SWITZERLAND

2011

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1. GENERAL INFORMATION

1.1. Country overview

Switzerland is one of the most mountainous countries in Europe, with more than 70 per cent of its area covered by the Alps, in the central and southern sections, and the Jura in the north-west. Between the two mountain systems lies the Swiss plateau, which is about 400m above sea level and some 50km wide, it extends from Lake Geneva in the south-west to Lake Constance in the north-east. The principal river system is formed by the Rhine and its tributaries. Other significant rivers are the Rhône, the Ticino, and the Inn. The major bodies of water are Lake Maggiore and the lakes of Lugano, Neuchâtel, Lucerne, Zurich, Thun and Brienz. Switzerland's neighbouring countries are France, Germany, Austria, Liechtenstein and Italy.

Switzerland has 7,785,806 (2009 data) inhabitants, with an overall population density of about 195 people per km2. The population is unevenly distributed, with the principal concentrations occurring in the Swiss plateau. The major language communities are: German, French, Italian, and Romansh. Foreign nationals and their families make up roughly 21 per cent of the population.

1.1.1. Governmental System

Switzerland is a nation based on consensus, composed of several ethnic groups with a variety of languages and religions. With the adoption of a constitution in 1848, Switzerland became a federal state. This federal state is organised into three political levels: the communes (2596, 2009 data), the cantons (26) and the Confederation.

The Swiss parliament, or Federal Assembly, is made of up of two chambers: the National Council and the Council of States. Every four years, the people elect the 200 members of the National Council. All Swiss citizens over the age of 18 may take part in elections, both actively and passively. In other words, they may cast their votes and stand for election themselves. Federal civil servants are required to choose between their profession and elected office should they be elected.

The government is made up of seven members, elected by the United Federal Assembly. Swiss citizens have the right to propose new legislation pertaining to the constitution by launching a popular initiative. If they gather 100,000 signatures to support the proposal within 18 months, it must be put to a nation-wide vote. Federal legislation, decisions of parliament and certain international treaties are subject to an optional referendum. If any person or group manages to collect 50,000 signatures within 100 days of the official publication of the proposed legislation, voters are given the chance to decide. Referendums also contribute to political consensus because they prompt parliament to incorporate the views of as many interested parties as possible in the debate on new laws or legislative amendments. Thus, a compromise can be reached that is supported by a majority, and which is unlikely to fall victim to an optional referendum later on.

1.1.2. Geography and Climate

Switzerland covers an area of 41,300 km^2, comprising 31% forest and grove, 37% cropland and pastureland, 7% built-up and 25% un-productive land (situation in the mid-1990s). The size of the built-up area more than doubled between 1950 and 1990 and has continued to expand ever since, mainly at the expense of agricultural land. The location in the heart of Europe leads to substantial imports and exports of goods and services, and to transit freight flows through Switzerland. Swiss topography is defined by the Alps. According to the snow and avalanche research institute SLF around 50% of Switzerland’s surface area is higher than 1000 meters above sea level and around 25% higher than 2000 meters above sea level. Furthermore, around 4% of the country’s surface area is covered by water.

Climatic conditions, average temperature and precipitation patterns vary significantly across Switzerland, depending mainly on altitude and location. The Alps – running from south-west to east – act as a climatic divide. Measurements indicate a marked shift towards a warmer climate – particularly since the 1970s. Changes in precipitation are less clear, e.g. for annual mean precipitation no significant trends are found in the 20th century.

Annual temperature has increased by +1.6°C between 1864 and 2008 which corresponds to a linear temperature trend of about +0.11°C per decade. Temperature trends have accelerated substantially for more recent time periods. Over the last 100 years (1909-2008), annual temperature has increased by about 0.12-0.19°C per decade with no pronounced differences between geographical locations (north-south, low-high).

1.1.3. Population

According to an recent trends, the population is expected to grow to 8,162,000 by 2036. Afterwards the positive population development is likely to reverse and begin to decrease. Switzerland's population is expected to be 8,061,000 in 2050.

TABLE 1. POPULATION INFORMATION

							Average annual growth rate (%)
Year	1970	1980	1990	2000	2005	2009*	2000 to 2009*
Population (millions)	6.19	6.34	6.75	7.20	7.46	7.79	0.8
Population density (inhabitants/km²)	150	159	169	180	186	195	0.85
Urban Population** as % of total	N.A	74	74	73	73	73	0
Area (1000 km²)						41.284	

* Latest available data

** Population living in urban regions according to the definition of the Federal Statistical Office
Source: Federal Statistical Office, Portrait démographique de la Suisse, 2010

1.1.4. Economic Data

As a consequence of Switzerland's lively economic revival up to the middle of 2010 , the federal government's expert group on economic forecasts revised the federal government's growth forecast for 2010 to 2.7% (previously 1.8%). The prospects for 2011 are less positive than recently assumed, due to modest world economic prospects, as well as the appreciation of the Swiss franc producing significant drag and having a negative influence on Swiss export growth. Based on estimates from the expert group, the economic recovery in Switzerland will not completely cease in 2011, but with forecast GDP growth of 1.2% it will be significantly slower than in 2010.

TABLE 2. GROSS DOMESTIC PRODUCT (GDP)

							Average annual growth rate (%)
	1970	1980	1990	2000	2005	2009**	2000 to 2009**
GDP (current USD m)	N.A.	109852	238220	249912	372477	491923	5.4
GDP (constant USD m as of 2000)	N.A.	178231	221699	249912	258647	291312	1.5
GDP per capita (PPP* USD/capita)	N.A.	13748	24379	31094	35816	40483	2.5
GDP per capita (current USD/capita)	N.A.	17,383	35,490	34,786	50,084	63,535	5.0

* PPP: Purchasing Power Parity

** Latest available data

Sources

http://www.seco.admin.ch

www.imf.org, 2 December 2010

www.bns.ch, 15 February 2011

1.2. Energy Information

1.2.1. Estimated available energy

TABLE 3. ESTIMATED AVAILABLE ENERGY SOURCES (no available data)

	Estimated available energy sources					
	Fossil Fuels			Nuclear	Renewables	
	Solid	Liquid	Gas	Uranium	Hydro	Other Renewable
Total amount in specific units*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Total amount in Exajoule (EJ)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

* Solid, Liquid: Million tons; Gas: Billion m3; Uranium: Metric tons; Hydro, Renewable: TW

1.2.2. Energy Statistics

TABLE 4. ENERGY STATISTICS (in Exa-Joule)	1970	1980	1990	2000	2005	2009*	Average annual growth rate (%) 2000 to 2009*
Energy consumption**							
- Total	0.665	0.848	1.009	1.104	1.138	1.154	0.49
- Solids***	0.027	0.014	0.015	0.006	0.006	0.006	0.81
- Liquids	0.515	0.521	0.523	0.532	0.542	0.521	-0.25
- Gases	0.002	0.036	0.068	0.102	0.117	0.113	1.14
- Nuclear	0.020	0.149	0.243	0.272	0.240	0.285	0.51
- Hydro	0.113	0.121	0.110	0.136	0.118	0.134	-0.21
- Other Renewables and Waste	0.010	0.036	0.057	0.081	0.091	0.103	2.69
- Net electricity import	-0.022	-0.029	-0.008	-0.025	0.023	-0.008	-12.36
Energy production							
- Total	0.129	0.206	0.248	0.308	0.290	0.332	0.81
- Solids***							
- Liquids							
- Gases			0.000				
- Nuclear	0.007	0.049	0.081	0.091	0.080	0.095	0.53
- Hydro	0.113	0.121	0.110	0.136	0.118	0.134	-0.21
- Other Renewables and Waste	0.010	0.036	0.056	0.081	0.091	0.102	2.63
Net import (Import - Export)							
- Total	0.571	0.708	0.848	0.845	0.914	0.935	1.13

* Latest available data
** Energy consumption = Primary energy consumption + Net import (Import - Export) of secondary energy.
*** Solid fuels include coal, lignite
Source: Swiss Energy Statistics 2009, SFOE

1.2.3. Energy policy

In February 2007, the Federal Council (the executive) decided to focus its energy policy on four main areas:

- Promotion of energy efficiency
- Promotion of renewable energy sources
- Construction of new large power plants (Nuclear power plants, Gas-fired power plants)
- International energy policy[1]

On 23 March 2011, the Federal Council decided to update Switzerland's energy policy. This update should provide answers to national and international questions related to future electricity supply. The Federal Council commissioned the Federal Department of the Environment, Transport, Energy and Communications DETEC to draw up new energy perspectives. These have to take into account three electricity supply scenarios:

- Electricity supply option 1: Continuation of current electricity mix and optional early replacement of the three oldest NPPs in order to ensure the highest possible level of safety.
- Electricity supply option 2: No replacement of existing NPPs after their closure at the end of their operational lifespan.
- Electricity supply option 3: Early nuclear phase-out, existing NPPs are shut down before the end of their safety-related operational lifespan.

