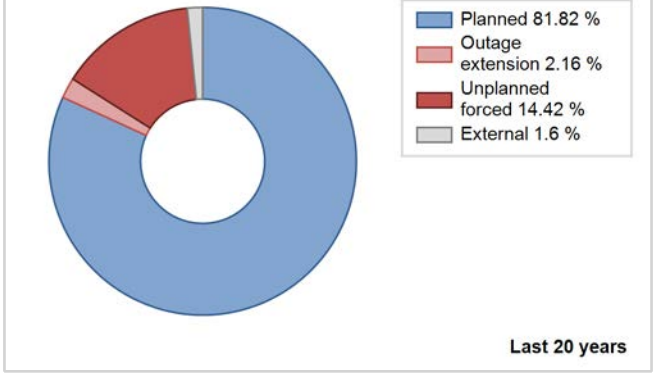
2020	8073.53	8035	987	91.48	91.48	93.12	91.47	0.00	0.00	8.52	0.00
2021	7878.34	7890	987	90.07	90.07	91.12	90.07	0.86	0.78	9.16	0.00
2022	8458.50	8425	987	96.17	96.17	97.83	96.18	3.83	3.83	0.00	0.00
2023	7816.91	7827	987	97.16	97.16	90.41	89.35	0.00	0.00	2.84	0.00
2024	7001.26	7304	987	83.16	83.16	80.75	83.15	2.82	2.41	14.43	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024			1983 to 2024		
		Hours Lost			Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		212			248	
B.	Refuelling without maintenance				37		
C.	Inspection, maintenance or repair combined with refuelling	1077			786		
D.	Inspection, maintenance or repair without refuelling	191			49		
E.	Testing of plant systems or components				1	0	
H.	Nuclear regulatory requirements					6	
J.	Grid limitation, failure or grid unavailability						0
L.	Human factor related					8	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						30
P.	Fire					1	
Z.	Other				0	11	
Subtotal		1268	212		873	274	30
Total		**1480**			**1177**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		0
12. Reactor I&C Systems		27
14. Safety Systems		20
15. Reactor Cooling Systems		95
16. Steam generation systems		17
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries		33
32. Feedwater and Main Steam System	212	48
33. Circulating Water System		7
34. Miscellaneous Systems		3
41. Main Generator Systems		18
42. Electrical Power Supply Systems		5
Total	**212**	**275**

Highlights (2024)

NA

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2024 Operating Experience

US-395 SUMMER-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	SCE&G (SOUTH CAROLINA ELECTRIC & GAS CO.)
Owner	:	SCE&G (SOUTH CAROLINA ELECTRIC & GAS CO.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYAMB)
Thermal power	:	2900 MWth
Gross electrical power	:	1006 MWe
Reference unit power (net)	:	973 MWe

Key Dates

Construction Date	:	1973-03-21
Grid Date	:	1982-11-16
Commercial Date	:	1984-01-01
Age at end of year	:	42 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	43.3
Average discharge burnup [MWd/t]	:	38900
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	17.83
Number of control rod assemblies	:	-
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

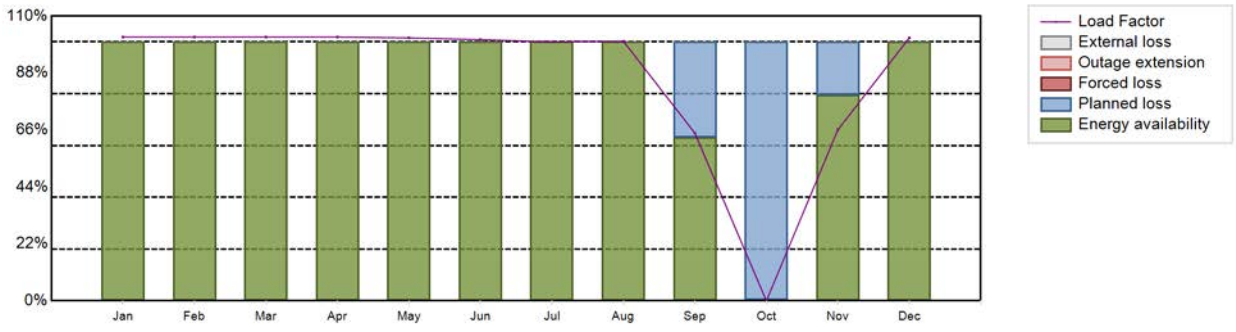
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	327
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.4
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	8.33
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Lake (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	7421.17 GW(e).h
Energy Availability Factor (EAF)	:	86.86 %
Unit Capability Factor (UCF)	:	86.86 %
Load Factor (LF)	:	86.83 %
Operating Factor (OF)	:	86.91 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	13.14 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1150 hours

Annual Summary



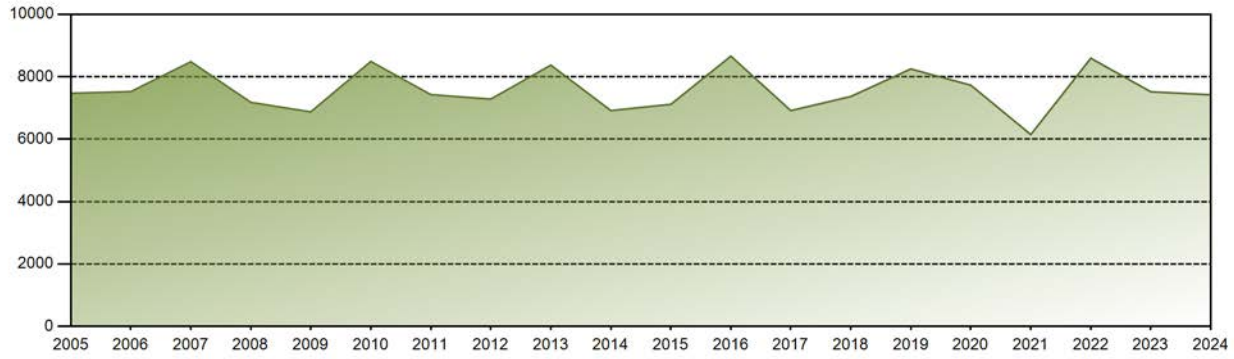
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	737.35	689.89	736.30	713.63	735.06	706.56	724.13	725.74	453.70	0.00	463.38	735.43	7421.17
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	63.18	0.24	79.62	100.00	86.86
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	63.18	0.24	79.62	100.00	86.86
LF [%]	101.86	101.87	101.85	101.87	101.54	100.86	100.03	100.25	64.76	0.00	66.05	101.59	86.83
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	66.39	0.00	77.25	100.00	86.91
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.82	99.76	20.38	0.00	13.14
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	286950.67 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.27 %
Cumulative Energy Availability Factor (EAF)	:	86.68 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.01 %
Cumulative Unit Capability Factor (UCF)	:	86.68 %	Cumulative Planned Unavailability Factor (PUF)	:	11.31 %
Cumulative Load Factor (LF)	:	84.76 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	86.17 %			

Electricity Production (net) [GWh]

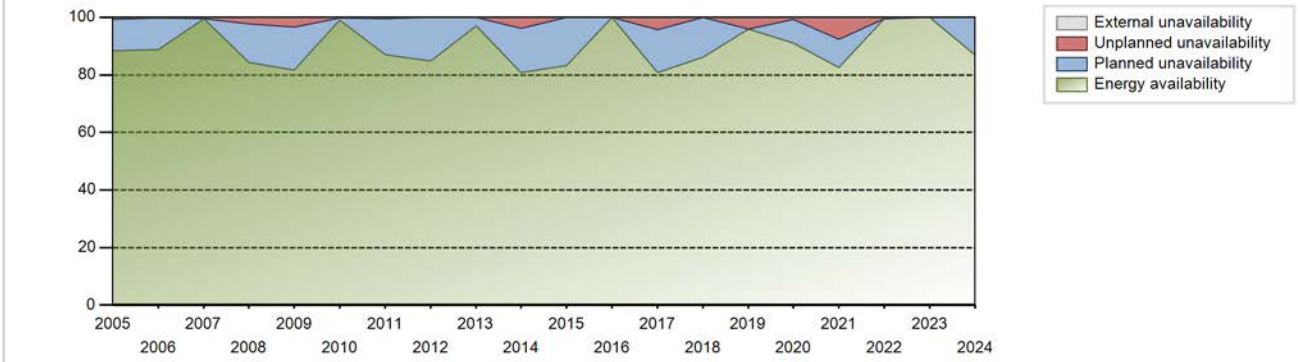


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1984	4208.59	5362	900	61.26	61.26	53.24	61.04	10.76	7.38	31.36	0.00
1985	5235.09	6272	885	71.64	71.64	67.53	71.60	6.13	4.68	23.68	0.00
1986	7160.64	8346	885	95.33	95.33	92.36	95.27	4.67	4.67	0.00	0.00
1987	5168.12	6135	885	70.07	70.07	66.66	70.03	5.44	4.03	25.90	0.00
1988	5068.16	5952	885	67.79	67.79	65.20	67.76	5.40	3.87	28.34	0.00
1989	5412.76	7073	885	80.79	80.79	69.82	80.74	19.04	18.99	0.21	0.00
1990	6117.27	7261	885	82.90	82.90	78.91	82.89	0.00	0.00	17.10	0.00
1991	5346.13	7065	885	80.65	80.65	68.96	80.65	0.72	0.58	18.77	0.00
1992	7515.20	8532	885	97.14	97.14	96.67	97.13	0.00	0.00	2.86	0.00
1993	6109.46	7258	885	82.87	82.87	78.81	82.85	1.44	1.21	15.92	0.00
1994	4456.04	6022	885	68.77	68.77	57.48	68.74	0.00	0.00	31.23	0.00
1995	7561.35	8478	885	96.80	96.80	97.53	96.78	0.02	0.02	3.17	0.00
1996	7155.13	7829	923	89.60	89.60	88.24	89.13	0.00	0.00	10.40	0.00
1997	7267.91	7805	948	89.87	89.87	87.49	89.10	1.52	1.39	8.75	0.00
1998	8188.92	8638	953	98.71	98.71	98.07	98.61	1.29	1.29	0.00	0.00
1999	7376.30	7779	954	88.85	88.85	88.26	88.80	0.74	0.66	10.49	0.00
2000	6358.81	6688	966	76.23	76.23	75.02	76.14	0.46	0.35	23.42	0.00
2001	6757.53	7095	966	81.02	81.02	79.86	80.99	0.87	0.71	18.27	0.00
2002	7379.52	7645	966	87.28	87.28	87.21	87.27	0.52	0.46	12.26	0.00
2003	7352.06	7564	966	86.37	86.37	86.88	86.35	1.14	1.00	12.64	0.00
2004	8243.34	8413	966	95.80	95.80	97.15	95.78	4.20	4.20	0.00	0.00
2005	7469.40	7746	966	88.44	88.44	88.26	88.41	0.69	0.61	10.95	0.00
2006	7521.40	7783	966	88.86	88.86	88.88	88.85	0.29	0.26	10.88	0.00
2007	8479.04	8719	966	99.53	99.53	100.20	99.53	0.47	0.47	0.00	0.00
2008	7178.10	7404	966	84.31	84.31	84.59	84.29	2.57	2.23	13.47	0.00
2009	6872.04	7150	966	81.64	81.64	81.21	81.62	3.94	3.35	15.01	0.00
2010	8487.08	8681	966	99.11	99.11	100.29	99.10	0.20	0.20	0.69	0.00
2011	7426.23	7622	966	87.02	87.02	87.76	87.01	0.66	0.58	12.40	0.00
2012	7281.60	7456	971	84.89	84.89	85.37	84.88	0.00	0.00	15.11	0.00
2013	8369.88	8501	971	97.05	97.05	98.39	97.03	0.00	0.00	2.95	0.00
2014	6914.78	7078	971	80.80	80.80	81.29	80.80	4.41	3.72	15.48	0.00
2015	7115.39	7301	971	83.35	83.35	83.65	83.34	0.00	0.00	16.65	0.00
2016	8658.36	8784	971	100.00	100.00	101.51	100.00	0.00	0.00	0.00	0.00
2017	6913.29	7079	973	80.85	80.85	81.11	80.81	5.01	4.27	14.89	0.00
2018	7366.39	7540	973	86.17	86.17	86.42	86.07	0.00	0.00	13.83	0.00
2019	8248.44	8402	973	95.92	95.92	96.77	95.91	4.08	4.08	0.00	0.00
2020	7727.52	8002	973	91.11	91.11	90.41	91.10	0.73	0.67	8.22	0.00

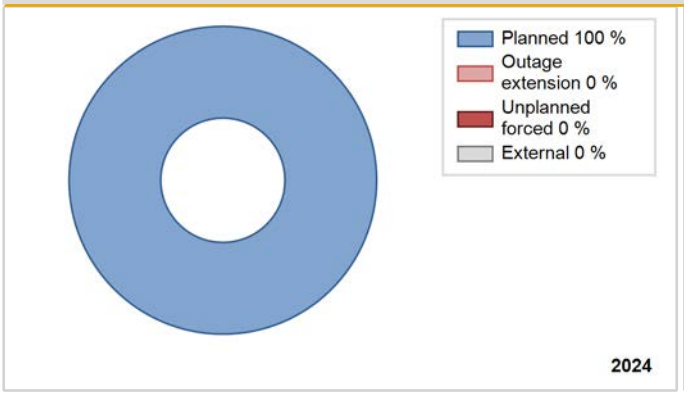
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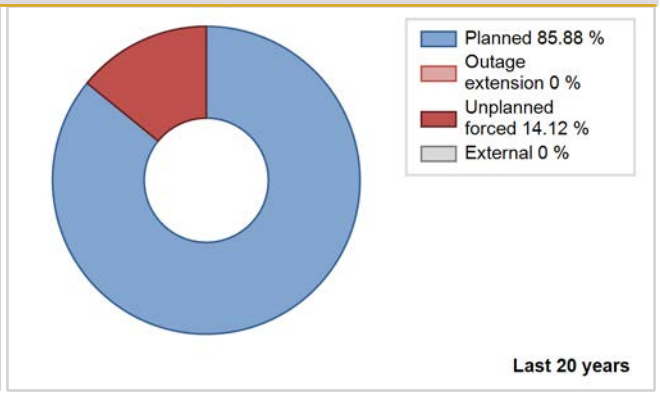
2021	6146.32	7224	973	82.47	82.47	72.11	82.47	8.36	7.52	10.01	0.00
2022	8591.09	8710	973	99.43	99.43	100.79	99.43	0.57	0.57	0.00	0.00
2023	7517.23	7699	973	99.99	99.99	88.19	87.89	0.00	0.00	0.01	0.00
2024	7421.17	7634	973	86.86	86.86	86.83	86.91	0.00	0.00	13.14	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1984 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					123	
B. Refuelling without maintenance				39		
C. Inspection, maintenance or repair combined with refuelling	1003			895		
D. Inspection, maintenance or repair without refuelling	146			122		
E. Testing of plant systems or components				2	0	
H. Nuclear regulatory requirements					1	
J. Grid limitation, failure or grid unavailability						0
L. Human factor related					7	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)					1	
Z. Other					40	
Subtotal	1149			1058	172	1
Total	**1149**			**1231**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1984 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		5
12. Reactor I&C Systems		14
13. Reactor Auxiliary Systems		8
14. Safety Systems		3
15. Reactor Cooling Systems		25
16. Steam generation systems		16
31. Turbine and auxiliaries		9
32. Feedwater and Main Steam System		13
34. Miscellaneous Systems		1
35. All other I&C Systems		1
41. Main Generator Systems		18
42. Electrical Power Supply Systems		14
Total		**127**

Highlights (2024)

NA

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2024 Operating Experience

US-280 SURRY-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	DOMINION (Dominion Energy)
Owner	:	DOMINRES (Dominion Resources, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYSUB)
Thermal power	:	2587 MWth
Gross electrical power	:	890 MWe
Reference unit power (net)	:	838 MWe

Key Dates

Construction Date	:	1968-06-25
Grid Date	:	1972-07-04
Commercial Date	:	1972-12-22
Age at end of year	:	52 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	38
Average discharge burnup [MWd/t]	:	48000
Active core diameter [m]	:	3.035
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	21.6
Number of control rod assemblies	:	32
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

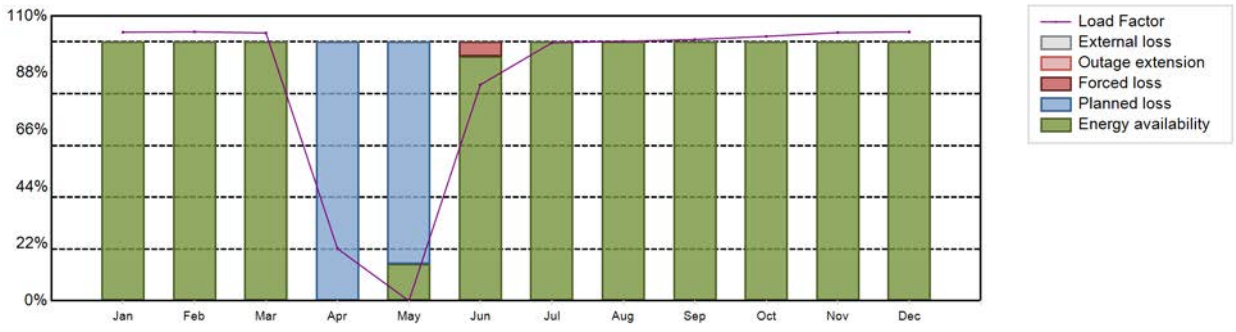
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	318
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.422
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.59
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6287.09 GW(e).h
Energy Availability Factor (EAF)	:	84.08 %
Unit Capability Factor (UCF)	:	84.08 %
Load Factor (LF)	:	85.41 %
Operating Factor (OF)	:	84.07 %

Forced Loss Rate (FLR)	:	0.55 %
Unplanned Capability Loss Factor (UCL)	:	0.46 %
Planned Unavailability Factor (PUF)	:	15.46 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1399 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	646.74	605.90	644.13	121.67	0.00	503.48	621.25	624.86	608.88	636.86	625.92	647.40	6287.09
EAF [%]	100.00	100.00	100.00	0.00	14.25	94.33	100.00	100.00	100.00	100.00	100.00	100.00	84.08
UCF [%]	100.00	100.00	100.00	0.00	14.25	94.33	100.00	100.00	100.00	100.00	100.00	100.00	84.08
LF [%]	103.73	103.88	103.45	20.17	0.00	83.45	99.64	100.22	100.92	102.15	103.60	103.84	85.41
OF [%]	100.00	100.00	100.00	20.00	0.00	89.03	100.00	100.00	100.00	100.00	100.00	100.00	84.07
FLR [%]	0.00	0.00	0.00	0.00	0.00	5.67	0.00	0.00	0.00	0.00	0.00	0.00	0.55
UCL [%]	0.00	0.00	0.00	0.00	0.00	5.67	0.00	0.00	0.00	0.00	0.00	0.00	0.46
PUF [%]	0.00	0.00	0.00	100.00	85.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.46
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	291073.07 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7.99 %
Cumulative Energy Availability Factor (EAF)	:	80.14 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.96 %
Cumulative Unit Capability Factor (UCF)	:	80.18 %	Cumulative Planned Unavailability Factor (PUF)	:	12.85 %
Cumulative Load Factor (LF)	:	79.52 %	Cumulative Externally cause unavailability (XUF)	:	0.04 %
Cumulative Operating Factor (OF)	:	80.64 %			

Electricity Production (net) [GWh]

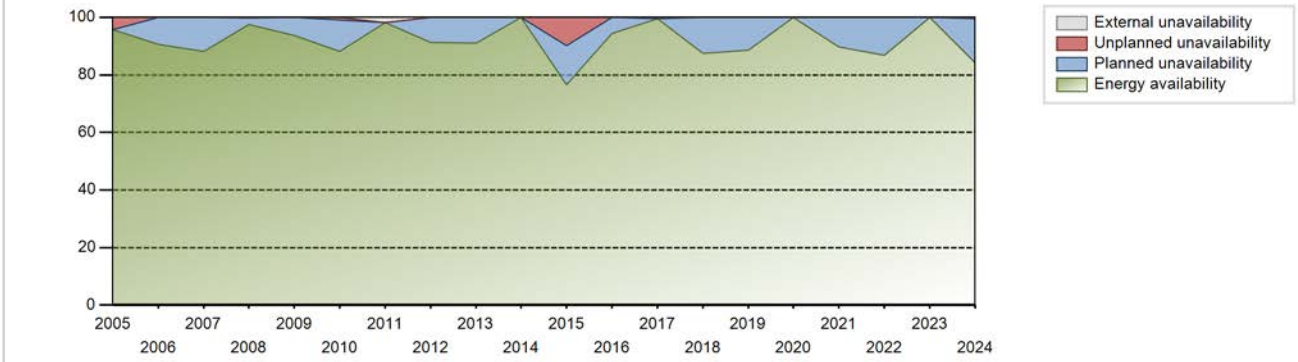


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1972	407.60	1048	794	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1973	3479.70	5377	788	61.88	61.88	50.41	61.38	27.15	23.06	15.06	0.00
1974	3318.10	4800	788	54.81	54.81	48.07	54.79	32.59	26.50	18.69	0.00
1975	3858.40	5343	788	56.10	56.10	56.05	61.16	18.03	12.34	31.56	0.00
1976	4396.80	6010	788	63.58	63.58	63.52	68.42	18.17	14.12	22.31	0.00
1977	5023.90	6661	776	74.03	74.03	73.91	76.04	3.67	2.82	23.15	0.00
1978	4704.20	6291	775	69.27	69.27	69.29	71.82	8.43	6.38	24.35	0.00
1979	2255.10	3045	775	33.22	33.22	33.22	34.76	66.59	66.20	0.59	0.00
1980	2472.60	3762	775	42.17	42.17	36.32	42.83	40.05	28.17	29.66	0.00
1981	2377.40	3403	775	39.05	39.05	35.02	38.85	11.43	5.04	55.91	0.00
1982	5483.10	7776	775	89.22	89.22	80.76	88.77	7.28	7.01	3.77	0.00
1983	3517.10	5010	775	56.29	56.41	51.81	57.19	3.64	2.13	41.45	0.13
1984	3334.11	5138	775	58.15	58.15	48.98	58.49	4.21	2.56	39.30	0.00
1985	5618.28	7827	779	89.33	89.33	82.28	89.35	10.30	10.26	0.41	0.00
1986	4488.63	6013	781	68.08	68.08	65.61	68.64	3.77	2.67	29.25	0.00
1987	4633.40	6113	781	70.14	70.14	67.72	69.78	16.11	13.47	16.39	0.00
1988	2685.03	3632	781	18.73	18.73	39.14	41.35	73.97	53.22	28.06	0.00
1989	3170.53	4217	781	46.83	46.83	46.34	48.14	53.17	53.17	0.00	0.00
1990	4772.20	6655	781	74.91	74.91	69.75	75.97	4.53	3.55	21.54	0.00
1991	6590.94	8760	781	100.00	100.00	96.34	100.00	0.00	0.00	0.00	0.00
1992	5223.79	7033	781	79.61	79.61	76.15	80.07	3.23	2.66	17.74	0.00
1993	6229.24	8402	781	95.89	95.89	91.05	95.91	1.52	1.48	2.64	0.00
1994	4881.92	6560	781	74.30	74.30	71.36	74.89	0.41	0.30	25.39	0.00
1995	5746.95	7505	784	85.42	85.42	83.64	85.67	2.81	2.47	12.11	0.00
1996	7137.78	8784	801	100.00	100.00	101.45	100.00	0.00	0.00	0.00	0.00
1997	5640.47	7067	801	80.74	80.74	80.39	80.67	3.86	3.24	16.02	0.00
1998	5752.38	7170	801	81.87	81.87	81.98	81.85	6.87	6.04	12.09	0.00
1999	7116.20	8760	801	100.00	100.00	101.42	100.00	0.00	0.00	0.00	0.00
2000	6548.43	8188	801	93.23	93.23	93.07	93.21	0.34	0.32	6.45	0.00
2001	5941.63	7380	810	84.27	84.27	83.74	84.25	0.00	0.00	15.73	0.00
2002	7149.46	8760	810	100.00	100.00	100.76	100.00	0.00	0.00	0.00	0.00
2003	5419.78	6741	810	76.97	76.97	76.38	76.95	6.27	5.15	17.88	0.00
2004	6457.13	7943	810	90.45	90.45	90.75	90.43	0.36	0.33	9.22	0.00
2005	6746.56	8376	810	95.63	95.63	95.08	95.62	4.37	4.37	0.00	0.00
2006	6311.00	7931	799	90.56	90.56	90.17	90.54	0.00	0.00	9.44	0.00
2007	6195.20	7720	799	88.15	88.15	88.51	88.13	0.00	0.00	11.85	0.00
2008	6890.50	8560	799	97.46	97.46	98.18	97.45	0.31	0.31	2.23	0.00

