ГОСУДАРСТВЕННАЯ КОРПОРАЦИЯ ПО АТОМНОЙ ЭНЕРГИИ «РОСАТОМ»

Nuclear Technologies in Russia: Sustainable Innovative Development

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St. Petersburg
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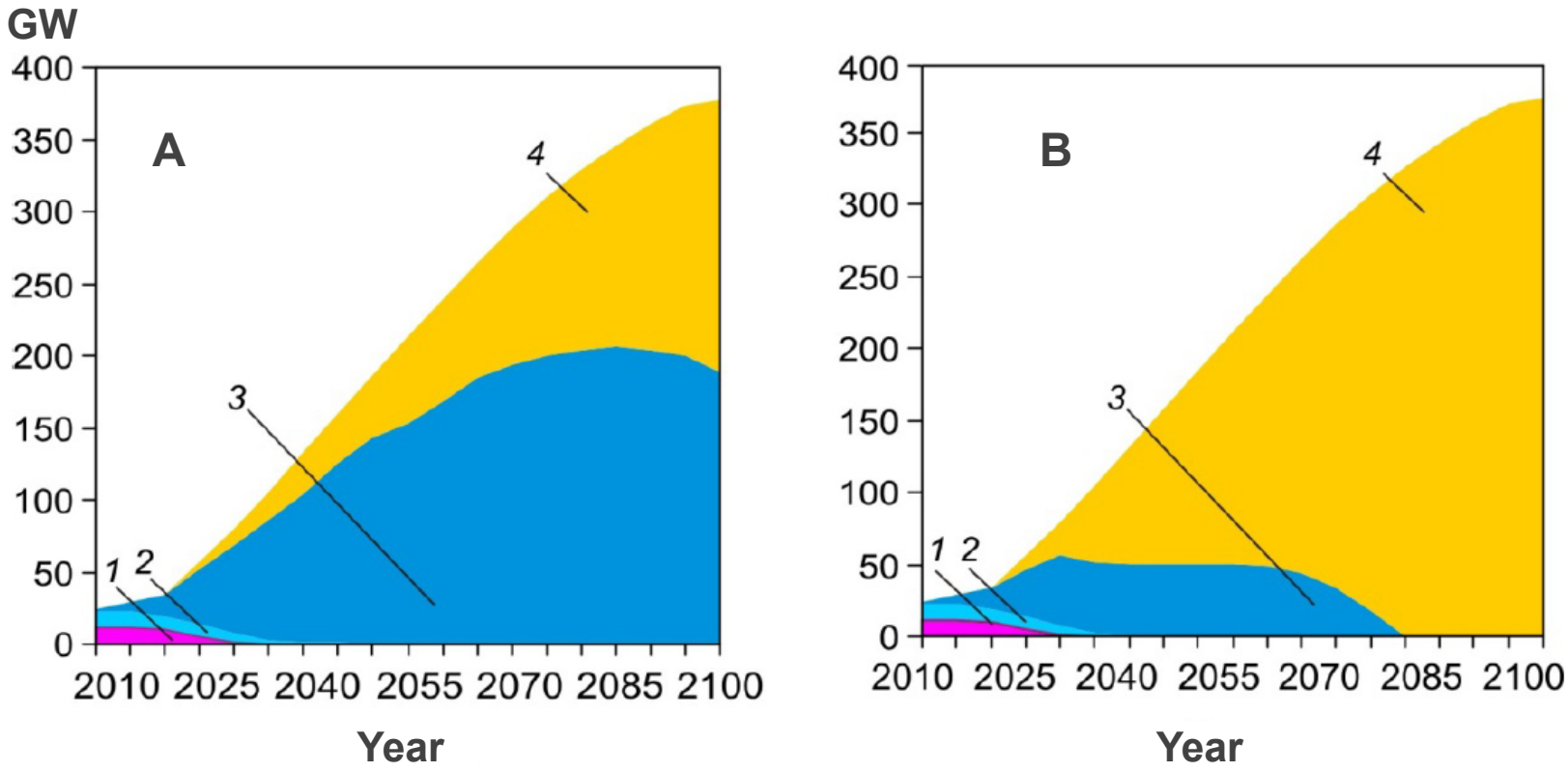
Development of nuclear energy

Fast reactors: driver for Russian nuclear industry development



NPP capacity subject to Fast Reactors being commissioned
using Pu (A) and using Pu+U (B):
1 – RBMK; 2 – VVER (Gen II); 3 – VVER (Gen III+); 4 – FR