1.3. The electricity system

1.3.1. Electricity policy and decision making process

The Electricity Supply Act (effective since 1 January 2008) creates the framework for a phased liberalisation of the Swiss electricity market. The market was partially opened for eligible customers[2] in 2008. Full liberalisation is foreseen for 2014, subject to an optional referendum.

[1] Negotiations with the European Union on an electricity agreement began in 2007 in order to enhance the integration of the Swiss and EU electricity markets. Further negotiations will need to take into account the 3rd liberalization package and the Renewables Directive of the EU.

[2] Corporations with an annual electricity consumption of more than 100,000 kWh

In order to increase the share of electricity produced from renewable energy sources, an amendment was made to the Electricity Supply Act introducing compensatory feed-in remuneration to cover the cost of electricity from renewable energy sources[3].

1.3.2. Structure of electric power sector

Roughly 40% of Swiss electricity generation comes from nuclear power, with the remaining share mostly derived from large hydropower plants. Switzerland‘s electricity market is highly fragmented. The supply of electricity is assured by some 900 companies, including 7 generation and transmission companies and approximately 80 producers. Many tasks are undertaken by the communes, which also supply water and gas. In some cantons and cities, a single vertically-integrated company is responsible for the entire supply chain, while in other cantons these are provided by a variety of companies. The public sector stake in the capital stock of electricity supply companies is currently around 80%, while the remaining 20% is held by private-sector companies (at home and abroad).

Switzerland regulated grid usage in the Electricity Supply Act (StromVG) of 2007. The Act stipulates that the high-voltage transmission grid should be operated by the national grid company, Swissgrid, which guarantees non-discriminatory access to the grid for all companies.

The Act also stipulates the unbundling of previously vertically integrated companies[4].

ElCom, the new regulator, is authorised to audit grid usage charges and electricity tariffs and to order reductions in unjustified profits by way of compensation. Since 2009 it has also arbitrated on disputes related to compensatory feed-in remuneration.

1.3.3. Main indicators

In 2009, hydropower’s share of total electricity production was 56%, nuclear power contributed 39%. The remainder of 5% is covered by fossil and renewable sources.

TABLE 5. ELECTRICITY PRODUCTION, CONSUMPTION AND CAPACITY

	1970	1980	1990	2000	2005	2009*	Average annual growth rate (%) 2000 to 2009*
Capacity of electrical plants (GWe)							
- Combustible Fuels	0.570	0.600	0.487	0.795	0.855	0.881	1.15

[3] The share of electricity produced from renewable energy sources (except large hydropower plants) should reach 5.4TWh or about 10% of the country's present-day electricity consumption by 2030.

[4] In the previously monopolised market, companies tended to be vertically integrated, i.e. they performed all tasks along the complete value chain (generation, transmission, distribution, selling and trading).

- Hydro	9.620	11.450	13.125	14.895	15.010	15.336	0.32
- Nuclear	0.350	1.940	2.950	3.200	3.220	3.238	0.13
- Wind			0.000	0.003	0.012	0.018	22.03
- Geothermal							
- Solar			0.002	0.015	0.026	0.071	18.86
- Total	10.540	13.990	16.564	18.908	19.123	19.544	0.37
Electricity production (TW.h)							
- Thermal	1.763	0.957	1.014	2.371	2.933	2.819	1.94
- Hydro	31.273	33.542	30.675	37.851	32.759	37.136	-0.21
- Nuclear	1.850	13.663	22.298	24.949	22.020	26.119	0.51
- Wind				0.003	0.008	0.023	25.4
- Geothermal							
- other renewable			0.087	0.174	0.198	0.397	9.6
- Total (1)	34.886	48.162	54.074	65.348	57.918	66.494	0.19
Total Electricity consumption (TW.h)	25.087	35.252	46.578	52.373	57.330	57.494	1.04

(1) Electricity transmission losses are not deducted.

* Latest available data

Source: Swiss Energy Statistics 2009, SFOE

TABLE 6. ENERGY RELATED RATIOS

	1970	1980	1990	2000	2005	2009*
Energy consumption per capita (GJ/capita)	107.5	133.8	149.5	153.1	152.1	148.0
Electricity consumption per capita (kW.h/capita)	4052.8	5560.3	6900.4	7272.0	7685.0	7380.4
Electricity production/Energy production (%)	97.4	84.2	78.5	76.4	71.9	72.1
Nuclear/Total electricity (%)	5.3	28.4	41.2	38.2	38.0	39.3
Ratio of external dependency (%) (1)	85.9	83.5	84.0	76.5	80.3	81.0

(1) Net import / Total energy consumption.

* Latest available data

2. NUCLEAR POWER SITUATION

2.1. Historical development and current organisational structure

2.1.1. Overview

Development of a nuclear programme

In November 1945, the Swiss government established the independent Atomic Energy Committee with the mandate to advise the government in all civilian and military matters dealing with nuclear energy. In 1946, the Swiss government mandated the Atomic Energy Committee to investigate all aspects dealing with nuclear weapons, i.e. to prepare the necessary measures for protecting army and population against their impact and also to study what would be required to develop such weapons. On 18 March 1957, parliament ratified the IAEA Statute which entered into force on 29 July 1957. In 1969, Switzerland signed the Non-Proliferation Treaty which was ratified by parliament on 9 March 1977.

As early as 1946, Brown Boveri & Cie (BBC), now ABB Group, took the first steps to build up a team of physicists and to launch a development programme. BBC was later joined by Sulzer Brothers and Escher-Wyss. Initial studies dealt with graphite-carbon dioxide reactor concepts, but from 1952 on, the development concentrated on heavy water moderated reactors with the subsequent planning of the research reactor DIORIT. In 1955, more than 150 private companies joined forces and formed the company "Reactor Ltd" to build and operate the new privately-owned research centre in Würenlingen, with two reactors on the site: SAPHIR and DIORIT. In 1960, the federal government took over the research centre, known under its abbreviation EIR (Eidgenössisches Institut für Reaktorforschung). In 1988, the merger of EIR and SIN (Schweizerisches Institut für Nuklearphysik) led to the creation of the Paul Scherrer Institute (PSI).

In Switzerland, the nuclear age began on 30 April 1957, when the SAPHIR research reactor went critical under the responsibility of Swiss scientists and engineers. This pool reactor had been purchased in 1955 from the US Government, after being exhibited in Geneva during the First International Conference on the Peaceful Uses of Atomic Energy. SAPHIR was shut down permanently at the end of 1993. Decommissioning work, based on a licence granted in 2000, was still under way in 2009.

DIORIT, the first reactor designed and constructed in Switzerland, reached criticality on 15 August 1960. It was moderated and cooled by heavy water; the fuel was initially natural uranium; a special loop allowed for the testing of power reactor fuel elements. DIORIT was shut down permanently in 1977. At the end of 2003 all radioactive material was removed from the reactor building.

In 1962 saw the construction of the experimental nuclear power reactor in Lucens, a 30 MW(th), 6 MW(e), heavy-water moderated, carbon dioxide cooled reactor located in an underground cavern. Criticality was reached in late 1966 and commissioning in early 1968. In spite of numerous difficulties, the supply consortium led by Sulzer Brothers had demonstrated that Swiss industry was capable of building nuclear plants. The goal was the development of a small to medium-sized power reactor fuelled with natural uranium within a massive containment system. As enriched uranium became readily available during the mid-1960s, the unit size of commercially offered LWR nuclear power plants (NPPs) increased drastically and Swiss utilities started construction of such plants very early on, the interest in the Lucens reactor type decreased and further large expenses for such a development could not be justified. The decision was taken to operate the reactor until the end of 1969; unfortunately, on 21 January 1969, the plant was abruptly put out of service by a partial core meltdown that destroyed the integrity of the primary system and released radioactivity into the cavern. After decontamination, decommissioning and termination of intermediate storage of radioactive material the whole site was prepared for unrestricted reuse in 2003.

Nuclear power plant projects

In August 1965, a turnkey contract was awarded by Nordostschweizerische Kraftwerke AG (NOK) to a consortium made up of Westinghouse International Atomic Power Co, Ltd. and Brown Bovery & Cie for the supply of a 350 MW(e) plant equipped with a pressurised water reactor and two turbo-generators (Beznau). In late 1967, NOK took the option to order a duplicate of the first unit. Beznau I reached criticality by the end of June 1969, and Beznau II in October 1972.

Also in 1965, Bernische Kraftwerke AG (BKW) chose a 306 MW(e) plant equipped with a boiling water reactor manufactured by General Electric (GE) and twin turbo-generators from BBC (Mühleberg). In July 1971, full power was achieved, but on 28 July a turbine fire broke out. Sixteen months later the plant was officially handed to the owner.

In 1973, a supply contract was signed by a consortium of Swiss utilities with Kraftwerk Union (Siemens) for the delivery of a 900 MW(e) pressurized water reactor and turbo-generator (Gösgen). Construction of the plant went very smoothly until the first connection to the grid in February and 80% power test in March 1979. However, the accident at Three Mile Island on 29 March 1979 led to an 8 month delay in commissioning.

