FINLAND

(Updated 2011)

1. GENERAL INFORMATION

Finland (in Finnish Suomi) is a republic in northern Europe, bounded on the north by Norway, on the east by Russia, on the south by the Gulf of Finland and Estonia, on the south-west by the Baltic Sea and on the west by the Gulf of Bothnia and Sweden. Nearly one third of the country lies north of the Arctic Circle. The area of Finland, includes 31 557 km^2 of inland lake area, totals 338 000 km^2. The terrain is generally level, hilly areas are more prominent in the north and mountains are found only in the extreme north-west.

1.1 Country overview

1.1.1 Geography and Climate

The average (1971-2000) July temperature in the capital Helsinki on the southern coast is 17.2 °C. The February average in Helsinki is about -4.9 °C. The corresponding figures at Sodankylä (Lapland) in the northern Finland are 14.3 °C and -12.7 °C. Precipitation (snow and rain) averages about 460 mm in the north and 640 mm in the south. Snow covers the ground for four to five months a year in the south, and about seven months in the north.

1.1.2 Population

Finland has a population of 5.38 million and an average population density of 17.6 per km^2 of land. Historical population data is shown in Table 1. The annual population growth rate between the years 2000 and 2010 is 0.37%. More than two thirds of the population reside in the southern third of the country.

In Finland the total primary energy consumption[1] per capita was about 89% higher than the European Union (EU27) average (according to 2008 statistics). This is mainly due to the weather, which demands space heating for most of the time, and the structure of the industry, which is energy intensive process industry (wood, especially paper, heavy metal and chemical). A third factor is relatively high transportation requirements per capita caused by the low population density.

TABLE 1. POPULATION INFORMATION

							Average annual growth rate (%)
Year	1970	1980	1990	2000	2005	2010	1990 to 2010

[1] Using the definition adopted by the IEA and the EU (nuclear power is converted into primary energy with a 33% gross efficiency, and hydro and wind power as well as imported electricity with 100% efficiency).

Population (millions)	4.6	4.9	5	5.2	5.2	5.38	0.37
Population density (inhabitants/km²)	15.1	15.7	16.4	17	17.2	17.6	N/A
Urban Population as % of total #	50.3	59.8	61.4	61.1	62.4	63.4	N/A
Area§ (1000 km²)						304.6	N/A

1.1.3 Economic Data

TABLE 2. GROSS DOMESTIC PRODUCT (GDP)

Time	1975	1980	1990	2000	2005	20010	Average annual growth rate (%) 2000 to 2010
GDP (millions of current# Euro)	18 011	33 240	89 291	132 110	157 307	180 295	3.2
GDP (millions of constant 2000# Euro)	68 235	79 727	107 780	132 110	150 379	157 998	1.8
GDP per capita (current# Euro/capita)	3 823	6 954	17 908	25 524	29 991	33 618	2.8

Source: *Statistics Finland: National Accounts Preliminary annual data and 4th quarter of 2010.*
 # In December 2000: 1 euro = 0.898 US$ and in December 2010: 1 euro = 1.322 US$

1.2 Energy information

Finland's energy mix is diverse and well balanced, and many of its power plants can be optimised for up to three different fuels. About 2.5 million inhabitants (slightly less than half) lived in district heated apartments and about 74 per cent of all district heat was produced in 2007 in combined heat and power plants and in total CHP covered 29 per cent of Finland’s electricity demand.

1.2.1 Estimated Available Energy

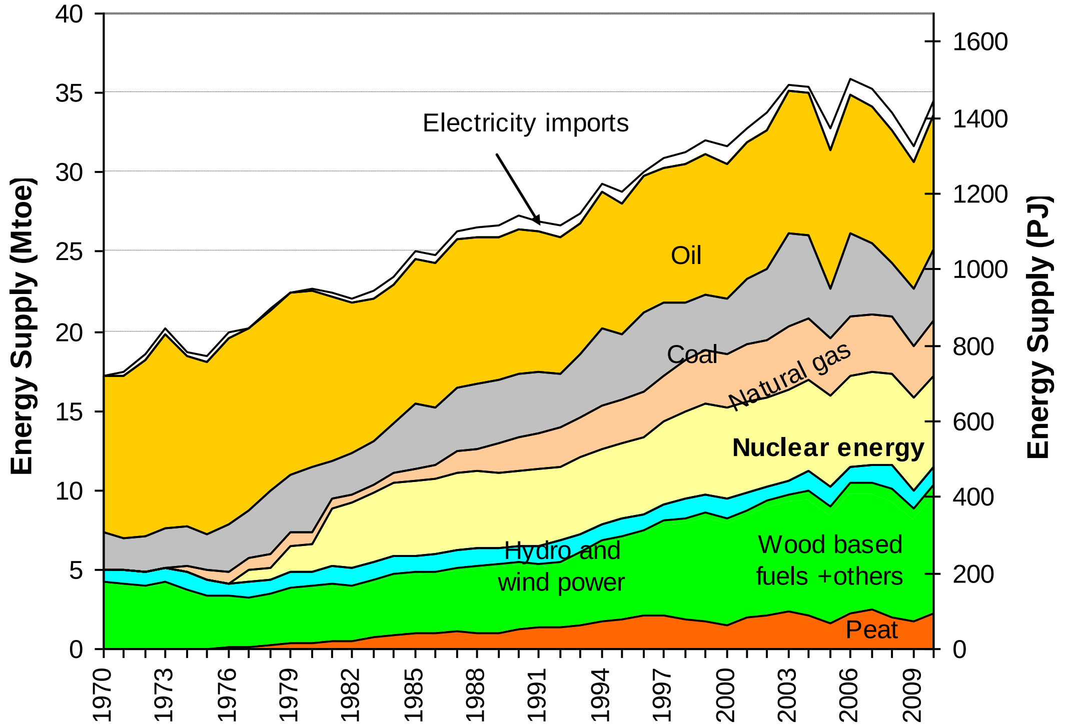
Finland is highly dependent on foreign energy supplies. Crude oil and oil products constitute a major part of imported energy. Other main fuels imported to Finland are coal and natural gas. The primary indigenous energy resources in Finland are hydro power, wood, wood waste, pulping liqueurs and peat. The peat resources are about 800–1000 Mtoe (34–42 EJ) and reserves are estimated at 280 Mtoe. These could be exploited with an annual rate of 4.0–4.7 Mtoe for about 60 years. The use of wood and wood based fuels in 2009 was 0.267 EJ (6.4 Mtoe) corresponding to about 20% of the total primary energy consumption. Unexploited hydropower reserves have been estimated to correspond to an annual production of the order of up to 9.5 TW·h. However, most of the unharnessed river areas are either nature reserves or frontier rivers or tiny waterfalls. Economically significant additional potential until 2020 could be about 0.6 TW·h.

Indigenous fuels and hydropower covered about 31.3% of the primary energy demand in 2009. Finland imports all of its oil, natural gas, coal and uranium. Total demand for primary energy in 2009 was 31.7 Mtoe (1.33 EJ) and the different energy sources used are given in Table 3. The long-term trend of energy supply from 1970 onwards is depicted in Fig. 1 and the trend in final energy consumption in different sectors in Fig. 2.

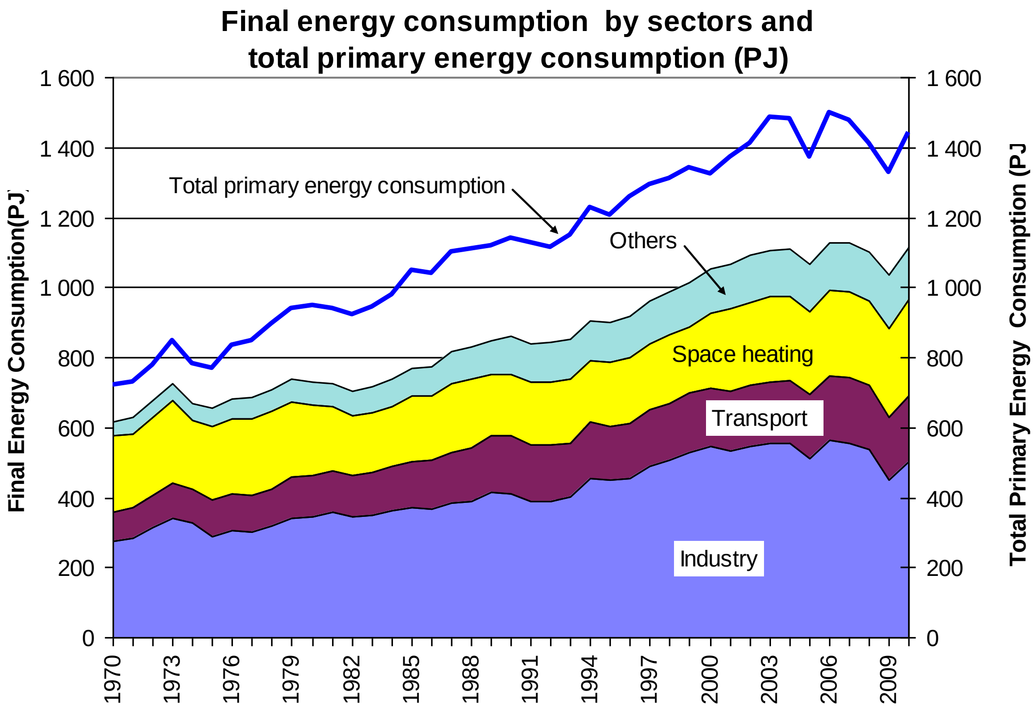
TABLE 3. PRIMARY ENERGY SOURCES IN 2010 [a]

Energy Source	Mtoe	PJ	%
Oil	8.45	354	24.5
Coal	4.45	186	12.9
Natural gas	3.55	149	10.3
Indigenous fuels	10.32	432	29.9
Hydro power	1.12	47	3.3
Nuclear power	5.7	239	16.5
Net electricity imports	0.9	38	2.6
Total	**34.5**	**1444**	**100**

[a] Using the definition adopted by the IEA and the CEC (nuclear power is converted into primary energy with a 33% gross efficiency, and hydro and wind power as well as imported electricity with 100% efficiency). This definition has been applied in Finland since 1997.



Source: Statistics Finland



Final energy consumption in different sectors (PJ and total primary energy consumption (1970-2010)). In 2010 the shares of the sectors of final energy consumption were: industry 45.2%,space heating 24.6%, transport 16.6%, and others 13.5%.. Source: Statistics Finland.

High proportion of energy-intensive process industries and high requirements for space heating and long transportation distances make the total energy consumption per capita in Finland one of the highest in the OECD area. In 2010, the primary energy consumption per capita in Finland was 6.0 toe. The historical energy statistics are given in Tables 4 and 5.

TABLE 4. PRIMARY ENERGY SOURCES (Mtoe)

	1985	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Oil	9.20	9.02	8.29	8.50	8.62	8.78	8.96	8.94	8.66	8.73	8.61	8.36	8.01	8.45
	(36.8%)	*(33.1%)*	*(28.8%)*	*(26.9%)*	*(26.3%)*	*(26.0%)*	*(25.2%)*	*(25.3%)*	*(26.4%)*	*(24.3%)*	*(24.4%)*	*(24.8%)*	*(25.3%)*	*(24.5%)*
Coal	4.01	4.00	4.03	3.56	4.01	4.41	5.84	5.26	3.11	5.18	4.57	3.39	3.63	4.45
	(16.0%)	*(14.6%)*	*(14.0%)*	*(11.3%)*	*(12.3%)*	*(13.1%)*	*(16.4%)*	*(14.9%)*	*(9.5%)*	*(14.4%)*	*(13.0%)*	*(10.0%)*	*(11.4%)*	*(12.9%)*
Natural Gas	0.81	2.17	2.81	3.39	3.68	3.65	4.04	3.89	3.56	3.81	3.52	3.60	3.21	3.55
	(3.3%)	*(7.9%)*	*(9.8%)*	*(10.7%)*	*(11.2%)*	*(10.8%)*	*(11.4%)*	*(11.0%)*	*(10.9%)*	*(10.6%)*	*(10.0%)*	*(10.7%)*	*(10.1%)*	*(10.3%)*
Nuclear Power	**4.68**	**4.72**	**4.72**	**5.62**	**5.69**	**5.57**	**5.69**	**5.68**	**5.82**	**5.73**	**5.86**	**5.74**	**5.89**	**5.70**
	(18.7%)	*(17.3%)*	*(16.4%)*	*(17.8%)*	*(17.4%)*	*(16.5%)*	*(16.0%)*	*(16.0%)*	*(17.8%)*	*(16.0%)*	*(16.6%)*	*(17.0%)*	*(18.6%)*	*(16.5%)*
Hydro and Wind Power	1.05	0.92	1.10	1.25	1.13	0.92	0.82	1.29	1.17	0.99	1.22	1.48	1.10	1.12
	(4.2%)	*(3.4%)*	*(3.8%)*	*(4.0%)*	*(3.4%)*	*(2.7%)*	*(2.3%)*	*(3.6%)*	*(3.6%)*	*(2.7%)*	*(3.5%)*	*(4.4%)*	*(3.5%)*	*(3.3%)*
Peat	0.98	1.27	1.90	1.48	2.05	2.14	2.37	2.12	1.64	2.24	2.44	1.95	1.71	2.23
	(3.9%)	*(4.7%)*	*(6.6%)*	*(4.7%)*	*(6.3%)*	*(6.4%)*	*(6.7%)*	*(6.0%)*	*(5.0%)*	*(6.2%)*	*(6.9%)*	*(5.8%)*	*(5.4%)*	*(6.5%)*
Wood-based Fuels	3.61	3.99	4.96	6.39	6.24	6.73	6.87	7.22	6.71	7.53	7.22	7.22	6.39	7.35
	(14.4%)	*(14.6%)*	*(17.2%)*	*(20.2%)*	*(19.1%)*	*(20.0%)*	*(19.3%)*	*(20.4%)*	*(20.5%)*	*(21.0%)*	*(20.5%)*	*(21.4%)*	*(20.1%)*	*(21.3%)*
Others	0.25	0.26	0.26	0.40	0.46	0.48	0.54	0.60	0.66	0.68	0.75	0.94	0.72	0.75
	(1.0%)	*(0.9%)*	*(0.9%)*	*(1.3%)*	*(1.4%)*	*(1.4%)*	*(1.5%)*	*(1.7%)*	*(2.0%)*	*(1.9%)*	*(2.1%)*	*(2.8%)*	*(2.3%)*	*(2.2%)*
Net Imports of Electricity	0.41	0.92	0.72	1.02	0.86	1.03	0.42	0.42	1.46	0.98	1.08	1.10	1.04	0.90
	(1.6%)	*(3.4%)*	*(2.5%)*	*(3.2%)*	*(2.6%)*	*(3.0%)*	*(1.2%)*	*(1.2%)*	*(4.5%)*	*(2.7%)*	*(3.1%)*	*(3.3%)*	*(3.3%)*	*(2.6%)*
Total Consumption	25.00	27.28	28.79	31.60	32.73	33.71	35.55	35.42	32.80	35.85	35.27	33.77	31.71	34.50

1 Mtoe = 41.868 PJ (1 tce = 0.611 toe). Nuclear energy is given in terms of fuel equivalent based on generation efficiency of 33 per cent.
Hydro and wind power and imported electricity are converted directly to primary energy without taking account of generation efficiency.