Russia: Fast Reactors Development

Russia: leadership in Fast Reactor Technologies supported by Government

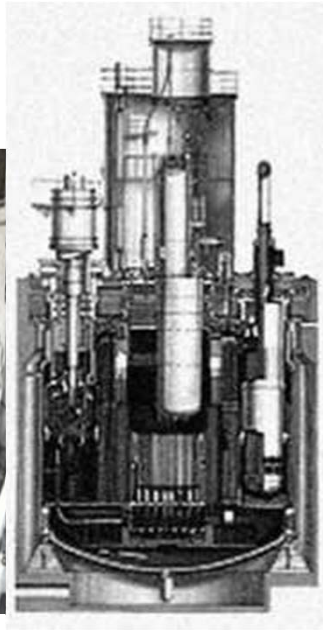
BN Reactor Technology development in Russia

BR-5/10
1958-2002

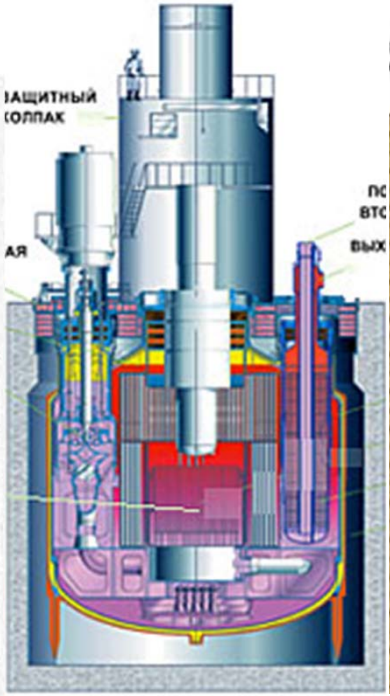
BOR-60
since 1969

BN-350
1972-1999

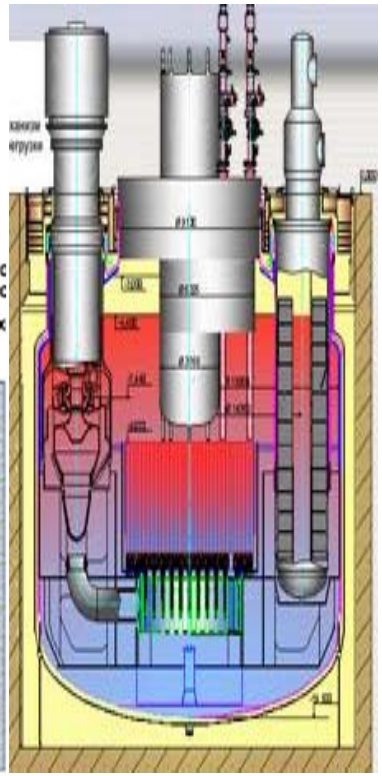
BN-600
since 1980



BN-800
2014



BN-1200
2021



New Nuclear Technology Platform

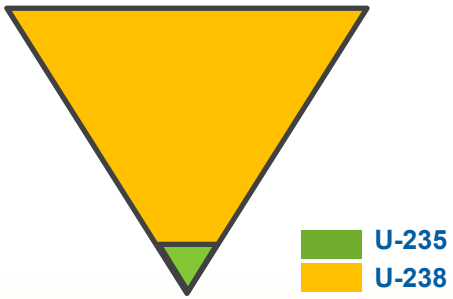
Background Factors

- Deployment of U-235 resources
- Accumulation of radwastes and SNF
- Need to eliminate accidents in deterministic terms

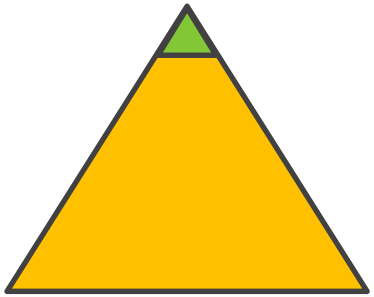
Basic Philosophy

- Inherent Safety (elimination of accidents resulting in population evacuation)
- Radiation Equivalent Management of Radwastes
- Non-proliferation (no separation of fissile material through technological cycle)
- Sustainable Resources (involvement of U-238 into fuel cycle and Pu recycling)
- Fast reactors' CAPEX reduction to at least light-water reactors CAPEX