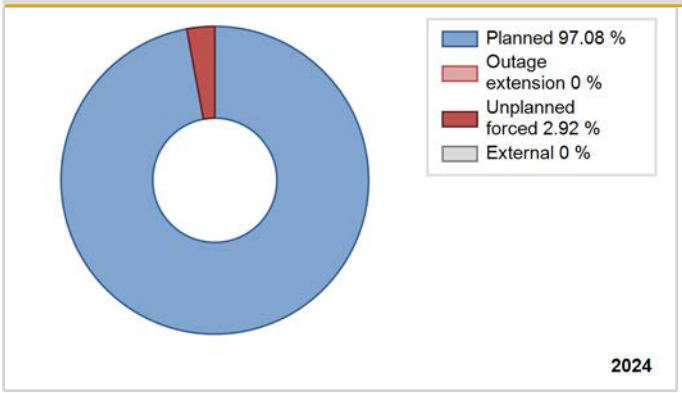
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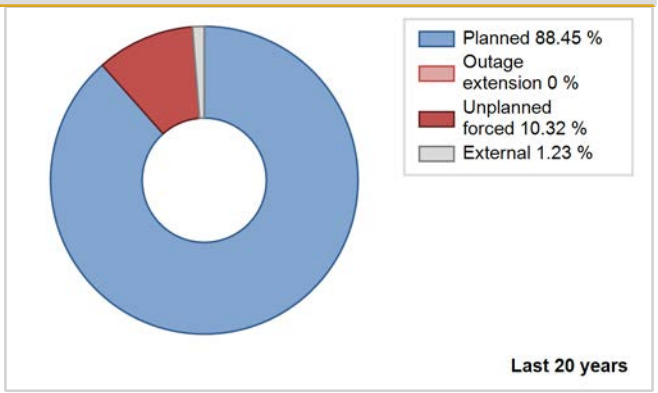
2009	6597.35	8214	799	93.78	93.78	94.26	93.77	0.00	0.00	6.22	0.00
2010	6206.40	7724	839	88.25	88.25	88.30	88.17	1.06	0.95	10.80	0.00
2011	7423.81	8590	839	98.07	100.00	101.01	98.06	0.00	0.00	0.00	1.93
2012	6839.54	8019	838	91.30	91.30	92.92	91.29	0.00	0.00	8.70	0.00
2013	6836.37	7980	838	91.09	91.09	93.12	91.09	0.00	0.00	8.91	0.00
2014	7570.57	8760	838	100.00	100.00	103.13	100.00	0.00	0.00	0.00	0.00
2015	5669.30	6701	838	76.50	76.50	77.23	76.50	11.35	9.80	13.70	0.00
2016	7111.17	8294	838	94.42	94.42	96.61	94.42	0.00	0.00	5.58	0.00
2017	7513.73	8720	838	99.54	99.54	102.35	99.54	0.46	0.46	0.00	0.00
2018	6561.75	7671	838	87.56	87.56	89.39	87.57	0.00	0.00	12.44	0.00
2019	6642.08	7754	838	88.53	88.53	90.48	88.52	0.00	0.00	11.47	0.00
2020	7551.07	8783	838	100.00	100.00	102.58	99.99	0.00	0.00	0.00	0.00
2021	6618.86	7868	838	89.82	89.82	90.16	89.82	0.00	0.00	10.18	0.00
2022	6392.66	7607	838	86.84	86.84	87.08	86.84	0.00	0.00	13.16	0.00
2023	7488.81	8760	838	99.99	99.99	102.02	100.00	0.00	0.00	0.01	0.00
2024	6287.09	7385	838	84.08	84.08	85.41	84.07	0.55	0.46	15.46	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1972 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		41			428	
B. Refuelling without maintenance				39		
C. Inspection, maintenance or repair combined with refuelling	1358			759		
D. Inspection, maintenance or repair without refuelling				309		
E. Testing of plant systems or components				1	1	
F. Major backfitting, refurbishment or upgrading activities with refuelling				1		
H. Nuclear regulatory requirements					142	
L. Human factor related					14	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
Z. Other					87	
Subtotal	1358	41		1109	672	4
Total		**1399**			**1785**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1972 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		0
12. Reactor I&C Systems		24
13. Reactor Auxiliary Systems		5
14. Safety Systems		4
15. Reactor Cooling Systems		151
16. Steam generation systems		41
17. Safety I&C Systems (excluding reactor I&C)		2
31. Turbine and auxiliaries	41	17
32. Feedwater and Main Steam System		66
34. Miscellaneous Systems		36
41. Main Generator Systems		22
42. Electrical Power Supply Systems		65
Total	**41**	**433**

Highlights (2024)

NA

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2024 Operating Experience

US-281 SURRY-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	DOMINION (Dominion Energy)
Owner	:	DOMINRES (Dominion Resources, Inc.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYSUB)
Thermal power	:	2587 MWth
Gross electrical power	:	890 MWe
Reference unit power (net)	:	838 MWe

Key Dates

Construction Date	:	1968-06-25
Grid Date	:	1973-03-10
Commercial Date	:	1973-05-01
Age at end of year	:	51 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	38
Average discharge burnup [MWd/t]	:	48000
Active core diameter [m]	:	3.035
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	21.6
Number of control rod assemblies	:	32
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

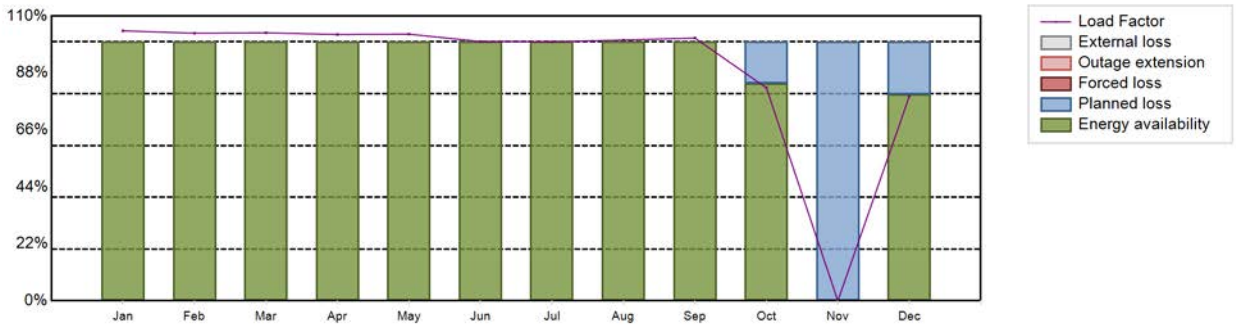
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	318
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.422
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.59
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6634.46 GW(e).h
Energy Availability Factor (EAF)	:	88.73 %
Unit Capability Factor (UCF)	:	88.73 %
Load Factor (LF)	:	90.13 %
Operating Factor (OF)	:	88.73 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	11.27 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	990 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	650.22	602.75	644.52	620.73	642.21	604.29	624.05	627.84	612.43	512.92	0.00	492.49	6634.46
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	83.87	0.14	79.84	88.73
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	83.87	0.14	79.84	88.73
LF [%]	104.29	103.34	103.51	102.88	103.01	100.15	100.09	100.70	101.50	82.27	0.00	78.99	90.13
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	83.87	0.00	79.97	88.73
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.13	99.86	20.16	11.27
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	289598.01 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	5.66 %
Cumulative Energy Availability Factor (EAF)	:	80.65 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.84 %
Cumulative Unit Capability Factor (UCF)	:	80.7 %	Cumulative Planned Unavailability Factor (PUF)	:	14.45 %
Cumulative Load Factor (LF)	:	79.66 %	Cumulative Externally cause unavailability (XUF)	:	0.05 %
Cumulative Operating Factor (OF)	:	80.7 %			

Electricity Production (net) [GWh]

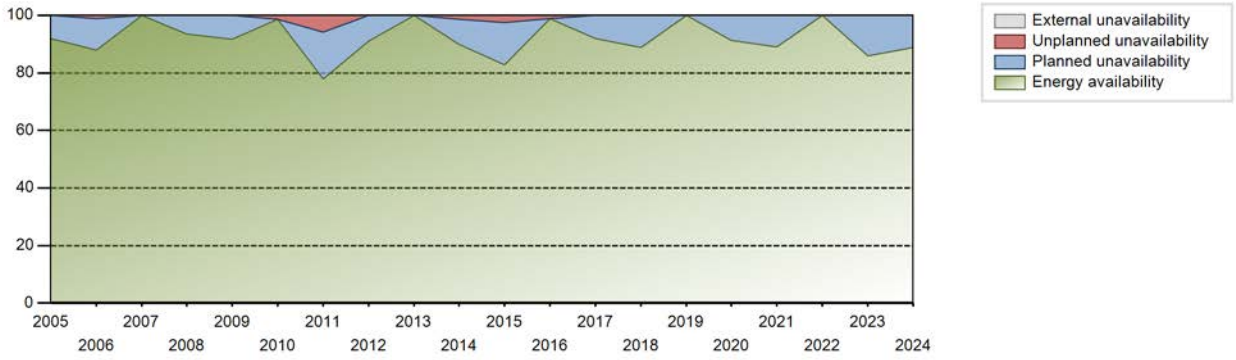


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1973	3377.50	5392	790	77.93	77.93	66.14	77.09	5.82	4.82	17.25	0.00
1974	2660.50	3854	788	44.00	44.00	38.54	44.00	36.59	25.39	30.61	0.00
1975	5053.10	6967	788	73.25	73.25	73.20	79.53	11.31	9.35	17.40	0.00
1976	3343.40	4585	788	48.34	48.34	48.30	52.20	43.48	37.19	14.47	0.00
1977	4457.30	5980	776	65.56	65.56	65.57	68.26	27.45	24.81	9.63	0.00
1978	5372.00	7244	775	79.12	79.12	79.13	82.69	4.04	3.33	17.54	0.00
1979	611.50	818	775	9.01	9.01	9.01	9.34	0.00	0.00	90.99	0.00
1980	2241.60	3139	775	35.97	35.97	32.93	35.74	2.54	0.94	63.09	0.00
1981	5150.30	6972	775	79.57	82.36	75.86	79.59	3.12	2.65	14.99	2.78
1982	5492.20	7729	775	88.72	88.72	80.90	88.23	1.95	1.76	9.52	0.00
1983	4086.10	5729	775	64.98	64.98	60.19	65.40	5.41	3.71	31.31	0.00
1984	5209.38	7327	775	83.31	83.31	76.52	83.41	16.69	16.69	0.00	0.00
1985	4072.44	5857	775	65.77	65.77	59.99	66.86	0.32	0.21	34.02	0.00
1986	4498.94	6072	780	68.71	68.71	65.80	69.32	14.94	12.07	19.23	0.00
1987	4790.95	6456	781	73.60	73.60	70.03	73.70	22.97	21.94	4.45	0.00
1988	3570.90	4993	781	56.55	56.55	52.05	56.84	18.21	12.59	30.86	0.00
1989	893.58	1355	781	13.32	13.32	13.06	15.47	48.28	12.44	74.24	0.00
1990	5837.77	7919	781	84.82	84.82	85.33	90.40	15.18	15.18	0.00	0.00
1991	3985.21	5886	781	66.55	66.55	58.25	67.19	17.38	14.00	19.45	0.00
1992	6426.48	8470	781	96.33	96.33	93.68	96.43	0.00	0.00	3.67	0.00
1993	4541.66	6283	781	71.02	71.02	66.38	71.72	9.76	7.68	21.30	0.00
1994	6260.97	8251	781	94.05	94.05	91.51	94.19	0.00	0.00	5.95	0.00
1995	5517.38	7087	787	80.65	80.65	79.96	80.90	7.47	6.51	12.84	0.00
1996	6081.46	7539	801	85.88	85.88	86.43	85.83	1.69	1.48	12.64	0.00
1997	6451.27	8034	801	91.75	91.75	91.94	91.71	1.33	1.23	7.02	0.00
1998	7178.88	8760	801	100.00	100.00	102.31	100.00	0.00	0.00	0.00	0.00
1999	5874.83	7493	801	85.56	85.56	83.73	85.54	3.20	2.83	11.61	0.00
2000	6539.43	8022	801	91.33	91.33	92.94	91.33	0.00	0.00	8.67	0.00
2001	6720.74	8203	815	93.68	93.68	94.14	93.64	0.54	0.50	5.82	0.00
2002	6523.67	7966	815	90.97	90.97	91.38	90.94	1.18	1.09	7.95	0.00
2003	5612.12	6861	815	78.33	78.33	78.61	78.32	2.04	1.63	20.03	0.00
2004	7051.74	8606	815	97.98	97.98	98.50	97.97	2.02	2.02	0.00	0.00
2005	6488.55	8046	815	91.86	91.86	90.87	91.84	0.00	0.00	8.14	0.00
2006	6189.36	7705	799	87.97	87.97	88.43	87.96	1.32	1.17	10.86	0.00
2007	7086.34	8760	799	100.00	100.00	101.24	100.00	0.00	0.00	0.00	0.00
2008	6606.84	8205	799	93.42	93.42	94.14	93.41	0.00	0.00	6.58	0.00
2009	6412.30	8026	799	91.63	91.63	91.61	91.62	0.00	0.00	8.37	0.00

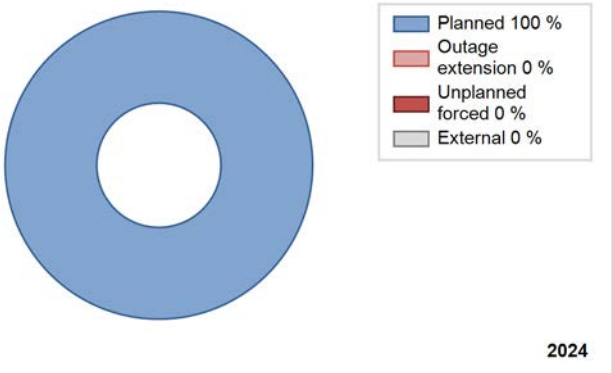
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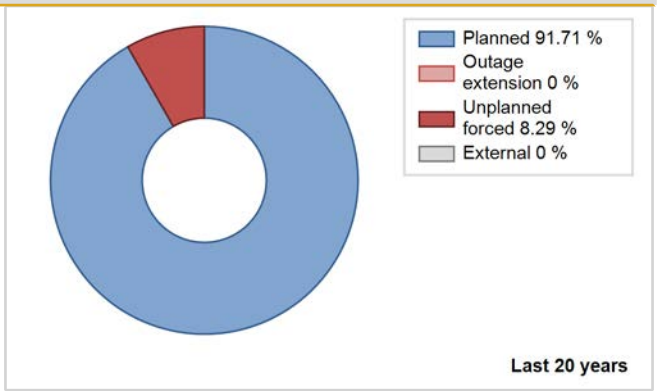
2010	6966.03	8646	799	98.70	98.70	99.53	98.70	1.30	1.30	0.00	0.00
2011	5605.67	6771	839	77.88	77.88	78.12	77.29	6.89	5.76	16.36	0.00
2012	6775.06	8001	838	91.10	91.10	92.04	91.09	0.00	0.00	8.90	0.00
2013	7568.22	8760	838	100.00	100.00	103.09	99.99	0.00	0.00	0.00	0.00
2014	6761.76	7882	838	89.96	89.96	92.11	89.98	1.51	1.38	8.66	0.00
2015	6120.41	7250	838	82.77	82.77	83.37	82.76	3.01	2.57	14.66	0.00
2016	7499.35	8691	838	98.94	98.94	101.88	98.94	1.06	1.06	0.00	0.00
2017	6913.92	8057	838	91.98	91.98	94.18	91.97	0.00	0.00	8.02	0.00
2018	6657.38	7788	838	88.90	88.90	90.69	88.90	0.00	0.00	11.10	0.00
2019	7530.89	8760	838	100.00	100.00	102.59	100.00	0.00	0.00	0.00	0.00
2020	6789.08	8014	838	91.25	91.25	92.23	91.23	0.00	0.00	8.75	0.00
2021	5968.00	7103	838	89.04	89.04	81.30	81.08	0.00	0.00	10.96	0.00
2022	7533.78	8760	838	100.00	100.00	102.63	100.00	0.00	0.00	0.00	0.00
2023	6345.86	7526	838	85.81	85.81	86.45	85.91	0.13	0.11	14.09	0.00
2024	6634.46	7794	838	88.73	88.73	90.13	88.73	0.00	0.00	11.27	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1973 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					404	
B. Refuelling without maintenance				33		
C. Inspection, maintenance or repair combined with refuelling	990			1045		
D. Inspection, maintenance or repair without refuelling				165		
E. Testing of plant systems or components				1		
F. Major backfitting, refurbishment or upgrading activities with refuelling				1		
H. Nuclear regulatory requirements					18	
L. Human factor related					13	
Z. Other				4	0	
Subtotal	990			1249	435	
Total	**990**			**1684**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1973 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		29
13. Reactor Auxiliary Systems		3
14. Safety Systems		48
15. Reactor Cooling Systems		23
16. Steam generation systems		96
31. Turbine and auxiliaries		83
32. Feedwater and Main Steam System		86
33. Circulating Water System		2
34. Miscellaneous Systems		14
35. All other I&C Systems		1
41. Main Generator Systems		6
42. Electrical Power Supply Systems		21
Total		**412**

Highlights (2024)

NA

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2024 Operating Experience

US-387 SUSQUEHANNA-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	PPL_SUSQ (PPL Susquehanna, LLC)
Owner	:	PPL_CORP (PPL Corporation (former PENNSYLVANIA POWER & LIGHT CO. (PP&L)))
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 2)
Thermal power	:	3952 MWth
Gross electrical power	:	1330 MWe
Reference unit power (net)	:	1257 MWe

Key Dates

Construction Date	:	1973-11-02
Grid Date	:	1982-11-16
Commercial Date	:	1983-06-08
Age at end of year	:	42 years

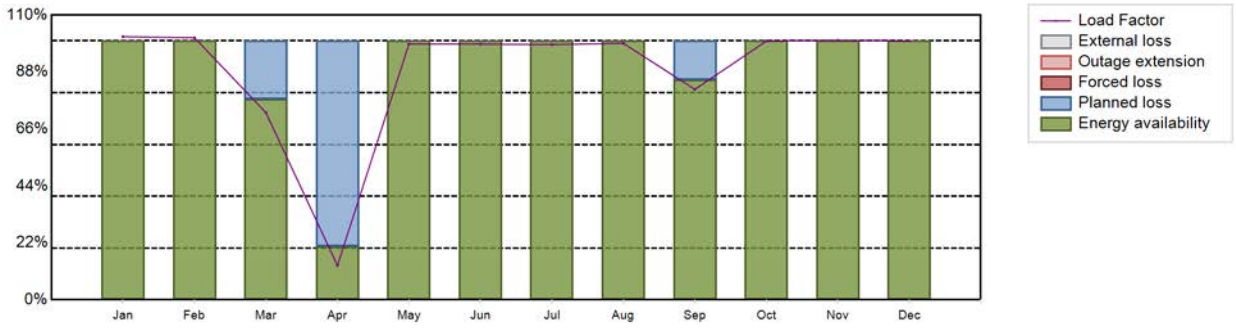
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.19
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	304
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.372
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	30	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	36000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.57	HP cylinder inlet steam pressure [MPa]	:	6.69
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	764	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	19.32	Number of main condensate pumps	:	-
Number of control rod assemblies	:	185	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	9810.77 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	90.37 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	90.37 %	Planned Unavailability Factor (PUF)	:	9.63 %
Load Factor (LF)	:	88.85 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	90.29 %	Total off-line time	:	853 hours

Annual Summary



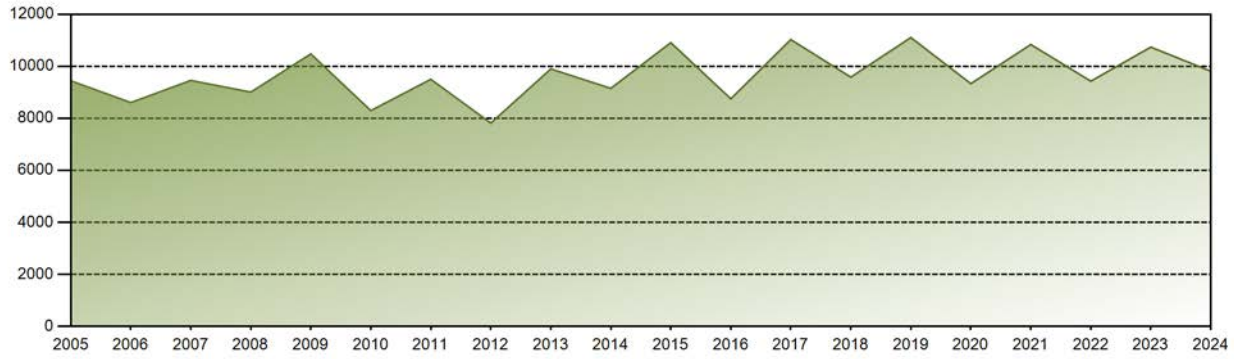
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	950.57	885.58	675.14	120.12	923.74	893.75	921.78	926.34	735.59	934.68	908.38	935.08	9810.77
EAF [%]	100.00	100.00	77.57	20.74	100.00	100.00	100.00	100.00	84.89	100.00	100.00	100.00	90.37
UCF [%]	100.00	100.00	77.57	20.74	100.00	100.00	100.00	100.00	84.89	100.00	100.00	100.00	90.37
LF [%]	101.64	101.22	72.29	13.27	98.77	98.75	98.56	99.05	81.28	99.94	100.23	99.99	88.85
OF [%]	100.00	100.00	77.52	20.00	100.00	100.00	100.00	100.00	84.72	100.00	100.00	100.00	90.29
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	22.43	79.26	0.00	0.00	0.00	0.00	15.11	0.00	0.00	0.00	9.63
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	353952.37 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.33 %
Cumulative Energy Availability Factor (EAF)	:	86.59 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.11 %
Cumulative Unit Capability Factor (UCF)	:	86.65 %	Cumulative Planned Unavailability Factor (PUF)	:	10.25 %
Cumulative Load Factor (LF)	:	85.08 %	Cumulative Externally cause unavailability (XUF)	:	0.05 %
Cumulative Operating Factor (OF)	:	86.12 %			

Electricity Production (net) [GWh]