Source: Statistics Finland.

TABLE 5. ENERGY STATISTICS

(Energy values are in Exajoule (EJ), 10^{18} J)										Annual Average Growth rate (%)	
	1970	1980	1990	2000	2003	2004	2005	2009	2010	1980 to 2000	2000 to 2010
Energy Consumption[1]											
Total[1]	0.72	0.95	1.14	1.32	1.48	1.47	1.37	1.33	1.44	1.7 %	0.9 %
Solids[2]	0.10	0.19	0.22	0.21	0.34	0.31	0.20	0.22	0.28	0.4 %	2.9 %
Liquids[3]	0.41	0.46	0.38	0.35	0.37	0.37	0.36	0.34	0.35	-1.3 %	-0.05 %
Gases[4]	0	0.03	0.09	0.14	0.17	0.16	0.15	0.134	0.148	7.7 %	0.5 %
Hydro and Wind	0.03	0.04	0.04	0.05	0.03	0.05	0.05	0.046	0.047	1.8 %	-1.1 %
Other Renewables and	0.17	0.14	0.17	0.27	0.28	0.30	0.28	0.267	0.307	3.2 %	1.4 %

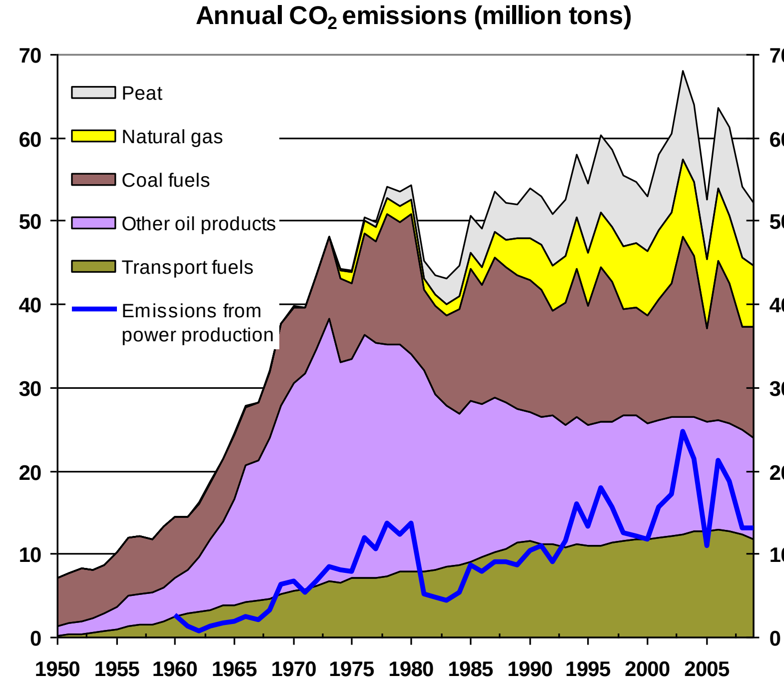
Waste[5]											
Nuclear	0	0.07	0.20	0.24	0.24	0.24	0.24	0.246	0.239	6.1 %	0.14 %
Other	0.006	0.006	0.01	0.02	0.02	0.03	0.03	0.030	0.031	5.0 %	6.4 %
Net import of electricity	0.002	0.004	0.04	0.04	0.02	0.02	0.06	0.043	0.038	12.1 %	-1.2 %

(1) Energy consumption = Primary energy consumption + Net import of electricity; (2) Solids = coal + peat; (3) Liquids = oil, (4) Gases = natural gas; (5) Wood based fuels and wood waste. **Source**: Energy Statistics up to 2010, Statistics Finland.

The objectives of Finnish energy policy are: security of supply; effective energy markets and economy; environmental acceptability and safety. In Finland, energy supply decisions on energy systems take place at a fairly decentralised level – with the exception of nuclear power. A substantial proportion of energy is imported and produced by private enterprises. The energy companies with majority ownership by state are also run on a purely commercial basis.

In 1994, Finland ratified the Framework Convention on Climatic Change. For the reference year (1990) of the convention, the total CO_2-emissions in Finland were 56.59 million tons and the total emission of greenhouse gases (GHG) 70.36 Mt CO_2 eq. In the Kyoto Protocol to the Framework Convention on Climatic Change the EU commitment is to reduce greenhouse gas emissions, calculated as an average of the emissions between 2008 and 2012, by 8% from the 1990 level. According to the burden sharing between the EU countries, Finland's commitment is to return the emissions to the 1990 level. Meeting the emission limits – especially those of carbon dioxide – would be a challenging task to be accomplished without the expanded use of nuclear power and renewable energy sources. The long-term trend in CO_2 emissions is depicted in Fig. 3. In years 1991 to 1993 the GHG emissions decreased slightly below the level in 1990 and were slightly below that reference level also in 2000, when the hydro power production and net electricity imports had large share in electricity production. On the other hand in 2003 the CO_2 emissions from fuel combustion were the highest (30% above the reference level) due to record low hydro power production in Finland since 1970 and very much lower net electricity imports. The main actions aimed to restrict the emissions growth have been increasing the use of wood-based fuels, natural gas, a substitute for coal, as well as upgrading the capacity of nuclear power plants. Energy conservation has also played a role. The total GHG emissions reached the all time peak level in 2003. During 2005 the total consumption of energy decreased considerably owing to the six-week paper industry dispute and exceptionally mild weather conditions. Furthermore, the quantity of energy produced from coal was low and the imported electricity increased clearly. Owing to these coincident factors the total GHG emissions in 2005 temporarily returned to the level of the reference year 1990. During 2009 the economic recession brought the emissions to an even lower level, but during 2010 the CO_2 emissions from energy production increased by 15.3 per cent.

FIGURE 1



GHG emissions (Mt CO_2-eq/a)

	Energy Sector	Other sectors	Total GHG emissions
1990	**54.5**	**15.9**	**70.4**
1991	53.1	15.1	68.2
1992	52.4	14.4	66.8
1993	54.3	14.6	68.9
1994	59.6	14.7	74.2
1995	56.1	14.7	70.8
1996	61.8	14.8	76.5
1997	60.2	15.0	75.2
1998	57.0	14.7	71.7
1999	56.4	14.7	71.1
2000	54.4	14.8	69.2
2001	59.7	14.7	74.4
2002	62.2	14.3	76.5
2003	69.7	14.6	84.3
2004	65.6	14.7	80.3
2005	54.0	14.5	68.5
2006	65.2	14.5	79.7
2007	63.2	15.0	78.1
2008	55.2	15.4	70.5
2009	51.9	14.4	66.3
2010	59.8		

FIG. 3. Carbon dioxide emissions in Finland from fuel combustion by fuel type (left) and greenhouse gas emissions from energy and other sectors (right).

In November 2008 the Government's report to the Parliament on Climate and Energy Strategy was issued. The report presents the Government's outlines for energy and climate policy in the forthcoming years, alongside proposals for key measures for the attainment of the EU's objectives regarding the promotion of renewable energy, the enhancement of efficiency in energy consumption, and decreasing greenhouse gas emissions.

According to the trend outlined in the strategy, the share of indigenous energy, and that of renewable energy in particular, will increase markedly over current levels. The share of renewable energy will increase to 38 per cent of total final energy consumption, the efficiency of the energy system will improve, and greenhouse gas emissions will begin to fall on a permanent basis. Furthermore, the share of coal and oil on Finnish energy balance sheet will decrease, and the diversity of the domestic energy system will further improve, while the risk to the energy supply posed by crises originating outside Finland will diminish. To an extent, the energy system would be based on greater use of electricity than before.

The strategy presents) two scenarios: (1) the baseline in compliance with current measures and development, and (2) the objective, meeting the EU's and national objectives. According to the scenarios, for 2020, electricity consumption would, at the baseline, be 103 TW·h, primary energy consumption 479 TW·h, final energy consumption 347 TW·h and greenhouse gas (GHG) emissions 89 Mt CO_2-eqv. and corresponding emissions outside the emission trading sector, 36 Mt CO_2-eqv. According to the objective, in 2020, electricity consumption will equal 98 TW·h, primary energy consumption 430 TW·h, final energy consumption 310 TW·h and emissions outside the emission trading sector 30 Mt CO_2-eqv. Emissions within industries included in emission trading are specified in accordance with EU–wide emission trading, which is under modification. In the vision for 2050 the total GHG emissions are aimed to be reduced to 21 Mt CO_2-eqv. being 30% out of the 1990 level of 70.4 Mt CO_2-eqv.

One year after the publication of the Climate and Energy Strategy the Ministry of Employment and the Economy published in November 2009 a new report, which concluded that electricity consumption has settled into a lower-than-expected growth trend, due to the economic recession, structural change in the forest industry and the intensely growing efficiency of electricity consumption in households and services. Estimated consumption of electricity totals around 91 TWh for 2020, while for 2009, consumption was estimated to be some 80 TWh. The actual figure was somewhat higher (81.3 TWh) and the recovery from recession was faster than anticipated and the power consumption reached 87.5 TWh in 2010. Finland's climate and energy strategy of 2008 projected a consumption figure of 98 TWh as the objective for 2020. According to the estimate presenting late 2009, electricity consumption in 2030 was estimated by the Ministry to total some 100 TWh. Fig.4 presents the forecasted electricity consumption by sectors up to to year 2030 according to Confederation of Finnish Industries and Finnish Energy Industries, and by the Ministry of Employment and the Economy in November 2009.

The goal of the Energy Strategy of 2008 is to increase the share of renewable energy to 38 per cent by 2020, in line with the obligation proposed by the Commission for Finland. This is a challenging obligation, and its attainment fundamentally depends on having final energy consumption enter a downward trend. Finland's natural resources would facilitate the additional use of renewable energy, but in order to realise this, the current subsidy and steering systems must be rendered more effective, and structures changed. Indeed, meeting such an obligation would require an intense increase in the use of wood-based energy, waste fuels, heat pumps, biogas and wind energy. As a new promotional method, a cost-effective feed-in tariff system, operating on market terms as far as possible, will be introduced.

The starting point for electricity sourcing is access to sufficient and moderately priced electricity with good security of supply, so that electricity sourcing simultaneously supports other climate and energy policy goals. The high share of energy-intensive industry, and the long lighting and heating season are characteristic of the Finnish electricity consumption structure. In future, electricity sourcing will continue to be based on a versatile system based on several energy sources, diversified thanks to the cogeneration of power and heat. Domestic production capacity will be able to provide for peak consumption and possible import disturbances.

In constructing our own capacity, priority will be given to plants that do not emit greenhouse gases, or ones with low emissions, such as combined power and heat plants using renewable fuels, and financially profitable and environmentally acceptable hydro and wind power plants. Furthermore, preparations have been performed for constructing additional nuclear power.

1.3 The electricity system

1.3.1 Electricity policy and decision making

Energy supply in Finland is highly competitive and both the state-owned, municipality-owned and private sector energy and electricity supply utilities operate essentially on the same commercial basis as the industry in general. The Finnish power system is widely decentralised and has a diverse organisation. The main types of ownership are: (i) partly privatised, state-controlled power companies; (ii) industrial companies, and (iii) municipal and other distribution companies.

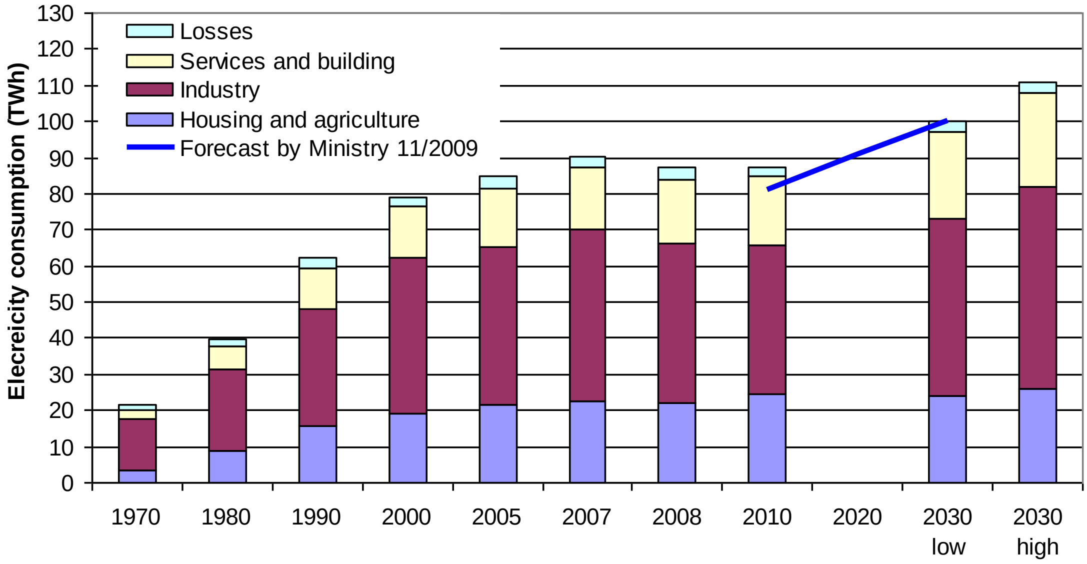


FIG 4. Electricity consumption during 1970-2010 and electricity demand up to 2030 estimated by the industry [Confederation of Finnish Industries and Finnish Energy Industries, 2009] and by the Ministry of Employment and the Economy in November 2009.

1.3.2 Structure of electric power sector

There are about 400 power plants in Finland and about half of these are hydroelectric. Fortum Power and Heat Oy is the largest power producer in Finland. Industry and its electricity producing firms together have a share of approximately the same size. The rest of power is produced by the local and regional energy companies. In addition, Finland imports electricity from Russia, the Nordic electricity markets and from Estonia to satisfy its remaining energy requirements.

Fortum is a leading energy company in the Nordic countries and other parts of the Baltic Rim. Fortum's activities cover the generation, distribution and sale of electricity and heat, the operation and maintenance of power plants as well as energy related services. Fortum Power and Heat Oy is engaged in nuclear energy activities. In addition to the Loviisa nuclear power plant, Fortum owns minority shares in the Olkiluoto nuclear power plant and the Swedish Forsmark and Oskarshamn nuclear power plants. Fortum Corporation was listed on the Helsinki Exchanges in December 1998. The State presently owns around 51% of its shares. In 2010, the sales of the Fortum Group amounted to about EUR 6300 million, power generation totalled 53.7 T·Wh, out of which the share of nuclear power was 41%. At the end of 2010 the company employed around 10 600 people, out of which the share of staff in Finland was about 2600 persons.