Once Through Cycle



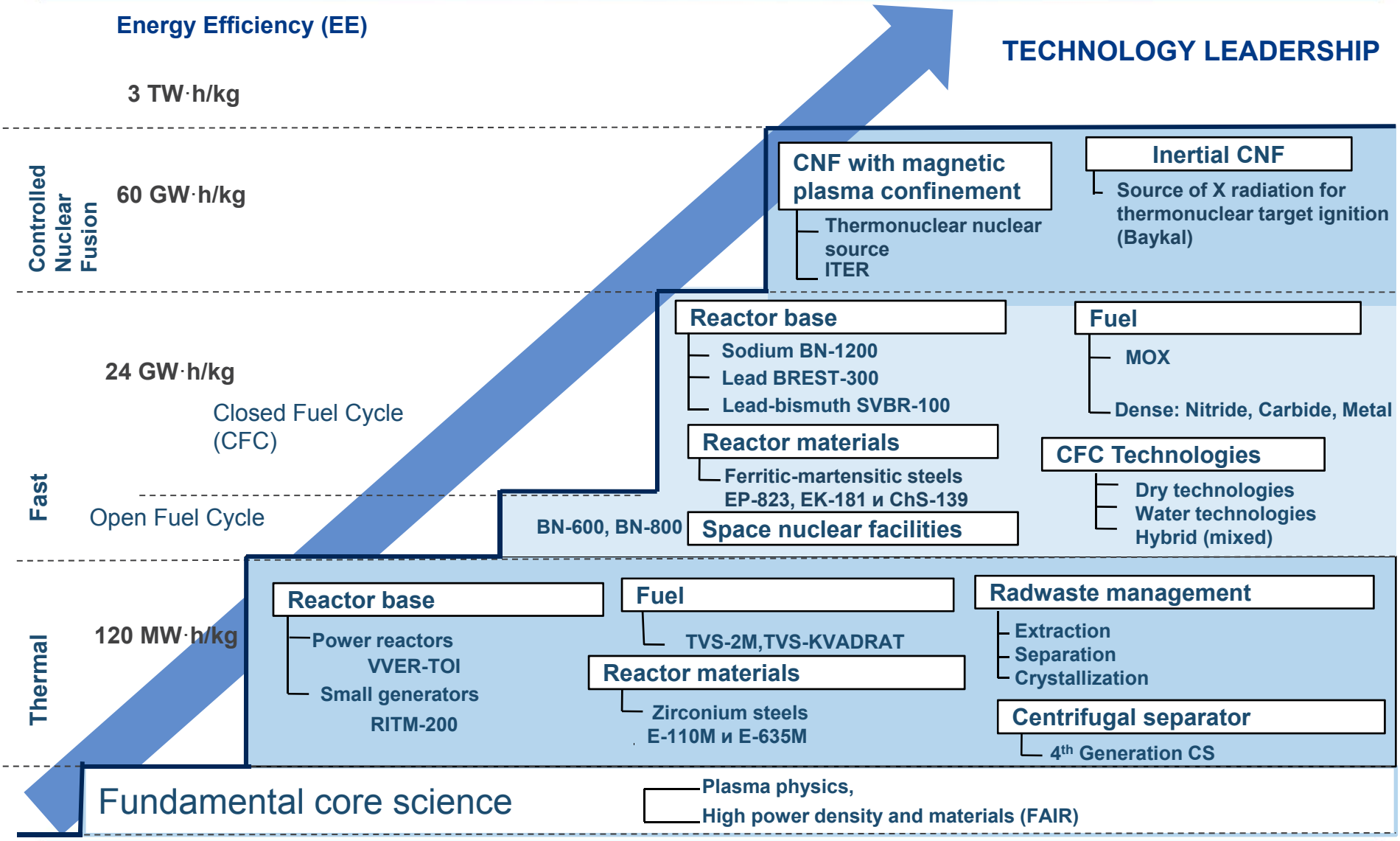
Closed Fuel Cycle



Innovative Solutions To Be Founded

Parameter	Current PWR	New Platform
Breeding ratio	≤ 0.60	up to 1.50
Radwaste, %	100	0.5
Reactivity margin, β	~ 3–5	≤ 1

Roadmap of Innovative Nuclear Technologies



How It Looks Like in Russia

Unique Russian fast reactor R&D and operation experience, nuclear fuel development and spent nuclear fuel management & recycling:

Reactor Technology		R&D	Industrial Scale
Reactor System	Sodium	+	+
	Lead-bismuth	+	+
	Lead	+	– / +
Nuclear Fuel	MOX pellet	+	+
	MOX vibro-packed	+	+
	High-density fuel	+	+ / –
	MA handling	+	– / +
Reprocessing	Aqueous processes	+	+
	Pyroprocessing	+	+ / –
	Gas-Fluoride	+	–
Final Disposal	Deep Geological Disposal	+	– / +