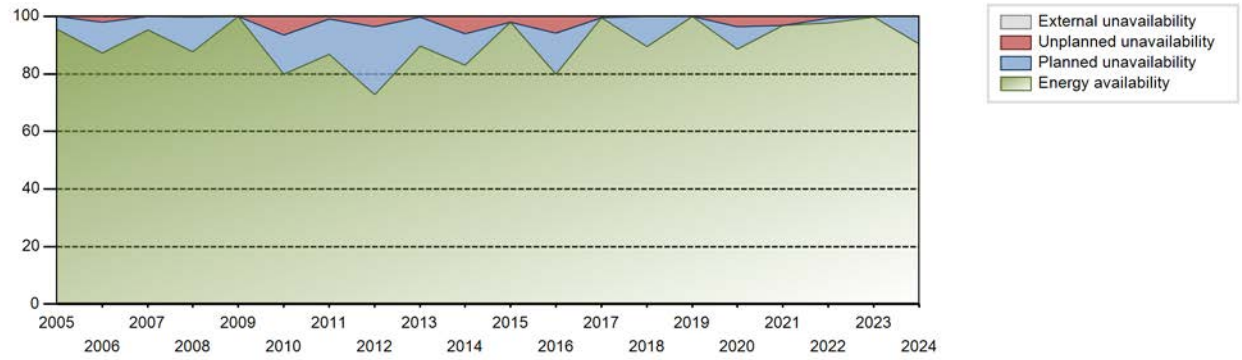


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1983	4472.80	4891	1034	76.29	76.29	66.58	73.31	11.82	10.23	13.49	0.00
1984	6088.14	6377	1032	72.02	74.45	67.16	72.60	13.03	11.15	14.40	2.43
1985	5286.43	5469	1032	60.37	60.37	58.48	62.43	6.06	3.89	35.74	0.00
1986	5839.25	5992	1032	66.81	66.81	64.59	68.40	12.07	9.17	24.02	0.00
1987	6132.87	6331	1032	70.74	70.74	67.84	72.27	10.27	8.10	21.16	0.00
1988	8410.06	8206	1032	93.06	93.06	92.77	93.42	5.00	4.90	2.04	0.00
1989	6483.95	6447	1032	72.15	72.15	71.72	73.60	8.90	7.04	20.81	0.00
1990	6446.70	6528	1033	73.14	73.14	71.24	74.52	4.60	3.53	23.33	0.00
1991	8821.60	8596	1035	98.04	98.04	97.21	98.13	1.96	1.96	0.00	0.00
1992	6400.29	6568	1040	73.60	73.60	70.06	74.77	7.61	6.06	20.34	0.00
1993	5232.40	5205	1040	57.49	57.49	57.43	59.42	19.76	14.15	28.36	0.00
1994	8414.45	8249	1040	94.18	94.18	92.36	94.17	0.00	0.00	5.82	0.00
1995	7432.27	7126	1073	81.11	81.11	79.03	81.35	0.00	0.00	18.89	0.00
1996	7752.89	7434	1090	84.68	84.68	80.97	84.63	3.04	2.65	12.67	0.00
1997	9085.32	8274	1090	94.47	94.47	95.15	94.45	5.53	5.53	0.00	0.00
1998	7652.80	7015	1090	81.47	81.47	80.15	80.08	6.20	5.38	13.15	0.00
1999	8814.47	8234	1090	94.01	94.01	92.31	94.00	5.99	5.99	0.00	0.00
2000	8180.56	7598	1090	86.52	86.52	85.44	86.50	0.33	0.28	13.19	0.00
2001	9412.96	8718	1090	99.53	99.53	98.58	99.52	0.23	0.23	0.25	0.00
2002	8026.62	7493	1105	85.67	85.67	83.39	85.54	0.64	0.55	13.78	0.00
2003	9359.91	8585	1105	98.04	98.04	96.70	98.00	1.79	1.79	0.17	0.00
2004	8027.00	7359	1135	84.08	84.08	81.22	83.78	0.00	0.00	15.92	0.00
2005	9442.62	8357	1105	95.41	95.41	97.55	95.40	0.00	0.00	4.59	0.00
2006	8602.67	7639	1135	87.24	87.24	86.52	87.20	2.27	2.02	10.73	0.00
2007	9456.33	8349	1149	95.37	95.37	93.95	95.31	0.00	0.00	4.63	0.00
2008	9005.70	7704	1149	87.72	87.72	89.23	87.70	0.33	0.29	11.99	0.00
2009	10475.53	8760	1185	100.00	100.00	100.91	100.00	0.00	0.00	0.00	0.00
2010	8294.36	6958	1239	80.00	80.00	77.82	79.43	7.48	6.47	13.53	0.00
2011	9499.00	7588	1260	86.83	86.83	86.42	86.62	1.09	0.98	12.19	0.00
2012	7814.86	6382	1257	72.69	72.69	70.78	72.65	4.77	3.64	23.67	0.00
2013	9898.58	7860	1257	89.73	89.73	89.88	89.72	0.27	0.24	10.02	0.00
2014	9150.78	7276	1257	83.06	83.06	83.10	83.06	1.94	6.11	10.83	0.00
2015	10908.97	8584	1257	97.99	97.99	99.07	97.99	2.01	2.01	0.00	0.00
2016	8749.66	7016	1257	79.86	79.86	79.24	79.87	6.81	5.83	14.31	0.00
2017	11026.09	8711	1257	99.44	99.44	100.13	99.44	0.56	0.56	0.00	0.00
2018	9582.31	7840	1257	89.49	89.49	87.02	89.50	0.00	0.00	10.51	0.00
2019	11105.06	8760	1257	100.00	100.00	100.85	100.00	0.00	0.00	0.00	0.00

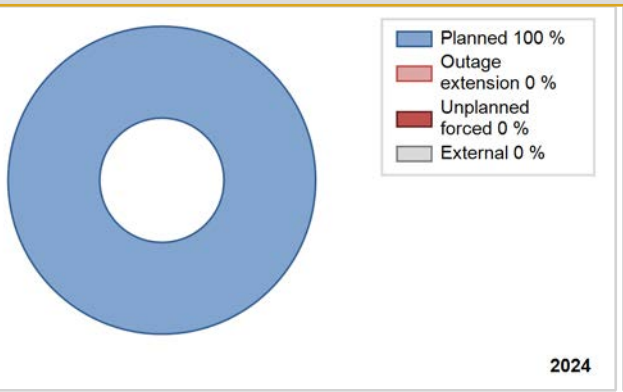
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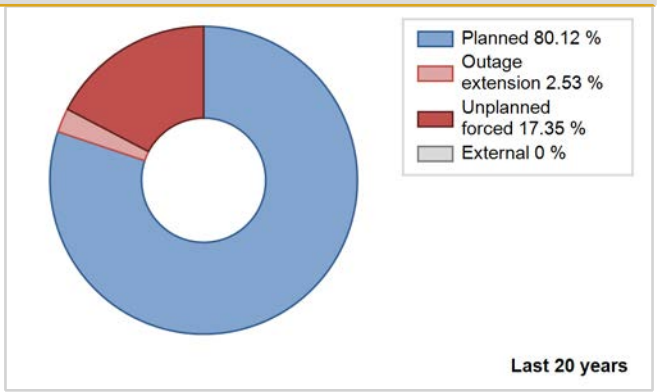
2020	9332.24	7790	1257	88.69	88.69	84.52	88.68	3.97	3.67	7.64	0.00
2021	10838.48	8491	1257	96.94	96.94	98.43	96.93	3.06	3.06	0.00	0.00
2022	9428.21	7862	1257	97.82	97.82	85.62	89.75	0.80	0.79	1.39	0.00
2023	10738.36	8534	1257	99.68	99.68	97.52	97.42	0.09	0.10	0.22	0.00
2024	9810.77	7931	1257	90.37	90.37	88.85	90.29	0.00	0.00	9.63	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1983 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					213	
B. Refuelling without maintenance				36		
C. Inspection, maintenance or repair combined with refuelling	743			715	9	
D. Inspection, maintenance or repair without refuelling	110			114		
E. Testing of plant systems or components				38		
H. Nuclear regulatory requirements					18	
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					25	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						3
S. Fuel management limitation (including high flux tilt, stretch out or coast-down operation)				10		
Z. Other				47	32	
Subtotal	853			960	297	5
Total	**853**			**1262**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1983 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		8
12. Reactor I&C Systems		12
13. Reactor Auxiliary Systems		8
14. Safety Systems		11
15. Reactor Cooling Systems		36
17. Safety I&C Systems (excluding reactor I&C)		6
31. Turbine and auxiliaries		55
32. Feedwater and Main Steam System		33
33. Circulating Water System		11
34. Miscellaneous Systems		31
35. All other I&C Systems		2
41. Main Generator Systems		11
42. Electrical Power Supply Systems		18
Total		**242**

Highlights (2024)

NA

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2024 Operating Experience

US-388 SUSQUEHANNA-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	PPL_SUSQ (PPL Susquehanna, LLC)
Owner	:	PPL_CORP (PPL Corporation (former PENNSYLVANIA POWER & LIGHT CO. (PP&L)))
Reactor Supplier	:	GE (GENERAL ELECTRIC CO.)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	BWR / BWR-4 (Mark 2)
Thermal power	:	3952 MWth
Gross electrical power	:	1330 MWe
Reference unit power (net)	:	1257 MWe

Key Dates

Construction Date	:	1973-11-02
Grid Date	:	1984-07-03
Commercial Date	:	1985-02-12
Age at end of year	:	40 years

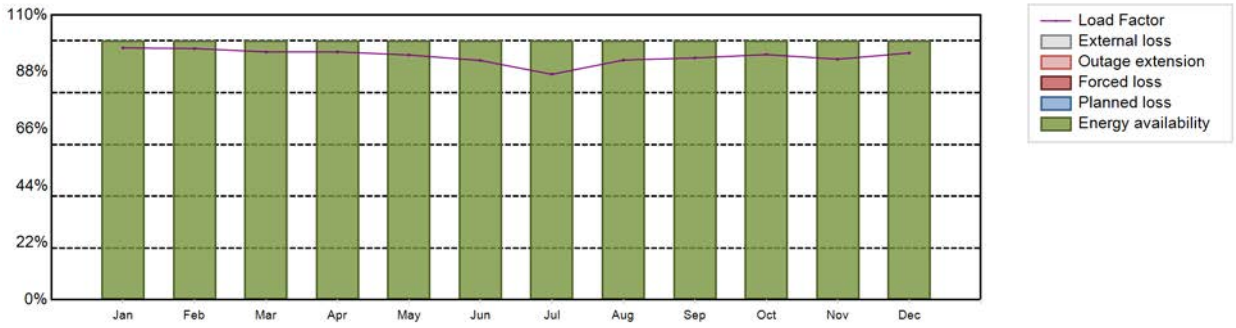
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	7.19
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	287
Fuel material	:	UO2	Number of SG	:	NA
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.372
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	24	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	30	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	36000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	4.57	HP cylinder inlet steam pressure [MPa]	:	6.69
Active core height/length [m]	:	3.81	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	764	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	14.32	Number of main condensate pumps	:	-
Number of control rod assemblies	:	185	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	2	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h	Forced Loss Rate (FLR)	:	0 %
Energy Availability Factor (EAF)	:	100 %	Unplanned Capability Loss Factor (UCL)	:	0 %
Unit Capability Factor (UCF)	:	100 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	94.07 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	100 %	Total off-line time	:	hours

Annual Summary



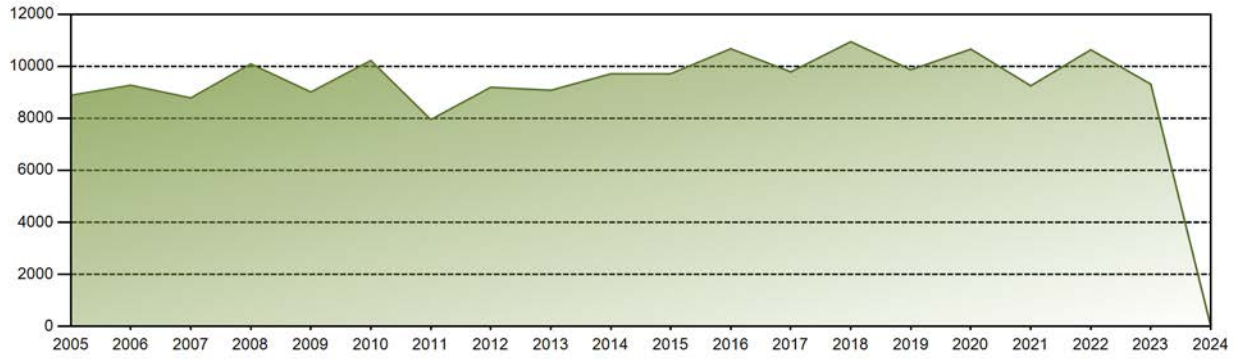
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	909.85	849.21	894.32	866.68	884.33	836.56	814.60	866.03	845.45	885.85	842.28	891.66	10386.82
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	97.29	97.07	95.76	95.76	94.56	92.43	87.10	92.60	93.42	94.72	92.94	95.34	94.07
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.35 %
Cumulative Energy Availability Factor (EAF)	:	89.32 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.2 %
Cumulative Unit Capability Factor (UCF)	:	89.33 %	Cumulative Planned Unavailability Factor (PUF)	:	8.48 %
Cumulative Load Factor (LF)	:	87.7 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	89.07 %			

Electricity Production (net) [GWh]

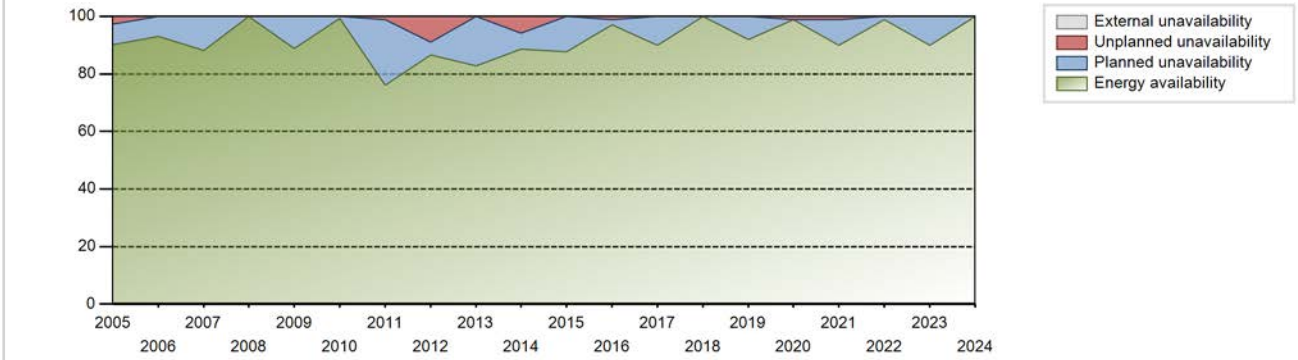


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	7323.31	7463	1032	90.18	90.61	84.07	87.24	9.39	9.39	0.00	0.43
1986	5458.36	5730	1032	63.50	63.50	60.38	65.41	16.73	12.76	23.74	0.00
1987	8598.43	8431	1032	96.03	96.03	95.11	96.24	3.97	3.97	0.00	0.00
1988	5915.25	5985	1034	66.32	66.32	65.13	68.14	0.20	0.13	33.55	0.00
1989	6777.04	6745	1038	76.89	76.89	74.53	77.00	2.10	1.65	21.46	0.00
1990	8290.70	8143	1038	94.41	94.41	91.14	92.96	5.18	5.16	0.43	0.00
1991	7041.38	6955	1041	78.37	78.37	77.21	79.39	3.36	2.72	18.91	0.00
1992	7186.16	7119	1044	80.17	80.17	78.36	81.05	2.41	1.98	17.85	0.00
1993	8337.86	8094	1044	92.30	92.30	91.17	92.40	7.70	7.70	0.00	0.00
1994	6909.84	6577	1073	74.66	74.66	73.49	75.08	0.85	0.64	24.70	0.00
1995	8192.74	7691	1094	87.83	87.83	85.49	87.80	1.91	1.71	10.46	0.00
1996	9127.17	8346	1094	95.03	95.03	94.98	95.01	4.97	4.97	0.00	0.00
1997	7732.57	7211	1094	82.36	82.36	80.69	82.32	2.53	2.13	15.50	0.00
1998	8820.75	8172	1094	93.29	93.29	92.04	93.29	5.18	5.09	1.61	0.00
1999	7794.67	7268	1094	83.00	83.00	81.33	82.97	4.59	3.99	13.01	0.00
2000	9347.19	8587	1094	97.76	97.76	97.27	97.76	2.24	2.24	0.00	0.00
2001	8397.15	7693	1111	87.93	87.93	86.94	87.82	0.00	0.00	12.07	0.00
2002	9306.16	8439	1111	96.35	96.35	95.62	96.34	3.65	3.65	0.00	0.00
2003	8654.66	7701	1140	88.15	88.15	87.23	87.91	0.00	0.00	11.85	0.00
2004	10057.13	8784	1140	100.00	100.00	100.43	100.00	0.00	0.00	0.00	0.00
2005	8885.73	7900	1140	90.20	90.20	88.97	90.17	2.83	2.63	7.17	0.00
2006	9270.90	8155	1140	93.12	93.12	92.84	93.09	0.00	0.00	6.88	0.00
2007	8781.57	7726	1140	88.21	88.21	87.94	88.20	0.00	0.00	11.79	0.00
2008	10091.45	8784	1140	100.00	100.00	100.78	100.00	0.00	0.00	0.00	0.00
2009	9011.13	7775	1140	88.78	88.78	90.23	88.76	0.00	0.00	11.22	0.00
2010	10221.22	8686	1190	99.19	99.19	98.05	99.16	0.00	0.00	0.81	0.00
2011	7951.26	6600	1260	76.06	76.06	74.08	75.34	1.51	1.17	22.77	0.00
2012	9194.97	7609	1257	86.65	86.65	83.28	86.62	9.37	8.96	4.39	0.00
2013	9076.94	7256	1257	82.83	82.83	82.42	82.82	0.16	0.13	17.04	0.00
2014	9710.29	7756	1257	88.54	88.54	88.18	88.54	4.77	5.94	5.52	0.00
2015	9714.51	7685	1257	87.73	87.73	88.22	87.73	0.03	0.03	12.25	0.00
2016	10673.32	8523	1257	97.03	97.03	96.67	97.03	1.09	1.07	1.90	0.00
2017	9784.47	7876	1257	89.89	89.89	88.86	89.91	0.00	0.00	10.11	0.00
2018	10945.59	8760	1257	100.00	100.00	99.40	100.00	0.00	0.00	0.00	0.00
2019	9867.64	8059	1257	92.01	92.01	89.61	92.00	0.00	0.00	7.99	0.00
2020	10658.67	8683	1257	98.86	98.86	96.53	98.85	1.14	1.14	0.00	0.00
2021	9251.27	7879	1257	89.94	89.94	84.02	89.94	1.15	1.05	9.01	0.00

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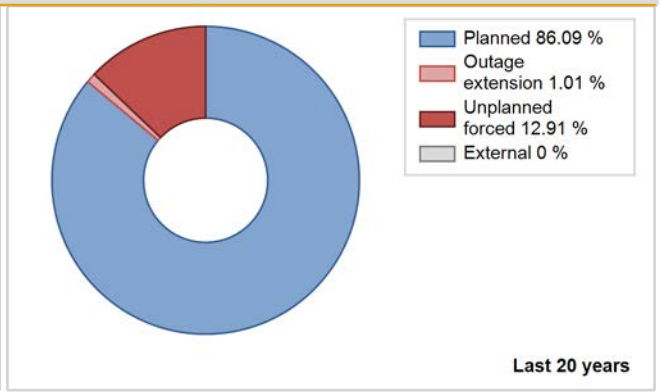
2022	10634.60	8661	1257	98.88	98.88	96.58	98.87	0.00	0.00	1.12	0.00
2023	9312.42	7818	1257	90.01	90.01	84.57	89.25	0.01	0.08	9.90	0.00
2024	Data not provided										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					195	
B. Refuelling without maintenance				20		
C. Inspection, maintenance or repair combined with refuelling				663		
D. Inspection, maintenance or repair without refuelling				66		
E. Testing of plant systems or components				48		
L. Human factor related					4	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z. Other					12	
Subtotal				797	211	1
Total	**0**			**1009**		

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Equipment Related Unplanned Full Outages, Analysis by System		
System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		12
12. Reactor I&C Systems		14
13. Reactor Auxiliary Systems		4
14. Safety Systems		6
15. Reactor Cooling Systems		17
31. Turbine and auxiliaries		34
32. Feedwater and Main Steam System		34
34. Miscellaneous Systems		27
41. Main Generator Systems		19
42. Electrical Power Supply Systems		33
Total		**200**

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2024 Operating Experience

US-250 TURKEY POINT-3 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	FPL (Florida Power & Light Co.)
Owner	:	FPL (Florida Power & Light Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYAMB)
Thermal power	:	2644 MWth
Gross electrical power	:	829 MWe
Reference unit power (net)	:	837 MWe

Key Dates

Construction Date	:	1967-04-27
Grid Date	:	1972-11-02
Commercial Date	:	1972-12-14
Age at end of year	:	52 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18
Number of control rod assemblies	:	29
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

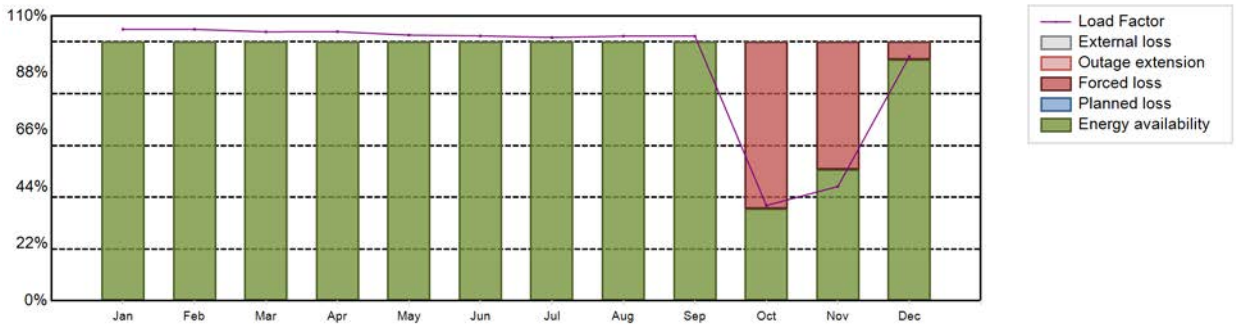
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	338
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.13
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6761.57 GW(e).h
Energy Availability Factor (EAF)	:	89.92 %
Unit Capability Factor (UCF)	:	89.92 %
Load Factor (LF)	:	91.97 %
Operating Factor (OF)	:	89.91 %

Forced Loss Rate (FLR)	:	10.08 %
Unplanned Capability Loss Factor (UCL)	:	10.08 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	886 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	652.87	610.83	646.07	626.44	639.01	616.72	633.43	636.61	616.39	229.21	266.50	587.49	6761.57
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	35.48	50.82	93.14	89.92
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	35.48	50.82	93.14	89.92
LF [%]	104.84	104.85	103.89	103.95	102.62	102.34	101.72	102.23	102.28	36.81	44.16	94.34	91.97
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	36.29	49.93	93.15	89.91
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.52	49.18	6.86	10.08
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.52	49.18	6.86	10.08
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	256143.74 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.75 %
Cumulative Energy Availability Factor (EAF)	:	81.1 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	4.05 %
Cumulative Unit Capability Factor (UCF)	:	81.22 %	Cumulative Planned Unavailability Factor (PUF)	:	14.73 %
Cumulative Load Factor (LF)	:	79.77 %	Cumulative Externally cause unavailability (XUF)	:	0.12 %
Cumulative Operating Factor (OF)	:	79.44 %			

Electricity Production (net) [GWh]

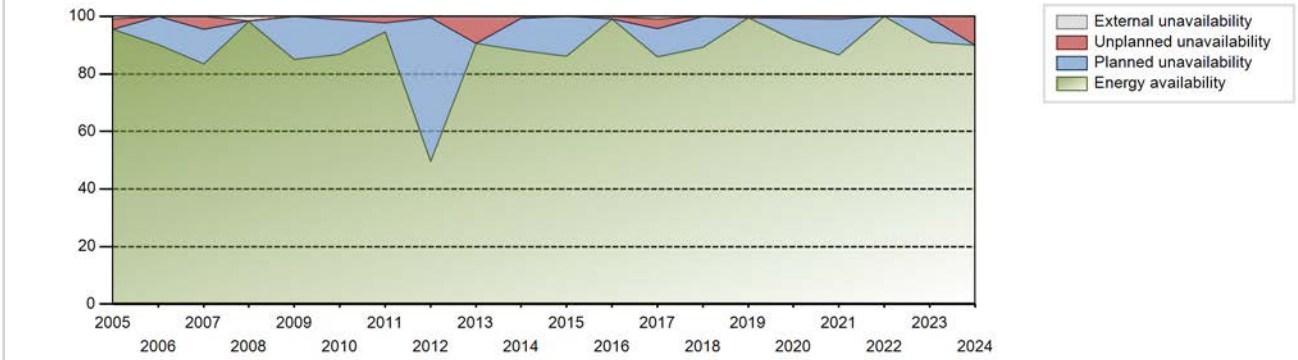


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1972	101.10	420	670	100.00	100.00	14.55	40.86	0.00	0.00	0.00	0.00
1973						Data not provided					
1974	3478.80	6090	666	100.00	100.00	59.63	69.52	0.00	0.00	0.00	0.00
1975	4376.00	6948	666	74.91	74.91	75.01	79.32	5.56	4.41	20.67	0.00
1976	4322.00	6665	666	73.94	73.94	73.88	75.88	0.56	0.42	25.64	0.00
1977	4474.10	6994	666	76.56	76.56	76.69	79.84	4.46	3.58	19.86	0.00
1978	4502.70	7087	666	77.20	77.20	77.18	80.90	2.53	2.00	20.80	0.00
1979	2881.60	4509	666	49.39	49.39	49.39	51.47	3.82	1.96	48.64	0.00
1980	4389.00	6812	657	77.93	77.93	76.05	77.55	0.97	0.77	21.31	0.00
1981	933.20	1385	646	13.23	13.23	16.49	15.81	57.53	17.92	68.84	0.00
1982	3771.40	5612	646	64.25	64.25	66.64	64.06	11.20	8.11	27.64	0.00
1983	4331.00	6415	659	73.35	73.35	75.02	73.23	1.99	1.49	25.16	0.00
1984	4784.19	7253	666	82.62	82.62	81.78	82.57	11.67	10.91	6.47	0.00
1985	3420.99	5224	666	59.70	60.99	58.64	59.63	4.64	2.97	36.04	1.29
1986	4513.06	6816	666	77.87	77.87	77.36	77.81	17.05	16.00	6.13	0.00
1987	885.28	1566	666	17.91	17.91	15.17	17.88	63.55	31.22	50.87	0.00
1988	3467.96	5320	666	60.60	60.60	59.28	60.56	39.29	39.22	0.18	0.00
1989	3605.10	5696	666	65.06	65.06	61.79	65.02	14.66	11.18	23.77	0.00
1990	3388.41	5200	666	59.37	59.37	58.08	59.36	4.04	2.50	38.13	0.00
1991	1332.05	2155	666	50.01	50.01	22.83	24.60	0.59	0.30	49.69	0.00
1992	3428.22	5896	666	67.16	67.16	58.60	67.12	5.96	4.26	28.59	0.00
1993	5657.35	8421	666	96.14	96.14	96.97	96.13	1.78	1.75	2.11	0.00
1994	4924.92	7513	666	85.83	85.83	84.42	85.76	1.93	1.69	12.48	0.00
1995	5218.97	7846	666	89.61	89.61	89.46	89.57	0.82	0.74	9.65	0.00
1996	5750.84	8490	673	96.73	96.73	97.27	96.65	3.27	3.27	0.00	0.00
1997	5252.35	7570	693	87.00	87.00	86.52	86.42	1.37	1.21	11.79	0.00
1998	5408.30	7757	693	89.01	89.78	89.09	88.55	1.08	0.98	9.24	0.77
1999	6112.35	8684	693	99.14	99.14	100.69	99.13	0.86	0.86	0.00	0.00
2000	5684.42	8122	693	92.47	92.47	93.38	92.46	0.00	0.00	7.53	0.00
2001	5526.02	7923	693	90.46	90.46	91.03	90.45	1.95	1.80	7.74	0.00
2002	6215.43	8760	693	100.00	100.00	102.38	100.00	0.00	0.00	0.00	0.00
2003	5445.57	7930	693	90.56	90.56	89.70	90.53	1.99	1.83	7.61	0.00
2004	4734.02	6934	693	78.96	78.96	77.77	78.94	3.97	3.27	17.77	0.00
2005	5798.91	8362	693	95.47	96.41	95.52	95.46	3.59	3.59	0.00	0.94
2006	5581.94	7905	693	90.25	90.25	91.95	90.24	0.00	0.00	9.75	0.00
2007	6078.10	7320	693	83.57	83.57	100.12	83.56	5.06	4.45	11.97	0.00
2008	6139.53	8617	693	98.12	99.78	100.86	98.10	0.00	0.00	0.22	1.66