Teollisuuden Voima Oyj was founded in 1969 by a number of Finnish industrial companies with the purpose of building and operating large power plants. TVO produces electricity for its shareholders on a production cost basis at the Olkiluoto nuclear power plant in Eurajoki and at the Meri-Pori coal-fired power plant. TVO's principal task is to secure economical, safe and environmentally friendly electricity generation for its shareholders at Olkiluoto's current plant units. The company's objective is to keep the plant units as good as new and in good condition, and to ensure the development of the personnel's expertise. TVO has six shareholder companies and three share series (Table 6): A. existing units (OL1 & 2), B. the Meripori coal-fired plant and C. the new reactor unit under construction (Olkiluoto 3).

TVO forms part of the PVO Group, whose parent company is Pohjolan Voima Oy. The power produced by TVO is delivered to the shareholders at production cost basis (so called Mankala principle). In 2010, the company's net sales amounted to EUR 363 million and it sold 14.1 TW·h of electricity. TVO had an average of around 837 permanent employees. The Decision-in-Principle for Olkiluoto 4 reactor unit was made by the Government in early May, 2010 and ratified by the Parliament at the beginning of July, 2010.

TABLE 6. SHAREHOLDERS (%) IN DIFFERENT SHARE SERIES OF TVO

	A series (OL1 & OL2)	B series (OL3)	C series (Meri-Pori)
EPV Energia Oy	6.5	6.6	6.5
Fortum Power and Heat Oy	26.6	25.0	26.6
Karhu Voima Oy	0.1	0.1	0.1
Kemira Oyj	1.9	–	1.9
Oy Mankala Ab	8.1	8.1	8.1
Pohjolan Voima Oy	56.8	60.2	56.8
Total	100	100	100

Fennovoima Oy is a new Finnish nuclear power company established in 2007 that aims to construct new 1500-2500 MW nuclear power plant in Finland to produce power cost-effectively to its 69 Finnish share-holding companies. The operation of the plant is scheduled to begin by the end of this decade. Fennovoima will produce electricity for its owners' needs at production cost basis (Mankala principle). Each owner will receive the share of capacity proportional to its ownership in the company. Owners of Fennovoima include enterprises in industry, trade and services, as well as regional and local energy companies. With its 34 percent share, the nuclear expert E.ON Kärnkraft Finland is a minority shareholder in the company. E.ON will offer its nuclear expertise for utilisation in the project. Fennovoima has conducted the Environmental Impact Assessment procedure for three sites and the Decision-in-Principle including two site alternatives, Simo and Pyhäjoki in northern Finland, was made by the Government in early May, 2010 and ratified by the Parliament at the beginning of July, 2010. In 2011 Fennovoima will choose one of the sites as the location of the plant.

Posiva Oy is responsible for the characterisation of the site for the final disposal of spent fuel and, at later date, the construction and operation of the final disposal facility. In addition, Posiva's line of business includes other expert services in the field of nuclear waste management, provided for the two owner companies and other customers. In 2009, Posiva employed around 85 people working in the field of nuclear waste management. Posiva utilises not only Finnish expertise in the field but also contracts international research institutes. Research connected with nuclear waste management is carried out in universities, research institutes and consulting companies representing expertise in different fields. Posiva is owned by TVO (60%) and Fortum Power and Heat Oy (40%). The company had a turnover of some EUR 60.5 million in 2010 and is headquartered in Olkiluoto in the municipality of Eurajoki.

The Finnish power system (Fig. 5) consists of power plants, the main grid, regional networks, distribution networks and end-users of electricity. The system is a part of the interconnected Nordic power system together with the systems in Sweden, Norway and Denmark. Moreover, there is a direct current connection from Russia to Finland, enabling connection between the systems, which apply different principles, and also enabling power trading across the border. There is also a DC connection to Sweden under the Gulf of Bothnia and a link to Estonia. Furthermore, a new 800 MW /500 kV direct current electricity transmission connection between Finland and Sweden (Fenno-Skan 2) is under construction and is expected to begin commercial operation by the end of 2011.

Regional and distribution network activities are the responsibility of the electric utilities, which are licensed to operate their networks by the pertinent authority. Electricity transmission is priced using a so-called point-tariff system (postage stamp). The user can procure electricity from anywhere in the country without restriction. The user pays one grid transmission fee at his grid connection point, which covers the transmission costs for the use of the entire grid, without any additional fees. The producer can feed power into the network using the same payment principle. The grid operators are–responsible for operating, maintaining and developing their networks. In the present situation there is a need to improve the monitoring of power grid operations because of their monopolistic nature. To accomplish this, a separate monitoring authority was set up, the Energy Market Authority. The transmission of electricity over the national grid as well as the boundary interconnections with Sweden, Norway and Russia are managed by a system responsible grid company Fingrid Plc., which is owned by the two major producers (Fortum and PVO), Finnish government and institutional investors.

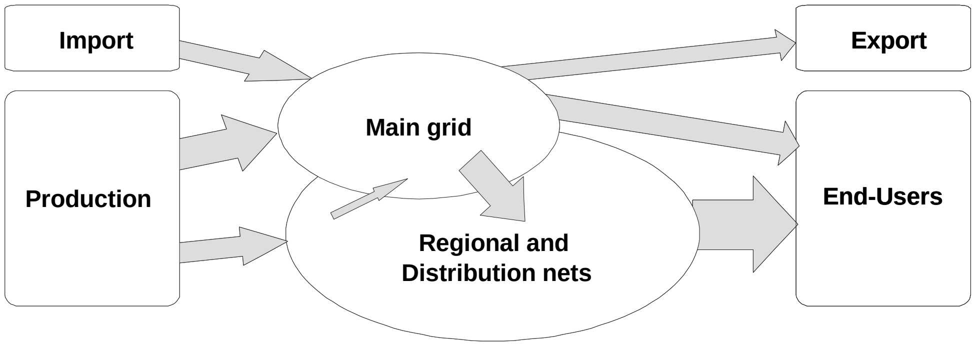


FIG. 5. The Finnish power system.

The biggest bulk sellers of electricity in Finland are Fortum Power and Heat Oy and Vattenfall. They sell electricity directly to large, business-to-business customers and electricity retailers. Electricity retail is carried out mainly by the local and regional electrical companies. There are about one hundred of these players in Finland. No special permits are required to sell electricity, so the industry is open to new competitors as well.

Industrial and domestic consumers are free to use the power supplier they prefer. The power industry is covered by the same laws as other commercial activities. Companies are fully responsible for their economic operations. The main government influence on energy decisions is through taxes and some minor subsidies. Anyone has the right to construct a power station or a transmission line. Licence for construction of power plants is needed only for nuclear and hydropower plants. New power plant projects (nuclear facilities and thermal power plants (> 300 MW_{th})) and high-voltage transmission lines (≥ 220 kV)) need to undergo environmental impact assessment procedure. The construction of a transmission line requires a licence from the Energy Market Authority and a cross-border transmission line requires a licence from the Ministry of Employment and the Economy. The licence of electricity imports has been abolished. This deregulation has made it possible for Finnish electricity consumers to co-operate directly with foreign power producers and traders. The state promotes the use of renewable energy and conservation measures by giving some investment subsidies or other forms of support.

The decision-making process for building nuclear facilities is rather complex and requires (besides the normal environmental impact assessment procedure necessary for major power plant projects) ultimately also the approval of the Decision-in-Principle by the

Parliament (cf. Section 3.1). The Nuclear Energy Act of 1987 defines the procedures required for new nuclear power plants irrespective of private or state ownership. The same is true what comes to other nuclear facilities, such as the waste management facilities, and to decommissioning.

The historical trends of electricity supply and the installed capacities are given in Table 7. Table 8 gives additional details for electricity supply and consumption in the years 1995, 2000, 2005 and 2009. The total domestic electricity production in 2010 was 77 TW·h and the total consumption of electricity was 87.5 TW·h. The share of electricity supply in primary energy consumption is gradually increasing and reached the level of 46.3% in 2009 (Table 8). The trend of electricity supply from 1970 onwards is given in Fig. 7. The type of power supply is depicted in Fig. 8 and the energy sources in electricity supply in 2010 are given in Fig 9.

TABLE 7. ELECTRICITY SUPPLY/PRODUCTION (NET) AND CAPACITY (GROSS)

									Annual Average Growth rate (%)	
Capacity of electrical plants, gross (GWe)	**1970**	**1980**	**1990**	**2000**	**2005**	**2007**	**2008**	**2009**	**2010**	**1980 to 2000**	**2000 to 2010**
Total	4.72	10.38	13.54	17.29	17.99	16.91	17.04	17.06	16.72	2.6 %	-0.33 %
Thermal	2.60	7.13	8.47	11.54	12.09	11.06	11.10	11.06	10.68	2.4 %	-0.77 %
Hydro	2.13	2.13	2.68	2.96	3.04	2.99	3.03	3.05	3.07	1.7 %	0.39 %
Nuclear	—	1.12	2.39	2.76	2.78	2.80	2.80	2.80	2.82	4.6 %	0.22 %
Geothermal	—	—	—	—	—	—	—	—	—	—	—
Wind	—	—	—	0.038	0.082	0.057	0.11	0.143	0.147	—	14.49 %
Electricity supply/ production, net (TW•h)											
Total supply	21.82	39.92	62.33	79.16	84.67	90.37	87.25	81.29	87.46	3.5 %	1.0 %
Total domestic production	21.29	38.71	51.59	67.28	67.66	77.82	74.47	69.20	76.96	2.8 %	1.4 %
Thermal	11.86	21.97	22.71	31.17	31.70	41.14	35.25	33.75	42.02	1.8 %	3.0 %
Hydro	9.43	10.12	10.75	14.45	13.43	13.99	16.91	12.57	12.77	1.8 %	-1.2 %
Wind	—	—	—	0.08	0.17	0.19	0.26	0.28	0.29		14.3 %
Geothermal	—	—	—	—	—	—	—	—	—	—	—
Nuclear	—	6.63	18.13	21.58	22.36	22.50	22.05	22.60	21.89	6.1 %	0.1 %
Net imports of electricity	0.53	1.21	10.74	11.88	17.02	12.56	12.77	12.09	10.50	12.1 %	-1.2 %

Source: Energy Statistics 2010, Statistics Finland.

TABLE 8. ELECTRICITY SUPPLY (INCL. NET IMPORTS) BY PLANT TYPES AND CONSUMPTION IN DIFFERENT SECTORS IN 1995, 2000, 2005 AND 2009.

	1995			2000			2005			2009		
Electricity supply	EJ [1]	TW·h	%	EJ	TW·h	%	EJ	TW·h	%	EJ	TW·h	%
Nuclear power	0.198	18.1	26.3	0.233	21.6	27.3	0.244	22.4	26.4	0.247	22.6	27.8
Conventional condensing power	0.097	8.9	12.9	0.127	6.9	8.8	0.1709	5.3	6.3	0.1704	8.96	11.0
Hydropower	0.046	12.8	18.5	0.038	14.5	18.3	0.048	13.4	15.9	0.045	12.6	15.5
Wind power	0.00004	0.0	0.02	0.00023	0.1	0.1	0.00061	0.2	0.2	0.00100	0.28	0.3
Cogeneration (CHP), district heating [2]		11.3	16.3	0.149	13.4	16.9	0.06	15.8	18.6	0.068	15.3	18.8
Cogeneration (CHP), industry [2]		9.5	13.7	0.270	10.8	13.7	0.052	10.6	12.5	0.039	9.5	11.7
Net imports	0.030	8.4	12.2	0.043	11.9	15.0	0.061	17.0	20.1	0.044	12.1	14.9
Total electricity supply	0.456	68.9	100	0.503	79.2	100	0.641	84.7	100.0	0.615	81.286	100
Electricity consumption												
Industry		37.0	53.7		43.8	55.3		43.7	51.6		37.3	45.9
Households and agriculture		17.1	24.7		19.0	24.0		23.4	27.6		25.1	30.9
Services and public consumption		11.9	17.2		13.8	17.4		14.6	17.2		16.1	19.8
Losses		3.0	4.4		2.6	3.3		3.0	3.6		2.8	3.4
Total primary energy consumption	1.204			1.321			1.370			1.328		
Share (%) of electricity supply out of primary energy consumption	37.9%			38.1%			46.8%			46.3%		

[1] Primary energy; the definition of CEC used in conversion of electricity production into primary energy.
[2] For the cogeneration (CHP) primary energy (EJ) includes also the heat output and the actual efficiency achieved is taken into account.
Source: Energy Statistics 2010; Statistics Finland.

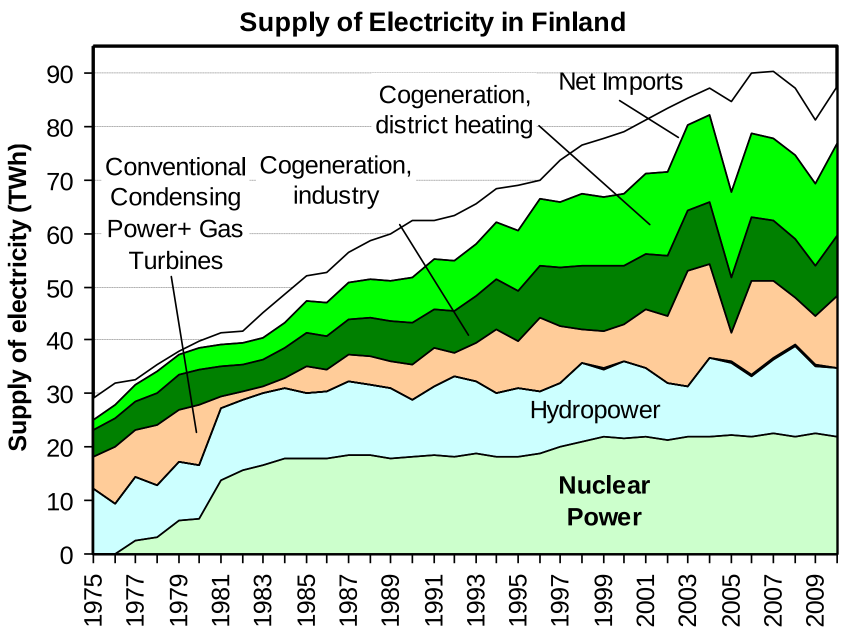


FIG. 7. Electricity Supplies in Finland (1970–2010).