In December 1973, a consortium of Swiss utilities and one German utility awarded a turnkey contract to General Electric Technical Services Overseas (GETSCO) and BBC for the supply of a 940 MW(e) nuclear power plant equipped with a boiling water reactor (Leibstadt). Construction began in 1974 and the plant was commissioned in December 1984.

Political controversy and legal framework

The nuclear controversy began in Switzerland in 1969 with the first signs of local opposition to a nuclear plant project at Kaiseraugst, near Basel. For 20 years, the Kaiseraugst project was to remain centre stage in the nuclear controversy: Site permit, local referenda, legal battles, site occupation by opponents in 1975, parliamentary vote in favour of construction in 1985, and finally parliamentary decision in 1989 to end the project definitively. The Chernobyl accident of spring 1986 had a dramatic impact on the political climate. Although some of the necessary permits had already been issued for two planned NPPs at Kaiseraugst and Graben, their construction was subsequently abandoned, as well as other projects in Verbois, Inwil and Rüthi.

The nuclear controversy led to several anti-nuclear initiatives at federal level:

i. an attempt to forbid all nuclear plants, both new and those already in operation - rejected by 51.2% of the vote in February 1979;

ii. aimed at forbidding future nuclear plants, leaving untouched the plants in operation, two initiatives differing only in the treatment to be applied to Leibstadt, then under construction - rejected by 55% of the vote in September 1984;

iii. nuclear phase-out - rejected by 52.9% of the vote in September 1990;

iv. 10-year moratorium - accepted by 54.6% of the vote in September 1990;

v. In 1999, two new initiatives were organised aiming at the ban of the construction of new NPPs until 2010 and the closure of all NPPs after a 30 year lifespan. Both initiatives were rejected in May 2003 by 58.4% and 66.3% respectively.

A new Nuclear Energy Act came into force on 1 February 2005. It allowed the possibility of building new reactors, with the possibility of a referendum against their construction; no time limit is imposed on the life of existing nuclear power plant; the general license is maintained. It introduces a 10-year-moratorium on the export of nuclear fuel for reprocessing from 2006 to 2016. It also includes provisions for decommissioning, a concept of monitored long-term geological disposal of radioactive waste that combines elements of final disposal and reversibility, and a system for funding the costs of decommissioning and of radioactive waste management. It simplifies licensing procedures and introduces the general right of appeal. A new Nuclear Energy Ordinance came into force together with the Act.

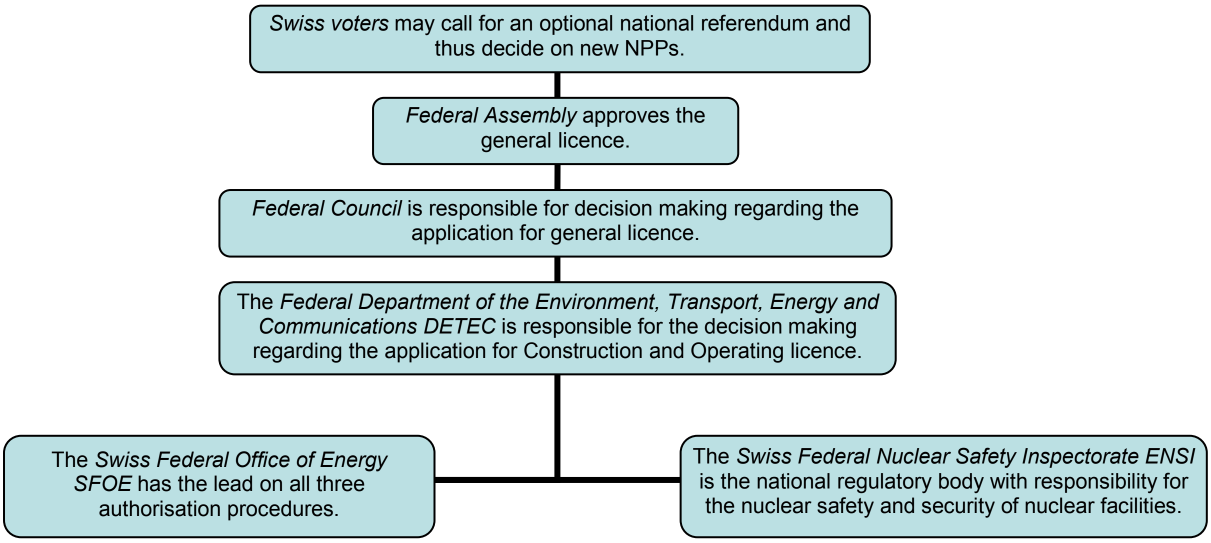
During the 10-year moratorium regarding reprocessing, which began in July 2006, spent fuel is stored in Switzerland, with a view to later reprocessing or direct disposal. Plutonium and uranium gained from reprocessing of spent fuel that was sent abroad before July 2006 is recycled in Swiss NPPs. The radioactive waste arising from reprocessing of spent fuel is returned to Switzerland.

<u>Radioactive waste management</u>

The safe disposal of radioactive waste is the responsibility of those parties who produce it, namely the following nuclear power plant operators: BKW FMB Energie AG (Mühleberg), KKW Gösgen-Däniken AG, KKW Leibstadt AG, Nordostschweizerische Kraftwerke Baden – now Axpo (Beznau I and II), Energie Ouest Suisse – now Alpiq. In 1972 the above operators established the National Co-operative for the Disposal of Radioactive Waste (Nagra) together with the federal government (which is responsible for the disposal of radioactive waste from the healthcare sector, industry and research and is represented by the Federal Department of Home Affairs).

So far there are no deep geological repositories in Switzerland. For both Low/Intermediate Level Waste (L/ILW) and High Level Waste (HLW) repositories, a site selection process according to the Sectoral Plan procedure for deep geological repositories was started with the promulgation of the Sectoral Plan on 2 April 2008 by the Federal Council. In October 2008 Nagra submitted a list of potential geological siting areas to the authorities. The Swiss Federal Nuclear Safety Inspectorate (ENSI) reviewed these sites proposals and presented the results on 26 February 2010. ENSI approved the six geological siting areas proposed for L/ILW and the three geological siting areas proposed for HLW. At the end of the first stage of the procedure and of a three-month formal hearing, the Federal Council will decide on the further developments in the site selection.

2.1.2. Current organisational chart(s)



2.2. Nuclear power plants: Overview

2.2.1. Status and performance of nuclear power plants

Five NPPs are currently in operation in Switzerland. There are three research reactors and two central disposal facilities for radioactive waste. Disposal facilities for radioactive waste are situated in the surroundings of the NPPs too.

TABLE 7. STATUS AND PERFORMANCE OF NUCLEAR POWER PLANTS

Station	Type	Net Capacity	Operator	Status	Reactor Supplier	Construction Date+	Grid Date ++	Commercial Date	Shutdown Date	UCF for 2009 **
Beznau I	PWR	365	Axpo AG	in operation	WH[5]	1965-09-01	1969-07-17	1969-09-01	-	96.0
Beznau II	PWR	365	Axpo AG	in operation	WH	1968-01-01	1971-10-23	1971-12-01	-	86.4
Mühleberg	BWR	373	BKW FMB Energie AG	in operation	GETSCO[6]	1967-03-01	1971-07-01	1972-11-06	-	90.6
Gösgen	PWR	970	Kernkraftwerk Gösgen-Däniken AG	in operation	KWU[7]	1973-12-01	1979-02-02	1979-11-01	-	95.3
Leibstadt	BWR	1165	Kernkraftwerk Leibstadt AG	in operation	GETSCO	1974-01-01	1984-05-24	1984-12-15	-	92.2

* UCF (Unit Capability Factor) for the latest available year (only applicable to reactors in operation).

** Latest available data

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

++ Date of the first connection to the grid

Source: PRIS database (www.iaea.org/pris).