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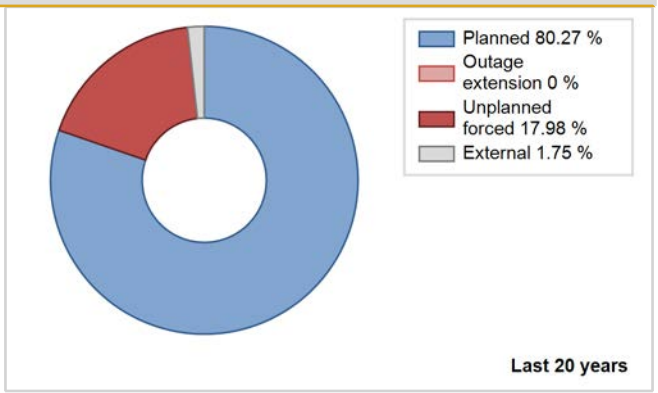
2009	5249.30	7451	693	85.06	85.06	86.47	85.06	0.00	0.00	14.94	0.00
2010	5358.09	7594	693	86.71	86.71	88.26	86.69	1.19	1.04	12.25	0.00
2011	5822.87	8291	693	94.66	94.66	95.92	94.65	2.25	2.18	3.16	0.00
2012	2477.38	4121	802	49.51	49.51	38.67	46.91	0.88	0.44	50.05	0.00
2013	6239.35	7945	802	90.70	90.70	88.80	90.69	9.30	9.30	0.00	0.00
2014	5900.85	7726	802	88.19	88.19	83.99	88.20	0.78	0.69	11.11	0.00
2015	6002.32	7552	802	86.22	86.22	85.44	86.21	0.00	0.00	13.78	0.00
2016	7174.17	8710	802	99.15	99.15	101.84	99.16	0.85	0.85	0.00	0.00
2017	6163.82	7531	802	85.98	86.95	87.73	85.97	3.60	3.25	9.80	0.97
2018	6462.92	7811	837	89.22	89.22	90.49	89.17	0.00	0.00	10.78	0.00
2019	7533.69	8726	837	99.62	100.00	102.75	99.61	0.00	0.00	0.00	0.38
2020	6556.42	7996	837	92.01	92.01	89.18	91.03	0.85	0.79	7.21	0.00
2021	5848.82	7584	837	86.57	86.57	79.77	86.58	1.07	0.94	12.49	0.00
2022	7570.46	8760	837	100.00	100.00	103.25	100.00	0.00	0.00	0.00	0.00
2023	6809.83	7950	837	91.04	91.04	92.88	90.75	0.60	0.55	8.41	0.00
2024	6761.57	7898	837	89.92	89.92	91.97	89.91	10.08	10.08	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			1972 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		886			369	
B. Refuelling without maintenance				33		
C. Inspection, maintenance or repair combined with refuelling				838		
D. Inspection, maintenance or repair without refuelling				231		
E. Testing of plant systems or components				7	1	
F. Major backfitting, refurbishment or upgrading activities with refuelling				2		
J. Grid limitation, failure or grid unavailability						3
L. Human factor related				16	4	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						55
P. Fire					2	
Z. Other				135	18	
Subtotal		886		1262	394	58
Total		**886**			**1714**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1972 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	51	2
12. Reactor I&C Systems		36
13. Reactor Auxiliary Systems		39
14. Safety Systems		16
15. Reactor Cooling Systems		72
16. Steam generation systems		20
17. Safety I&C Systems (excluding reactor I&C)		1
21. Fuel Handling and Storage Facilities		1
31. Turbine and auxiliaries		37
32. Feedwater and Main Steam System	835	45
33. Circulating Water System		2
34. Miscellaneous Systems		39
35. All other I&C Systems		2
41. Main Generator Systems		56
42. Electrical Power Supply Systems		11
Total	**886**	**379**

Highlights (2024)

NA

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2024 Operating Experience

US-251 TURKEY POINT-4 UNITED STATES OF AMERICA

Status at end of year	:	**Operational**
Operator	:	FPL (Florida Power & Light Co.)
Owner	:	FPL (Florida Power & Light Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)



Reactor Unit Details

Reactor type and model	:	PWR / WH 3LP (DRYAMB)
Thermal power	:	2644 MWth
Gross electrical power	:	829 MWe
Reference unit power (net)	:	821 MWe

Key Dates

Construction Date	:	1967-04-27
Grid Date	:	1973-06-21
Commercial Date	:	1973-09-07
Age at end of year	:	51 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	3.04
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	157
Fuel linear heat generation rate [kW/m]	:	18
Number of control rod assemblies	:	29
Number of external reactor coolant loops	:	3
Coolant type	:	H2O

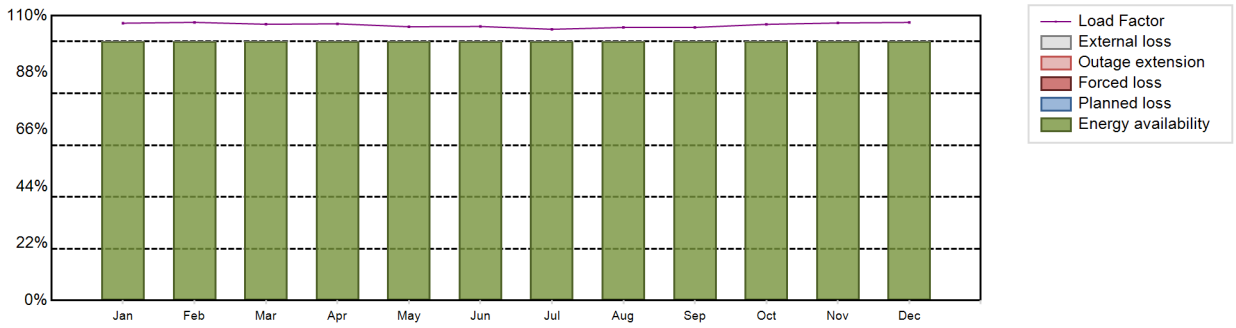
Operating coolant pressure [MPa]	:	15.7
Reactor outlet temperature [°C]	:	338
Number of SG	:	3
Containment type	:	-
Containment design pressure [MPa]	:	0.41
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	5.13
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Sea (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	0 GW(e).h
Energy Availability Factor (EAF)	:	100 %
Unit Capability Factor (UCF)	:	100 %
Load Factor (LF)	:	106.38 %
Operating Factor (OF)	:	100 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	654.32	613.81	650.81	631.66	645.85	625.66	639.90	644.14	623.46	651.53	634.48	655.99	7671.59
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LF [%]	107.12	107.42	106.69	106.86	105.73	105.84	104.76	105.45	105.47	106.66	107.19	107.39	106.38
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	0 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.43 %
Cumulative Energy Availability Factor (EAF)	:	81.67 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.79 %
Cumulative Unit Capability Factor (UCF)	:	81.7 %	Cumulative Planned Unavailability Factor (PUF)	:	14.51 %
Cumulative Load Factor (LF)	:	80.54 %	Cumulative Externally cause unavailability (XUF)	:	0.04 %
Cumulative Operating Factor (OF)	:	80.18 %			

Electricity Production (net) [GWh]

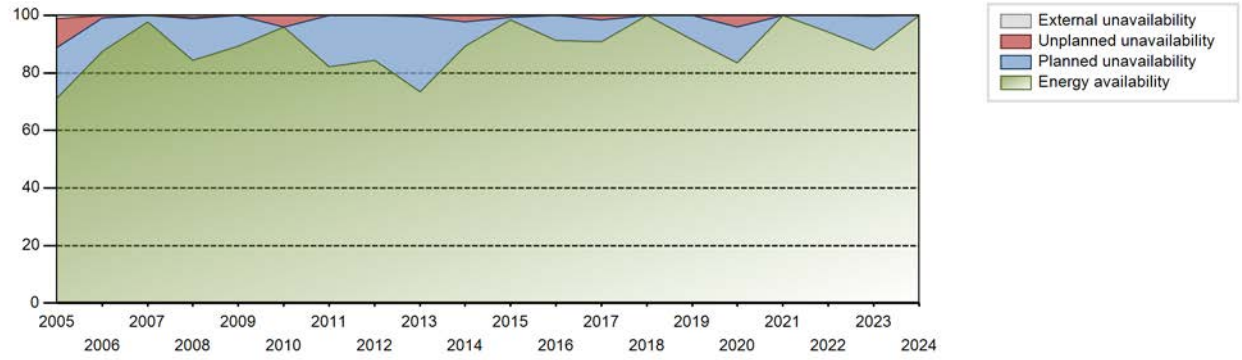


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1973	Data not provided										
1974	4513.40	6759	728	100.00	100.00	70.77	77.16	0.00	0.00	0.00	0.00
1975	3991.90	6172	666	68.33	68.33	68.42	70.46	0.88	0.60	31.07	0.00
1976	3774.80	5825	666	64.33	64.33	64.52	66.31	6.81	4.70	30.97	0.00
1977	3671.00	5578	666	62.74	62.74	62.92	63.68	3.32	2.15	35.10	0.00
1978	3791.40	6693	666	64.99	64.99	64.99	76.40	4.78	3.26	31.75	0.00
1979	3846.60	6361	666	65.94	65.94	65.93	72.61	7.34	5.22	28.84	0.00
1980	3856.50	6093	657	69.40	69.40	66.82	69.36	0.00	0.00	30.60	0.00
1981	4507.20	6801	646	77.32	77.32	79.65	77.64	3.42	2.74	19.94	0.00
1982	3847.20	5806	646	66.35	66.35	67.98	66.28	11.74	8.82	24.83	0.00
1983	2978.90	4568	659	52.44	52.44	51.60	52.15	10.71	6.29	41.26	0.00
1984	3084.14	4774	666	54.43	54.43	52.72	54.35	29.05	22.28	23.29	0.00
1985	5177.93	7852	666	89.68	89.81	88.75	89.63	6.85	6.60	3.59	0.13
1986	1744.00	2790	666	31.88	31.88	29.89	31.85	10.14	3.60	64.53	0.00
1987	2657.55	4314	666	49.31	49.31	45.55	49.25	50.69	50.69	0.00	0.00
1988	3267.74	4986	666	56.80	56.80	55.86	56.76	19.71	13.95	29.25	0.00
1989	2107.57	3676	666	42.00	42.00	36.12	41.96	22.72	12.35	45.65	0.00
1990	4384.92	6692	666	76.42	76.42	75.16	76.39	12.38	10.80	12.79	0.00
1991	808.05	1335	666	48.18	48.18	13.85	15.24	0.59	0.29	51.53	0.00
1992	4642.28	7139	666	81.31	81.31	79.35	81.27	13.23	12.40	6.30	0.00
1993	4746.29	7277	666	83.11	83.11	81.35	83.07	2.03	1.72	15.17	0.00
1994	4844.35	7437	666	84.95	84.95	83.03	84.90	3.83	3.38	11.67	0.00
1995	5780.13	8629	666	98.52	98.52	99.07	98.50	1.48	1.48	0.00	0.00
1996	5165.36	7771	673	88.63	88.63	87.37	88.47	0.33	0.29	11.07	0.00
1997	5442.56	7809	693	89.60	89.60	89.65	89.14	1.04	0.94	9.46	0.00
1998	6181.46	8760	693	100.00	100.00	101.82	100.00	0.00	0.00	0.00	0.00
1999	5735.27	8185	693	93.45	93.45	94.47	93.44	0.00	0.00	6.55	0.00
2000	5591.38	8028	693	91.41	91.41	91.85	91.39	0.87	0.80	7.79	0.00
2001	6105.26	8623	693	98.44	98.44	100.57	98.44	1.56	1.56	0.00	0.00
2002	5854.08	8369	693	95.55	95.55	96.43	95.54	0.17	0.16	4.28	0.00
2003	5562.48	8033	693	91.71	91.71	91.63	91.70	0.00	0.00	8.29	0.00
2004	6079.18	8662	693	98.62	98.62	99.87	98.61	1.38	1.38	0.00	0.00
2005	4240.96	6243	693	71.30	72.37	69.86	71.27	12.25	10.11	17.52	1.07
2006	5383.75	7669	693	87.56	87.56	88.68	87.55	1.07	0.95	11.49	0.00
2007	5148.80	8552	693	97.63	97.63	84.81	97.63	0.00	0.00	2.37	0.00
2008	5234.90	7415	693	84.43	85.15	86.00	84.41	0.40	0.34	14.50	0.72
2009	5435.35	7811	693	89.18	89.18	89.53	89.17	0.00	0.00	10.82	0.00

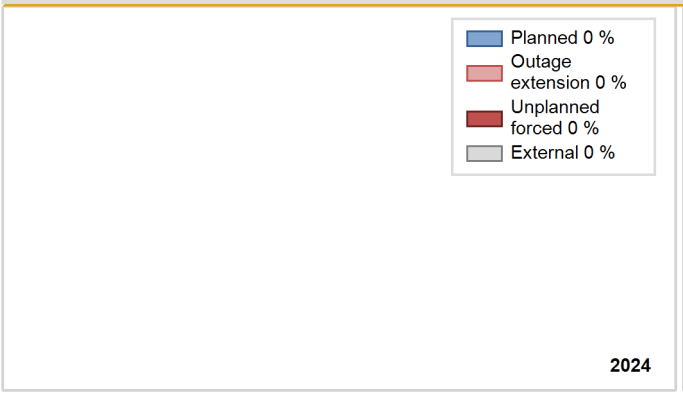
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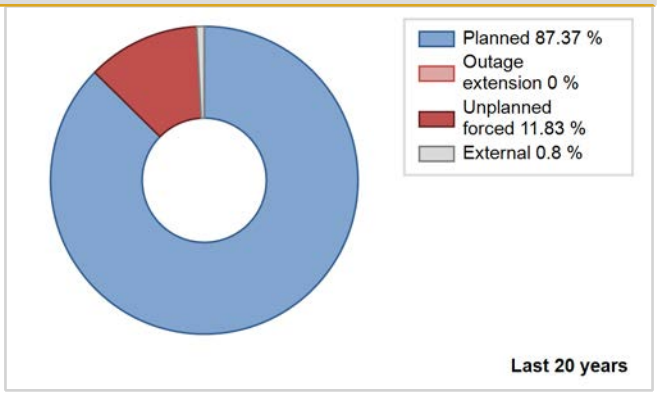
2010	5949.82	8397	693	95.87	95.87	98.01	95.86	4.13	4.13	0.00	0.00
2011	5089.88	7202	693	82.24	82.24	83.84	82.21	0.00	0.00	17.76	0.00
2012	5235.36	7416	693	84.44	84.44	86.00	84.43	0.00	0.00	15.56	0.00
2013	4674.70	6156	802	73.43	73.43	68.84	70.27	0.65	0.48	26.09	0.00
2014	6149.85	7828	802	89.35	89.35	87.54	89.36	2.41	2.20	8.45	0.00
2015	7047.86	8623	802	98.44	98.44	100.32	98.44	0.61	0.61	0.96	0.00
2016	6559.29	8022	802	91.33	91.33	93.11	91.33	0.00	0.00	8.67	0.00
2017	6554.48	7956	802	90.82	90.82	93.30	90.82	1.74	1.61	7.57	0.00
2018	7292.15	8760	821	100.00	100.00	101.39	100.00	0.00	0.00	0.00	0.00
2019	6608.74	8011	821	91.46	91.46	91.89	91.45	0.00	0.00	8.54	0.00
2020	6062.56	7338	821	83.54	83.54	84.07	83.54	4.60	4.03	12.43	0.00
2021	7571.21	8760	821	100.00	100.00	105.27	100.00	0.00	0.00	0.00	0.00
2022	6908.00	7997	821	94.19	94.19	96.05	91.29	0.00	0.00	5.81	0.00
2023	6656.18	7715	821	87.92	87.92	92.55	88.07	0.38	0.33	11.75	0.00
2024	Data not provided										

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1973 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					280	
B. Refuelling without maintenance				37		
C. Inspection, maintenance or repair combined with refuelling				1065		
D. Inspection, maintenance or repair without refuelling				216	56	
E. Testing of plant systems or components				5	1	
J. Grid limitation, failure or grid unavailability						1
L. Human factor related					9	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						46
Z. Other					8	
Subtotal				1323	354	47
Total		**0**			**1724**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1973 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		62
12. Reactor I&C Systems		16
13. Reactor Auxiliary Systems		2
14. Safety Systems		4
15. Reactor Cooling Systems		70
16. Steam generation systems		74
31. Turbine and auxiliaries		48
32. Feedwater and Main Steam System		21
33. Circulating Water System		2
34. Miscellaneous Systems		26
35. All other I&C Systems		2
41. Main Generator Systems		2
42. Electrical Power Supply Systems		38
Total		**367**

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2024 Operating Experience

US-424 VOGTLE-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	SOUTHERN (Southern Nuclear Operating Company, Inc.)
Owner	:	GPCO (GEORGIA POWER CO.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3626 MWth
Gross electrical power	:	1229 MWe
Reference unit power (net)	:	1150 MWe

Key Dates

Construction Date	:	1976-08-01
Grid Date	:	1987-03-27
Commercial Date	:	1987-06-01
Age at end of year	:	37 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	36400
Active core diameter [m]	:	3.4
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

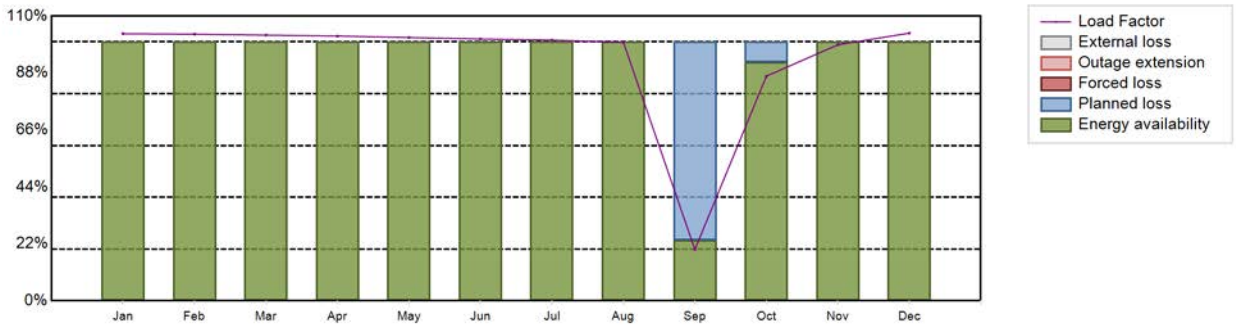
Operating coolant pressure [MPa]	:	15.82
Reactor outlet temperature [°C]	:	325
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.365
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.81
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	2
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9464.58 GW(e).h
Energy Availability Factor (EAF)	:	93.05 %
Unit Capability Factor (UCF)	:	93.05 %
Load Factor (LF)	:	93.69 %
Operating Factor (OF)	:	93.04 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	6.95 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	611 hours

Annual Summary



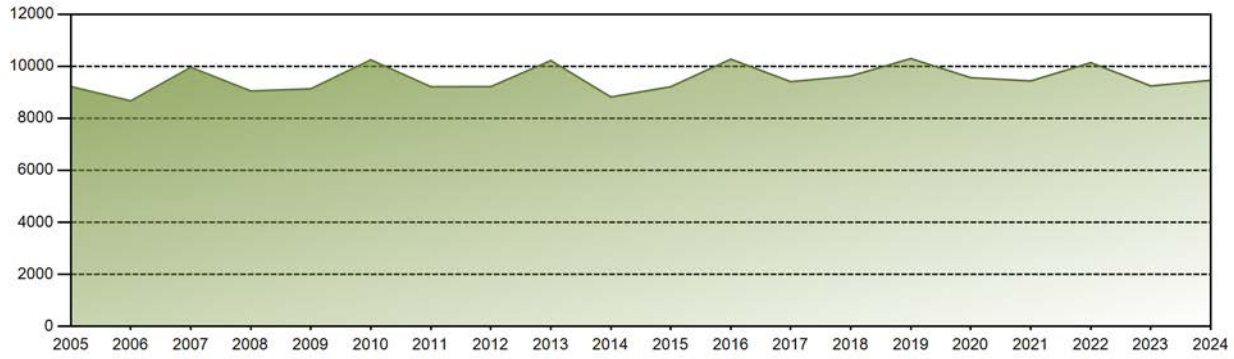
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	882.67	824.25	876.78	846.85	870.02	837.36	861.47	854.20	164.05	742.37	819.96	884.61	9464.58
EAF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	23.33	92.17	100.00	100.00	93.05
UCF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	23.33	92.17	100.00	100.00	93.05
LF [%]	103.16	102.98	102.61	102.28	101.69	101.13	100.69	99.84	19.81	86.77	98.89	103.39	93.69
OF [%]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	23.33	92.07	100.00	100.00	93.04
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.67	7.83	0.00	0.00	6.95
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	345090.76 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.45 %
Cumulative Energy Availability Factor (EAF)	:	91.78 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.35 %
Cumulative Unit Capability Factor (UCF)	:	91.8 %	Cumulative Planned Unavailability Factor (PUF)	:	6.85 %
Cumulative Load Factor (LF)	:	92.16 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	91.77 %			

Electricity Production (net) [GWh]