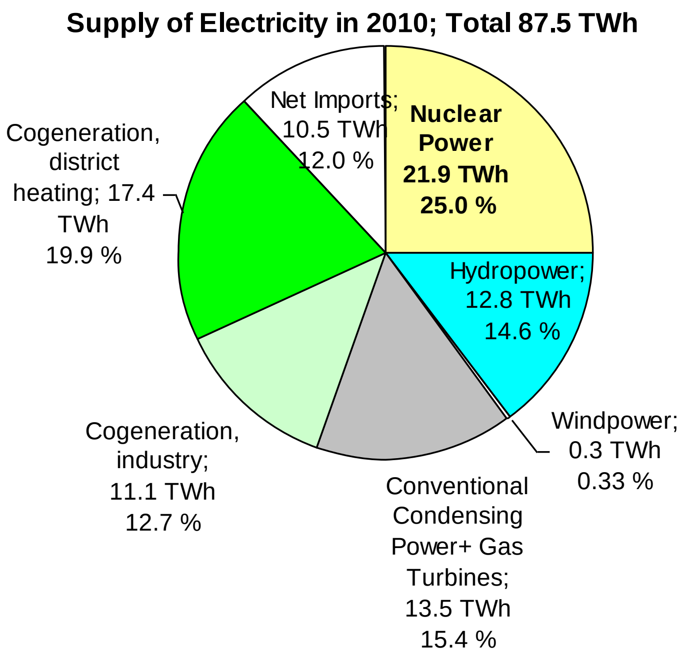


FIG. 8. Electricity supply in 2010 by type of generation (total 87.5 TW·h).

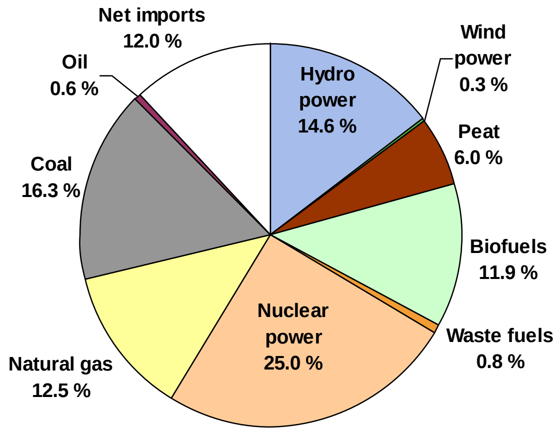


FIG. 9. Electricity supplies by energy sources in Finland in 2010; total supply 87.5 TW·h.

1.3.3 Electricity production and installed generating capacity and energy related ratios

The main sources of power production in Finland are thermal, nuclear and hydropower plants. In 2010 the shares of these sources in the domestic power production were 54.6%, 28.4% and 16.6%, respectively. So far only a very small volume (about 0.4%) of electricity is produced by wind power, although the relative increase of wind power capacity has recently been quite rapid. Finland's electricity generation capacity (nominal) totalled at the beginning of 2010 about 16 600 MW; broken down as follows (Source: Statistics Finland). In addition, electricity is imported from Russia, the Nordic electricity market and Estonia.

• Hydro power	3 074 MW	• CHP, industry	3 238 MW
• Nuclear power	2 696 MW	• Gas turbines	783 MW
• Condensing power	2 405 MW	• Wind power *(March 2008)*	147 MW
• CHP, district heating	4 256 MW	• Electricity import (max. allowed capacity)	3 850 MW

The per capita electricity consumption in 2010 was about 16 500 kW·h. Electricity represented in 2009 about 46.6 per cent of the primary energy consumption. The share has continuously risen. In the industry sector electricity is the main source of energy. In 2010, the Finnish industry consumed 45.9 TW·h (47.2%) of the electricity. As compared to the previous year the consumption of electricity by the industry increased by 4 TW·h (10.6%). The most important branch is pulp and paper production, which in 2010 consumed 53.8% of the total electricity needs of the industry. Other significant branches are the metal and chemical industries. Some energy related ratios are given in Table 9.

1.4 Energy Taxation

In 1990, Finland became the first country to enact an energy tax based on the carbon content of energy products. However, after the deregulation of the electricity market in 1995, this taxation system was found to impair severely the Finnish electricity producers' competitiveness in Nordic markets. Several changes have been implemented to reform the energy taxation and harmonise it with the practises within the EU.

Until the end of 2010 Finnish energy taxation system levied a tax on the end use of electricity (EUR 2.5/MWh for industry and EUR 8.7/MWh for other consumers). There was also a Precautionary Stock Fee of 0.013 cent/kWh for all customers. From 2011 onwards there are two tax classes (16.9 and 6.9 €/MWh) for electricity. In heating fuel taxation a new structure based on two components was introduced in 2011. It takes into account energy content of the product (energy content tax (€/MJ)) and CO_2 emissions of the product (CO_2 tax (€/MJ), based on 30 €/tCO_2).

CO_2 tax for fossil fuels used in CHP is halved to avoid overlap with ETS and to improve the competitiveness of CHP compared to separate heat production.

1.5 Privatisation and deregulation

1.5.1 General electricity market situation in Finland

The Electricity Market Act, which came into force in 1995, has set great challenges for the Finnish electricity market. Since the beginning of 1997, the markets have been deregulated for all consumers, and the over 3 million electricity consumers in Finland are now able to purchase their electricity from any supplier they choose. Deregulation of the electricity market has resulted in considerable changes in companies in the sector and in their ownership structures. In order to rationalise their operations, companies have, for example, established joint ventures for both electricity supply and sales. The enforcement of legislation pertaining to Finnish electricity markets and the grid operators´ operations are overseen by Energy Market Authority in collaboration with the Finnish competition authorities.

The Finnish Power Exchange (EL-EX) for buying and selling electricity started its operations in August 1996. The Nordic Power Exchange, Nord Pool, is the marketplace for trading electric power in the Nordic countries. Established in 1993, Nord Pool is the world's first multinational commodity exchange for electric power.

The licences specify the franchised territory for the distribution companies. In Finland there is only one company (Fingrid Plc.) for transmission of high-voltage electricity. In their territories the distribution utilities are obligated to connect end-users and production sites to the distribution network against reasonable compensation.

TABLE 9. ENERGY RELATED RATIOS

								Annual Average Growth rate (%)	
Year	**1970**	**1980**	**1990**	**2000**	**2005**	**2009**	**2010**	**1980 to 2000**	**2000 to 2010**
Primary energy consumption, GJ per capita	160	190	230	250	260	250	270	1.4 %	0.8 %
Electricity consumption, kW•h/capita	4700	8100	12700	15200	16300	15300	16300	3.2 %	0.7 %
Nuclear production/Total domestic electricity production (%)		17.1	35.1	32.1	29.6	32.7	28.4	3.2%	-1.2%
Nuclear production/Total electricity supply (%)		16.6	28.6	27.3	26.0	27.8	25.0	2.5%	-0.8%
Ratio[1] of external dependency (%)	70.7	78.8	76.5	69.8	68.9	68.8	66.7	-0.6%	-0.5%

Annual capacity factors (%) of power plants									
Total[2]	60.3	40.7	45.0	48.5				0.9%	
Thermal[2]	57.5	38.7	33.7	35.0				-0.5%	
Nuclear[3]	—	44.5	90.1	92.8	95.9	95.9	92.6	3.7%	-0.02%
Hydro[2]	63.7	66.6	47.3	58.1				-0.7%	
Wind[2]			4.6	23.4					
Geothermal	—	—	—	—	—	—	—	—	—
Other renewables[2]									

[1] *Net import of primary energy per Total primary energy consumption; nuclear is not considered domestic*
[2] ***Source:*** *IAEA Energy and Economics Database*
[3] ***Source:*** *Finnish utilities; net capacity weighted average of Lo 1-2 and OL 1-2 during commercial operation*

Transmission and distribution companies are obligated to transmit electricity in their networks if transmission capacity is available. Electricity retailers who have dominant market position in a distribution network have an obligation to offer electricity to small-scale customers at a reasonable public price. Customers can choose between this local offer and any other offers on the competitive market. Foreign ownership in electricity supply is also possible.

Generation and transmission investments are funded by loans from the domestic and international financial market, by self-financing and by equity capital. The state does not fund investments by the utilities and gives no guarantee for debts. The state is only involved as an equity investor in the state-owned companies and requires fair return on equity capital.

1.5.2 Impacts of deregulation on nuclear power sector in Finland

The existing nuclear power plants in Finland are operating as base load units and have had most of the time an average annual load factor of more than 90%. The electricity production costs are low for both Loviisa and Olkiluoto NPPs. The investment costs of the existing nuclear plants are to large extent already paid and the operating costs are low compared with conventional thermal power stations. Hence, the deregulation of electricity market does not have any significant impacts on the competitiveness of nuclear power. The present nuclear power plants have become more competitive as emission trading has been introduced. In that case, a long lifetime for most of the existing nuclear power plants can be foreseen.

2. NUCLEAR POWER SITUATION

2.1 Historical development and current organizational structure

The Technical Research Centre of Finland (VTT) has a research reactor in operation since 1962. The Loviisa Power Plant units, on the southern coast (cf. Fig. 10), owned by Fortum Power and Heat Oy (Fortum), were ordered in 1969 and 1971 and started commercial operation in 1977 and 1981. The Olkiluoto Power Plant units, on the western coast, owned by Teollisuuden Voima Oyj (TVO), were ordered in 1972 and 1974 and started commercial operation in 1979 and 1982. The Loviisa power plant has two Russian (Soviet) VVER (PWR) reactors and Olkiluoto power plant has two Swedish BWRs. At the start of the operation the nominal net capacity of the Loviisa units was 420 MW(e) each and the initial net rating of the Olkiluoto units was 660 MW(e) each. The power level (net) of the Olkiluoto units was raised to 710 MW(e) in 1984. In the connection of the latest operating licence renewal process and plant modernisation projects (cf. Section 2.2.3), the authorities approved in 1998 the uprating of the power production capacities (net) of the Loviisa and Olkiluoto plants up to 2×488 MW(e) and 2×840 MW(e). Thereafter the capacity of the reactor units at Olkiluoto have further been raised up to 860 MW(e) each during 2005–2006 through the modernization of the high-pressure turbines. In addition, the net capacity of Olkiluoto 1 was increased to 880 MW(e) from July 2010 onwards in further turbine improvements. Similar improvement is planned for unit 2 in the connection of the maintenance outage of 2011.

The nuclear steam supply system (NSSS) and twin turbine generators for Loviisa nuclear power plant were supplied by V/0 Atomenergoexport of the former USSR. Imatran Voima Oy, IVO (predecessor of Fortum Power and Heat Oy) acted as its own architect engineer and co-ordinated the design and supply of equipment from several countries. This included the integration of West German instrumentation and, under Westinghouse licence, an ice condenser containment system.

The Olkiluoto units were ordered on turnkey contracts from Asea-Atom (now Westinghouse Electric Sweden Ab). TVO had the responsibility for the second unit's civil engineering systems. In 1993, the containment buildings were retrofitted with Siemens filtered venting system.

2.2 Nuclear power plants: Overview

2.2.1 Status and performance of nuclear power plants

In 2010, 27.9% of the total electricity supply in Finland was produced by nuclear power. Finland's four nuclear power plant units (Table 11) have a total net capacity of 2 816 MW(e) at the end of 2010. They have operated reliably and complied with existing safety and environmental protection standards. For years, the annual load factors of all the units have been around 90%. Both companies have invested a lot to keep the annual outages as short as possible. During 2010, all the Finnish nuclear power units continued very reliable operation.

The historical trend of annual load factors of the Finnish nuclear power plants is shown in Fig. 11. The development of annual occupational collective doses (manSv/a/reactor) of the Finnish nuclear power plants (both with 2 reactor units) are shown in Fig. 12. The annual number of abnormal events (1970–2010) according to the INES-scale is depicted in Fig. 13.

TABLE 11. STATUS OF NUCLEAR POWER PLANTS

Station	Type	Gross/Net Capacity (MW_e)	Operator	Status	Reactor Supplier
LOVIISA-1	VVER	510/488	FORTUM Power and Heat	Operational	AEE
LOVIISA-2	VVER	510/488	FORTUM Power and Heat	Operational	AEE
OLKILUOTO-1	BWR	910/880	TVO	Operational	ASEASTAL
OLKILUOTO-2	BWR	910/880	TVO	Operational	ASEASTAL
OLKILUOTO-3	PWR	– /~1600	TVO	Under construction	AREVA NP

Station	Construction Start Date	Criticality Date	Grid Date	Commercial Date	Shutdown Date
LOVIISA-1	01-May-71	21-Jan-77	08-Feb-77	09-May-77	
LOVIISA-2	01-Aug-72	17-Oct-80	04-Nov-80	05-Jan-81	
OLKILUOTO-1	01-Feb-74	21-Jul-78	02-Sep-78	10-Oct-79	
OLKILUOTO-2	01-Aug-75	13-Oct-79	18-Feb-80	10-Jul-82	
OLKILUOTO-3	spring 2005				

Source: IAEA Power Reactor Information System (PRIS).

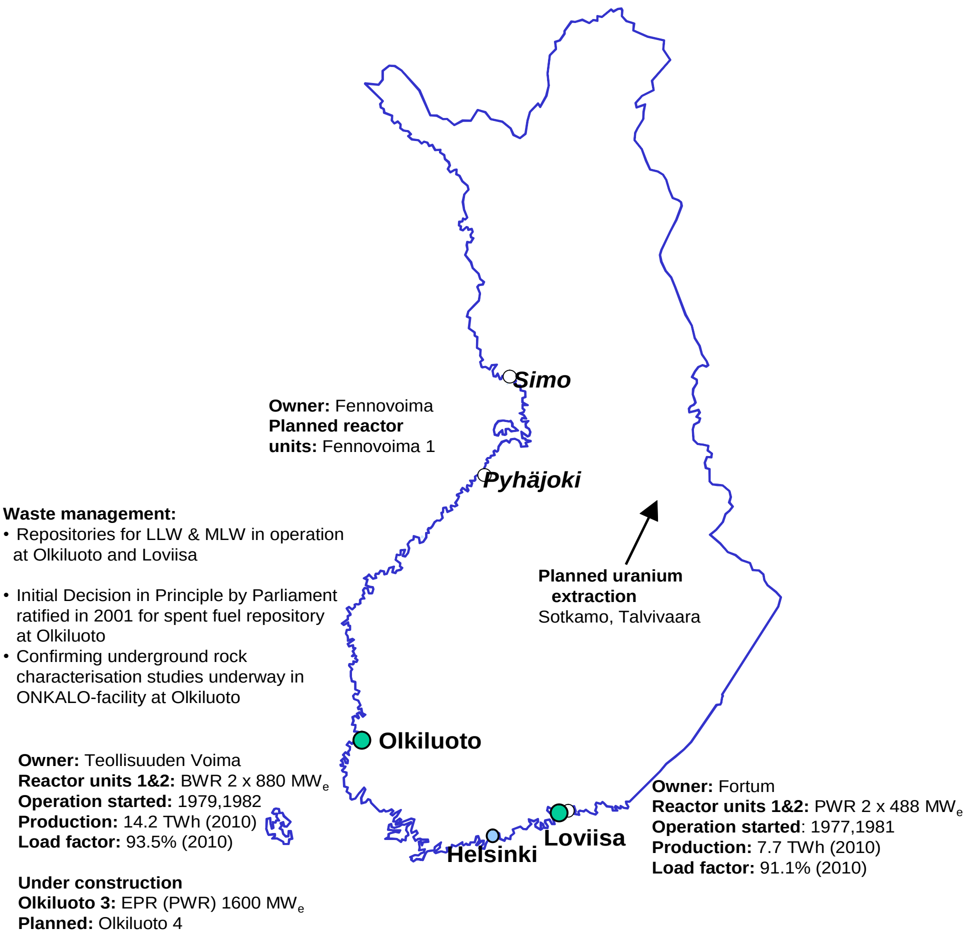


FIG. 10. Locations of the existing Finnish nuclear power plants in Loviisa and Olkiluoto and candidate sites, out of which Fennovoima Oy will make final choice during summer 2011.