Beznau I + II : http://www.axpo.ch

Mühleberg : http://www.bkw-fmb.ch

Gösgen : http://www.kkg.ch

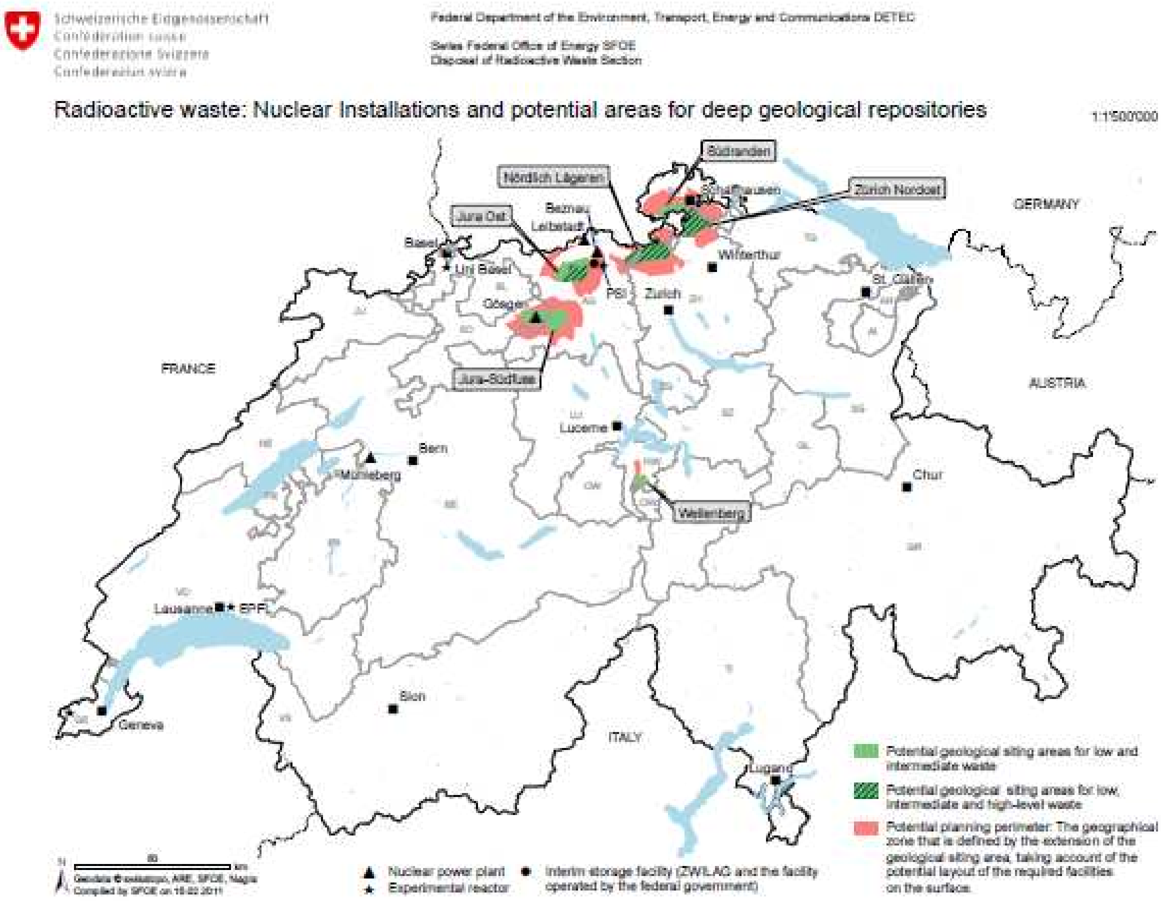
Leibstadt : http://www.kkl.ch

5 WH: Westinghouse Electric Corporation

6 GETSCO: General Electric Technical Services Corporation

7 KWU: Siemens Kraftwerk Union AG

Figure 1



2.2.2. Plant upgrading, plant life management and license renewals

In the course of time all Swiss NPPs have upgraded their power capacity. At the end of 2009, the nominal net powers were twice 365 MWe for Beznau-, 373 MWe for Mühleberg-, 970 MWe for Gösgen- and 1165 MWe for Leibstadt-NPP.

The power plants of Beznau (Unit 1 & 2), Gösgen and Leibstadt have unlimited operating licences. In December 2009 the Federal Department of the Environment, Transport, Energy and Communications DETEC granted an unlimited operating licence for the operator of Mühleberg. This decision has been appealed before the Federal Administrative Court and can in a later stage additionally be appealed before the Federal Supreme Court.

2.3. Future development of Nuclear Power

2.3.1. Nuclear power development strategy

The Swiss government announced a new energy policy in 2007 which includes renewable energies, energy efficiency, energy foreign policy and new large-scale power stations including the replacement of the existing five NPPs. In 2008, the three big electricity companies Alpiq, Axpo and BKW submitted general licence

applications for three new nuclear units at Goesgen, Beznau and Muehleberg, all three on existing nuclear sites.
On 14 March 2011, the head of the Federal Department of the Environment, Transport, Energy and Communications DETEC suspended the licensing procedure for new NPPs. The Swiss Federal Nuclear Safety Inspectorate ENSI has been charged with planning a safety review of the existing NPPs. ENSI will analyse the causes of the accident at the Fukushima NPP in order to release guidelines regarding protection against seismic activity and cooling.

TABLE 8. PLANNED NUCLEAR POWER PLANTS

Station/Project Name	Type	Capacity	Expected Construction Start Year	Expected Commercial Year
Ersatz Kernkraftwerk Beznau AG*	n.a.	max. 1600	ca. 2017	2025-2027
Ersatz Kernkraftwerk Mühleberg AG*	n.a.	max. 1600	ca. 2017	2025-2027
Niederamt AG*	n.a.	max. 1600	ca. 2017	2025-2027

* NPPs are not planned by the government. These are the applications that have been submitted by the operators in 2008.

In Switzerland, nuclear energy is used solely for peaceful purposes, e.g. for producing electricity and for application in medicine, industry and research. The 10-year average annual proportion of nuclear energy used for producing electricity is 39% (up to 45% in winter), which is above the European average of 33%. Switzerland's five NPPs have a total capacity of 3.2 GW, and an annual availability rate of approximately 90%.

The owners and operators of NPPs are responsible for fuel cycle planning and decision-making. They make contracts in accordance with national legislation and international agreements. The strategy chosen by the NPP operators includes both the reprocessing and storage of spent fuel, the latter with a view to later reprocessing or direct disposal. The reprocessing takes place abroad (France and UK). Plutonium and uranium gained from reprocessing is used for fuel fabrication and is reused in Swiss NPPs. The radioactive waste arising from reprocessing is returned to Switzerland. A dry storage facility at Beznau NPP (ZWIBEZ) and a Central Storage Facility (ZZL, operated by ZWILAG) have been built for the interim storage of spent fuel and radioactive waste returned from reprocessing abroad. In addition, a facility for the wet storage of spent fuel at Gösgen NPP was commissioned in 2008.

In accordance with the polluter-pays principle, producers of radioactive waste in Switzerland are responsible for ensuring its safe disposal at their own cost. The various ongoing costs (e.g. for reprocessing, studies carried out by Nagra, construction of interim storage sites) have to be paid as they arise. Decommissioning costs and expenditure associated with the management (including disposal) of radioactive waste after a nuclear power plant has been closed down, are secured through contributions paid into two independent funds by the operator:

- Decommissioning fund for nuclear facilities
- Disposal fund for nuclear power plants

The Nuclear Energy Act and the Ordinance on the Decommissioning Fund and the Waste Management Fund (7 December 2007) form the legal basis for these two funds.

2.3.2. Project management

Applications were submitted in order to start the licensing procedure. The organisations involved in new NPPs are *AXPO (Ersatz Kernkraftwerk Beznau AG)*, *BKW (Ersatz Kernkraftwerk Mühleberg AG)* and *Alpiq (Kernkraftwerk Niederamt AG)*.

The *Federal Council* is responsible for decision making regarding the application for general licence. The decision of the Federal Council will be brought before parliament. It is then subject to an optional referendum. The Swiss government consists of the seven members of the Federal Council who are elected by the United Federal Assembly for a four-year term.

The *Federal Department of the Environment, Transport, Energy and Communications DETEC* is responsible for the decision making regarding the application for Construction and Operating licence. Its decisions can be appealed to the Federal Administrative Court, and at a later stage to the Federal Supreme Court. More than 1900 people work within DETEC (including its agencies like SFOE).

The *Swiss Federal Office of Energy SFOE* has the lead on all three authorisation procedures. The SFOE employs more than 200 staff. As of the beginning of 2010, the SFOE comprises four divisions and two operational sections.

The *Swiss Federal Nuclear Safety Inspectorate ENSI* is the national regulatory body with responsibility for the nuclear safety and security of Swiss nuclear facilities. In the licensing procedures it is also responsible for safety-related examination and assessment of the facilities. ENSI's annual budget is in the order of CHF 40 million (i.e. about EUR 26 million). Most of ENSI's expenses are covered by fees which licence holders have to pay to the federal government. ENSI currently employs 115 staff: physicists, mechanical, electrical and civil engineers, geologists, chemists, biologists and psychologists, in addition to technical and administrative personnel.

Other public entities involved in the above mentioned authorisation procedures are the *Swiss Federal Nuclear Safety Commission NSC*, the *Federal Office for the Environment FOEN*, the *Federal Office for Spatial Development ARE* and the *cantons*.

2.3.3. Project funding

No government financial support is granted for the construction of new NPPs. Some public entities, such as the cantons nevertheless have considerable shares of some of the relevant companies.

2.3.4. Electric grid development

Grid expansion may be necessary depending on the actual projects for new NPPs and the location. No further details can be given at the moment.

2.3.5. Site Selection

On 9 June 2008, Kernkraftwerk Niederamt AG, a subsidiary of Atel Holding AG (now known as Alpiq Holding AG), submitted an application to the Swiss Federal Office of Energy (SFOE) for a general licence for a nuclear power plant with a maximum output of 1,600 MW. The plan is for the new facility to be constructed in Niederamt (canton of Solothurn) near the existing Gösgen NPP.