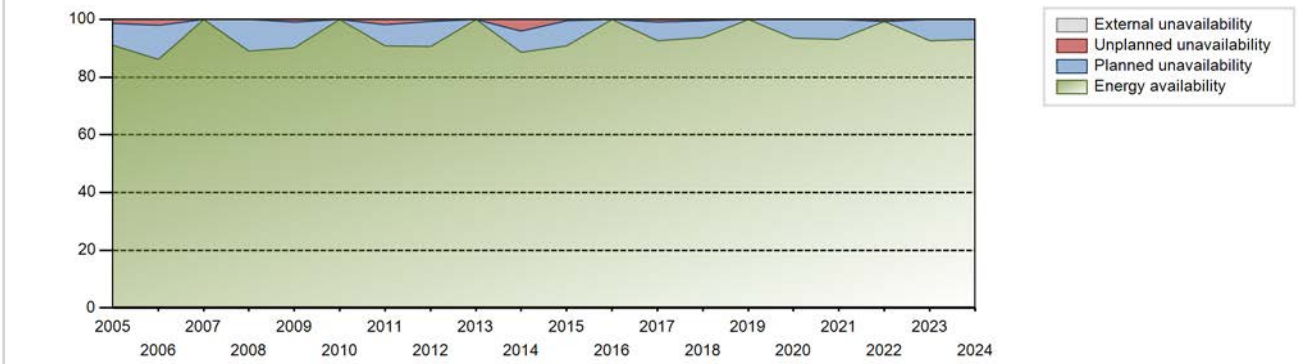


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1987	Data not provided										
1988	6799.71	6569	1079	74.25	74.25	71.74	74.78	12.68	10.78	14.97	0.00
1989	8709.38	8275	1083	94.19	94.19	91.80	94.46	5.81	5.81	0.00	0.00
1990	7353.06	6980	1079	78.39	78.39	77.79	79.68	2.65	2.14	19.48	0.00
1991	7501.74	7016	1100	78.95	78.95	77.85	80.09	0.00	0.00	21.05	0.00
1992	9383.53	8523	1105	96.88	96.88	96.67	97.03	3.12	3.12	0.00	0.00
1993	8600.74	7577	1145	86.29	86.29	85.70	86.50	1.26	1.10	12.61	0.00
1994	8817.16	7847	1168	89.64	89.64	86.14	89.58	0.62	0.56	9.80	0.00
1995	9984.01	8621	1162	98.43	99.18	98.08	98.41	0.00	0.00	0.82	0.74
1996	8149.80	7162	1162	81.55	81.55	79.85	81.53	5.76	4.98	13.47	0.00
1997	8270.11	7167	1162	81.85	81.85	81.25	81.82	4.29	3.67	14.48	0.00
1998	10216.95	8738	1162	99.75	99.75	100.37	99.75	0.00	0.00	0.25	0.00
1999	9425.86	8108	1152	92.59	92.59	93.34	92.56	0.00	0.00	7.41	0.00
2000	9196.57	7963	1148	90.66	90.66	91.20	90.65	0.90	0.82	8.52	0.00
2001	10144.38	8665	1148	98.92	98.92	100.87	98.92	1.08	1.08	0.00	0.00
2002	8638.76	7469	1148	85.29	85.29	85.90	85.26	2.76	2.42	12.29	0.00
2003	9411.48	8097	1152	92.47	92.47	93.26	92.43	0.00	0.00	7.53	0.00
2004	10162.27	8694	1152	98.98	98.98	100.43	98.98	0.83	0.83	0.19	0.00
2005	9220.15	7964	1152	90.95	90.95	91.37	90.91	1.54	1.43	7.63	0.00
2006	8671.05	7536	1152	86.05	86.05	85.92	86.03	2.27	2.00	11.95	0.00
2007	9960.29	8760	1109	100.00	100.00	102.53	100.00	0.00	0.00	0.00	0.00
2008	9050.43	7828	1109	89.12	89.12	92.91	89.12	0.00	0.00	10.88	0.00
2009	9135.00	7861	1150	90.12	90.12	90.68	89.74	1.10	1.00	8.88	0.00
2010	10247.42	8760	1150	100.00	100.00	101.72	100.00	0.00	0.00	0.00	0.00
2011	9216.93	7954	1150	90.82	90.82	91.49	90.80	1.90	1.76	7.42	0.00
2012	9216.97	7961	1150	90.65	90.65	91.24	90.63	0.67	0.62	8.73	0.00
2013	10222.36	8760	1150	100.00	100.00	101.46	99.99	0.00	0.00	0.00	0.00
2014	8820.19	7752	1150	88.50	88.50	87.55	88.49	4.45	4.12	7.39	0.00
2015	9215.78	7947	1150	90.72	90.72	91.48	90.72	0.45	0.41	8.87	0.00
2016	10273.15	8784	1150	100.00	100.00	101.70	100.00	0.00	0.00	0.00	0.00
2017	9408.65	8109	1150	92.57	92.57	93.40	92.57	1.04	0.97	6.47	0.00
2018	9627.22	8216	1150	93.79	93.79	95.57	93.79	0.51	0.48	5.73	0.00
2019	10297.02	8760	1150	100.00	100.00	102.21	100.00	0.00	0.00	0.00	0.00
2020	9562.45	8221	1150	93.60	93.60	94.66	93.59	0.00	0.00	6.40	0.00
2021	9436.79	8152	1150	93.06	93.06	93.67	93.06	0.00	0.00	6.94	0.00
2022	10141.46	8699	1150	99.30	99.30	100.67	99.30	0.70	0.70	0.00	0.00
2023	9244.23	7983	1150	92.61	92.61	91.76	91.13	0.00	0.00	7.39	0.00

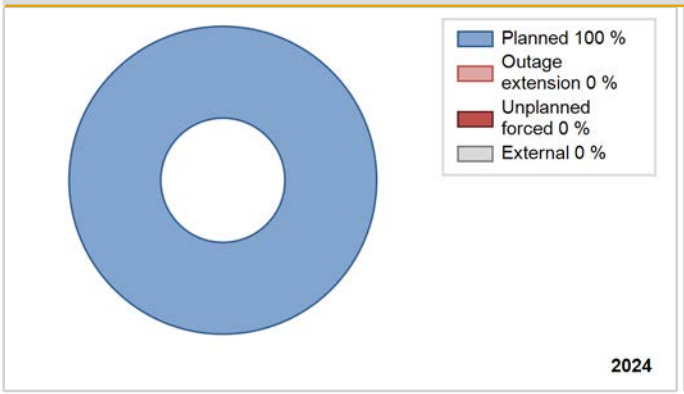
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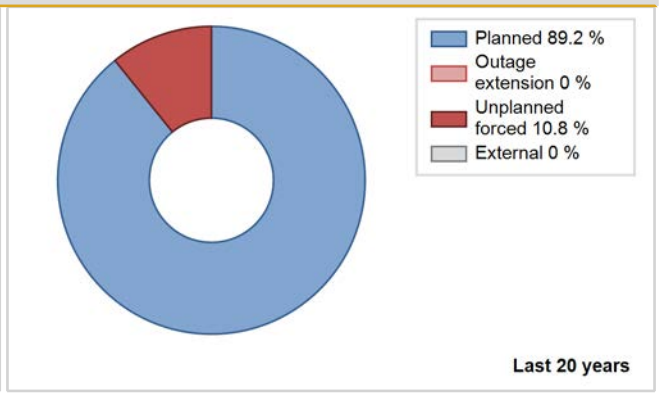
2024	9464.58	8173	1150	93.05	93.05	93.69	93.04	0.00	0.00	6.95	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			1987 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					104	
B. Refuelling without maintenance				32		
C. Inspection, maintenance or repair combined with refuelling	610			546		
D. Inspection, maintenance or repair without refuelling				17		
E. Testing of plant systems or components				2	0	
H. Nuclear regulatory requirements					5	
L. Human factor related					8	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						1
Z. Other				1	0	2
Subtotal	610			598	117	3
Total	**610**			**718**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1987 to 2024
	Hours Lost	Average hours lost per reactor-year
12. Reactor I&C Systems		6
13. Reactor Auxiliary Systems		1
14. Safety Systems		21
15. Reactor Cooling Systems		21
16. Steam generation systems		4
17. Safety I&C Systems (excluding reactor I&C)		6
31. Turbine and auxiliaries		4
32. Feedwater and Main Steam System		20
34. Miscellaneous Systems		0
35. All other I&C Systems		2
41. Main Generator Systems		18
42. Electrical Power Supply Systems		7
Total		**110**

Highlights (2024)

NA

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2024 Operating Experience

US-425 VOGTLE-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	SOUTHERN (Southern Nuclear Operating Company, Inc.)
Owner	:	GPCO (GEORGIA POWER CO.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3626 MWth
Gross electrical power	:	1229 MWe
Reference unit power (net)	:	1152 MWe

Key Dates

Construction Date	:	1976-08-01
Grid Date	:	1989-04-10
Commercial Date	:	1989-05-20
Age at end of year	:	35 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	36400
Active core diameter [m]	:	3.4
Active core height/length [m]	:	3.66
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.8
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

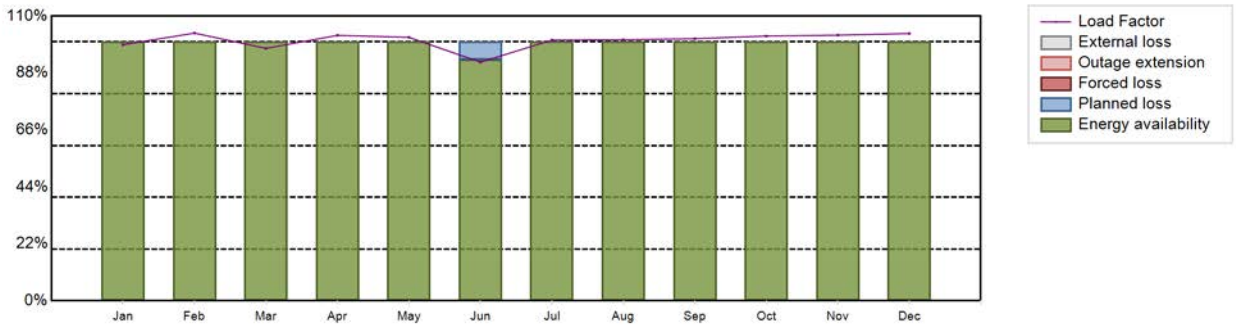
Operating coolant pressure [MPa]	:	15.82
Reactor outlet temperature [°C]	:	325
Number of SG	:	4
Containment type	:	Single
Containment design pressure [MPa]	:	0.365
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.81
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Towers
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	10179.43 GW(e).h
Energy Availability Factor (EAF)	:	99.44 %
Unit Capability Factor (UCF)	:	99.44 %
Load Factor (LF)	:	100.6 %
Operating Factor (OF)	:	99.43 %

Forced Loss Rate (FLR)	:	0 %
Unplanned Capability Loss Factor (UCL)	:	0 %
Planned Unavailability Factor (PUF)	:	0.56 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	50 hours

Annual Summary



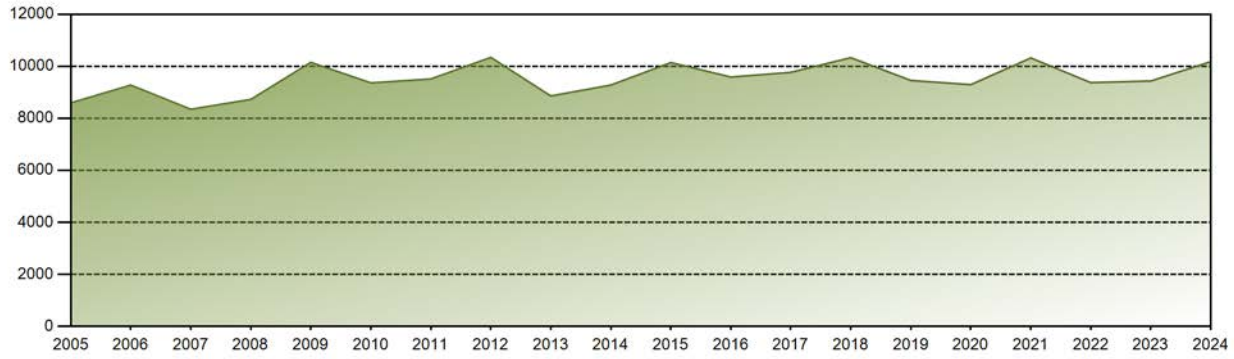
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	847.92	829.06	834.55	850.45	872.26	764.63	862.91	864.07	839.86	876.63	852.24	884.84	10179.43
EAF [%]	100.00	100.00	100.00	100.00	100.00	93.12	100.00	100.00	100.00	100.00	100.00	100.00	99.44
UCF [%]	100.00	100.00	100.00	100.00	100.00	93.12	100.00	100.00	100.00	100.00	100.00	100.00	99.44
LF [%]	98.93	103.40	97.50	102.53	101.77	92.19	100.68	100.81	101.26	102.28	102.61	103.24	100.60
OF [%]	100.00	100.00	100.00	100.00	100.00	93.06	100.00	100.00	100.00	100.00	100.00	100.00	99.43
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUF [%]	0.00	0.00	0.00	0.00	0.00	6.88	0.00	0.00	0.00	0.00	0.00	0.00	0.56
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	330457.03 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.47 %
Cumulative Energy Availability Factor (EAF)	:	92.3 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.38 %
Cumulative Unit Capability Factor (UCF)	:	92.31 %	Cumulative Planned Unavailability Factor (PUF)	:	6.31 %
Cumulative Load Factor (LF)	:	92.37 %	Cumulative Externally cause unavailability (XUF)	:	0.01 %
Cumulative Operating Factor (OF)	:	92.16 %			

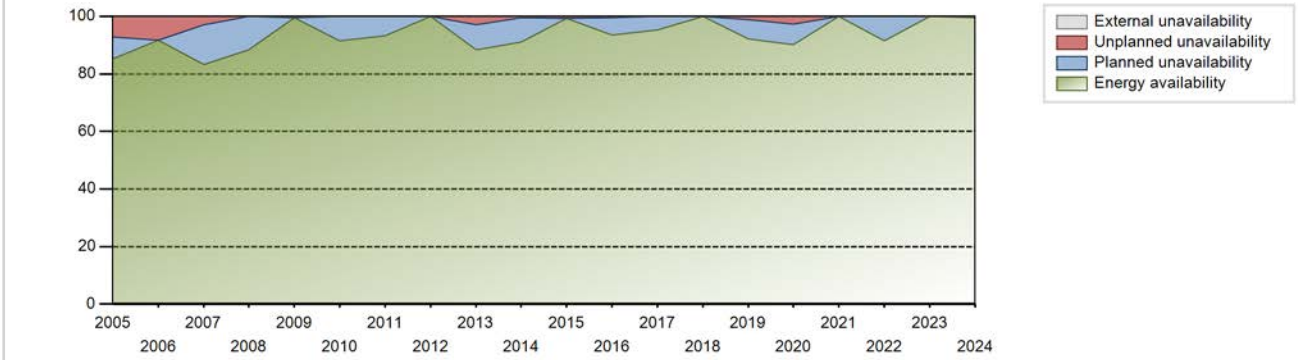
Electricity Production (net) [GWh]



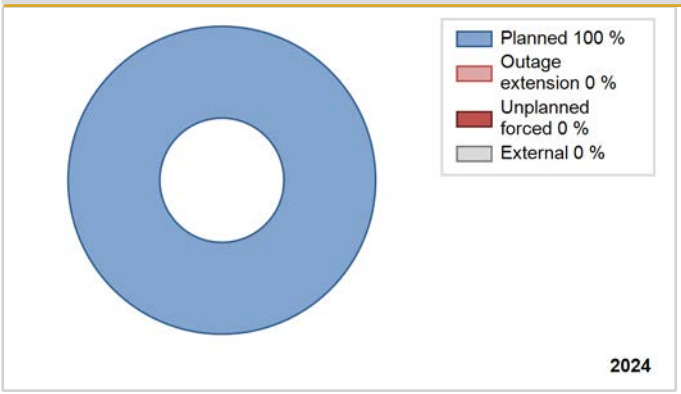
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1989	5547.17	5104	1110	95.42	95.42	96.38	95.60	2.29	2.24	2.34	0.00
1990	6868.02	7125	1110	81.06	81.06	70.63	81.34	1.91	1.58	17.36	0.00
1991	8897.44	8375	1097	95.44	95.44	92.59	95.61	2.20	2.15	2.42	0.00
1992	7779.64	7175	1109	80.79	80.79	79.86	81.68	0.94	0.76	18.45	0.00
1993	8680.90	7737	1140	88.11	88.11	86.88	88.32	0.38	0.34	11.56	0.00
1994	9331.60	8062	1168	92.12	92.12	91.16	92.03	4.81	4.65	3.23	0.00
1995	9165.65	7908	1162	90.29	90.77	90.04	90.27	0.00	0.00	9.23	0.48
1996	9037.64	7899	1162	89.94	89.94	88.54	89.92	0.59	0.54	9.52	0.00
1997	10310.83	8760	1162	100.00	100.00	101.29	100.00	0.00	0.00	0.00	0.00
1998	8388.61	7347	1162	83.89	83.89	82.38	83.87	4.82	4.25	11.87	0.00
1999	9022.63	7833	1156	89.47	89.47	89.09	89.42	0.57	0.51	10.02	0.00
2000	10337.82	8784	1149	100.00	100.00	102.39	100.00	0.00	0.00	0.00	0.00
2001	9456.68	8112	1149	92.61	92.61	93.95	92.60	0.06	0.05	7.34	0.00
2002	8418.90	7328	1149	83.66	83.66	83.64	83.65	5.60	4.96	11.38	0.00
2003	9736.64	8401	1149	95.93	95.93	96.74	95.90	0.00	0.00	4.07	0.00
2004	9168.69	7970	1149	90.78	90.78	90.84	90.73	0.60	0.55	8.67	0.00
2005	8592.88	7464	1149	85.24	85.24	85.37	85.21	7.79	7.20	7.56	0.00
2006	9276.10	8024	1149	91.65	91.65	92.16	91.60	8.35	8.35	0.00	0.00
2007	8347.29	7323	1127	83.31	83.31	84.55	83.60	3.45	2.98	13.71	0.00
2008	8727.13	7767	1127	88.43	88.43	88.16	88.42	0.00	0.00	11.57	0.00
2009	10150.93	8710	1152	99.45	99.45	100.59	99.43	0.55	0.55	0.00	0.00
2010	9363.05	8011	1152	91.46	91.46	92.78	91.45	0.00	0.00	8.54	0.00
2011	9512.37	8163	1152	93.20	93.20	94.26	93.18	0.00	0.00	6.80	0.00
2012	10341.23	8784	1152	100.00	100.00	102.19	100.00	0.00	0.00	0.00	0.00
2013	8860.32	7748	1152	88.45	88.45	87.79	88.44	3.14	2.86	8.68	0.00
2014	9276.53	7984	1152	91.13	91.13	91.92	91.14	0.58	0.53	8.34	0.00
2015	10144.14	8692	1152	99.22	99.22	100.52	99.22	0.78	0.78	0.00	0.00
2016	9586.97	8220	1152	93.57	93.57	94.74	93.58	0.43	0.40	6.03	0.00
2017	9767.38	8347	1152	95.28	95.28	96.79	95.29	0.00	0.00	4.72	0.00
2018	10331.91	8760	1152	100.00	100.00	102.38	100.00	0.00	0.00	0.00	0.00
2019	9457.10	8076	1152	92.21	92.21	93.71	92.19	1.33	1.24	6.54	0.00
2020	9295.37	7913	1152	90.09	90.09	91.86	90.08	2.83	2.62	7.29	0.00
2021	10320.36	8760	1152	100.00	100.00	102.27	100.00	0.00	0.00	0.00	0.00
2022	9373.75	8023	1152	91.59	91.59	92.89	91.59	0.00	0.00	8.41	0.00
2023	9436.09	8255	1152	99.98	99.98	93.51	94.24	0.02	0.02	0.00	0.00
2024	10179.43	8734	1152	99.44	99.44	100.60	99.43	0.00	0.00	0.56	0.00

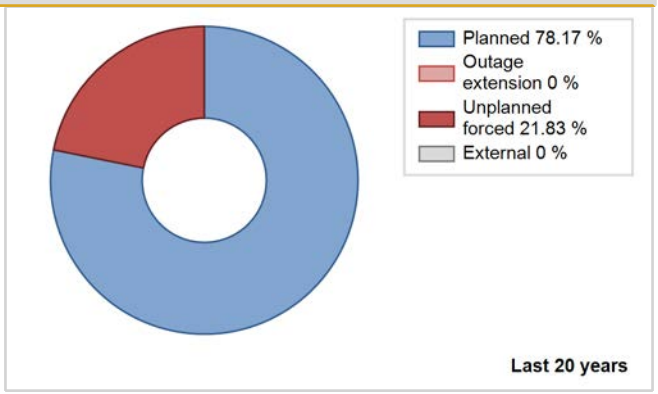
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1989 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure					88	
B. Refuelling without maintenance				39		
C. Inspection, maintenance or repair combined with refuelling				465		
D. Inspection, maintenance or repair without refuelling	50			45		
E. Testing of plant systems or components				1		
L. Human factor related					21	
Z. Other				2	12	1
Subtotal	50			552	121	1
Total	**50**			**674**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1989 to 2024 Average hours lost per reactor-year
12. Reactor I&C Systems		7
13. Reactor Auxiliary Systems		7
14. Safety Systems		9
15. Reactor Cooling Systems		21
16. Steam generation systems		2
31. Turbine and auxiliaries		1
32. Feedwater and Main Steam System		22
34. Miscellaneous Systems		2
35. All other I&C Systems		5
41. Main Generator Systems		13
42. Electrical Power Supply Systems		2
Total		**91**

Highlights (2024)

NA

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2024 Operating Experience

US-5025 VOGTLE-3 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	SOUTHERN (Southern Nuclear Operating Company, Inc.)
Owner	:	GPCO (GEORGIA POWER CO.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	TOSHIBA (TOSHIBA CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / AP-1000
Thermal power	:	3400 MWth
Gross electrical power	:	1250 MWe
Reference unit power (net)	:	1117 MWe

Key Dates

Construction Date	:	2013-03-02
Grid Date	:	2023-03-31
Commercial Date	:	2023-07-31
Age at end of year	:	1 years

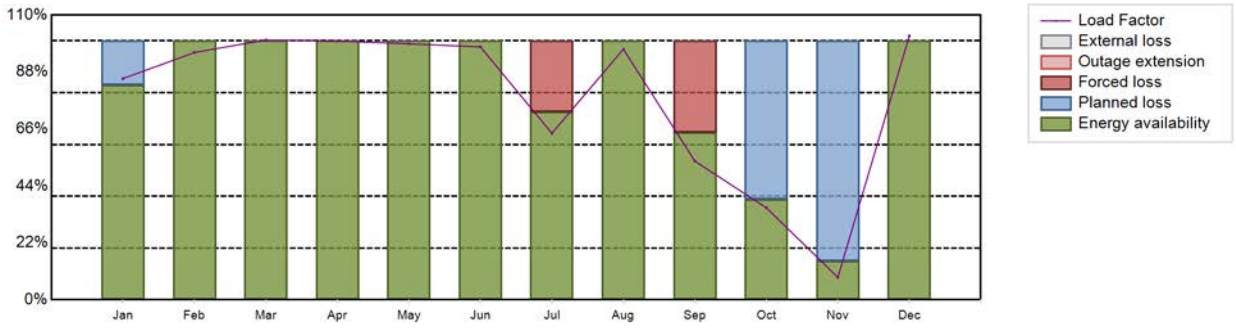
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	7679.43 GW(e).h	Forced Loss Rate (FLR)	:	6.05 %
Energy Availability Factor (EAF)	:	81.19 %	Unplanned Capability Loss Factor (UCL)	:	5.22 %
Unit Capability Factor (UCF)	:	81.19 %	Planned Unavailability Factor (PUF)	:	13.59 %
Load Factor (LF)	:	78.27 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	81.14 %	Total off-line time	:	1657 hours

Annual Summary



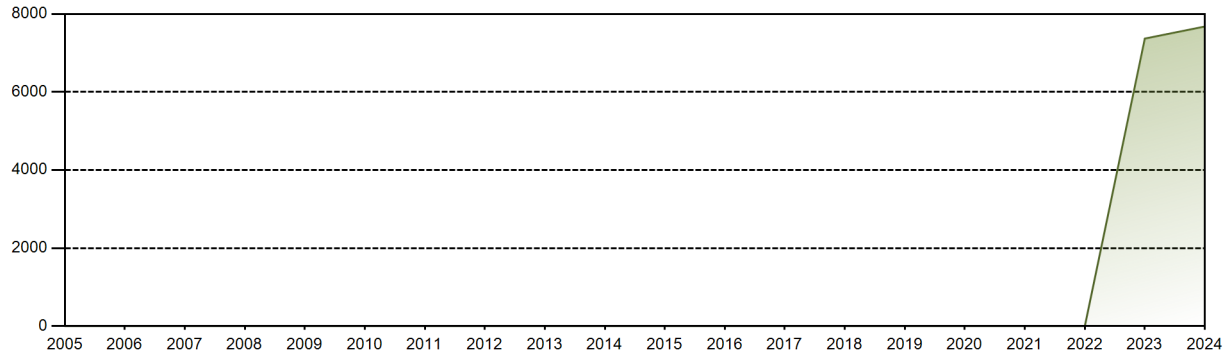
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	710.15	742.70	832.88	803.89	821.78	785.58	534.68	804.49	430.95	295.33	70.05	846.96	7679.43
EAF [%]	83.11	100.00	100.00	100.00	100.00	100.00	72.67	100.00	64.51	38.87	14.93	100.00	81.19
UCF [%]	83.11	100.00	100.00	100.00	100.00	100.00	72.67	100.00	64.51	38.87	14.93	100.00	81.19
LF [%]	85.45	95.53	100.36	99.96	98.88	97.68	64.34	96.80	53.58	35.54	8.70	101.91	78.27
OF [%]	86.16	96.70	100.00	100.00	100.00	100.00	72.58	100.00	64.44	38.71	14.70	100.00	81.14
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	27.33	0.00	35.49	0.00	0.00	0.00	6.05
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	27.33	0.00	35.49	0.00	0.00	0.00	5.22
PUF [%]	16.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	61.13	85.07	0.00	13.59
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