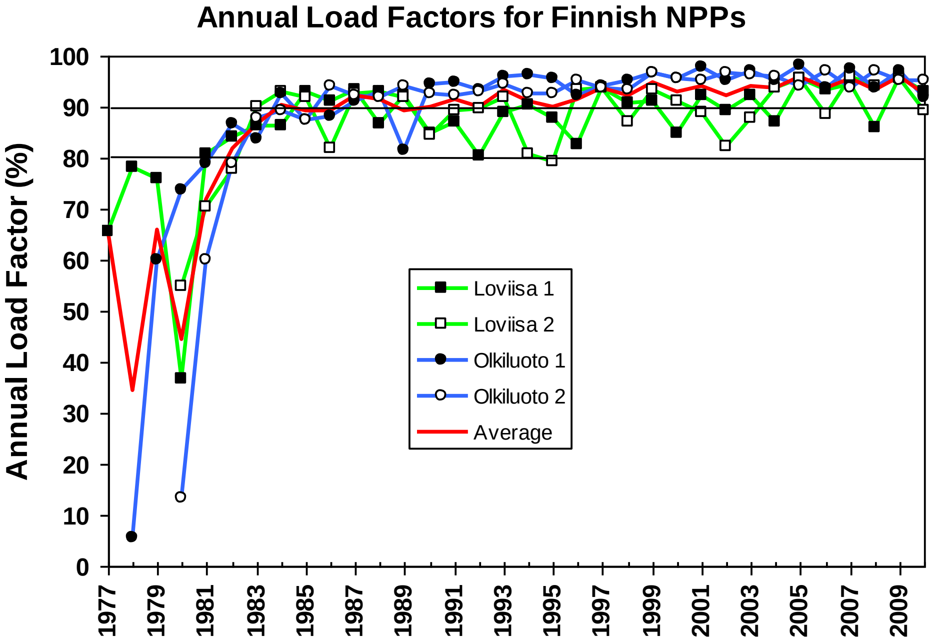


FIG. 11. The development of annual load factors of the Finnish nuclear power plants.

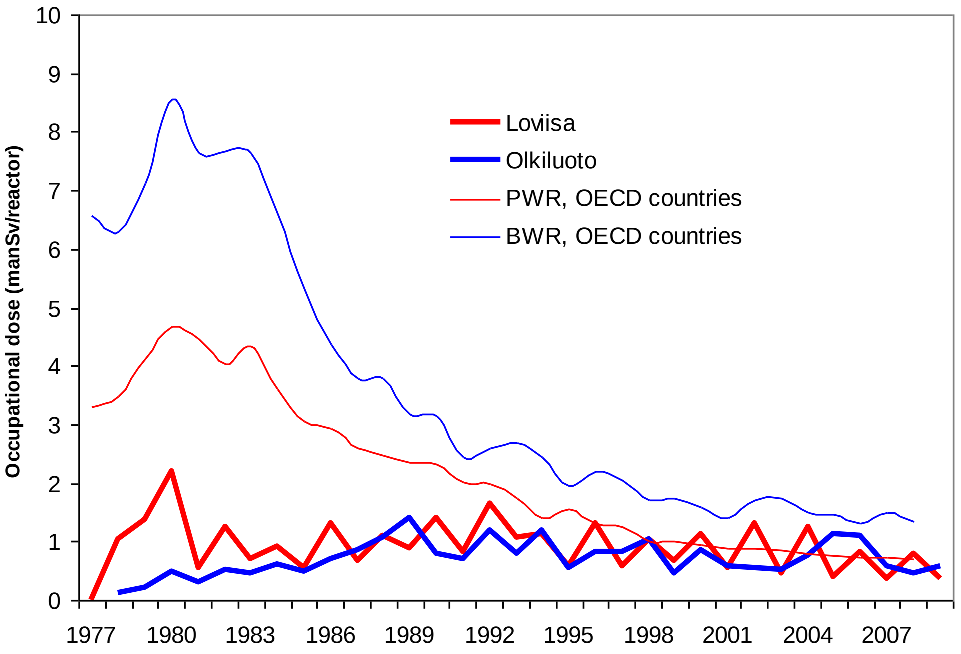


FIG. 12. The annual occupational doses per rector unit to the personnel of the Finnish nuclear power plants as compared to the average world experience (ISOE statistics of OECD/NEA.

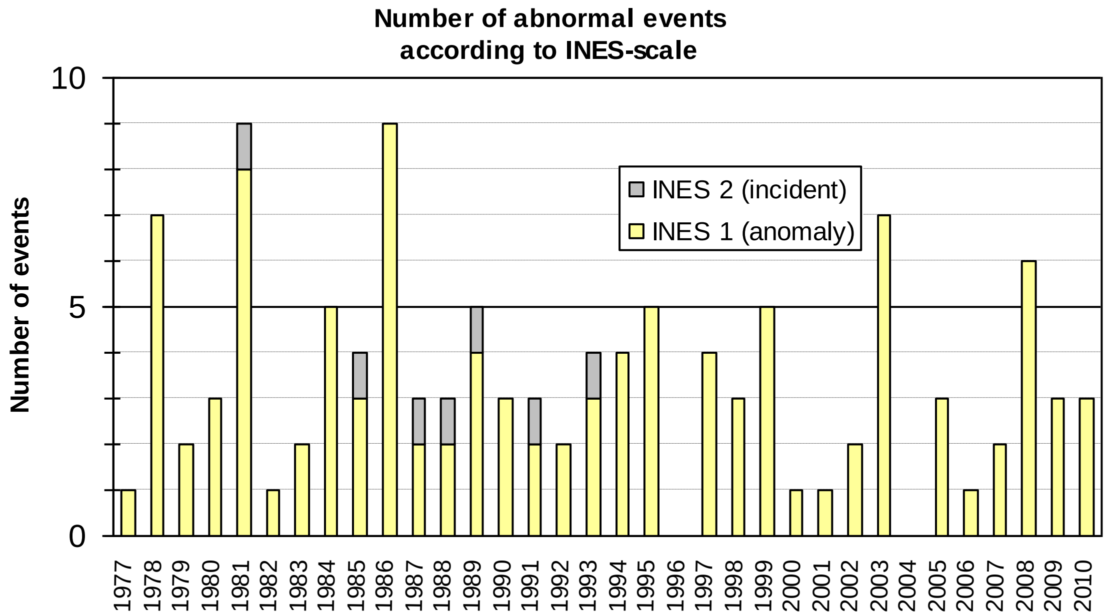


FIG. 13. The total annual number of abnormal events (anomalies & incidents) according to the International Nuclear Events Scale (INES) at the Finnish nuclear power plants. During 2007 there were two events rated at the level of 1 at the Olkiluoto NPP

2.2.2 Plant upgrading and plant life management and licence renewals

Major modernisation and power uprating actions have been carried out in the connection of the licence renewal processes. Several technical modifications at the plants and thorough updating of the Final Safety Analysis Reports were necessary. The upgrading of nuclear power plant capacity in 1997–1998 was altogether 350 MW_e. Thereafter smaller capacity upgrading have been achieved for the Olkiluoto plant units by renewals of the turbine systems. In April 1998 the Government granted the licence to the Loviisa 1 and 2 plant units at the uprated power level. The licence was valid up to the end of 2007. It covered also the repository for low and medium level nuclear waste and interim storages for spent fuel including the necessary expansion of these facilities. The licence for the operational waste repository is valid until the end of 2055. The thermal power of both Loviisa units was uprated to 109% from the rated power specified in the former operating licence.

Since the operating licences of the Loviisa 1 & 2 reactor units would have expired at the end of 2007, the operating licence renewal application was submitted to the authorities for a regulatory review in the autumn of 2006 and, in July 2007, the Government granted the renewal of the operating licences of Loviisa 1 & 2 up to 2027 and 2030, respectively. As part of the automation renewal (LARA project), the I&C systems of the plant will be renewed gradually; there will be four stages per plant unit. The first system commissioning took place in 2007 and the last stage will be carried out in 2014.

The application in late 1990s for renewal operating licence of Olkiluoto NPP was made for uprated 115.7% reactor power. The Government granted the licence to Olkiluoto 1 and 2 units in August 1998 at the uprated power level. Thereafter the capacity of the reactor units at Olkiluoto have further been raised up to 860 MW(e) each during 2005–2006 through the modernization of the high-pressure turbines.

The current operating licences of Olkiluoto 1 & 2 are valid until 2018 and required that a comprehensive periodic safety review (PSR) needed to be carried out by the end of 2008. This

PSR was submitted to the safety authority, STUK, for its approval. TVO begun preparations for the PSR already in 2004. STUK reviewed during 2009 the documentation provided by TVO and gave some recommendations to TVO in its final review report published in 2010.

TVO has also replaced the low-pressure turbines of unit 1 during 2010 and thereby raised the output of the reactor units to 880 MW. During the 2011 maintenance outage the capacity of unit 2 will be raised similarly to 880 MW as well. Furthermore, TVO has preliminary plans to increase capacity further, up to 2 x 1000 MW, in connection with the application for the renewal of the operation licence required after 2018.

2.3 Future development of Nuclear Power

In May 2002, the Finnish Parliament ratified the Government's earlier favourable Decision-in-Principle (DiP) on the fifth nuclear power plant unit. TVO chose Olkiluoto as the location of the unit in October 2003 and, in December 2003, made the investment decision to choose the European Pressurised Water Reactor (EPR) with a net electrical output of around 1600 MW. The plant's supplier is a consortium composed of Areva NP and Siemens AG. Nuclear power capacity is being increased, mainly in an effort to restrict the use of fossil fuels in order to counter climate change. Furthermore, good experiences of the existing nuclear power plants, the steady price of nuclear electricity and Finland's small indigenous energy resources were additional contributing factors. Moreover, the Finnish public has adopted a relatively positive attitude towards an increase in nuclear power within the country. The different phases of the process related to the fifth reactor in Finland are depicted in Fig. 14.

Finnish nuclear power companies had closely followed the development of nuclear technology in the 1990s and also participated in certain plant concept development projects. In 1998 the Finnish nuclear power companies, Fortum and TVO, separately launched the environmental impact assessment (EIA) procedures in compliance with the legislation in force, in order to study the environmental effects of a new nuclear power plant unit built either in Loviisa or at Olkiluoto. The environmental impact assessment procedures were completed in February 2000, when the Ministry of Trade and Industry issued its final statement on the reports, concluding that the environmental impacts have been studied with sufficiently comprehensive scope.

In November 2000, TVO filed an application to the Government for a DiP concerning the construction of a new nuclear power plant unit. In the application, the size of the new unit was defined at 1000–1600 MW with a technical operating lifetime of 60 years. The locations, Loviisa and Olkiluoto, competed as equal alternatives, as did the boiling water and pressurised water technologies as technical alternatives. The application also included the nuclear facilities required for the handling, storage and final disposal of operating waste.

The Government made its favourable DiP on the fifth nuclear power unit in January 2002. In May 2002, Parliament decided to ratify the DiP by a vote of 107–92. Thus, TVO was authorised to continue preparations for the construction of a new nuclear reactor unit.

TVO initiated an invitation to tender for the project in the autumn of 2002 and received the tenders for the new plant unit in March 2003. After the evaluation of the tenders, TVO chose Olkiluoto as the location of the plant in October 2003 and continued contract negotiations with the supplier consortium, comprising the German Framatome ANP GmbH, the French Framatome ANP SAS (now Areva NP) and the German Siemens AG. The investment decision on the construction of the Olkiluoto 3 nuclear power plant unit was made in December 2003.

In January 2004, TVO submitted a licence application to the Government for the construction of a nuclear power plant unit called Olkiluoto 3 in the municipality of Eurajoki on the Olkiluoto nuclear power plant site.

In accordance with the Nuclear Energy Act and the Nuclear Energy Decree, the Ministry of Trade and Industry handled the application on behalf of the Government. The Ministry invited statements from the Finnish Radiation and Nuclear Safety Authority (STUK) and several other authorities and organisations. In addition, the Ministry sent the construction licence application for information to several other institutions with a view to obtaining possible statements from them.

The Statement of Position of the Finnish Radiation and Nuclear Safety Authority (STUK) was submitted to the Ministry in January 2005. According to STUK´s overall assessment, the Olkiluoto 3 nuclear power plant unit can be built safely, fulfilling the requirements set by the Nuclear Energy Act. Furthermore, in its Statement of Position STUK presented some specifying comments and restrictions. In February 2005, the Government granted the licence for constructing the Olkiluoto 3 unit. The reactor's thermal output will be 4 300 MW and electric output about 1 600 MW.

The construction of the reactor started in summer of 2005 and by the end of 2010 the civil construction works had been completed to a large extent. Several major components, such as the reactor pressure vessel, pressurizer and three steam generators, have been installed. Installation and pipeline welding works continued at the plant. The turn key supplier Areva has informed TVO that most of the work at the plant will be completed in 2012. According to Areva, commissioning will take about eight months, which means that operation could be started during the latter half of 2013. There have been some problems in design and construction works and the project has been delayed by approximately four years, compared to the original schedule.

The next step in the licensing process will be the handling of the application for an operating licence. This application is expected to be submitted to the Government by the end of 2011 or early in 2012. Its processing is expected to take at least one year. Consequently the commercial operation of Olkiluoto 3 will probably start first close to the end of 2013.