On 4 December 2008, on behalf of Axpo Holding AG and BKW FMB Energie AG respectively, Ersatz Kernkraftwerk Beznau AG and Ersatz Kernkraftwerk Mühleberg AG each submitted an application to the SFOE for a general licence for the construction of new NPPs to replace the existing Beznau I, Beznau II and Mühleberg facilities. The plan is for these new NPPs, each with a maximum output of 1,600 MW, to be constructed at the locations of the existing facilities, namely in Beznau (canton of Aargau) and Mühleberg (canton of Bern).

All three applications have been examined in detail by the Swiss Federal Nuclear Safety Inspectorate ENSI. It attested on 15 November 2010 that the data provided by the applicants are scientifically correct. The reviewed applications satisfy the legal requirements. The Nuclear Safety Commission NSC released its opinion on 10 January 2011. It states that ENSI delivered an in-depth safety review. The NSC has also made a number of recommendations.

On 14 March 2011, the head of the Federal Department of the Environment, Transport, Energy and Communications DETEC suspended the licensing procedure for new NPPs. ENSI has been charged with planning a safety review of the existing NPPs. ENSI will analyse the causes of the accident at the Fukushima NPP in order to release guidelines regarding protection against seismic activity and cooling.

2.4. Organisations involved in construction of NPPs

Not available.

2.5. Organisations involved in operation of NPPs

The following organisations operate a nuclear power plant:

- KKG AG
- KKL AG
- Axpo AG
- BKW FMB Energie AG

Major Switzerland based vendors / supporting organisations are:

- ABB AG
- Alstom AG
- AF-Colenco AG

- CCI Schweiz AG

More information can be found at www.nuclearindustry.ch

2.6. Organisations involved in decommissioning of NPPs

No commercial NPP is under decommissioning.

2.7. Fuel cycle including waste management

Fuel supply

Natural uranium is currently procured from two sources: long-term contracts and spot market contracts.

Enrichment is provided by the USA, Russia and countries of the European Union. The fuel elements are manufactured in the USA, countries of the European Union and Russia.

Legal framework

Under Swiss legislation, the utilities are free to choose between reprocessing and direct disposal of the spent fuel. The Nuclear Energy Act sets out a series of conditions which must be fulfilled for an authorisation for the export of spent fuel for reprocessing to be granted. The conditions include an international agreement with the country of destination, the existence in that country of an adequate facility corresponding to international standards and the ratification by that country of the Convention on Nuclear Safety and the Joint Convention. Furthermore, the shipment of spent fuel for reprocessing abroad is not allowed for a period of 10 years which started in July 2006.

The management (handling and storage) of radioactive waste is governed by the provisions of the Nuclear Energy Act and the Nuclear Energy Ordinance, both of which entered into force on 1 February 2005. The management of radioactive waste originating from medicine, industry and research is governed by the Radiological Protection Act and the Radiological Protection Ordinance both of which entered into force on 1 October 2004.

All radioactive waste is to undergo storage in repositories situated in suitable geological formations; near-surface disposal is not allowed. Since no repository is yet available, all radioactive waste is stored in interim storage facilities.

Storage facilities

At present, the following spent fuel and radioactive waste management facilities exist in Switzerland:

- NPPs:

  All Swiss NPPs have on-site installations for the conditioning and storage of their own operational waste.
- Central Storage Facility:

This facility operated by the company ZWILAG in Würenlingen is comprised of an interim storage facility for spent fuel and all kinds of radioactive waste, conditioning installations and a plasma furnace for melting and incineration of low level waste.

- Separate storage facility ZWIBEZ at Beznau nuclear power plant:

  It consists of a hall for low level operational waste and a hall for the dry storage of spent fuel.

- Wet storage facility at Gösgen nuclear power plant:

  An additional spent fuel pond on the site of the Gösgen nuclear power plant. It is intended for independent operation over several years after the future shutdown of the Gösgen nuclear power plant.

- National Collection Centre and Federal Storage Facility:

  These installations for radioactive waste from medicine, industry and research are operated by the Paul Scherrer Institute (PSI) in Würenlingen.

<u>Deep geological repositories and site selection process</u>

The responsibility for radioactive waste management lies with the waste producers. Legislation requires in principle that radioactive waste produced in Switzerland be disposed of in Switzerland. The option for the disposal of radioactive waste within the framework of a bilateral or multilateral project is kept as an option, but is not actively pursued.

Two repositories are proposed, one for short-lived low and intermediate level waste (“L/ILW”) and one for high level waste and spent fuel as well as long-lived intermediate level waste (“HLW”) mainly from reprocessing. The site selection process has to follow a sectoral plan procedure within the framework of spatial planning legislation. The site selection process according to the Sectoral Plan procedure for deep geological repositories was started with the promulgation of the Sectoral Plan on 2 April 2008 by the Federal Council.

The SFOE is in charge of this procedure, which will lead to the designation of sites for each waste category in around ten years. The procedure allows the coordination of a broad range of actors and is divided into three stages. With regard to the first stage of the site selection process, Nagra submitted its proposals for suitable geological siting areas for the repositories for HLW and L/ILW to the SFOE on 17 October 2008. ENSI has reviewed Nagra’s entire documentation and concluded on 26 February 2010 that the procedure followed by Nagra in preparing the proposals for the geological siting areas was transparent and reproducible.

In conclusion, ENSI approved the six geological siting areas proposed for L/ILW: Jura Ost (canton Aargau), Jura-Südfuss (canton Solothurn and canton Aargau), North of Lägeren (canton Zurich and canton Aargau), Südranden (canton Schaffhausen), Zürich Nordost (canton Zurich and canton Thurgau) and Wellenberg (canton Nidwalden and canton Obwalden). All these sites have clay-rich sediments as potential host rocks. These include the Opalinus clay, the Brauner Dogger, the Effingen Beds, and the marl formations of the Helveticum.

ENSI also approved the three geological siting areas proposed for HLW: Jura Ost, North of Lägeren and Zürich Nordost. All the potential HLW sites have Opalinus clay as host rock. ENSI's review has been commented by the Nuclear Safety Commission (KNS).

After a broad consultation, which was carried out between 1st September and 30th November 2010, the federal government is expected to decide on these potential siting areas in 2011. Once a decision has been reached, the first stage of the site selection process will have been concluded.

In stage 2, the proposed siting regions have an opportunity to co-determine the content of storage site projects and participate in studies on the socioeconomic effects and spatial planning impacts. The various sites also have to be compared from the point of view of safety before Nagra can propose at least two sites per waste category.

In stage 3, the remaining sites are studied in greater detail from the point of view of site selection and submission of a licence application, and the site-specific geological information is intensified, if necessary by carrying out further geological studies. With input from the siting region, the various storage site projects are defined in greater detail at this stage, and socioeconomic studies are intensified. The waste producers finally submit applications for a general licence (one each for HLW and L / ILW or one for a combined repository).

Parliament's decision concerning the government's approval of the general licence for deep geological repositories is expected around 2019/2020. That decision is subject to an optional national referendum.

A deep geological repository for L/ILW is expected in 2030 and a deep geological repository for HLW in 2040.

2.8. Research and development

2.8.1. R&D organisations

The Paul Scherrer Institute, PSI, is the largest research centre for natural and engineering sciences within Switzerland. Approximately 400 scientists at the Institute perform high-level research in a large variety of scientific questions that can be grouped into three main fields: Structure of Matter, Human Health, and Energy and Environment. Most of these scientists use the Institute's unique large-scale research facilities. By conducting fundamental and applied research, PSI works on long-term solutions for major challenges facing society, industry and science. The scientific results gained at PSI help us to understand the world around us by shedding light on the processes behind various physical and biological phenomena. At the same time, they constitute the basis for novel developments in technology and medicine.

PSI operates several large-scale facilities that allow experiments to be performed that would be impossible in smaller laboratories. In many cases these experiments provide decisive clues for solving a particular scientific problem. The facilities are unique in Switzerland, and some of them are the only ones of their type or scale in the world. In order to allow as many scientists as possible to benefit from the opportunities offered by PSI, the Institute provides access to the facilities within the framework of a User Service to researchers from universities, other research centres and industrial companies. Each year, about 2,300 researchers in these categories perform experiments at the facilities.

Structure of Matter:

Most researchers working in the Structure of Matter field are investigating the properties of various materials by determining how the atoms they are composed of are arranged and how they move. PSI's particle physicists go one step further and investigate the properties of the smallest building blocks of matter – the elementary particles.

Energy and Environment:

The goal of PSI's energy research is the development of technologies for a sustainable use of energy. This includes environmentally friendly energy production, the application of renewable energy sources, and low-loss energy storage. In addition, technologies are investigated which will contribute to the safe use of nuclear energy. Environmental research is concentrated on the study of processes taking place in the atmosphere.

Nuclear Energy Research

About 10% of the PSI's annual government funding of CHF 240 million in 2009 was earmarked for nuclear energy research. The PSI's government-funded nuclear energy research activities have been reduced by more than half over the past two decades. To a large extent this reduction was compensated by external funding. With the current staffing quota per year of about 185 person-years (plus about 30 PhD students), and about CHF 7m to 8m for operations and maintenance and investment costs, a balance has been reached. More than 50 per cent of the overall direct costs of nuclear energy research are externally funded by the Swiss Nuclear Power Plant Operators, the National Cooperative for the Disposal of Radioactive Waste (Nagra), the Swiss Federal Nuclear Safety Inspectorate (ENSI) and other national and in particular international agencies (inter alia EU and OECD/CSNI). Most of this support is for long-term research contracts.