«Breakthrough» for Nuclear Technology

Project “Breakthrough”: conversion from demonstration of isolated innovation technologies to global impact integral solution – experimental demonstration complex operated in on-site closed nuclear fuel cycle

Key Deliverables of the “Breakthrough” Project

Reactor BREST-300

- 17 tons of year overall production
- Increased level of reactor operation safety

2019

On-site demonstration SNF complex

- 20% decrease of SNF handling & management costs

2020

Reprocessing Unit

- 5 tons / year SNF
- No staff irradiation due to automated processes

2020

Dense Fuel Fabrication Unit

- 17 tons of year overall production
- Increased level of reactor operation safety

2019

Basic Detailed Design Commercial FR-1200 & on-site CNFC complex

- Power 1200 MW (e)
- Solemn regarding all regulatory requirements

2020

No analogue for the complex technology in the world

«Breakthrough»: Research & Experimental Base

Innovative solutions:

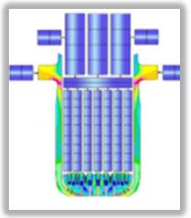
- Digital I&C for research reactors
- V&V facilities for virtual modeling
- Atomic spectrometry and introscopy

Hot cells with edge equipment

- Protective housing with a shield up to 10^{13} Bk
- Loadings up to10 kg U-235 and 2.5 kg Pu
- All technological operations with fresh and reprocessed powders and fuel fabrication

Upgrade completed in 2012

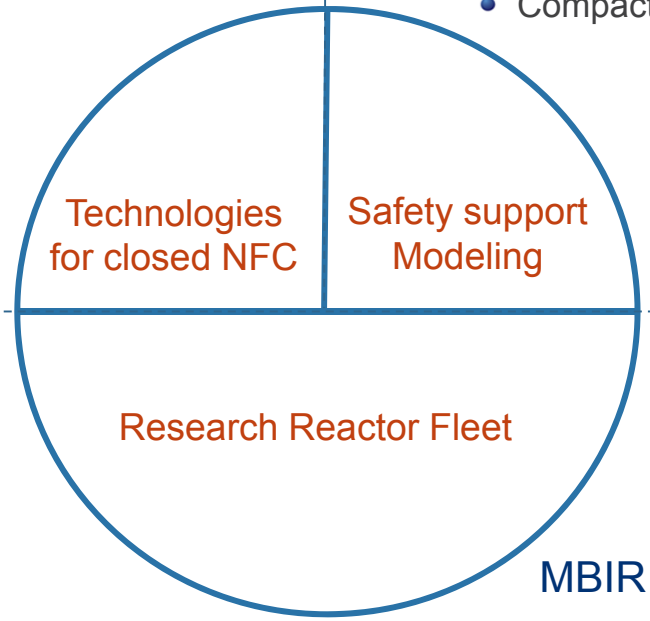
Supercomputers, virtual models for technological facilities



- Supercomputers 2.0 PFlops
- Compact supercomputers 5.0 TFlops

Completed in 2012

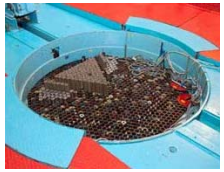
- Russian hardware and software
- Simulation modeling



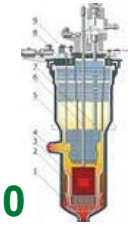
BFS – complex of fast criticality facilities

- The biggest critical facility in the world
- Both thermal and fast neutron spectrum
- Full-scale core modeling

Modernization in 2016



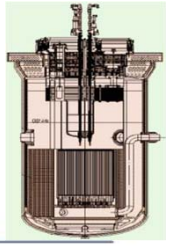
BOR-60



- Power – 150 MW(th)
- Flux – $3.7 \cdot 10^{15}$ /cm^2·s
- Heat density – 1.1 MW/l

Decommissioning in 2020

MBIR



- Power – 150 MW(th)
- Flux – $5{,}5 \cdot 10^{15}$ /cm^2 ·s
- Max burn-up rate – 6% h.a. per year

Commissioning in 2019

International Cooperation for Future of Fast Nuclear Energy

Conclusions

- «Breakthrough» is the top priority project for ROSATOM creating new nuclear inherently safe technologies for worldwide implementation
- Developed in accordance with philosophy principles of New Technology Platform
- Proved & commercialized technologies allow to:
  - Develop New Platform of nuclear power worldwide till the end of this century basing on currently available fissile resources
  - Reprocess of all accumulated SNF
  - Eliminate of weapon-grade reprocessing and enrichment technologies from nuclear fuel cycle
  - Bring back competitive capability to nuclear power