In May 2002, simultaneous with the DiP on the fifth Finnish reactor unit, Parliament unanimously ratified also a separate DiP on the final disposal of the spent nuclear fuel of the fifth nuclear power unit. According to this decision, the spent fuel of the possible fifth nuclear power unit would also be disposed of in the bedrock at Olkiluoto, like the spent nuclear fuel of the present nuclear power plants.

Phase of the Project	Started	Completed
Environmental Impact Assessment procedure (FIN5)	June 1998	February 2000
Application for Decision in Principle (DiP) for FIN5	November 2000	
Decision in Principle (DiP) by Government		January 2002
DiP ratified by Parliament		May 2002
Bidding process	September 2002	March 2003
Investment decision and main contract signed for OL3		December 2003
Construction licence application submitted	January 2004	
Excavations started	February 2004	
Construction licence granted		February 2005
Construction of the plant	March 2005	
Application of operating licence	2011/2012	
Granting of operation licence		2013
Commercial operation		2013

FIG. 14. Phases of the Olkiluoto 3 project. (Status in May 2011)

2.3.1 Nuclear power development strategy

In the spring of 2007, both TVO and Fortum announced that they had begun the environmental impact assessment (EIA) procedure for a new nuclear power plant unit (1000–1800 MW) at either the Olkiluoto or the Loviisa sites, respectively. The EIA report is an obligatory attachment of an application for a Decision-in-Principle (DiP) to the Government.

TVO filed its DiP application in April 2008. However, the Companies had not made any firm investment decisions with respect to constructing a new power plant unit. In the early summer of 2007, a new Finnish energy company, Fennovoima, was established, also with the intention to construct a nuclear power plant in Finland rated 1500–2500 MW. The shareholders of Fennovoima are Finnish trade, industry, and service companies, regional and local energy companies, as well as E.ON which, as a minority shareholder, offers its expertise in nuclear technology to Fennovoima's project. A summary of the phases involved in the planning of new reactors by TVO , Fortum and Fennovoima is presented in Fig. 15.

At the end of May 2007, TVO submitted the programme of the Environmental Impact Assessment (EIA) procedure for a planned fourth reactor unit at Olkiluoto in Eurajoki and the Ministry of Trade and Industry (now Ministry of Employment and the Economy) issued its statement on the programme at the end of September 2007. The nuclear power plant unit may be either a boiling or pressurised water reactor plant. This EIA procedure ended in June 2008.

At the end of June 2007, Fortum submitted the EIA programme for a planned third reactor unit at the Loviisa site and the Ministry issued its statement on the programme in the middle of October 2007. This EIA procedure was completed in August 2008. Fortum submitted the DIP application to the Government in February 2009.

Phase of the Project	**Started**	**Completed**
TVO delivers EIA programme of OL4 for review by Ministry	May 2007	
Ministry submits statement on EIA programme for OL4		September 2007
Preparation of EIA report for OL4	September 2007	February 2008
Application filed by TVO for DiP for OL4 unit	April 2008	
Ministry submits statement on EIA report by TVO		June 2008
Government makes positive DiP		May 6, 2010
DiP ratified by the Parliament		July 1, 2010
Fortum delivers EIA programme of Lo3 for review by Ministry	June 2007	
Ministry submits statement on EIA programme for Lo 3		October 2007
Preparation of EIA report for Lo 3	October 2007	April 2008
Ministry submits statement on EIA report by Fortum		August 2008
Application from Fortum for DiP for Lo3 unit	February 2009	
Government makes negative DiP		May 6, 2010
Fennovoima delivers EIA programme of new plant for review by MEE	January 2008	
MEE submits statement on EIA programme by Fennovoima		May 2008
Preparation of EIA report by Fennovoima	May 2008	October 2008
MEE submits statement on EIA report by Fennovoima		February 2009
Application for DiP for new reactor units by Fennovoima	January 2009	
Government makes positive DiP		May 6, 2010
DiP ratified by the Parliament		July 1, 2010

FIG. 15. Phases of the initiatives of TVO, Fortum andFennovoima with respect to building additional nuclear power plant unit(s)in Finland. (Status in May 2011)

In 1997–1999, Posiva conducted an EIA procedure covering 9000 tU (tons of uranium) of spent fuel. Posiva updated during 2008 the previously performed investigations for the EIA report. Posiva filed a DiP application in April 2008 concerning the spent fuel from the proposed Olkiluoto 4 unit. The total disposal capacity will thereby be increased to 9000 tU. The increase further up to 12000 tU, to cover the spent fuel arising from planned Loviisa 3, required a new EIA procedure that was completed in March 2009. Thereafter Posiva submitted the DiP application for this increase in March 2009 as well.

In the first phase of Fennovoima's project, during the summer of 2007, the company surveyed potential nuclear power plant sites in various parts of Finland. Following negotiations with several municipalities, the company begun the EIA within four municipalities. The EIA procedure was conducted at three sites (Pyhäjoki, Ruotsinpyhtää and Simo). In January 2008, Fennovoima submitted the EIA Program to the Ministry of Employment and the Economy for review, and submitted an EIA Report to the Ministry in October, while the whole procedure was completed in February 2009. The company filed in January 2009 an application of DiP for the planned reactor unit(s). The application included two alternative sites, Pyhäjoki and Simo.

The submitted DiP applications were subsequently handled according to the requirements of the Nuclear Energy Act under the leadership of the Ministry of Employment and the Economy. The Ministry processed all five DIP applications during 2009-2010 and the Government made its decisions in May 2010. All applications fulfilled all safety and environmental requirements. As specified by the Nuclear Energy Act, decisions on all DIPs were based on the project's overall good of the society, projected national energy needs in 2020 and the limit of two new nuclear power plant units at this time.

The Olkiluoto 4 and Fennovoima's new build project received positive DIPs by the Government as did Posiva's plan for repository enlargement project for Olkiluoto 4 spent fuel. Loviisa 3 was issued a negative DIP, as was Posiva's proposal to further expand ONKALO to accommodate Loviisa 3 spent fuel. The three positive DIPs were ratified in Parliament on 1 July 2010.

Positive DIPs were issued to the two utilities (TVO and Fennovoima) that will produce cost price electricity for the needs of Finnish industries that are funding these new build projects. The Government took also into account Fortum's stake (about 25 %) in TVO when deciding upon the DiPs.

Fennovoima has during the EIA- and DiP-processes narrowed down the site list to Simo and Pyhäjoki from the original four sites under consideration. Both municipalities have stated, as per the request of the Ministry, that they are willing to host Fennovoima´s plant and STUK has found both of these greenfield sites suitable for a nuclear power plant. Fennovoima is expected to choose the site in the summer of 2011.

The utilities, TVO and Fennovoima, have preliminarily planned to issue the call for tenders within about two years after the granting of DiPs.

2.4 Organisations involved in construction of NPPs

There are no domestic suppliers of whole power plants or nuclear steam supply systems (NSSS). However, the NPP owner Fortum Power and Heat Oy itself provides technical support to the Loviisa NPP as well as subsystem design services to Finnish and foreign customers. In addition, there are Finnish suppliers of smaller components.

During the construction of the existing NPPs the collaboration with foreign vendors provided Finnish companies with experience in supplying certain mechanical equipments to nuclear power stations. Domestic capabilities have thereafter also been developed for simulators, fuel handling, storage equipment, radiation dosimeters and monitoring equipment.

The design, deliveries and installation works in the connection of the modernisation projects were carried out by domestic and foreign companies.

2.5 Organizations involved in operation and decommissioning of NPPs

The operation, maintenance, and training at Loviisa are carried out by FPH. TVO takes care of the operation and maintenance and the operation of NPPs. The utilities are also responsible for the planning of future decommissioning of NPPs and other related nuclear facilities.

2.6 Fuel cycle including waste management

After joining the European Union the requirements of Euratom have been adopted in nuclear fuel supply to the Finnish NPPs.

Until the late 1990's the fuel to the Loviisa NPP came from the Russian supplier. Then the operator FPH started efforts for acquiring an optional fuel supplier from western sources besides the Russian fuel supplier. Together with the Hungarian Paks utility, test fuel assemblies have been bought from the BNFL. First lead assemblies from BNFL were loaded in Loviisa in 1998 and from 2001 until 2005 part of the fuel for Loviisa NPP has been delivered by the BNFL.

Uranium for TVO 1 and TVO 2 comes (or has come) from Canada, Australia, Niger, China and Russia. Most of the enrichment has taken place in Russia, the rest in Western Europe. Fuel elements delivered to Olkiluoto have been manufactured by ABB Atom in Sweden, Siemens in Germany and GENUSA in Spain.

2.6.1 Plans for prospecting and mining for uranium in Finland

Finnish bedrock contains uranium, and its abundance in some places appeals to exploring companies. Owing to recent uranium price hikes, international uranium prospecting companies have shown interest in Finland. Environmental impact assessment procedure is applied to all uranium mining projects, without any limitations on the annual amount of the extracted resource or on the area of an opencast mine.

In addition to the licensing based on the Mining Act and on other legislation (Environmental Protection, Nature Conservation, Protection of Wilderness Reserves, Land Use and Building, Occupational Safety and Health, Radiation), production of uranium or thorium also needs a license from the Government according to the Nuclear Energy Act.

The Ministry of Employment and the Economy promotes the use of mineral resources by securing a favourable operating environment for mineral exploration and mining activities. The Ministry has been responsible for the revision of the mining legislation in recent years. The new Mining Act was accepted by the Parliament on 15 March 2011, to enter into force on 1 July 2011. An amendment of the Nuclear Energy Act was included as well.

While securing the preconditions for mining and exploration, the Mining Act of 2011 takes account of environmental issues, citizens' fundamental rights, landowners' rights and municipalities' opportunities to influence decision-making. One of the changes is that the duties of the mining authority are transferred from the Ministry to a lower administrative level, the Safety Technology Authority (Tukes). Responsible for granting permits and supervising compliance with legislation, this new mining authority office of Tukes has been established at Rovaniemi, northern Finland.

In the Mining Act of 2011, exploration license is required for uranium exploration (e.g. drilling, trenching). Permit applications concerning a uranium mine under the Mining Act and

Nuclear Energy Act are handled jointly and decided on in a single decision by the Government. The mining license for a uranium mine requires that the mining project activities are aligned with the overall interests of the society, the municipality in question has given its consent, and safety requirements are being complied with.

There are several pending claim applications for uranium exploration and three accepted claims in force in late 2010. The still pending claim applications were filed in 2007 to 2010. The uranium exploration licenses are subject to more extensive hearings than those for other commodities. For the claim decisions for uranium given by the MEE in 2009 and 2010, the licensing procedure took two to three years. For the moment, Mawson Energi AB, the Swedish subsidiary of Mawson is the only active uranium exploration company in Finland and its main target presently is the Rompas Au-U prospect at Ylitornio, northern Finland,.

Operated by Talvivaara Mining Company Plc., the Talvivaara Ni-Zn-Cu-Co mine in Sotkamo, eastern Finland, is one of the largest sulphide nickel deposits in Europe. The company applies bioheapleaching to extract the metals from black schist-hosted ore. Although the average uranium grade is very low (0.0017%), the pregnant leach solution contains 15 to 25 mg/l U, sufficient for exploitation. Talvivaara released its plans to build a solvent extraction circuit for by-product recovery of uranium in February, 2010. Annual uranium production is expected to be about 350 to 500 tU. Proceeding with construction and operation of the uranium circuit requires a number of permits from the regulators. Planning, environmental impact assessment and licensing have been going on in 2010 to 2011. The environmental impact assessment procedure was completed in March 2011. The company has also left an application for considering the requirements contained in the Nuclear Energy Act

Cameco Corporation is providing technical assistance to Talvivaara in the design, construction, commissioning and operation of the uranium extraction circuit. Cameco and Talvivaara signed agreements in February 2011 for an up-front investment to cover the construction costs, and for purchase of the uranium concentrates produced at Sotkamo until 2027.

2.6.2 Nuclear waste management

Spent fuel from the reactors is stored for a few years in the fuel pools at the reactor buildings. Thereafter, spent fuel elements are transferred to interim spent fuel storage at the power plant sites. FPH and TVO are responsible for the management of spent fuel from NPPs in Loviisa and Olkiluoto. A specialised company, Posiva, which is jointly owned by the nuclear power companies TVO (60%) and FPH (40%), is taking care of the necessary R&D activities, design and implementation of the spent fuel disposal project of its owner companies. In the future Posiva also aims to supply similar design services for the needs of other countries.

The repository for medium- and low-level wastes has been in use since 1992 at the Olkiluoto site. A similar facility has also been in use since 1998 for low-level waste disposal at the Loviisa site. The disposal facility at Loviisa has been expanded for disposal of medium level wastes as well.

2.6.3 Financial provisions for nuclear waste management

Power companies in Finland pay annual contributions to the State Nuclear Waste Management Fund, which is a segregated fund operating under the auspices of the Ministry of Employment and the Economy. This provision covers all future measures: treatment, storage and final disposal of spent fuel and radioactive waste, as well as decommissioning of the plants. The power companies contributing to the fund are entitled to borrow back 75% of the contributions against securities.

Posiva Oy takes care of the R&D activities and realisation of the spent fuel disposal facility in Olkiluoto. The power companies take care by themselves of other actions in spent fuel management. In addition, FPH and TVO take care of the management of medium and low-level operational wastes and the decommissioning of the nuclear power plants and the management of the thereby arising wastes. FPH and TVO are independently responsible for funding of all nuclear waste management activities despite their co-operation on spent fuel disposal.

To ensure that the financial liability is covered, each year the utilities must present cost estimates for the future management of nuclear waste. The utilities are obliged to set aside a certain amount of money each year for the State Nuclear Waste Management Fund. At the end of 2010, the total liability of the utilities was around EUR 2 100 million and the total fund target, based on existing waste quantities and including the decommissioning of NPPs, amounted to around EUR 1 900 million with no discounting.

At the end of 2010, the funding covered most of the liability and around EUR 220 million were covered by securities. The administrative procedures are described in detail within the nuclear energy legislation in force. Roughly speaking, the cost of nuclear waste management, including the disposal of all arising wastes and the dismantling of the power plants and other nuclear facilities, is around 10% of the total power production cost. The past and expected future development of the total fund holdings and unfunded liabilities for the existing four reactors are depicted in Fig. 16.