About 50 per cent of the nuclear energy research at PSI concentrates on reactor safety and safety-related operational aspects of Swiss NPP and on nuclear waste disposal. With nearly 20 per cent of the resources, future reactor concepts, in particular their safety features, which rely on inherent safety mechanisms and on passive system layouts are investigated (to a limited extent through an active partnership of PSI in the Generation IV International Forum (GIF).

The main objectives of nuclear energy research carried out in the "Nuclear Energy and Safety" (NES) research department at the PSI are as follows:

- to contribute to the safe and economic operation of the existing NPPs in Switzerland and to the safe geological storage of radioactive waste by reinforcing the scientific bases of the technologies in the appropriate areas;
- to support the reactor operators and safety authority in Switzerland, as well as the securing of stand-by functionality in key areas, particularly those requiring the services of a Hot Lab;
- to prepare inputs to 'stakeholders' for decision-making purposes;
- to promote nuclear energy by means of R&D in terms of increased sustainability, safety and economy;

- to train young nuclear specialists over a broad spectrum of disciplines, including those with experience of other energy systems;

The NES department is structured into five research laboratories according to its specific scientific and technical areas of competence. It operates the only Hot Lab in the country, and the Reactor School offers education and training programmes for present and future reactor operators.

The following provides a brief description of the 12 programmes currently carried out within the NES department:

Operating reactors:

The STARS programme is a long-standing project aimed at the development, maintenance and application of a complex code and database system to be used for investigations on the behaviour of the Swiss nuclear reactors. Focus areas include combined system transient and uncertainty analysis, fuel modelling and neutronics.

The main focus in the HRA (Risk and Human Reliability) is related to the solution of current and future issues concerning the handling of human factors in the context of Probabilistic Safety Assessment (PSA).

In the LWR-PROTEUS programme, measurements are being taken of basic reactor physics data for modern, complex fuel bundles in a critical facility (PROTEUS). The data collected are subsequently used for the validation of computer codes, and the reduction in their uncertainties.

The Nuclear Fuels programme involves micro-structural/micro-mechanical examination of the ageing of core internals (fuel rods, structural materials), and the development of associated theoretical models. In particular, investigation of fuel damage and identification of possible causes of failure are also being carried out. Methods for the production of Gen IV fuels, and their associated fuel cycles, are also under consideration.

The Component Safety programme (INTEGER) involves the experimental characterisation of important ageing mechanisms (stress corrosion cracking, thermal fatigue and irradiation embrittlement) in primary pressure boundary components, the development and validation of advanced mechanistic material ageing models and probabilistic methods for improved integrity assessments and lifetime predictions, as well as the evaluation of advanced non-destructive techniques for the early detection of fatigue and stress corrosion crack initiation and for the characterisation of the actual degree of embrittlement in components.

The Source-Term Evaluation programme activities are centred around the ARTIST test facility, which reproduces, at reduced scale, aerosol deposition behaviour during a severe accident following a postulated steam generator tube rupture. General considerations of iodine chemistry are being investigated, with specific application to NPPs. The experimental programme is balanced by the development and validation of numerical models, the overall theme being aimed at replacing the existing empirical models by mechanistic modelling using CFD. All activities are directed towards source-term evaluation relevant to the Swiss NPPs.

Waste management:

The programme is an ongoing commitment, overseen by the federal government, to ensure the safe disposal of radioactive waste from the medical and nuclear industries, but also including that arising from nuclear research. The activities cover fundamental waste-disposal chemistry, the physics and chemistry of radio nuclides, and investigation of the geological boundaries for radionuclide transport. Results will ultimately find use in the comprehensive application of safety criteria. This R&D programme is carried out in close co-operation with Nagra, the organisation charged with the disposal of all Swiss radioactive waste.

Energy systems analysis:

These activities are carried out within the Laboratory for Energy System Analysis (LEA) which is an interdisciplinary laboratory supporting both NES and the General Energy Department (ENE). The Laboratory aims to contribute to effective decision-making on long-term technology strategies in energy supply and demand by ensuring the full integration of all environmental, economic and social factors. LEA also develops methodologies, and carries out the associated risk analyses, within the framework of the Human Reliability Assessment (HRA), the programme is also part of LEA.

The Technology Assessment (GaBE) programme involves analyses of fossil, nuclear and renewable energy technologies. It is based on an interdisciplinary framework, thus enabling comparisons to be made between current and future options for the electricity, heating and transport sectors.

In the Energy Economics programme, analyses are undertaken of energy systems, and associated technological changes, at the Swiss, European and global levels, all aimed at improving understanding of available options for the realisation of more sustainable energy mixes for the future.

Hot Laboratory Division (AHL):

The Hot Laboratory (Hot Lab) is the largest nuclear research facility under the supervision of the Swiss Federal Nuclear Safety Inspectorate (ENSI), and the only Swiss research facility capable of examining large quantities of radioactive materials. The two main tasks of the Hot Laboratory Division are to ensure a safe and efficient utilisation of the Hot Lab infrastructure, and to conduct state-of-the-art service work for the Swiss nuclear industry. Accordingly, AHL offers Hot Lab users modern analytical tools for the manipulation and investigation of radioactive materials. In particular, the laboratory is very well equipped for structural and chemical analyses of the materials used in NPPs and accelerator facilities.

2.8.2. Development of advanced nuclear technologies

Research on future reactors (generation III and IV) at PSI:

The ALPHA programme provides confirmation of the characteristics of passive safety systems for advanced LWRs, and is centred around the large-scale, integral test facility PANDA. More recently, the experimental base has been broadened to incorporate investigations of fundamental phenomena in both the primary circuit and containment, and includes the study of two-phase flow phenomena (such as bubbly flows), the prediction of critical heat flux, and mixture/stratification phenomena. A number of additional small- and medium-scale, single-effect test facilities are now also included under the project heading. At all three scales, experimentation is accompanied by the development and application of novel instrumentation techniques able to measure the distributed parameters characteristic of 3D flow fields. In parallel, there is an ongoing development and validation programme for the accompanying numerical tools, particularly CFD (Computational Fluid Dynamics), but including also multi-scale modelling approaches to basic phenomena such as boiling.

In the appropriately named FAST programme, activities are aimed at the development and implementation of a code system representing state-of-the-art safety analyses of nuclear systems incorporating fast neutron spectra.

The High-Temperature Materials programme activities involve characterisation of materials to be used in the future Generation IV reactors (particularly gas-cooled reactors), which will operate at significantly higher temperatures, and are subject to a more intense radiation environment than current Gen II reactors. Mechanistic models are being developed for the prediction of material behaviour, from the atomic level up to the scale of the continuum. Experimental validation of the models is also undertaken using advanced spectroscopic methods and, in particular, synchrotron radiation.

2.8.3. International co-operation and initiatives

The European Atomic Energy Community (Euratom) was established in 1957 by the Treaty of Rome. In 1978, Switzerland and Euratom (comprising 15 member states) signed a cooperation agreement in the field of controlled thermonuclear fusion and plasma physics. One aspect of this research cooperation in the medium term is to produce electrical energy by means of fusion reactors.

In the field of radioactive waste management, international researches are carried out in the rock laboratories at Mont Terri (canton Jura) and Grimsel (canton Bern). Thirteen organisations from six different countries are jointly carrying out a research programme in the Mont Terri rock laboratory. The scope of the project is to determine the properties of Opalinus clay. From 1996 to 2010 the allocated investments amount to CHF 51.4 million. Swiss partners contributed 36% and the other partners 64% to the budget.

The Grimsel Test Site (GTS) was established over 25 years ago as a centre for underground research and development (R&D) supporting a wide range of research projects on the disposal of radioactive waste, with currently 25 partners from 11 nations coming to work at this unique location. The GTS provides an environment which is analogous to that of a repository site, so allowing the development and testing of equipment, methodology and models under fully realistic conditions.

2.9. Human resources development

A joint programme by EPF Lausanne and ETH Zurich, two of Europe's leading science and engineering schools is offered in order to qualify multidisciplinary professions in industry, research and national authorities. Areas covered include the safe and reliable operation of existing and new reactors, the development of novel reactor types, the sustainable supply of nuclear fuel, the closure of the fuel cycle, the disposal of radioactive waste, and many others.

2.10. Stakeholder Communication

The accident at the Fukushima NPP and the suspension of the licensing procedure for new NPPs have triggered a big interest and public debate on the subject of nuclear power. This is likely to be closely followed by the media over the next years.

Governmental communication is focusing on radioactive waste disposal where efforts to keep the public, stakeholders and neighbouring countries informed has been intensified in the context of the ongoing procedure to identify sites for deep geological repositories. Governmental communication in this field is committed to ensuring a high level of transparency and public participation.