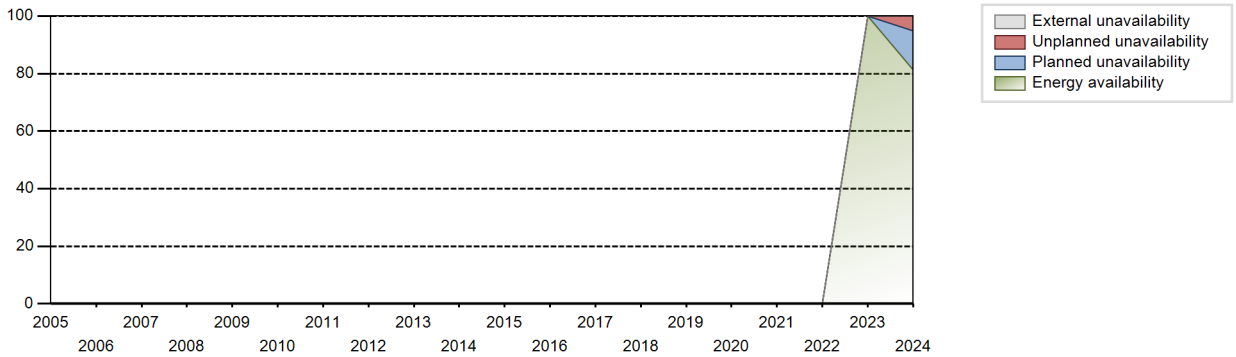
Lifetime energy generation	:	15049.1 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	4.08 %
Cumulative Energy Availability Factor (EAF)	:	86.73 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.69 %
Cumulative Unit Capability Factor (UCF)	:	86.73 %	Cumulative Planned Unavailability Factor (PUF)	:	9.58 %
Cumulative Load Factor (LF)	:	84.46 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	86.7 %			

Electricity Production (net) [GWh]

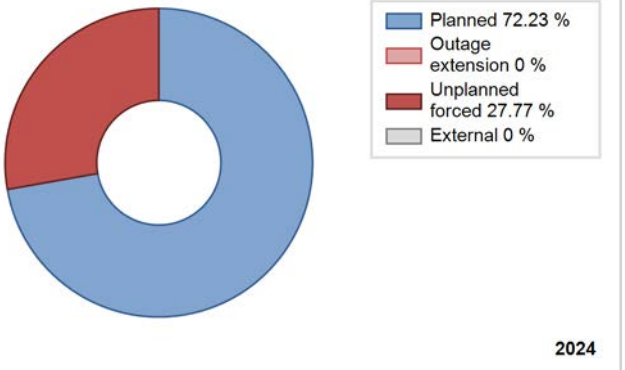


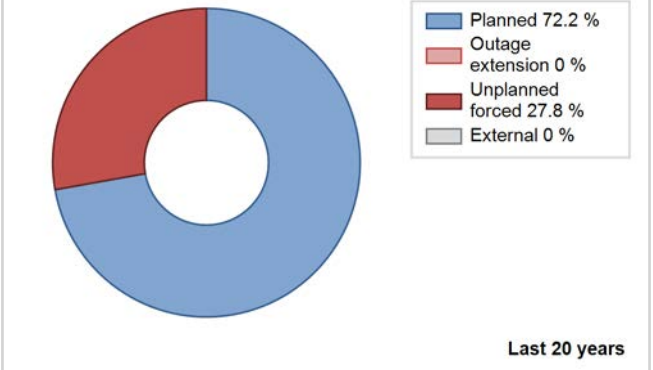
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2023	7369.68	6625	1117	99.98	99.98	99.26	100.00	0.02	0.02	0.00	0.00
2024	7679.43	7127	1117	81.19	81.19	78.27	81.14	6.05	5.22	13.59	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024			2023 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		460			325	
C. Inspection, maintenance or repair combined with refuelling	1071			756		
D. Inspection, maintenance or repair without refuelling	126			89		
Subtotal	1197	460		845	325	
Total		**1657**			**1170**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2023 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	256	140
41. Main Generator Systems	204	111
Total	**460**	**251**

Highlights (2024)

NA

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2024 Operating Experience

US-5026 VOGTLE-4 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	SOUTHERN (Southern Nuclear Operating Company, Inc.)
Owner	:	GPCO (GEORGIA POWER CO.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	TOSHIBA (TOSHIBA CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / AP-1000
Thermal power	:	3400 MWth
Gross electrical power	:	1250 MWe
Reference unit power (net)	:	1117 MWe

Key Dates

Construction Date	:	2013-11-19
Grid Date	:	2024-03-06
Commercial Date	:	2024-04-29
Age at end of year	:	0 years

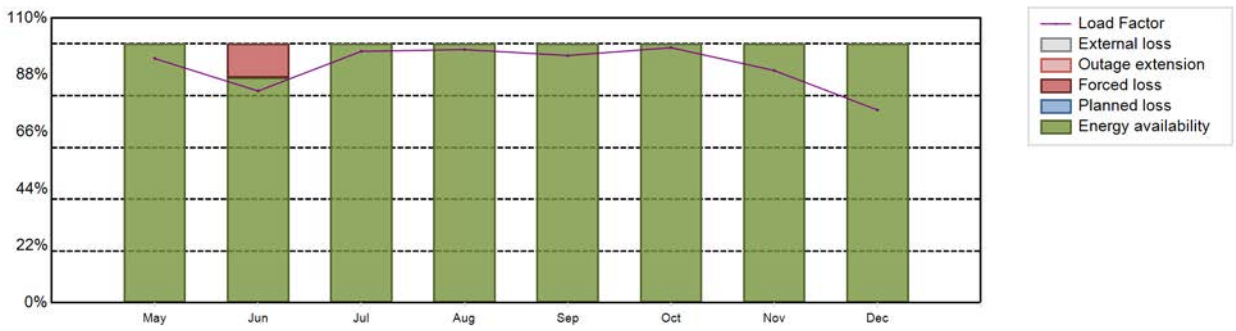
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	-
Reactor vessel centreline orientation	:	-	Reactor outlet temperature [°C]	:	-
Fuel material	:	-	Number of SG	:	-
Refuelling type	:	-	Containment type	:	-
Moderator material	:	-	Containment design pressure [MPa]	:	-
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	-	Number of turbine-generators per unit/reactor	:	-
Part of the core refuelled [%]	:	-	Turbine speed [rpm]	:	-
Average discharge burnup [MWd/t]	:	-	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	-	HP cylinder inlet steam pressure [MPa]	:	-
Active core height/length [m]	:	-	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	-	Primary means of condenser cooling	:	-
Fuel linear heat generation rate [kW/m]	:	-	Number of main condensate pumps	:	-
Number of control rod assemblies	:	-	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	-	Number of on-site safety related diesel generators	:	-
Coolant type	:	-	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	5990.63 GW(e).h	Forced Loss Rate (FLR)	:	1.59 %
Energy Availability Factor (EAF)	:	98.41 %	Unplanned Capability Loss Factor (UCL)	:	1.59 %
Unit Capability Factor (UCF)	:	98.41 %	Planned Unavailability Factor (PUF)	:	0 %
Load Factor (LF)	:	91.19 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	98.4 %	Total off-line time	:	1438 hours

Annual Summary



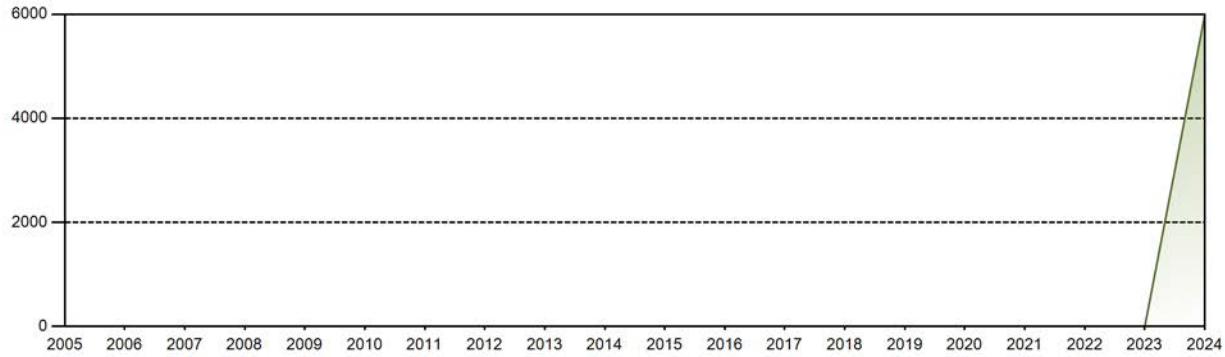
	Apr	Jan	Feb	Mar	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h					784.06	658.05	807.10	812.85	768.15	819.02	722.52	618.89	5990.63
EAF [%]					100.00	87.02	100.00	100.00	100.00	100.00	100.00	100.00	98.41
UCF [%]					100.00	87.02	100.00	100.00	100.00	100.00	100.00	100.00	98.41
LF [%]					94.35	81.82	97.12	97.81	95.51	98.55	89.71	74.47	91.19
OF [%]					100.00	86.94	100.00	100.00	100.00	100.00	100.00	100.00	98.40
FLR [%]					0.00	12.98	0.00	0.00	0.00	0.00	0.00	0.00	1.59
UCL [%]					0.00	12.98	0.00	0.00	0.00	0.00	0.00	0.00	1.59
PUF [%]					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

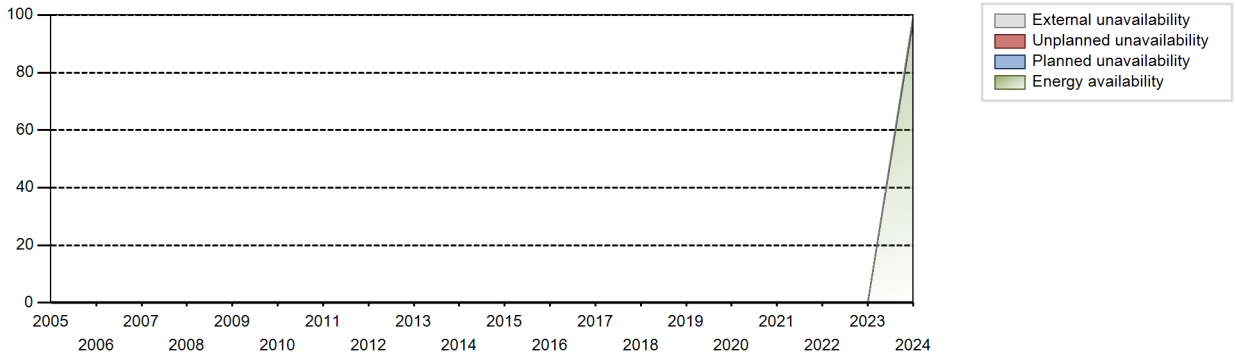
Lifetime energy generation	:	5990.63 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	1.59 %
Cumulative Energy Availability Factor (EAF)	:	98.41 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	1.59 %
Cumulative Unit Capability Factor (UCF)	:	98.41 %	Cumulative Planned Unavailability Factor (PUF)	:	0 %
Cumulative Load Factor (LF)	:	91.19 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	98.4 %			

Electricity Production (net) [GWh]

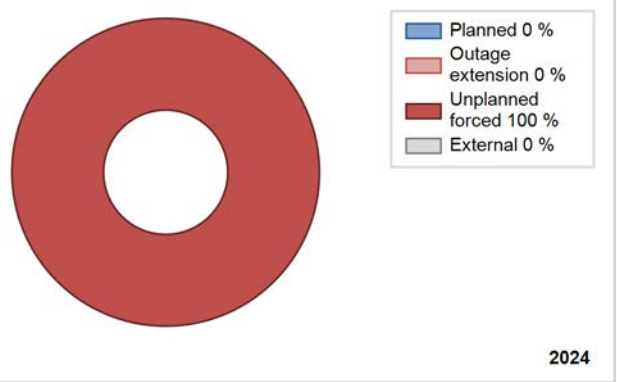


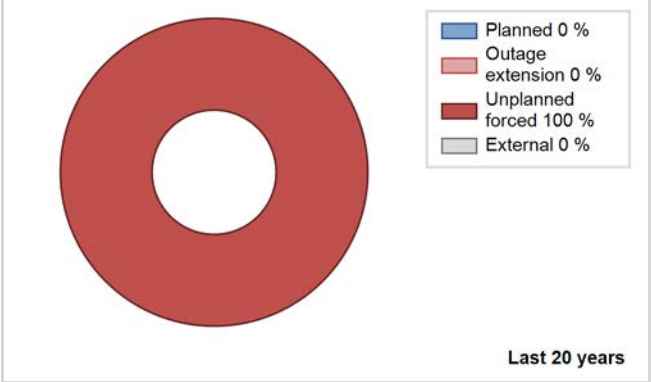
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2024	5990.63	5787	1117	98.41	98.41	91.19	98.40	1.59	1.59	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024			2024 to 2024		
	Hours Lost			Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		94			141	
Subtotal		94			141	
Total		**94**			**141**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	2024 to 2024
	Hours Lost	Average hours lost per reactor-year
31. Turbine and auxiliaries	94	112
Total	**94**	**112**

Highlights (2024)

NA

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2024 Operating Experience

US-382 WATERFORD-3 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	ENTERGY (Entergy Nuclear Operations, Inc.)
Owner	:	ENTLA (ENTERGY LOUISIANA, INC.)
Reactor Supplier	:	CE (COMBUSTION ENGINEERING CO.)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / CE 2LP (DRYAMB)
Thermal power	:	3716 MWth
Gross electrical power	:	1250 MWe
Reference unit power (net)	:	1168 MWe

Key Dates

Construction Date	:	1974-11-14
Grid Date	:	1985-03-18
Commercial Date	:	1985-09-24
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33
Average discharge burnup [MWd/t]	:	33450
Active core diameter [m]	:	3.45
Active core height/length [m]	:	3.81
Number of fissile fuel assemblies/bundles	:	217
Fuel linear heat generation rate [kW/m]	:	17.52
Number of control rod assemblies	:	41
Number of external reactor coolant loops	:	2
Coolant type	:	H2O

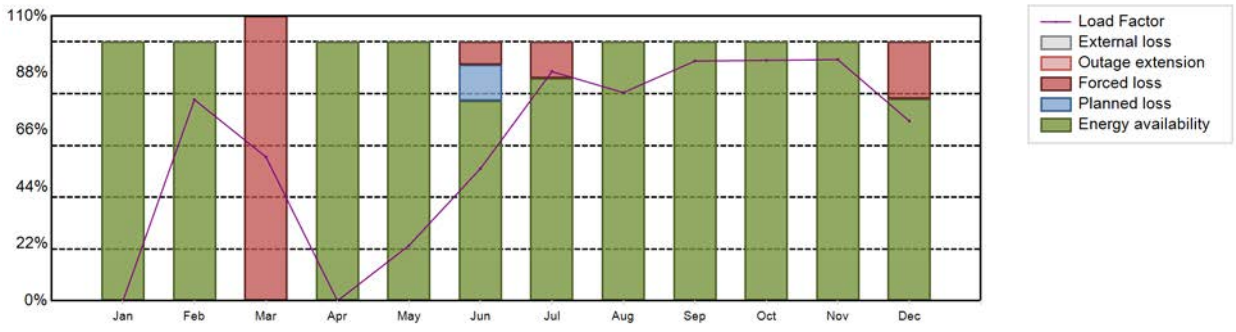
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	322
Number of SG	:	2
Containment type	:	-
Containment design pressure [MPa]	:	0.309
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.05
Output voltage [kV]	:	-
Primary means of condenser cooling	:	River (once-through)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	6170.41 GW(e).h
Energy Availability Factor (EAF)	:	80.51 %
Unit Capability Factor (UCF)	:	80.51 %
Load Factor (LF)	:	60.14 %
Operating Factor (OF)	:	69.08 %

Forced Loss Rate (FLR)	:	18.56 %
Unplanned Capability Loss Factor (UCL)	:	18.35 %
Planned Unavailability Factor (PUF)	:	1.14 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	2716 hours

Annual Summary



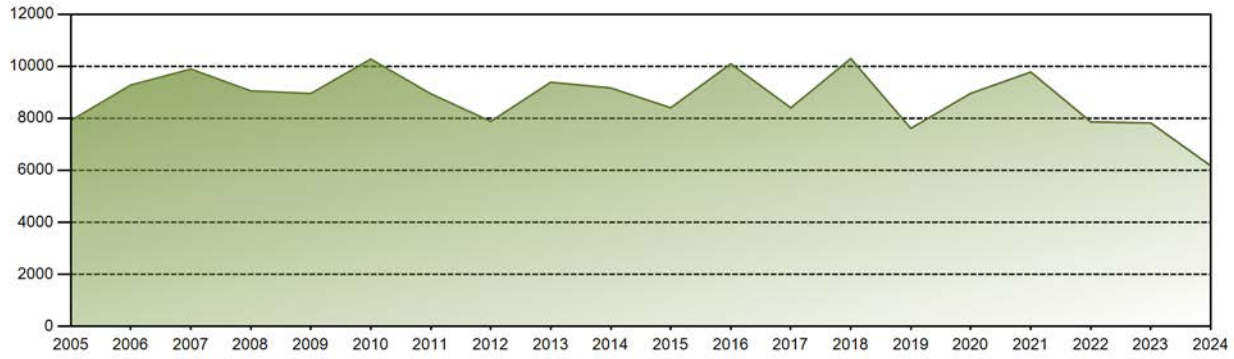
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	0.00	631.44	482.12	0.00	185.56	429.22	769.46	698.92	778.77	807.06	784.55	603.32	6170.41
EAF [%]	100.00	100.00	-72.36	100.00	100.00	77.37	85.97	100.00	100.00	100.00	100.00	77.95	80.51
UCF [%]	100.00	100.00	-72.36	100.00	100.00	77.37	85.97	100.00	100.00	100.00	100.00	77.95	80.51
LF [%]	0.00	77.67	55.55	0.00	21.35	51.04	88.55	80.43	92.61	92.87	93.16	69.43	60.14
OF [%]	0.00	83.76	56.66	0.00	53.23	75.42	96.24	88.44	100.00	100.00	100.00	76.08	69.08
FLR [%]	0.00	0.00	172.36	0.00	0.00	10.17	14.03	0.00	0.00	0.00	0.00	22.05	18.56
UCL [%]	0.00	0.00	172.36	0.00	0.00	8.76	14.03	0.00	0.00	0.00	0.00	22.05	18.35
PUF [%]	0.00	0.00	0.00	0.00	0.00	13.87	0.00	0.00	0.00	0.00	0.00	0.00	1.14
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	331909.85 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.09 %
Cumulative Energy Availability Factor (EAF)	:	87.16 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.79 %
Cumulative Unit Capability Factor (UCF)	:	87.39 %	Cumulative Planned Unavailability Factor (PUF)	:	9.83 %
Cumulative Load Factor (LF)	:	86.06 %	Cumulative Externally cause unavailability (XUF)	:	0.23 %
Cumulative Operating Factor (OF)	:	86.63 %			

Electricity Production (net) [GWh]

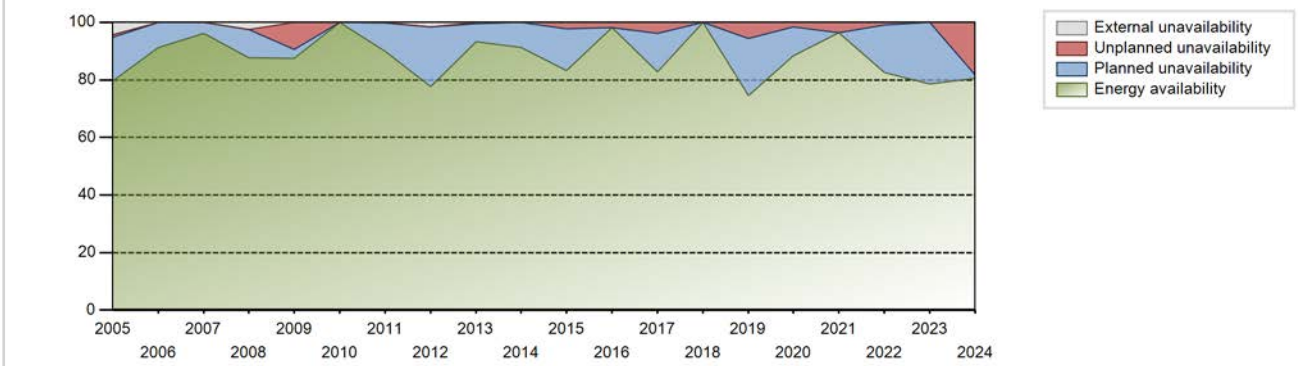


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	2773.07	3372	1099	75.85	75.85	69.71	75.51	23.80	23.69	0.46	0.00
1986	7308.38	6921	1096	79.47	79.47	76.07	79.01	5.80	4.90	15.64	0.00
1987	7434.08	7085	1075	80.93	80.93	78.94	80.88	9.29	8.29	10.79	0.00
1988	6548.41	6468	1075	73.70	73.70	69.35	73.63	2.86	2.17	24.13	0.00
1989	7609.43	7136	1075	81.51	81.51	80.81	81.46	2.84	2.38	16.11	0.00
1990	8604.23	8079	1075	92.25	92.25	91.37	92.23	1.51	1.42	6.34	0.00
1991	7274.94	6869	1075	78.46	78.88	77.25	78.41	1.26	1.00	20.11	0.42
1992	7622.16	7213	1075	82.14	82.14	80.72	82.12	1.72	1.43	16.43	0.00
1993	9138.83	8691	1075	99.22	99.22	97.05	99.21	0.78	0.78	0.00	0.00
1994	7931.92	7555	1075	86.28	86.28	84.23	86.24	0.41	0.35	13.37	0.00
1995	7763.45	7241	1075	82.68	82.68	82.44	82.66	6.01	5.29	12.03	0.00
1996	8926.85	8237	1075	93.81	93.81	94.54	93.77	6.19	6.19	0.00	0.00
1997	6720.68	6161	1075	70.35	70.35	71.37	70.33	0.00	0.00	29.65	0.00
1998	8620.78	7966	1075	90.96	90.96	91.54	90.94	8.54	8.50	0.54	0.00
1999	7441.74	6905	1075	78.87	78.87	79.02	78.82	10.89	9.64	11.50	0.00
2000	8477.38	7743	1075	88.17	88.17	89.78	88.15	0.61	0.55	11.29	0.00
2001	9539.06	8718	1075	99.52	99.52	101.30	99.52	0.48	0.48	0.00	0.00
2002	8847.93	8136	1075	92.78	92.78	93.96	92.88	0.00	0.00	7.22	0.00
2003	8503.13	7865	1075	89.66	89.66	90.30	89.78	1.25	1.13	9.21	0.00
2004	9654.42	8771	1075	99.86	99.86	102.24	99.85	0.14	0.14	0.00	0.00
2005	7913.75	6975	1089	79.65	84.02	82.95	79.61	0.85	0.72	15.26	4.37
2006	9279.81	7996	1158	91.30	91.30	91.48	91.28	0.00	0.00	8.70	0.00
2007	9893.00	8423	1157	96.18	96.18	97.61	96.15	0.00	0.00	3.82	0.00
2008	9053.98	7703	1157	87.73	90.27	89.09	87.69	0.06	0.05	9.68	2.53
2009	8956.07	7648	1176	87.52	87.52	86.94	87.31	9.80	9.51	2.97	0.00
2010	10276.18	8760	1168	100.00	100.00	100.43	100.00	0.00	0.00	0.00	0.00
2011	8942.35	7876	1168	89.93	89.93	87.40	89.91	0.18	0.17	9.91	0.00
2012	7880.31	6820	1168	77.68	79.22	76.81	77.64	0.00	0.00	20.78	1.55
2013	9386.86	8176	1168	93.33	93.33	91.73	93.32	0.59	0.55	6.12	0.00
2014	9166.31	7999	1168	91.32	91.32	89.59	91.31	0.00	0.00	8.68	0.00
2015	8405.17	7300	1168	83.33	83.33	82.15	83.33	2.54	2.17	14.50	0.00
2016	10095.50	8622	1168	98.16	98.16	98.40	98.16	1.84	1.84	0.00	0.00
2017	8401.72	7248	1168	82.75	82.75	82.11	82.74	4.54	3.94	13.32	0.00
2018	10298.11	8760	1168	100.00	100.00	100.65	100.00	0.00	0.00	0.00	0.00
2019	7612.50	6528	1168	74.54	74.54	74.40	74.52	6.88	5.51	19.95	0.00
2020	8961.22	7767	1168	88.42	88.42	87.34	88.42	1.72	1.55	10.03	0.00
2021	9779.29	8445	1168	96.41	96.41	95.58	96.40	3.59	3.59	0.00	0.00