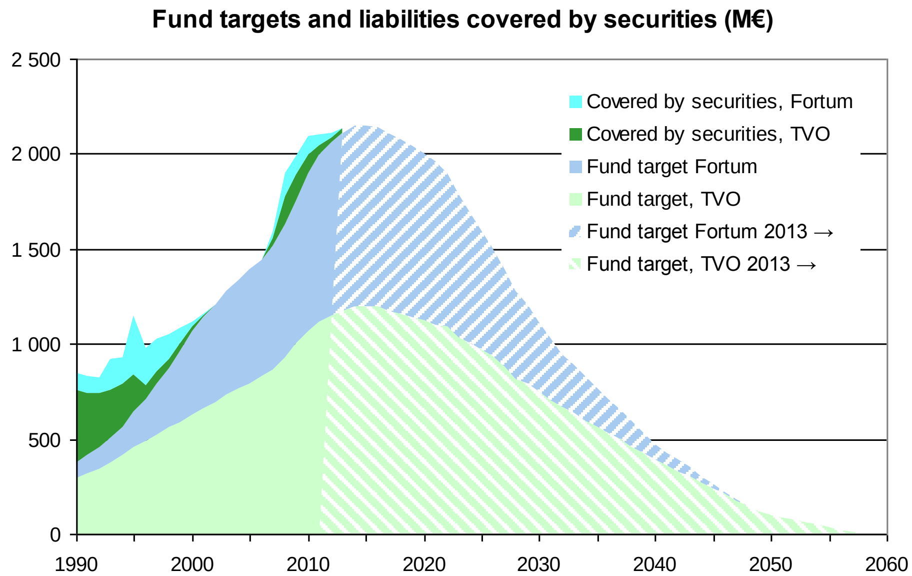


FIG. 16. The fund targets (for the 4 existing reactors) in the Nuclear Waste Management Fund and liabilities covered by securities. After 2012 the data are illustrative and take into account both the use of the funds for the implementation and additional inputs until the closing of the reactors.

2.6.4 Low- and intermediate-level waste management

After treatment, low- and intermediate-level waste generated during the operation of a nuclear power plant is initially stored at the plant. After interim storage, the waste is transferred to a repository for low- and intermediate-level waste on the plant site. At Olkiluoto, the disposal of waste in the repository began in 1992 and in Loviisa in 1997.

The repositories for low- and intermediate-level waste are located in the bedrock, at a depth of 60–110 metres. These repositories have separate silos or tunnels for low- and intermediate-level waste, and have been dimensioned to house all radioactive operational waste produced during the operative life of the present Olkiluoto and Loviisa units. Once all waste has been disposed of, the tunnels and shafts leading to the repositories will be filled and sealed.

2.6.5 Interim storage of spent fuel

Spent nuclear fuel from NPPs is stored at the power plant sites until its disposal. In addition to the storage pools in the reactor buildings, the Loviisa NPP has basket type and rack type pool storage attached to the reactor building. Its current storage capacity will be adequate until early 2010s, and additional capacity is planned through providing the pools with dense racks.

At the Olkiluoto plant, the effective capacity (excluding reserves for repair work) of the pools at the reactor buildings is about 370 tU. Subsequently, the spent fuel is transferred to an on-site facility with three storage pools, the capacity of each being around 400 tU, with high-capacity fuel racks. The spent fuel storage facility was commissioned in 1987 and its current capacity will be adequate until early 2010s. The construction of the extension of the interim storage facility taking into account the storage needs of Olkiluoto 3 unit as well is planned to be completed during 2013.

2.6.6 Spent fuel encapsulation and disposal facility

The amendment to the Nuclear Energy Act in 1994 halted Loviisa NPP's spent fuel shipments to Russia (Chelyabinsk) in 1996. Fortum and TVO agreed on co-operation in nuclear waste management concerning spent fuel treatment and disposal. However, the final responsibility for nuclear waste management stays with the company who produced the waste.

In May 1999, Posiva Oy, which is responsible for the disposal of spent nuclear fuel, filed an application to the Government for a Decision-in-Principle (DiP) on the construction of a final disposal facility. In May 2001, with a 159–3 majority of votes, the Finnish Parliament ratified the favourable DiP made by the Government in December 2000. The final disposal facility will be built on Olkiluoto, the DiP applying to the spent fuel from Finland’s present four nuclear power plant units. In May 2002, in parallel with the decision of the fifth Finnish nuclear unit, Parliament also ratified a new DiP on the final disposal of the spent nuclear fuel of the fifth reactor unit.

Similarly, in spring 2010 a new DiP concerning the disposal of spent fuel from the planned new reactor unit Olkiluoto 4 was made by the Government and ratified by the Parliament on July 1, 2010. Thus, the spent fuel arising from the operation of the Olkiluoto 3 and Olkiluoto 4 reactor units will also be disposed of in the bedrock on Olkiluoto. According to the present plan Posiva Oy will submit a construction licence application for the encapsulation and geological disposal facility to be located in Olkiluoto by the end of 2012. The next licensing stage is the application and handling of the application for operation licence. The plan is to start the operation of the facility by the end of 2020.

During their 50 to 60 years in operation, the present Olkiluoto and Loviisa nuclear power units produce at maximum around 4000 tonnes of spent fuel for final disposal. Spent fuel arising from the Olkiluoto 3 and Olkiluoto 4 units during their 60-year operative lifetime is estimated to total maximum of around 2500 tonnes each. Consequently the ratified DiPs for spent fuel arising from the operating reactors as well as from Olkiluoto reactor units 3 and 4 cover in total the disposal of 9 000 tons of spent fuel in the spent fuel disposal facility in Olkiluoto. The encapsulation facility is presently planned to be located at the same location as the underground disposal facility. In the encapsulation facility, the spent fuel rod assemblies are packed into water- and airtight double-layered metal canisters. The fuel rod assemblies at the Olkiluoto and Loviisa reactor units differ in shape and length. However, all of the fuel element types can be packed in copper-cast iron canisters of a similar construction. The canister for Olkiluoto 1&2 is 4.4 metres long, the Loviisa canister 3.4 metres long and the canister for Olkiluoto 3 is 5.2 metres long. . The canister diameter in each of these variants is the same.

The encapsulation plant contains a small interim storage for the canisters. Subsequently, the canisters are transferred into the repository, using either a lift with a radiation shield or via the access tunnel with a special vehicle.

The canisters can be positioned either vertically or horizontally in the repository at a depth of around 400 metres. Both options are under investigation. Through the vertical option, the canisters are placed in holes drilled at the bottom of the repository tunnels, spaced a few metres from each other. They are then surrounded with bentonite clay.

When the final disposal canisters have been placed in the repository, the encapsulation plant will be dismantled, the tunnels filled with a mixture of bentonite and crushed rock or with natural clay material, and the shafts leading to the repository closed. The underground repository will require no monitoring after it has been closed. After the facility has been closed and the above-ground structures have been dismantled, the land area can be used for new purposes.

Disposal of spent fuel is planned so that retrievability of the waste canisters is maintained. According to the plans, retrieval is possible at any stage of the final disposal process – including the phase after all the tunnels and shafts have been closed.

The plan has been drawn up for the Safety Case required for the application of the construction licence for a spent fuel disposal facility. According to the timetable set by the Ministry, all plans for the application will have to be finalised by 2012. The project plan aims at the step-wise development of the "safety case portfolio" through a number of successive report updates during the period 2005-2012, with the overall aim of having the repository operational in 2020. The time table of the triennial reporting is consistent with the amended Nuclear Energy Act. Following the Ministry's decision, Posiva presented in 2009 the first template versions of the documents needed for the construction licence application and the full PSAR documentation for the construction licence application should be ready for submission in 2012.

A new three-year programme for 2010-2012 (TKS2009) has been submitted for regulatory review in autumn 2009. Posiva has prepared an assessment of the identity and status of documents required for the disposal facility construction license application that is in compliance with the guidelines established in 2003 by the Ministry of Trade and Industry. The report has been submitted to the Ministry of Employment and the Economy in parallel with the current TKS-2009 report. In late 2009, Posiva submitted to the Radiation and Nuclear Safety Authority (STUK) a separate assessment concerning the documents that Posiva must, by regulation, submit to STUK in connection with the construction license application. In connection with the preparation of the report, Posiva has defined guidelines for supplementing the documents during the period from 2010 to 2012. The aim of the supplementation is to ensure that the documents are at least on a par with the level required for the construction license application. During this period, Posiva will acquire the relevant permits and licences and notify the authorities and international organisations as required. Additionally, Posiva will develop the processes and methods required in the construction of the disposal facility. The overall time table for the disposal of spent fuel from the Finnish nuclear power plants at Olkiluoto and Loviisa is illustrated in Fig. 17.

2.6.7 Underground rock characterisation facility

A deep underground rock characterisation and research facility (ONKALO) is under construction on the Olkiluoto site as part of the site confirmation investigations for spent fuel disposal. The excavation work for the ONKALO facility (Fig. 18) was begun in September 2004. The excavation works are now nearing completion.. Unlike the generic rock laboratories the ONKALO is being constructed at the actual repository site, and this means that the construction and operation of this facility should not cause major disturbances to the properties of bedrock that are important for the long-term safety. In addition, it should be possible to use the ONKALO later as a part of the repository. This means that the construction of the facility must comply with the rules and requirements applicable for nuclear facilities. Therefore a specific quality assurance programme has been launched for the present activities.

The original design and plans for the underground facility were reported in 2003. Since then a number of changes have been made in the layout of the ONKALO access tunnel, and the number of access shafts has been increased from one to three. Also the layout and the depth of the auxiliary rooms at the main characterisation level have been updated to match with the current needs.

The main characterisation level is located at the depth of –420 metres, but some of the auxiliary rooms are deeper down at the depth of –437 metres. The excavation work will be completed by early 2012 and the rest of the construction work should be ready in 2014. The total underground volume of the ONKALO will be approximately 365 000 m³, the combined length of tunnels and shafts being 9.8 km. The access tunnel from the surface to the repository level consists of approximately 4.6 km of tunneling with an inclination of 1:10. The shafts are excavated until the lower level. The personnel shaft will be equipped with a man-cage for personnel transport.

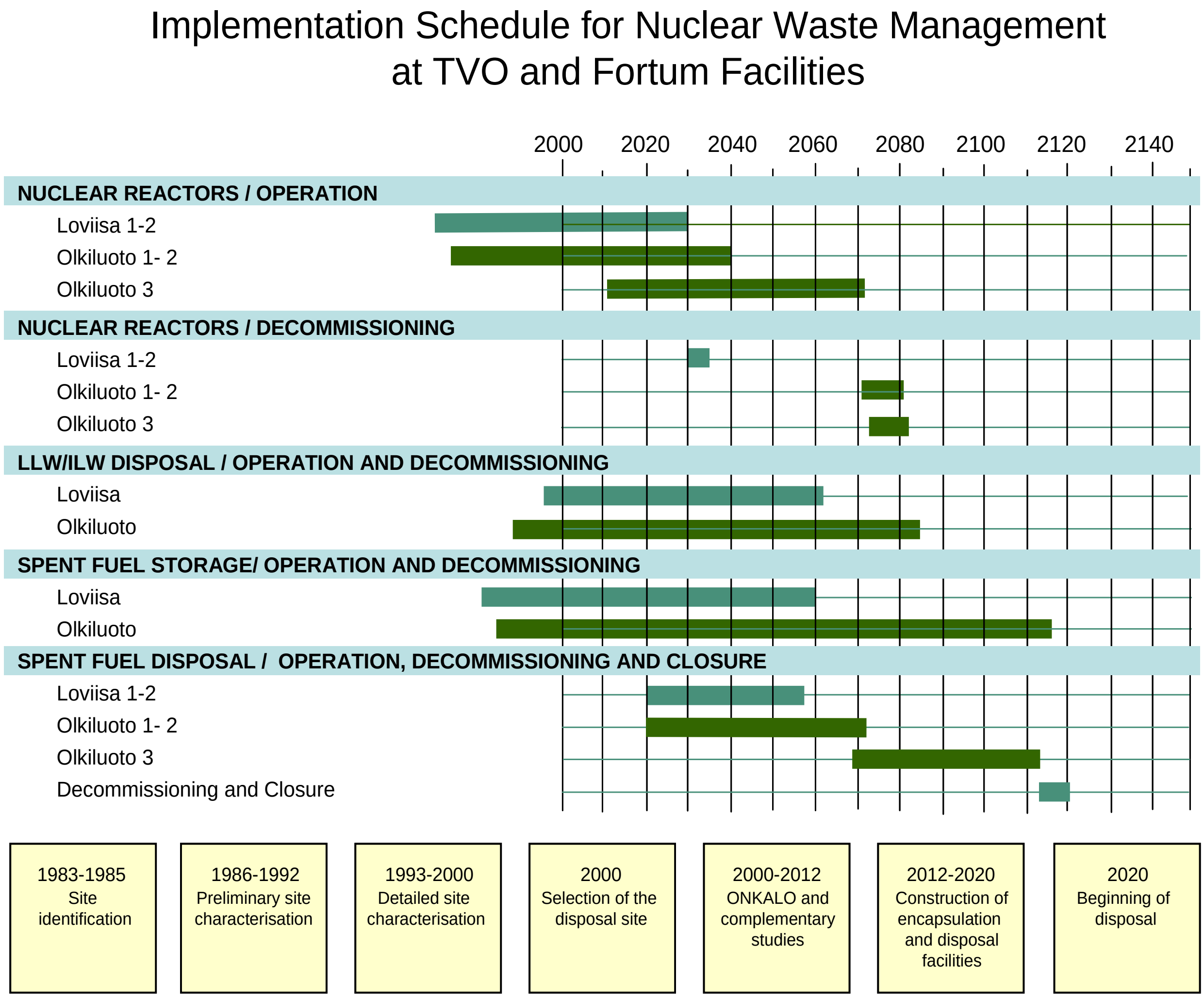


FIG. 17. Time table for the disposal of the spent nuclear fuel from the nuclear power plants at Loviisa and Olkiluoto.

The plan has been drawn up for the Safety Case required for the application of the construction licence for a spent fuel disposal facility. According to the timetable set by the Ministry, all plans for the application will have to be finalised by 2012. The project plan aims at the step-wise development of the “safety case portfolio” through a number of successive report updates during the period 2005–2012, with the overall aim of having the repository operational in 2020.

The construction of the ONKALO underground rock characterisation facility is well under progress. In April 2011, the tunnel length was 4665 metres. The ventilation and personnel shafts have been raise-bored to a depth of 290 metres. Key challenges in the ONKALO work concern the limitation of disturbance to the host rock due to the excavation. A special programme has been launched to address the control of hydraulic disturbance and a new low-pH cementitious grouting material has been developed and tested and, depending on the outcome of the ongoing review process, will be used as a grouting material to limit the groundwater inflow to the tunnel and shafts.

In the joint SKB - Posiva project on the horizontal variant of KBS-3 (“KBS3H”) testing and development of this alternative to the vertical reference concept (“KBS3V”) is focusing on detailed design issues.

At the end of 2009, a number of important reports were submitted for review by the authorities. These included the new three-year RTD programme for 2009–2012 (“TKS2009”), A majority of the RTD work to be carried out during this three-year period will involve the disposal of spent nuclear fuel. The work includes the completion of the investigations for site confirmation conducted at the Olkiluoto repository site, the design of required facilities, and the development of the selected disposal technology to the level required for the construction license application as well as the generation of a safety case relating to long-term safety for attachment to the construction license application.