3. NATIONAL LAWS AND REGULATIONS

3.1. Regulatory framework

3.1.1. Regulatory authority(s)

Licensing

The Federal Council is the authority that grants general licences. The Federal Department of the Environment, Transport, Energy and Communications grants construction licences and operating licences for nuclear facilities. For the three kinds of licences mentioned, the Swiss Federal Office of Energy (SFOE) is responsible for the co-ordination of the application procedure. In addition, the SFOE issues licences for the handling of nuclear materials and radioactive waste.

Supervision

The Swiss Federal Nuclear Safety Inspectorate (ENSI) is the national regulatory authority in Switzerland with responsibility for nuclear energy. ENSI has responsibility for the supervision of Swiss nuclear facilities, which includes the NPPs, the interim storage facilities for radioactive waste and the nuclear research facilities. Its responsibilities and duties are as follows:

• to establish safety and security criteria and requirements that reflect experience (feedback) and the state of science and technology;

• to prepare safety and security evaluation reports (SER) to support decisions by the licensing authority;

• to monitor compliance with regulations including inspections and reports and to request documentation on aspects of nuclear safety, nuclear security and radiological protection;

• to grant, suspend or withdraw permits;

• to order the application of measures necessary and appropriate to maintain nuclear safety and security, including the precautionary and active protection of personnel in NPPs, the public and the environment against radiation hazards;

• to ensure on-site and off-site emergency planning and the dissemination of appropriate information in an emergency according

Advisory committee

The Federal Nuclear Safety Commission is designated as an advisory committee to the Federal Council and the Federal Department of the Environment, Transport, Energy and Communications. It is involved in the licensing process as it reviews and comments on the safety evaluation reports prepared by the supervisory authorities.

Others

In the nuclear field, the supervisory authority with respect to nuclear safety and radiation protection is ENSI. In the non-nuclear field, the supervisory authorities are the Federal Office of Public Health (FOPH) und the Swiss National Accident Insurance Office. The FOPH manages the licensing procedures in the non-nuclear field according to the radiological protection legislation. It is responsible for waste produced from the healthcare sector, industry and research.

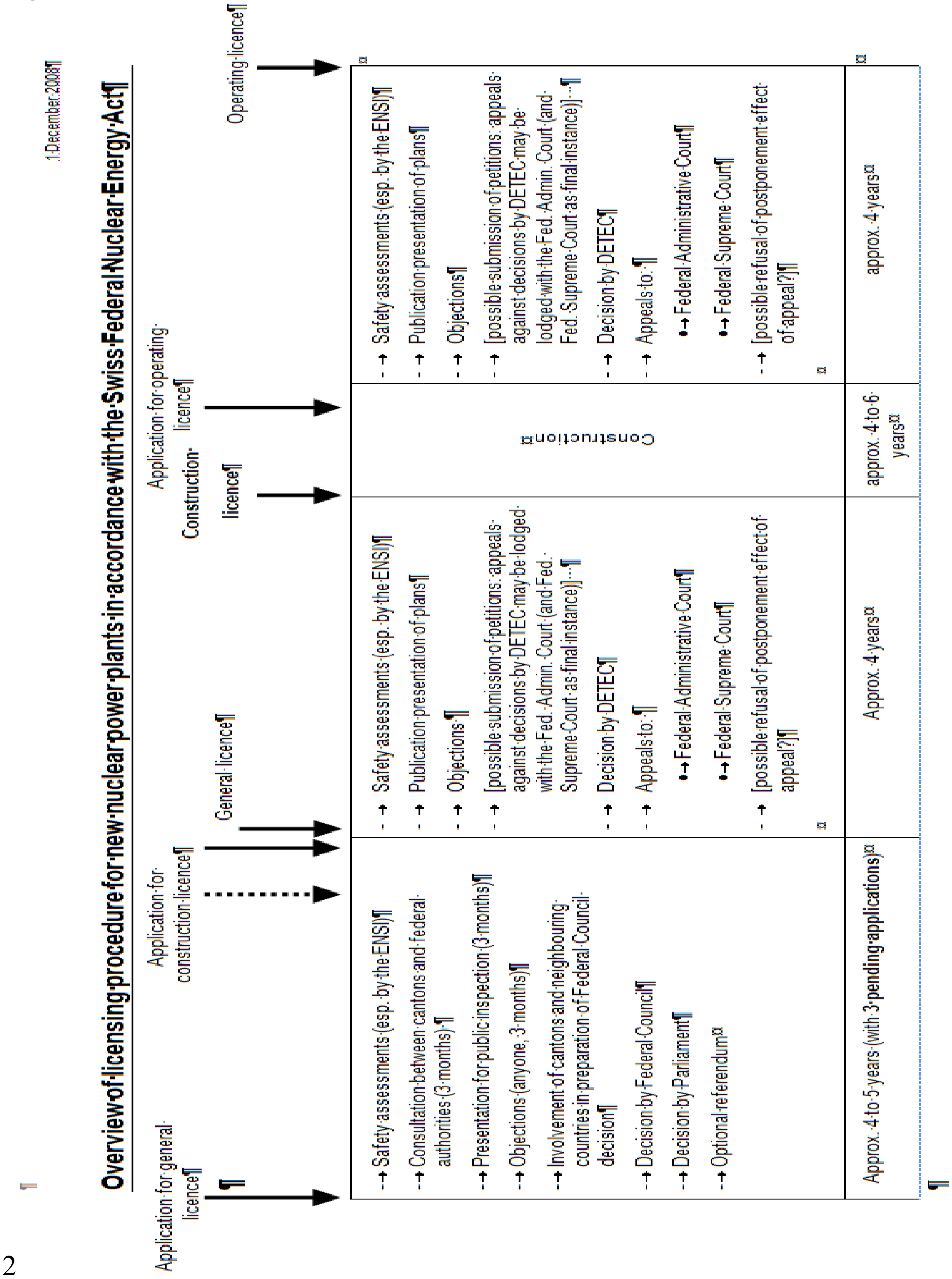
The National Emergency Operations Centre – part of the Federal Office of Civil Protection in the Federal Department of Defence, Civil Protection and Sport – is in charge of all emergency situations, including those arising from events at NPPs and relating to the protection of the public and the environment.

Several advisory committees to the government or governmental departments covering aspects of radiological protection, emergency planning and waste disposal have responsibilities associated with the operation of NPPs. However, they are not involved in the licensing process and have no authority over the plants.

3.1.2. Licensing Process

The following illustration shows the different stages of a licensing process for a NPP. On 14 March 2011, the head of the Federal Department of the Environment, Transport, Energy and Communications DETEC suspended the licensing procedure for new NPPs.

Figure



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3.2. Main national laws and regulations in nuclear power

- Nuclear Energy Act of 21 March 2003
- Nuclear Energy Ordinance of 10 December 2004
- Ordinance of 7 December 2007 on the Decommissioning Fund and the Waste Disposal Fund for Nuclear Installations (Decommissioning and Waste Disposal Funds Ordinance)
- Radiological Protection Act of 22 March 1991
- Radiological Protection Ordinance of 22 June 1994
- Federal Nuclear Energy Liability Act of 18 March 1983
- Ordinance of 12 November 2008 on the Federal Nuclear Safety Commission
- Federal Act of 22 June 2007 on the Swiss Federal Nuclear Safety Inspectorate
- Ordinance of 12 November 2008 on the Swiss Federal Nuclear Safety Inspectorate
- Safeguards Ordinance of 18 August 2004
- Ordinance of 20 October 2010 on the Emergency Organisation in case of ABC event or natural event
- Ordinance of 20 October 2010 on Emergency Protection Measures in the Vicinity of Nuclear Installations
- Ordinance of 17 October 2007 on the National Emergency Operations Centre
- Ordinance of 23 August 1978 on the Additional Protocols to the Non-Proliferation Treaty Safeguards Agreement
- Federal Act of 13 December 1996 on the Control of Dual-Use Goods and of Specific Military Goods; Goods Control Act
- Ordinance on the Export, Import and Transit of Dual Use Goods and Specific Military Goods; Goods Control Ordinance
- Ordinance of 5 December 2003 on Issuing Warnings, Raising the Alarm and Broadcasting Instructions to the Public; Alarm Ordinance

REFERENCES

www.uvek.admin.ch
Federal Department of the Environment, Transport, Energy and Communications
www.bfe.admin.ch
www.radioactivewaste.ch
Swiss Federal Office of Energy SFOE
www.ensi.ch
Swiss Federal Nuclear Safety Inspectorate ENSI
www.entsorgungsfonds.ch, www.stilllegungsfonds.ch
Decommissioning and waste disposal funds
www.are.admin.ch
Federal Office for Spatial Development
www.kns.admin.ch
Federal Nuclear Safety Commission
www.swisstopo.admin.ch
Federal Office of Topography
www.bfs.admin.ch
Federal Statistical Office/Swiss Statistics
www.nagra.ch
National Co-operative for the Disposal of Radioactive Waste Nagra