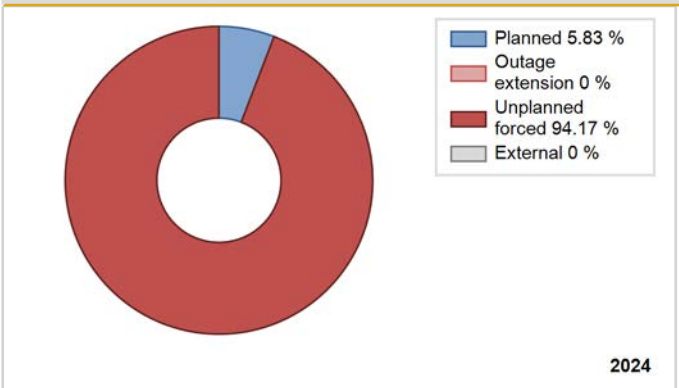
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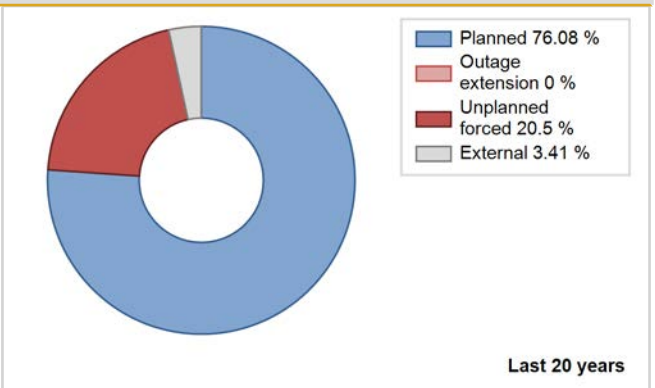
2022	7863.02	6777	1168	82.62	82.62	76.85	77.36	1.13	0.94	16.43	0.00
2023	7820.38	6752	1168	78.49	78.49	76.44	77.09	0.00	0.00	21.51	0.00
2024	6170.41	6068	1168	80.51	80.51	60.14	69.08	18.56	18.35	1.14	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause		2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
		Planned	Unplanned	External	Planned	Unplanned	External
A.	Plant equipment problem/failure		1682			223	
B.	Refuelling without maintenance				71		
C.	Inspection, maintenance or repair combined with refuelling				782		
D.	Inspection, maintenance or repair without refuelling	108			72		
E.	Testing of plant systems or components				1		
J.	Grid limitation, failure or grid unavailability						1
L.	Human factor related					8	
N.	Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)			68			23
Z.	Other					14	
Subtotal		108	1682	68	926	245	24
Total			**1858**			**1195**	

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories	1459	37
12. Reactor I&C Systems		12
13. Reactor Auxiliary Systems		8
14. Safety Systems		2
15. Reactor Cooling Systems		59
17. Safety I&C Systems (excluding reactor I&C)		22
31. Turbine and auxiliaries		36
32. Feedwater and Main Steam System		19
33. Circulating Water System		2
34. Miscellaneous Systems		3
35. All other I&C Systems		12
41. Main Generator Systems	291	19
42. Electrical Power Supply Systems		3
Total	**1750**	**234**

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2024 Operating Experience

US-390 WATTS BAR-1 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	TVA (Tennessee Valley Authority)
Owner	:	TVA (Tennessee Valley Authority)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (ICECND)
Thermal power	:	3459 MWth
Gross electrical power	:	1210 MWe
Reference unit power (net)	:	1157 MWe

Key Dates

Construction Date	:	1973-07-20
Grid Date	:	1996-02-06
Commercial Date	:	1996-05-27
Age at end of year	:	28 years

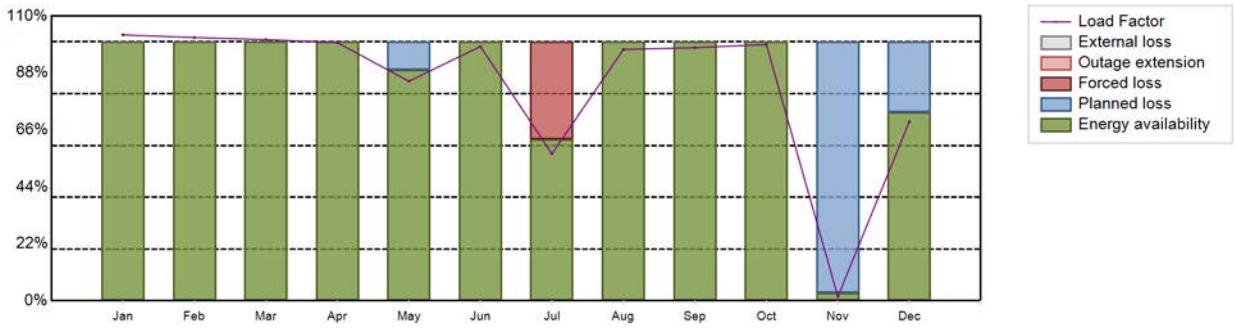
Design Characteristics

Primary Systems			Operating coolant pressure [MPa]	:	15.71
Reactor vessel centreline orientation	:	Vertical	Reactor outlet temperature [°C]	:	326
Fuel material	:	UO2	Number of SG	:	4
Refuelling type	:	OFF-line	Containment type	:	-
Moderator material	:	H2O	Containment design pressure [MPa]	:	0.105
Average fuel enrichment [% of U235]	:	-	**Secondary systems**		
Refuelling frequency [month]	:	18	Number of turbine-generators per unit/reactor	:	1
Part of the core refuelled [%]	:	32	Turbine speed [rpm]	:	1800
Average discharge burnup [MWd/t]	:	36000	Number of LP cylinders per turbine	:	-
Active core diameter [m]	:	3.37	HP cylinder inlet steam pressure [MPa]	:	6.85
Active core height/length [m]	:	3.65	Output voltage [kV]	:	-
Number of fissile fuel assemblies/bundles	:	193	Primary means of condenser cooling	:	Cooling Towers
Fuel linear heat generation rate [kW/m]	:	17.88	Number of main condensate pumps	:	-
Number of control rod assemblies	:	33	Number of FW pumps for full power operation	:	-
Number of external reactor coolant loops	:	4	Number of on-site safety related diesel generators	:	-
Coolant type	:	H2O	**Non-electrical applications**	:	none

Annual Production Results (2024)

Net Energy Production	:	8550.6 GW(e).h	Forced Loss Rate (FLR)	:	3.59 %
Energy Availability Factor (EAF)	:	85.63 %	Unplanned Capability Loss Factor (UCL)	:	3.19 %
Unit Capability Factor (UCF)	:	85.63 %	Planned Unavailability Factor (PUF)	:	11.18 %
Load Factor (LF)	:	84.13 %	Externally cause unavailability (XUF)	:	0 %
Operating Factor (OF)	:	85.2 %	Total off-line time	:	1300 hours

Annual Summary



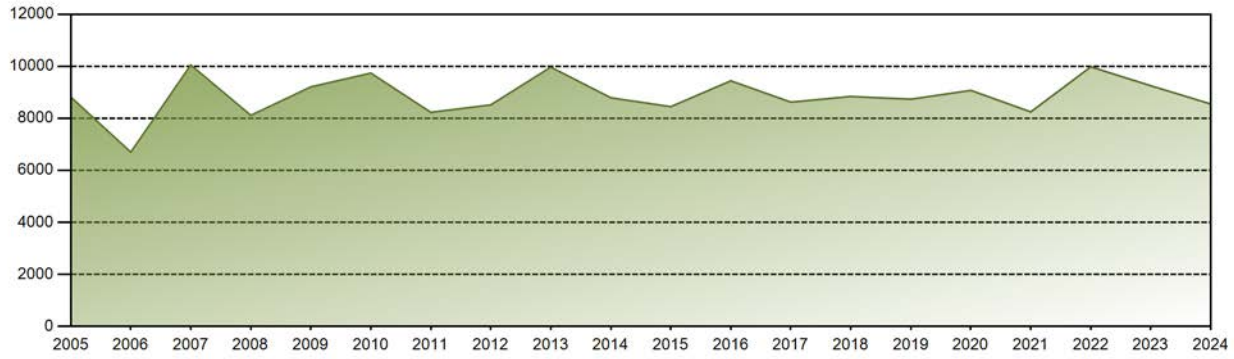
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	884.29	818.81	867.18	830.75	729.90	818.42	489.17	835.62	814.52	851.93	13.86	596.15	8550.60
EAF [%]	100.00	100.00	100.00	100.00	89.21	100.00	62.37	100.00	100.00	100.00	3.07	72.74	85.63
UCF [%]	100.00	100.00	100.00	100.00	89.21	100.00	62.37	100.00	100.00	100.00	3.07	72.74	85.63
LF [%]	102.73	101.68	100.88	99.73	84.79	98.25	56.83	97.07	97.78	98.97	1.66	69.25	84.13
OF [%]	100.00	100.00	100.00	100.00	88.84	100.00	61.29	100.00	100.00	100.00	2.91	69.22	85.20
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	37.63	0.00	0.00	0.00	0.00	0.00	3.59
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	37.63	0.00	0.00	0.00	0.00	0.00	3.19
PUF [%]	0.00	0.00	0.00	0.00	10.79	0.00	0.00	0.00	0.00	0.00	96.93	27.26	11.18
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	254238.47 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	2.32 %
Cumulative Energy Availability Factor (EAF)	:	90.32 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	2.14 %
Cumulative Unit Capability Factor (UCF)	:	90.34 %	Cumulative Planned Unavailability Factor (PUF)	:	7.51 %
Cumulative Load Factor (LF)	:	89.72 %	Cumulative Externally cause unavailability (XUF)	:	0.02 %
Cumulative Operating Factor (OF)	:	90.25 %			

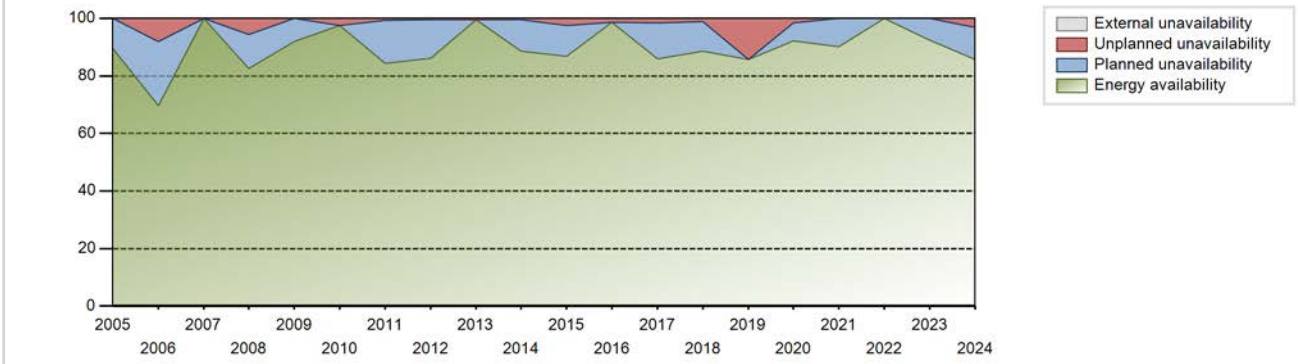
Electricity Production (net) [GWh]



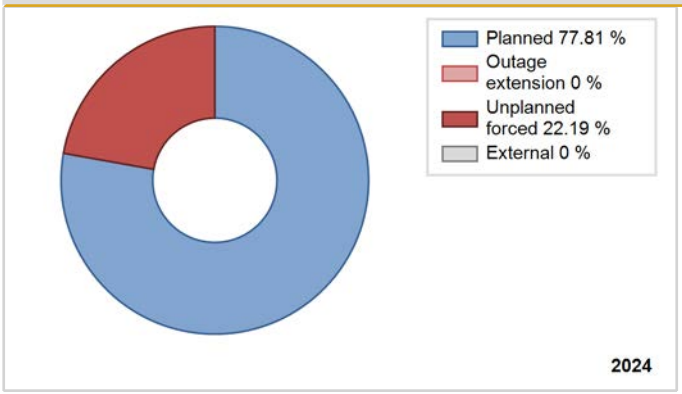
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1996	5544.23	5491	1109	90.65	90.65	88.78	91.16	0.21	0.19	9.17	0.00
1997	7600.09	7269	1117	82.27	82.27	77.67	82.98	5.73	5.00	12.73	0.00
1998	9680.98	8672	1117	98.96	98.96	98.93	99.00	1.04	1.04	0.00	0.00
1999	8267.43	7606	1118	86.84	86.84	84.42	86.83	0.00	0.00	13.16	0.00
2000	9076.39	8124	1118	92.50	92.50	92.42	92.49	0.00	0.00	7.50	0.00
2001	9626.58	8419	1125	96.13	96.13	97.52	96.11	3.87	3.87	0.00	0.00
2002	9079.35	7998	1125	91.30	91.30	92.13	91.30	2.10	1.95	6.74	0.00
2003	8549.61	7551	1121	86.16	86.16	86.91	86.20	4.65	4.20	9.64	0.00
2004	9856.92	8680	1121	98.82	98.82	100.10	98.82	1.18	1.18	0.00	0.00
2005	8816.42	7841	1121	89.52	89.52	89.77	89.50	0.00	0.00	10.48	0.00
2006	6697.05	6099	1121	69.66	69.66	68.20	69.62	10.49	8.16	22.18	0.00
2007	10049.69	8760	1123	100.00	100.00	102.16	100.00	0.00	0.00	0.00	0.00
2008	8112.31	7247	1123	82.53	82.53	82.24	82.50	6.44	5.68	11.79	0.00
2009	9207.46	8055	1123	91.96	91.96	93.60	91.95	0.00	0.00	8.04	0.00
2010	9738.46	8544	1123	97.55	97.55	98.99	97.53	2.45	2.45	0.00	0.00
2011	8230.98	7386	1123	84.33	84.33	83.67	84.32	0.93	0.79	14.88	0.00
2012	8516.47	7557	1123	86.04	86.04	86.34	86.03	0.62	0.53	13.42	0.00
2013	9967.80	8709	1123	99.42	100.00	101.31	99.41	0.00	0.00	0.00	0.58
2014	8789.69	7769	1123	88.69	88.69	89.35	88.69	0.51	0.45	10.85	0.00
2015	8449.15	7609	1123	86.86	86.86	85.89	86.86	2.79	2.49	10.65	0.00
2016	9441.96	8656	1123	98.54	98.54	95.72	98.54	1.46	1.46	0.00	0.00
2017	8622.85	7529	1123	85.94	85.94	87.65	85.95	1.87	1.64	12.41	0.00
2018	8840.45	7637	1157	88.51	88.51	87.22	87.18	1.24	1.11	10.38	0.00
2019	8735.99	7514	1157	85.79	85.79	86.19	85.78	14.21	14.21	0.00	0.00
2020	9075.10	7996	1157	92.16	92.16	89.29	91.03	1.63	1.52	6.32	0.00
2021	8246.82	7900	1157	90.18	90.18	81.37	90.18	0.00	0.00	9.82	0.00
2022	9979.10	8760	1157	100.00	100.00	98.46	100.00	0.00	0.00	0.00	0.00
2023	9253.94	8100	1157	92.44	92.44	91.30	92.47	0.00	0.00	7.55	0.00
2024	8550.60	7484	1157	85.63	85.63	84.13	85.20	3.59	3.19	11.18	0.00

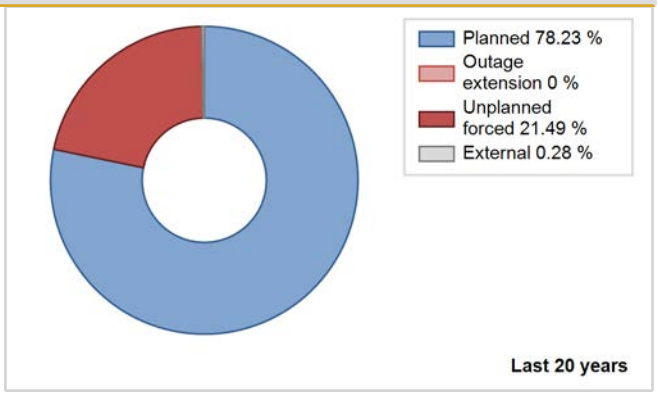
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Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1996 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		288			146	
B. Refuelling without maintenance				23		
C. Inspection, maintenance or repair combined with refuelling	929			612		
D. Inspection, maintenance or repair without refuelling	83			54		
E. Testing of plant systems or components				25		
J. Grid limitation, failure or grid unavailability						2
L. Human factor related					14	
P. Fire					1	
Z. Other				43	11	
Subtotal	1012	288		757	172	2
Total	**1300**			**931**		

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	1996 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories	288	10
12. Reactor I&C Systems		2
14. Safety Systems		7
15. Reactor Cooling Systems		16
16. Steam generation systems		2
31. Turbine and auxiliaries		49
32. Feedwater and Main Steam System		33
33. Circulating Water System		9
35. All other I&C Systems		1
41. Main Generator Systems		12
42. Electrical Power Supply Systems		12
Total	**288**	**153**

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Highlights (2024)

NA

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2024 Operating Experience

US-391 WATTS BAR-2 UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	TVA (Tennessee Valley Authority)
Owner	:	TVA (Tennessee Valley Authority)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (ICECND)
Thermal power	:	3411 MWth
Gross electrical power	:	1218 MWe
Reference unit power (net)	:	1164 MWe

Key Dates

Construction Date	:	1973-09-01
Grid Date	:	2016-06-03
Commercial Date	:	2016-10-19
Age at end of year	:	8 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	-
Part of the core refuelled [%]	:	-
Average discharge burnup [MWd/t]	:	-
Active core diameter [m]	:	3.37
Active core height/length [m]	:	3.65
Number of fissile fuel assemblies/bundles	:	193
Fuel linear heat generation rate [kW/m]	:	17.88
Number of control rod assemblies	:	33
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

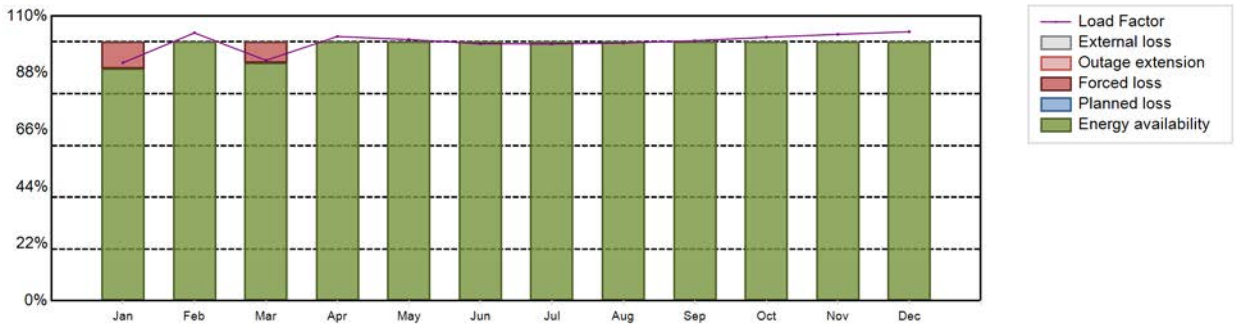
Operating coolant pressure [MPa]	:	15.71
Reactor outlet temperature [°C]	:	326
Number of SG	:	4
Containment type	:	Double
Containment design pressure [MPa]	:	1.05
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.85
Output voltage [kV]	:	-
Primary means of condenser cooling	:	-
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	10208.07 GW(e).h
Energy Availability Factor (EAF)	:	98.45 %
Unit Capability Factor (UCF)	:	98.45 %
Load Factor (LF)	:	99.84 %
Operating Factor (OF)	:	98.39 %

Forced Loss Rate (FLR)	:	1.55 %
Unplanned Capability Loss Factor (UCL)	:	1.55 %
Planned Unavailability Factor (PUF)	:	0 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	141 hours

Annual Summary



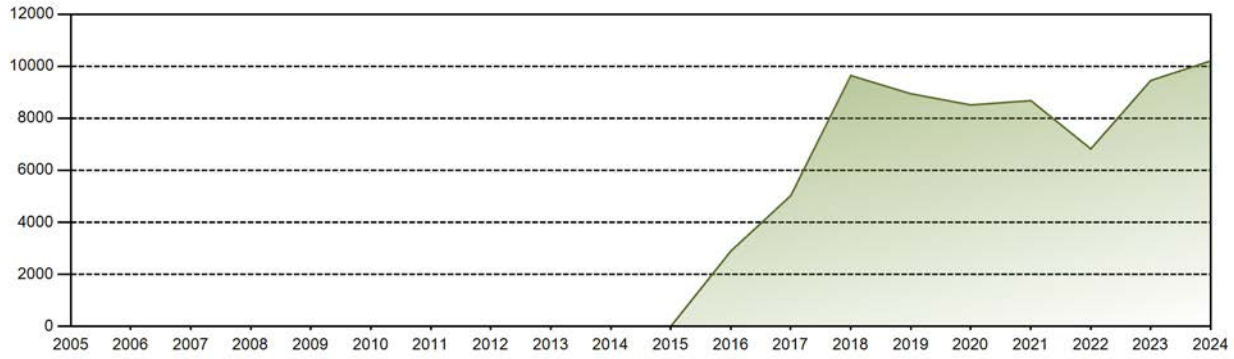
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	796.39	838.34	803.24	855.67	873.72	832.02	859.34	862.33	841.97	881.49	863.81	899.75	10208.07
EAF [%]	89.62	100.00	92.04	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.45
UCF [%]	89.62	100.00	92.04	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.45
LF [%]	91.96	103.48	92.88	102.10	100.89	99.28	99.23	99.57	100.46	101.79	102.93	103.90	99.84
OF [%]	89.25	100.00	91.79	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.39
FLR [%]	10.38	0.00	7.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55
UCL [%]	10.38	0.00	7.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55
PUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

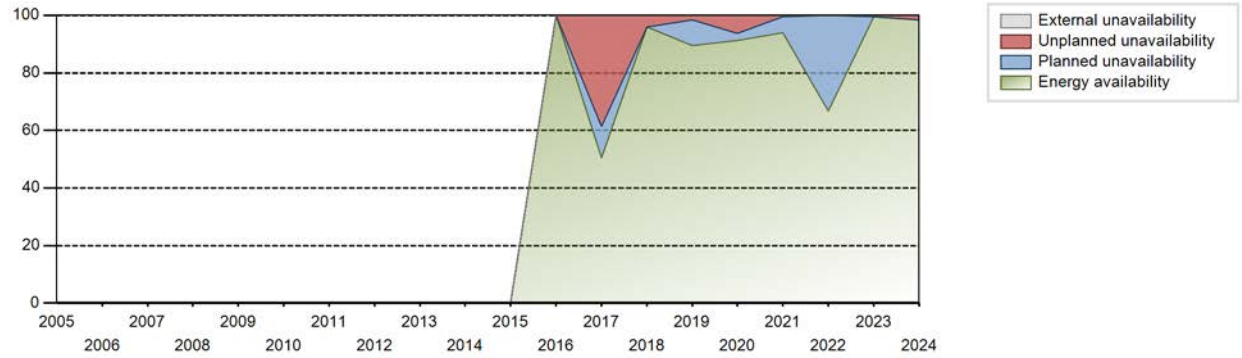
Lifetime energy generation	:	69104.04 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	7 %
Cumulative Energy Availability Factor (EAF)	:	86.02 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	6.48 %
Cumulative Unit Capability Factor (UCF)	:	86.02 %	Cumulative Planned Unavailability Factor (PUF)	:	7.51 %
Cumulative Load Factor (LF)	:	82.82 %	Cumulative Externally cause unavailability (XUF)	:	0 %
Cumulative Operating Factor (OF)	:	84.46 %			

Electricity Production (net) [GWh]

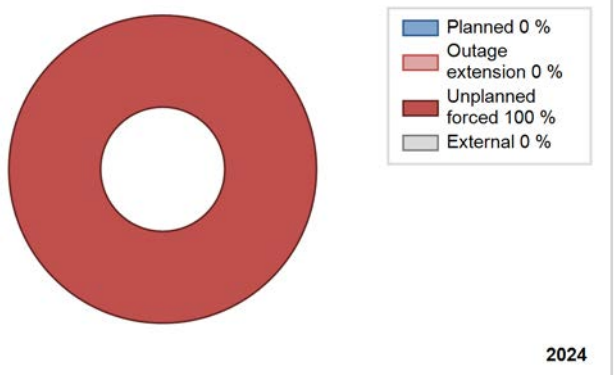


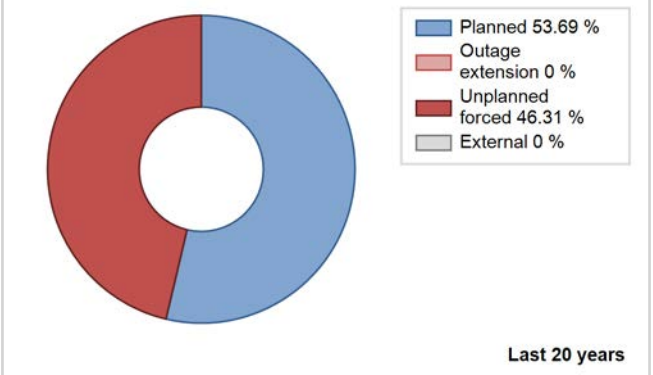
Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2016	2893.72	2593	1165	100.00	100.00	101.05	100.00	0.00	0.00	0.00	0.00
2017	5026.65	4421	1165	50.46	50.46	49.25	50.47	43.34	38.59	10.95	0.00
2018	9644.14	8397	1164	95.97	95.97	94.58	95.86	4.03	4.03	0.00	0.00
2019	8944.95	7820	1164	89.55	89.55	87.72	89.27	1.72	1.57	8.88	0.00
2020	8513.91	7548	1164	91.31	91.31	83.27	85.93	6.33	6.17	2.52	0.00
2021	8680.09	8227	1164	93.92	93.92	85.13	93.92	0.46	0.43	5.65	0.00
2022	6824.42	5845	1164	66.72	66.72	66.93	66.72	0.00	0.00	33.28	0.00
2023	9455.43	8098	1164	99.41	99.41	92.73	92.44	0.53	0.53	0.07	0.00
2024	10208.07	8643	1164	98.45	98.45	99.84	98.39	1.55	1.55	0.00	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





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Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			2016 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		80			513	
B. Refuelling without maintenance				497		
C. Inspection, maintenance or repair combined with refuelling				215		
D. Inspection, maintenance or repair without refuelling				3		
J. Grid limitation, failure or grid unavailability			61			8
L. Human factor related					8	
Z. Other					73	
Subtotal		80	61	715	594	8
Total		**141**			**1317**	

Equipment Related Unplanned Full Outages, Analysis by System

System	2024 Hours Lost	2016 to 2024 Average hours lost per reactor-year
11. Reactor and Accessories	80	18
12. Reactor I&C Systems		10
15. Reactor Cooling Systems		5
31. Turbine and auxiliaries		57
32. Feedwater and Main Steam System		379
34. Miscellaneous Systems		25
42. Electrical Power Supply Systems	61	7
Total	**141**	**501**

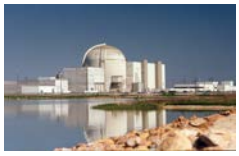
Highlights (2024)

NA

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2024 Operating Experience

US-482 WOLF CREEK — UNITED STATES OF AMERICA



Status at end of year	:	**Operational**
Operator	:	WCNOC (WOLF CREEK NUCLEAR OPERATING CORP.)
Owner	:	KCP&L (Kansas City Power & Light Co.)
Reactor Supplier	:	WH (WESTINGHOUSE ELECTRIC CORPORATION)
Turbine Supplier	:	GE (GENERAL ELECTRIC CO.)

Reactor Unit Details

Reactor type and model	:	PWR / WH 4LP (DRYAMB)
Thermal power	:	3565 MWth
Gross electrical power	:	1285 MWe
Reference unit power (net)	:	1200 MWe

Key Dates

Construction Date	:	1977-05-31
Grid Date	:	1985-06-12
Commercial Date	:	1985-09-03
Age at end of year	:	39 years

Design Characteristics

Primary Systems		
Reactor vessel centreline orientation	:	Vertical
Fuel material	:	UO2
Refuelling type	:	OFF-line
Moderator material	:	H2O
Average fuel enrichment [% of U235]	:	-
Refuelling frequency [month]	:	18
Part of the core refuelled [%]	:	33.3
Average discharge burnup [MWd/t]	:	33000
Active core diameter [m]	:	6.3
Active core height/length [m]	:	5.94
Number of fissile fuel assemblies/bundles	:	22
Fuel linear heat generation rate [kW/m]	:	17.85
Number of control rod assemblies	:	53
Number of external reactor coolant loops	:	4
Coolant type	:	H2O

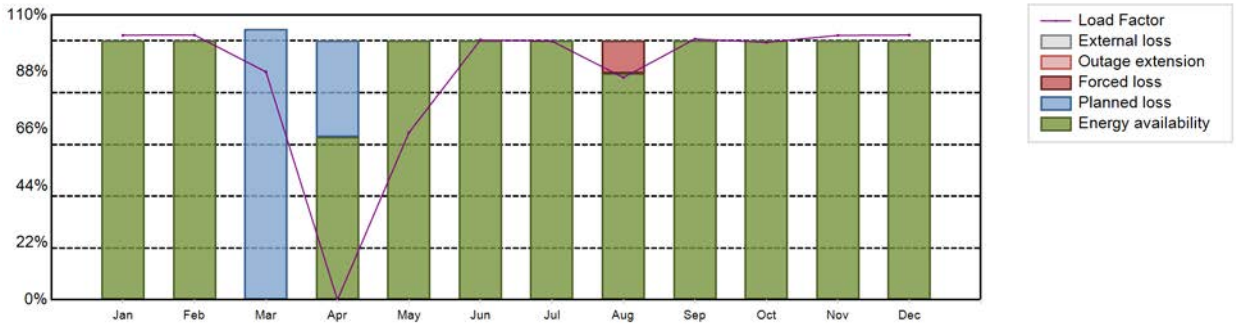
Operating coolant pressure [MPa]	:	15.8
Reactor outlet temperature [°C]	:	326
Number of SG	:	4
Containment type	:	-
Containment design pressure [MPa]	:	0.42
Secondary systems		
Number of turbine-generators per unit/reactor	:	1
Turbine speed [rpm]	:	1800
Number of LP cylinders per turbine	:	-
HP cylinder inlet steam pressure [MPa]	:	6.86
Output voltage [kV]	:	-
Primary means of condenser cooling	:	Cooling Pond (closed-cycle)
Number of main condensate pumps	:	-
Number of FW pumps for full power operation	:	-
Number of on-site safety related diesel generators	:	-
Non-electrical applications	:	none

Annual Production Results (2024)

Net Energy Production	:	9208.53 GW(e).h
Energy Availability Factor (EAF)	:	87.05 %
Unit Capability Factor (UCF)	:	87.05 %
Load Factor (LF)	:	87.36 %
Operating Factor (OF)	:	86.79 %

Forced Loss Rate (FLR)	:	1.2 %
Unplanned Capability Loss Factor (UCL)	:	1.06 %
Planned Unavailability Factor (PUF)	:	11.89 %
Externally cause unavailability (XUF)	:	0 %
Total off-line time	:	1160 hours

Annual Summary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
GW(e)-h	912.55	854.15	784.86	0.00	576.46	867.25	892.07	766.45	870.28	887.93	883.70	912.84	9208.53
EAF [%]	100.00	100.00	-4.53	62.82	100.00	100.00	100.00	87.50	100.00	100.00	100.00	100.00	87.05
UCF [%]	100.00	100.00	-4.53	62.82	100.00	100.00	100.00	87.50	100.00	100.00	100.00	100.00	87.05
LF [%]	102.21	102.27	88.03	0.00	64.57	100.38	99.92	85.85	100.73	99.45	102.14	102.24	87.36
OF [%]	100.00	100.00	87.08	0.00	66.53	100.00	100.00	87.23	100.00	100.00	100.00	100.00	86.79
FLR [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.50	0.00	0.00	0.00	0.00	1.20
UCL [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.50	0.00	0.00	0.00	0.00	1.06
PUF [%]	0.00	0.00	104.53	37.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.89
XUF [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Historical Summary

Lifetime energy generation	:	345557.3 GW(e).h	Cumulative Forced Loss Rate (FLR)	:	3.57 %
Cumulative Energy Availability Factor (EAF)	:	86.17 %	Cumulative Unplanned Capability Loss Factor (UCL)	:	3.21 %
Cumulative Unit Capability Factor (UCF)	:	86.21 %	Cumulative Planned Unavailability Factor (PUF)	:	10.58 %
Cumulative Load Factor (LF)	:	85.78 %	Cumulative Externally cause unavailability (XUF)	:	0.04 %
Cumulative Operating Factor (OF)	:	86.18 %			

Electricity Production (net) [GWh]

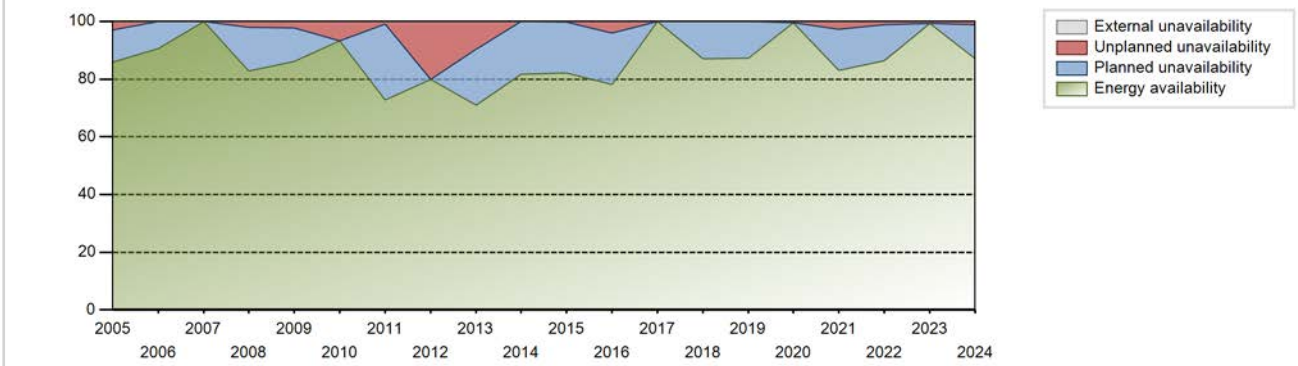


Year	Energy	Time Online	Reference Unit Power	Performance for Years of Commercial Operation							
				EAF	UCF	LF	OF	FLR	UCL	PUF	XUF
	[GW-h]	[Hours]	[MW]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
1985	3814.03	4350	1144	100.00	100.00	90.60	96.21	0.00	0.00	0.00	0.00
1986	6966.06	6416	1128	73.01	73.01	70.50	73.24	9.92	8.04	18.95	0.00
1987	6504.14	6009	1128	68.59	68.59	65.82	68.60	30.99	30.81	0.61	0.00
1988	6676.39	5963	1128	66.80	66.80	67.38	67.88	10.14	7.54	25.66	0.00
1989	9709.26	8618	1135	98.35	98.35	97.65	98.38	0.61	0.60	1.05	0.00
1990	7889.14	7036	1135	79.75	79.75	79.35	80.32	1.78	1.44	18.80	0.00
1991	5891.38	6288	1135	70.99	70.99	59.25	71.78	0.00	0.00	29.01	0.00
1992	8490.66	7538	1131	85.38	85.38	85.46	85.82	14.62	14.62	0.00	0.00
1993	7908.61	7000	1132	79.32	79.32	79.74	79.91	0.00	0.00	20.68	0.00
1994	8545.97	7500	1149	85.42	85.42	84.89	85.62	0.79	0.68	13.90	0.00
1995	10062.18	8625	1163	98.47	98.47	98.70	98.46	1.53	1.53	0.00	0.00
1996	8233.68	7078	1165	80.59	81.84	80.41	80.58	0.68	0.56	17.60	1.25
1997	8447.47	7255	1163	82.80	82.80	82.92	82.82	1.43	1.20	16.00	0.00
1998	10400.72	8760	1163	100.00	100.00	102.09	100.00	0.00	0.00	0.00	0.00
1999	9156.62	7847	1163	89.58	89.58	89.88	89.58	0.32	0.28	10.13	0.00
2000	9071.40	7795	1170	88.75	88.75	88.31	88.74	0.93	0.83	10.41	0.00
2001	10346.66	8731	1170	99.68	99.68	100.95	99.67	0.00	0.00	0.32	0.00
2002	9041.70	7695	1165	87.83	87.83	88.44	87.84	2.51	2.26	9.91	0.00
2003	8902.46	7594	1167	86.70	86.70	87.15	86.69	0.89	0.78	12.52	0.00
2004	10132.74	8650	1166	98.48	98.81	98.93	98.47	1.19	1.19	0.00	0.33
2005	8820.95	7528	1165	85.97	85.97	86.42	85.93	3.36	2.99	11.04	0.00
2006	9350.27	7935	1166	90.59	90.59	91.54	90.58	0.00	0.00	9.41	0.00
2007	10369.14	8760	1166	100.00	100.00	101.52	100.00	0.00	0.00	0.00	0.00
2008	8505.89	7271	1166	82.78	82.78	83.05	82.78	2.51	2.13	15.09	0.00
2009	8768.55	7541	1160	86.04	86.04	86.29	86.08	2.52	2.22	11.74	0.00
2010	9555.71	8163	1160	93.20	93.20	94.04	93.18	6.80	6.80	0.00	0.00
2011	7350.65	6333	1195	72.79	72.79	71.08	72.29	1.26	0.93	26.28	0.00
2012	8295.93	7014	1195	79.86	79.86	79.03	79.85	20.14	20.14	0.00	0.00
2013	7175.89	6210	1195	70.89	70.89	68.54	70.88	11.95	9.62	19.50	0.00
2014	8569.17	7161	1195	81.74	81.74	81.86	81.75	0.00	0.00	18.26	0.00
2015	8653.66	7194	1200	82.18	82.18	82.32	82.12	0.34	0.28	17.54	0.00
2016	8251.51	6867	1200	78.17	78.17	78.28	78.18	4.82	3.96	17.87	0.00
2017	10648.17	8760	1200	100.00	100.00	101.30	100.00	0.00	0.00	0.00	0.00
2018	9176.04	7597	1200	87.12	87.12	87.29	86.72	0.00	0.00	12.88	0.00
2019	9255.42	7643	1200	87.25	87.25	88.05	87.25	0.00	0.00	12.75	0.00
2020	10582.48	8743	1200	99.55	99.55	100.40	99.53	0.45	0.45	0.00	0.00
2021	8594.06	7274	1200	83.04	83.04	81.75	83.04	3.26	2.80	14.17	0.00

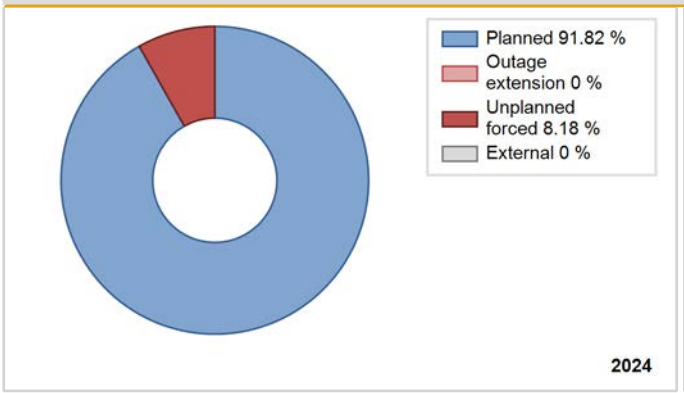
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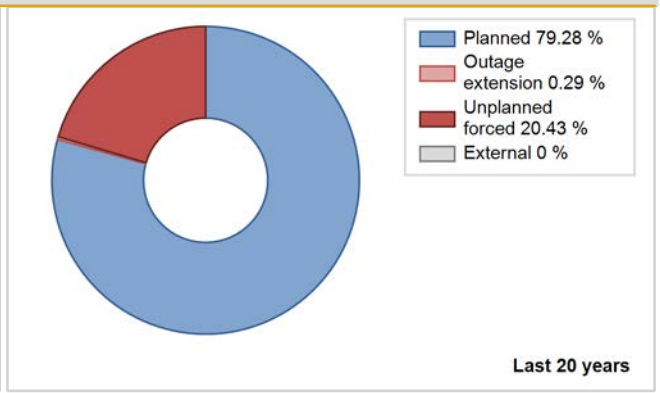
2022	8981.96	7565	1200	86.36	86.36	85.44	86.36	1.20	1.04	12.60	0.00
2023	10301.86	8760	1200	99.20	99.20	98.00	100.00	0.00	0.76	0.04	0.00
2024	9208.53	7624	1200	87.05	87.05	87.36	86.79	1.20	1.06	11.89	0.00

Key Factors in Last 20 Years [%]



Energy Losses by Type





Full Outages, Analysis by Cause

Outage Cause	2024 Hours Lost			1985 to 2024 Average hours lost per reactor-year		
	Planned	Unplanned	External	Planned	Unplanned	External
A. Plant equipment problem/failure		95			184	
B. Refuelling without maintenance				60		
C. Inspection, maintenance or repair combined with refuelling	1065			825	9	
D. Inspection, maintenance or repair without refuelling				47		
E. Testing of plant systems or components				0	1	
H. Nuclear regulatory requirements					2	
J. Grid limitation, failure or grid unavailability						3
L. Human factor related					71	
N. Environmental conditions (lack of cooling water due to dry weather, cooling water temperature limits, flood, storm, lightning, etc.)						4
Z. Other					13	
Subtotal	1065	95		932	280	7
Total	**1160**			**1219**		

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Equipment Related Unplanned Full Outages, Analysis by System

System	2024	1985 to 2024
	Hours Lost	Average hours lost per reactor-year
11. Reactor and Accessories		17
12. Reactor I&C Systems		9
15. Reactor Cooling Systems		10
16. Steam generation systems		26
17. Safety I&C Systems (excluding reactor I&C)		4
31. Turbine and auxiliaries		3
32. Feedwater and Main Steam System	95	46
33. Circulating Water System		3
34. Miscellaneous Systems		9
35. All other I&C Systems		5
41. Main Generator Systems		55
42. Electrical Power Supply Systems		5
Total	**95**	**192**

Highlights (2024)

NA

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6. NON-ELECTRIC APPLICATION OF NUCLEAR ENERGY IN MEMBER STATES

Table 6: Energy produced from Non-Electric Applications in 2024

							Number of Reactors with NEA	RUP [MWe]	Total Heat [GCal]	Electrical equivalent of heat [GWh]	% of NEA
						TOTALS:	46	34113	4915269.26	2644.07	0
ISO Code	Unit	Type	Model	District Heating	Process Heating	Desalination			Total Heat		% of NEA
				PDH Thermal energy [GCal]	PPH Thermal energy [GCal]	PDI Thermal energy [GCal]	Electrical energy for Reverse Osmosis [GWh]	Water production [m3]	Total Heat (PDH + PPH + PDI)	Electrical equivalent of heat [GWh]	
BG	KOZLODUY-5	PWR	VVER V-320	100109.08					100109.08	34.84	0.03
BG	KOZLODUY-6	PWR	VVER V-320	6962.01					6962.01	2.42	0
CH	BEZNAU-1	PWR	WH 2LP	117676					117676	40.95	0.11
CH	BEZNAU-2	PWR	WH 2LP	28548					28548	9.93	0.03
CH	GOESGEN	PWR	PWR 3 Loop		61620				61620	21.44	0.02
CN	HAIYANG-1	PWR	AP-1000	506336.22					506336.22	588.9	0.48
CN	HAIYANG-2	PWR	AP-1000	664625.4					664625.4	773	0.63
CZ	TEMELIN-1	PWR	VVER V-320	114757					114757	39.94	0.04
CZ	TEMELIN-2	PWR	VVER V-320	173975					173975	60.54	0.06
HU	PAKS-3	PWR	VVER V-213	20204.83					20204.83	6.88	0.01
HU	PAKS-4	PWR	VVER V-213	20355.64					20355.64	3.08	0.01
IN	MADRAS-2	PHWR	Horizontal Pres			36966	0	0	36966	12.86	0.06
IN	RAJASTHAN-2	PHWR	Horizontal Pres		84102.9				84102.9	29.27	0.15
IN	RAJASTHAN-3	PHWR	Horizontal Pres		81502.99				81502.99	28.36	0.13
IN	RAJASTHAN-4	PHWR	Horizontal Pres		81351.06				81351.06	28.31	0.13

ISO Code	Unit	Type	Model	District Heating	Process Heating	Desalination			Total Heat		% of NEA
				PDH Thermal energy [GCal]	PPH Thermal energy [GCal]	PDI Thermal energy [GCal]	Electrical energy for Reverse Osmosis [GWh]	Water production [m3]	Total Heat (PDH + PPH + PDI)	Electrical equivalent of heat [GWh]	
JP	GENKAI-3	PWR	M (4-loop)			14929	0	194813	14929	5.2	0
JP	GENKAI-4	PWR	M (4-loop)			4097	0	49790	4097	1.43	0
JP	IKATA-3	PWR	M (3-loop)			0	1855.13	13338	346.79	2.2	0
JP	OHI-3	PWR	M (4-loop)			0	0	716365	18625.49	20.03	0.02
JP	TAKAHAMA-3	PWR	M (3-loop)			0	0	289471.2	7526.25	7.53	0.01
RO	CERNAVODA-1	PHWR	CANDU 6	46361.18					46361.18	16.13	0.02
RO	CERNAVODA-2	PHWR	CANDU 6	38129.42					38129.42	13.27	0.02
RU	BALAKOVO-1	PWR	VVER V-320	11815	0				11815	4.11	0
RU	BALAKOVO-2	PWR	VVER V-320	14003	0				14003	4.87	0
RU	BALAKOVO-3	PWR	VVER V-320	12965	0				12965	4.51	0
RU	BALAKOVO-4	PWR	VVER V-320	18559	0				18559	6.46	0.01
RU	BELOYARSK-3	FBR	BN-600	285462	0				285462	99.34	0.17
RU	BILIBINO-2	LWGR	EGP-6	47278					47278	16.45	1.42
RU	BILIBINO-3	LWGR	EGP-6	54967					54967	19.13	1.65
RU	BILIBINO-4	LWGR	EGP-6	68105					68105	23.7	2.04
RU	KALININ-1	PWR	VVER V-338	38522	0				38522	13.41	0.01
RU	KALININ-2	PWR	VVER V-338	230951	0				230951	80.37	0.08
RU	KALININ-3	PWR	VVER V-320	54155	0				54155	18.85	0.02
RU	KALININ-4	PWR	VVER V-320	67310	0				67310	23.42	0.02
RU	KURSK-2	LWGR	RBMK-1000	20009	0				20009	6.96	1.01
RU	KURSK-3	LWGR	RBMK-1000	136837	0				136837	47.62	0.05
RU	KURSK-4	LWGR	RBMK-1000	225689	0				225689	78.54	0.08
RU	LENINGRAD-3	LWGR	RBMK-1000	185230	0				185230	64.46	0.07
RU	LENINGRAD-4	LWGR	RBMK-1000	155293	0				155293	54.04	0.06

ISO Code	Unit	Type	Model	District Heating	Process Heating	Desalination			Total Heat		% of NEA
				PDH Thermal energy [GCal]	PPH Thermal energy [GCal]	PDI Thermal energy [GCal]	Electrical energy for Reverse Osmosis [GWh]	Water production [m3]	Total Heat (PDH + PPH + PDI)	Electrical equivalent of heat [GWh]	
RU	NOVOVORONEZH-4	PWR	VVER V-179	126352	0				126352	43.97	0.11
RU	NOVOVORONEZH-5	PWR	VVER V-187	14805	0				14805	5.15	0.01
RU	SMOLENSK-1	LWGR	RBMK-1000	241463	0				241463	84.03	0.09
RU	SMOLENSK-2	LWGR	RBMK-1000	145534	0				145534	50.65	0.05
RU	SMOLENSK-3	LWGR	RBMK-1000	170244	0				170244	59.24	0.06
SK	BOHUNICE-3	PWR	VVER V-213	174348	0				174348	43.04	0.09
SK	BOHUNICE-4	PWR	VVER V-213	186266	0				186266	45.24	0.09

Notes: The non-electric applications table does not include data from Ukrainian reactor units as operational data were not submitted for the year 2024 by the time of publication.