APPENDIX 1: INTERNATIONAL, MULTILATERAL AND BILATERAL AGREEMENTS

International Organisations

- Statute of the International Atomic Energy Agency dated 26 October 1956
- Agreement dated 1 July 1959 on the Privileges and Immunities of the International Atomic Energy Agency
- Agreement dated 28 February 1972 between the International Atomic Energy Agency, the Government of Switzerland and the Government of the United States of America for the application of safeguards
- Statute of the OECD Nuclear Energy Agency dated 20 December 1957
- Protocol dated 20 December 1957 on the Tribunal established by the Convention on the Establishment of a Security Control in the Field of Nuclear Energy
- Rules of Procedure of the European Nuclear Energy Tribunal dated 11 December 1962
- Convention dated 20 December 1957 on the Establishment of a Security Control in the Field of Nuclear Energy

Safety of Spent Fuel and Nuclear Safety

- Convention dated 17 June 1994 on Nuclear Safety
- Joint Convention dated 5 September 1997 on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

Physical Protection of Nuclear Material

- Convention dated 26 October 1979 on the Physical Protection of Nuclear Material

Terrorism Suppression

- International Convention dated 13 April 2005 for the Suppression of Acts of Nuclear Terrorism
- European Convention dated 27 January 1977 on the Suppression of Terrorism

Radiation Protection

- Convention dated 22 June 1960 concerning the Protection of workers against Ionising Radiations

Information Exchange and Assistance in Case of an Emergency

- Agreement dated 30 November 1989 between the Government of Switzerland and the Government of France on information exchange in case of incidents or accidents with possible radiological consequences

- Agreement dated 10 August 1982 between the Government of Switzerland and the Government of Germany on mutual information in case of construction and operation of nuclear facilities near the border
- Agreement dated 15 December 1989 between the Government of Switzerland and the Government of Italy on quick information exchange in case of nuclear accidents
- Convention dated 26 September 1986 on Early Notification of a Nuclear Accident
- Convention dated 26 September 1986 on assistance in the case of a nuclear accident or radiological emergency
- Convention dated 31 May 1978 between the Government of Switzerland and the Government of Germany on the radioprotection in case of an alert
- Exchange of notes dated 25 July 1986 between Switzerland and Germany concerning the application of the Convention dated 31 May 1978/15 February 1980/25 July 1986 on the radioprotection in case of an alert
- Agreement dated 19 March 1999 between the Swiss Government and the Austrian Republic on quick information exchange in the field of nuclear security and radioprotection
- Exchange of letters dated 5/20 November 2008 between the Swiss Federal Council and the Government of France concerning the field and the modalities of alert and/or of transmission of information in case of minor event or of accidental situation in the nuclear power plant of Fessenheim or in the Swiss nuclear power plants of Beznau, Gösgen, Leibstadt and Mühleberg (with annex)
- Agreement dated 10 August 1982 for the reciprocal provision of information concerning the construction and operation of nuclear installations in frontier areas (with annex)

Nuclear Liability

- Agreement dated 22 October 1986 between the Government of Switzerland and the Government of Germany in the field of nuclear liability

Nuclear Research

- Convention dated 1 July 1953 for the Establishment of a European Organisation for Nuclear Research
- Financial Protocol dated 1 July 1953 Annexed to the Convention for the Establishment of a European Organisation for Nuclear Research
- Juridical Statute of the European Organisation for Nuclear Research on Swiss Territory
- Agreements with France concerning the extension in French territory of the domain of the European Organisation for Nuclear Research
- Cooperation Agreement dated 14 September 1978 in the Field of Controlled Thermonuclear Fusion and Plasma Physics between Switzerland and the European Atomic Energy Community
- Agreement dated 28 November 2007 in Form of an Exchange of Letters between the Swiss Government and the European Atomic Energy Community on the Application of the Agreement on the International Organisation ITER

- Agreement dated 28 November 2007 in Form of an Exchange of Letters between the Swiss Government and the European Atomic Energy Community on the Adhesion of Switzerland to the common European venture for ITER and the Development of the Fusion Energy
- Association Contract dated 8 February 2008 between the Swiss Government and the European Atomic Energy Community in the Field of Controlled Thermonuclear Fusion and Plasma Physics
- Agreement dated 11 October 2005 concerning the Staff Mobility in the Field of Controlled Thermonuclear Fusion and Plasma Physics and the Partners
- Exchange of letters dated 6 November 1986 between the Swiss Government and the European Atomic Energy Community concerning the Swiss Association to the Cooperation Agreement between EURATOM and the United States of America

Non-Proliferation and nuclear Weapons

- Treaty dated 5 August banning nuclear Weapon Tests in the Atmosphere, in outer Space and under Water
- Treaty dated 1 July 1968 on the Non-Proliferation of Nuclear Weapons
- Agreement dated 6 September 1978 between the Swiss Government and the International Atomic Energy Agency for the application of safeguards in Connection with the Treaty of Non-Proliferation of Nuclear Weapons
- Protocol additional to the Agreement dated 6 September 1978 between the Swiss Confederation and the International Atomic Energy Agency for the application of safeguards in Connection with the Treaty of Non-Proliferation of Nuclear Weapons
- Treaty dated 11 February 1971 on the Prohibition of the Emplacement of nuclear Weapons and other Weapons of mass Destruction on the Seabed and the Ocean Floor and in the Subsoil thereof

Bilateral Agreements concerning peaceful uses of nuclear energy

- Cooperation Agreement dated 28 January 1986 between the Government of Switzerland and the Government of Australia concerning peaceful uses of nuclear energy
- Cooperation Agreement dated 22 December 1987 between the Government of Switzerland and the Government of Canada concerning peaceful uses of nuclear energy
- Cooperation Agreement dated 12 November 1986 between the Government of Switzerland and the Government of China concerning peaceful uses of nuclear energy
- Cooperation Agreement dated 5 December 1988 between the Government of Switzerland and the Government of France concerning peaceful uses of nuclear energy
- Cooperation Agreement dated 14 February 1968 between the Government of Switzerland and the Government of Sweden concerning peaceful uses of nuclear energy

- Exchange of letters dated 30 November 1989 between the Government of Switzerland and the Government of France for the creation of a mixed commission on nuclear safety
- Cooperation Agreement dated 31 October 1997 between the Government of Switzerland and the Government of the United States of America concerning peaceful uses of nuclear energy
- Cooperation Agreement dated 6 April 1990 between the Government of Switzerland and the Government of Russia concerning peaceful uses of nuclear energy
- Additional Protocol dated 25 April 1990 to the Cooperation Agreement between the Government of Switzerland and the Government of Sweden concerning peaceful uses of nuclear energy

APPENDIX 2: MAIN ORGANISATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

National Nuclear Energy Authorities

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Bundeshaus Nord
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Attachment 1: PREFIXES AND CONVERSION FACTORS

TABLE 1. PREFIXES

Symbol	**Name**	**Factor**
E	exa	10^{18}
P	peta	10^{15}
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
K	kilo	10^{3}
H	hecto	10^{2}
da	deca	10^{1}
D	deci	10^{-1}
C	centi	10^{-2}
M	mili	10^{-3}
µ	micro	10-6
η	nano	10^{-9}
P	pico	10^{-12}
F	femto	10^{-15}
A	atto	10^{-18}

TABLE 2. CONVERSION FACTORS FOR ENERGY

To:	**TJ**	**Gcal**	**Mtoe**	**MBtu**	**GWh**
From:	Multiply by:				
TJ	1	238.8	2.388×10^{-5}	947.8	0.2778
Gcal	4.1868×10^{-3}	1	10^{-7}	3.968	1.163×10^{-3}
Mtoe	4.1868×10^{4}	107	1	3.968×10^{7}	11630
Mbtu	1.0551×10^{-3}	0.252	2.52×10^{-8}	1	2.931×10^{-4}
GWh	3.6	860	8.6×10^{-5}	3412	1

TABLE 3. CONVERSION FACTORS FOR MASS

To:	kg	T	lt	st	lb
From:	Multiply by:				
kg (kilogram)	1	0.001	9.84×10^{-4}	1.102×10^{-3}	2.2046
T (tonne)	1000	1	0.984	1.1023	2204.6
Lt (long tonne)	1016	1.016	1	1.12	2240.0
st (short tonne)	907.2	0.9072	0.893	1	2000.0
lb (pound)	0.454	4.54×10^{-4}	4.46×10^{-4}	5.0×10^{-4}	1

TABLE 4. CONVERSION FACTORS FOR VOLUME

To:	US gal	UK gal	bbl	ft^3	L	m^3
From:	Multiply by:					
US gal (US gallon)	1	0.8327	0.02381	0.1337	3.785	0.0038
UK gal (UK gallon)	1.201	1	0.02859	0.1605	4.546	0.0045
bbl (barrel)	42.0	34.97	1	5.615	159.0	0.159
ft^3 (cubic foot)	7.48	6.229	0.1781	1	28.3	0.0283
l (litre)	0.2642	0.22	0.0063	0.0353	1	0.001
m^3 (cubic metre)	264.2	220.0	6.289	35.3147	1000	1