Simultaneously, the preparation of documents required for the licence application has commenced. Additionally, the surveys and studies carried out in the ONKALO underground research facility will expand to the areas surrounding the repository host rock. Several investigation niches will be excavated in ONKALO to enable the conduct of studies and tests at the disposal depth. The studies and tests conducted at the investigation site, above ground and in ONKALO, support not only site modelling but usually also the establishment of features specific to the investigation site.

A total of five investigation niches have been excavated in ONKALO for special experiments and characterization efforts. The investigations to be conducted in the niches cover among others the following topics: bentonite studies, the properties of excavation damage zone (EDZ), rock mechanics investigations, detailed hydrogeological investigations and investigation of retention properties of intact rock.

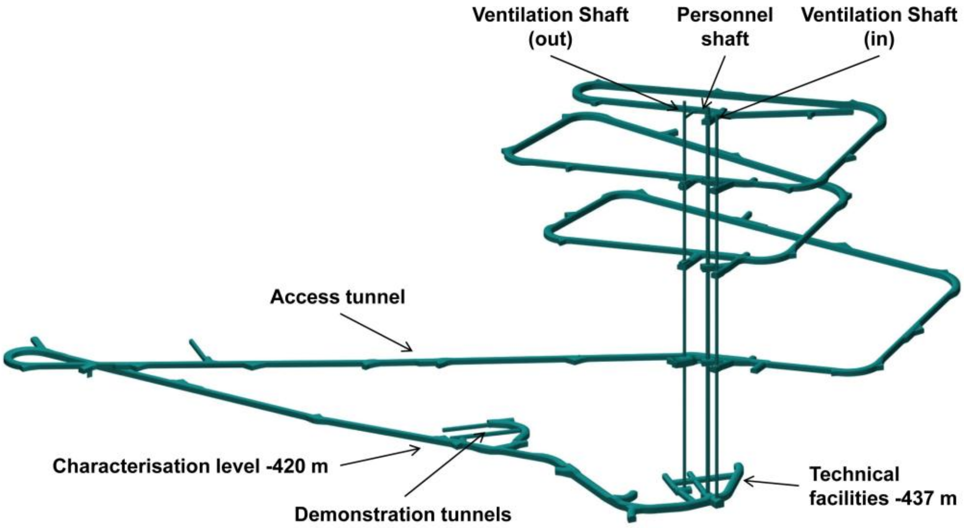


FIG. 18. Overall layout of the facility for underground rock characterisation (ONKALO)

2.6.8 Decommissioning: information and plans

No nuclear power plants are currently being decommissioned and such decommissioning projects are neither foreseen in the near future. According to the updated requirements of the Nuclear Energy Act the utilities need to update with six years intervals their technical plans for the decommissioning of the operating reactor units. The VTT Technical Research Centre of Finland has also performed in 2010 a more detailed planning of the shutdown and decommissioning of the research reactor FiR 1 they operate. The decision to implement the plan is dependent on the availability of sustainable funding for continued operation. The application for renewal of the operating licence of FiR 1 until the end of 2023 is currently being handled by the authorities. Studies are under way on the technical feasibility of disposing of the decommissioning wastes of FiR 1 in the LILW repository at the Loviisa site.

The next updates of the decommissioning plans of the utilities will be submitted for regulatory review in 2014. The plan for the Loviisa NPP is based on immediate decommissioning while for the Olkiluoto NPP, a safe storage period of about 30 years prior to dismantling is envisaged. The disposal plans for wastes from decommissioning of the NPPs are based on the extension of the on-site repositories for LILW. Besides the dismantling waste, also activated metal components accumulated during the operation of the reactors could be disposed of in those repositories. The engineered barriers will be selected taking account of the radiological and other safety related characteristics of each waste type. A special feature of the decommissioning plans is the emplacement of large components, such as pressure vessels and steam generators, in the disposal rooms as whole, without cutting them in pieces. The financial liability for future waste management (cf. Section 2.5.4) covers decommissioning costs as well.

2.7 Research and development

Finnish nuclear energy research has been decentralised among several research units and groups, which operate at different State research institutes, universities, and in utilities and consulting companies. The focus of nuclear R&D is on the safety and operational performance of the power plants, and the management and disposal of waste. Publicly funded nuclear energy research, on the other hand, provides impartial expertise in nuclear energy issues, contributes to maintaining the necessary personnel and equipment for research and development, and has established a framework for international collaboration.

The annual total funding for the Finnish research into nuclear fission and fusion energy is estimated to be around EUR 73.5 million. In late 2003, the Nuclear Energy Act was amended to secure funding for long-term nuclear safety and nuclear waste management research in Finland. The necessary financing is collected annually from the licence holders, into two special funds devoted to this purpose. These research funds are aimed at ensuring a high scientific-technical level for national safety research and maintaining national competencies in the long run. For reactor safety research, the amount of finance is proportional to the thermal power of the licensed plant or the thermal power presented in the Decision-in-Principle application or the construction licence application. For waste research, payments are proportional to the fund targets in the Nuclear Waste Management Fund. The total annual volume of these research funds for reactor safety and nuclear waste management is currently (in 2011) about EUR 7 million.

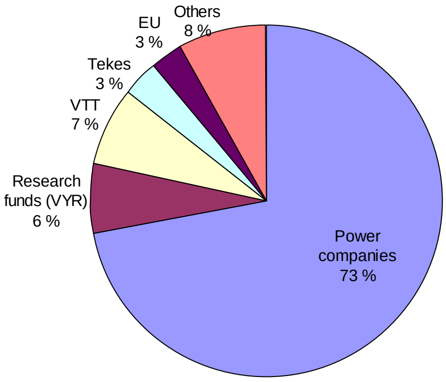


FIG. 19a. FUNDING SOURCES: The annual funding (2010) for national nuclear energy research is about EUR 73.5 million in total. Financing paid into funds for reactor safety and nuclear waste management research is collected from the operators of the nuclear power plants.

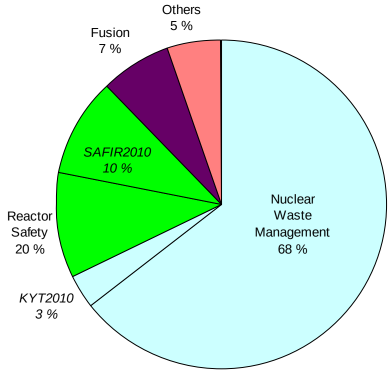


FIG. 19b. RESEARCH AREAS: Funding (2010) for different research areas of nuclear energy research (around EUR 73.5 million in total per year). The shares of the national research programmes, funded to a large extent from the dedicated research funds, are indicated for reactor safety (SAFIR2014) and nuclear waste management (KYT2014). The sector 'others' includes environmental impacts, research reactor and radiation protection.

2.7.1 R&D organizations

Finland has no institutes dedicated solely to nuclear energy research. Most research takes place at the VTT Technical Research Centre of Finland. Other major research institutes include the Aalto University and Lappeenranta Technical University (LUT), the Geological Survey of Finland (GTK), the Finnish Meteorological Institute and the universities of Helsinki, Jyväskylä and Tampere. In addition, the Radiation and Nuclear Safety Authority (STUK) and the power companies Fortum and TVO and Posiva Oy carry out internal research, or finance research at research institutes or universities. The versatile array of research subjects at research institutes and universities promotes spin-off and spin-in relationships with other industries. Spin-offs include simulation technologies, reliability engineering, fracture mechanics, and non-destructive testing, while spinin benefits have been enjoyed in areas such as human factors, digital automation systems and computational fluid dynamics.

2.7.2 Research programmes

The Finnish public nuclear energy research is organised into national research programmes. These research programmes mainly operate on the basis of funding provided by the dedicated funds (for reactor safety and nuclear waste management) described above. Additional funding is provided by Tekes, the Finnish Funding Agency for Technology and Innovation, VTT's basic funding and the European Union.

The main objective of these programmes is to provide the authorities with high-standard expertise and research results relevant to the safety of nuclear power plants and waste management and disposal, and to support various activities of the authorities. In addition, these programmes train new nuclear experts and promote technology and information transfer.

The current national research programmes on nuclear energy are as follows:

- National Nuclear Power Plant Safety Research (SAFIR2014), 2011–2014
- Finnish Research Programme on Nuclear Waste Management (KYT2014), 2011–2014
- Euratom – Tekes Fusion Energy Cooperation, 2007–2011

SAFIR2014 is the Finnish public research programme (http://safir2014.vtt.fi) on nuclear power plant safety coordinated by the VTT Technical Research Centre of Finland. The programme has been divided into nine research areas: 1. Man, Organisation and Society, 2. Automation and Control room, 3. Fuel Research and Reactor Analysis, 4. Thermal Hydraulics, 5. Severe Accidents, 6. Structural Safety of Reactor Circuits, 7. Construction Safety, 8. Probabilistic Risk Analysis (PRA) and 9. Development of Research Infrastructure.

The framework plan for SAFIR2014 covers especially the period 2011–2014, but it is based on safety challenges identified for a longer time span as well. Olkiluoto 3, the new nuclear power plant unit under construction and new Decisions-in-Principle have also been taken into account in the plan. The safety challenges set by the existing plants and the new projects, as well as the ensuing research needs do, however, converge to a great extent. The construction of new power plant units will increase the need for experts in the field in Finland. At the same time, the retirement of the existing experts is continuing. These factors together will call for more education and training, in which active research activities play a key role. This situation also makes long-term safety research face a great challenge.

KYT2014 is the Finnish public research programme (http://kyt2014.vtt.fi) on nuclear waste management coordinated by VTT Technical Research Centre of Finland. The contents of the KYT2014 Research Programme comprise key research subjects in terms of national expertise. These include new and alternative nuclear waste management technologies, research into the safety of nuclear waste management and sociological research related to the issue. Through these research programmes, the aim is to assemble extensive, coordinated safety research wholes, particularly with respect to research on the capacity of buffer and filling materials in final disposal, the long-term durability of the final disposal canister, and safety case. Studies directly related to licensing issues are excluded from this programme in order not to jeopardise the expected neutrality of the research. Outside this programme, the industry is conducting or financing separate R&D activities of a much larger scale on nuclear waste management, especially on spent fuel disposal.

The Ministry of Employment and the Economy (MEE) nominates separate steering groups for the SAFIR2014 and KYT2014 programmes. The total volume of these national research programmes on nuclear fission energy is around 90 person-years annually. Nuclear fusion research comprises about 50 person-years.

Tekes is funding the Euratom – Tekes Fusion Energy Cooperation to a total amount of around EUR 22 million for the period 2007–2011. From this, the yearly allocation for research will be EUR 1.4 million, the rest being intended for the support of industrial activities and coordination. This work is intended to cover all fusion energy research in Finland. These research activities are fully integrated with the European Fusion Programme through the Contract of Association between Tekes and Euratom. Association Euratom – Tekes is one of the 23 Fusion Associations of the European Fusion Programme in the EU Framework Programme. Multilateral European Fusion Development Agreement (EFDA) and bilateral Contracts of Associations are the main tools for steering fusion research activities in Europe. The main research areas include: 1. Fusion Plasma Physics, 2. Plasma-Wall Interactions, 3. Reactor Materials Research, 4. Development of Superconducting Wires, 5. Remote Handling Systems, and 6. System Studies.

Development of advanced nuclear technologies

In 1998, VTT launched a four-year research programme under the name "Advanced Light Water Reactors (ALWR)". At the beginning of the programme, VTT participated in several INNO-cluster projects within the 4th Framework Programme of the European Commission. The largest 4th Framework Programme project included passive safety injection experiments at Lappeenranta University of Technology for the investigation of a passive core make-up tank (CMT). Co-operation with European reactor vendors, Westinghouse Atom and Framatome ANP, started in 1999 and continued in 2000 and 2001 with several projects connected to the new European BWRs, SWR-1000 and BWR90+. The co-operation with TVO and GE on the development of ESBWR also continued. One common feature of the new research projects has been the increasing use of multidimensional computational fluid dynamics (CFD) codes for the development and evaluation of ALWRs and passive safety systems.

In the area of new generation nuclear reactor systems, VTT has participated in the EU's framework programme projects under the area of new innovative systems. One example of this is the past project "High Performance Light Water Reactor (HPLWR 1&2)". In addition, in the KYT2014 research programme, restricted activities are carried out in the area of advanced fuel cycle concepts – primarily the follow-up of research activities on partitioning and transmutation. Based on the initiative of the former Advisory Group on Nuclear Energy (YEN), the research network (GEN4FIN) on advanced nuclear energy systems was established in 2005. The aim of this research network is the further promotion of the maintenance and development of national expertise and international co-operation.

Within the research programme "Sustainable Energy (SusEn)" of the Academy of Finland a joint effort "New Type Nuclear Reactors (NETNUC)" has been started in early 2008 by a consortium comprising the Finnish Universities of Technology at Lappeenranta and Helsinki (LUT & Aalto University) and VTT Technical Research Centre of Finland (Fig. 20). Fortum provides additional funding for this joint project. The research work aims to contribute to the validation of the following hypotheses: (1) Key phenomena affecting the safety of new types of reactors are understood thoroughly, enabling the creation of systematic safety criteria that ensure the adequate safety and security of the reactors and fuel cycle facilities (Safety), (2) Advanced reactors and the associated fuel cycles can be developed that utilise more abundant natural isotopes and increase the effectiveness of fuel resource usage and produce less high-level nuclear waste (Sustainability) and (3) New types of reactors can be developed in international cooperation (SCWR, VHTR, GFR, SFR), capable of producing energy effectively and economically for electricity, process heat and hydrogen yields in cogeneration processes (Efficiency). The NETNUC research programme will be completed by the end of 2011.

VTT, TVO, Fortum and the Lappeenranta University of Technology are partners in the Sustainable Nuclear Energy Technology Platform (SNE-TP). The objectives of the platform coincide with many aspects of the NETNUC project. Consequently, SAFIR2014 and NETNUC both contribute to the objectives of SNE-TP, which covers both the present and advanced light-water reactors (e.g. EPR) and fast reactors with closed fuel cycle which is crucial to the long-term sustainability of nuclear fuel resources. SNE-TP also covers the production of other energy carriers besides electricity. Consequently, participation in this Technology platform ensures close networking with other European stakeholders and research organisations. The NETNUC project has been closely connected with EU projects (e.g. HPLWR2 for the SCWR concept and Raphael for VHTR/GFR gas-cooled concepts) and other global forums. Another important Technology Platform is Implementing Geological Disposal of Radioactive Waste (IGD-TP). The mission of the IGD-TP is to be a tool to support confidence-building in the safety and implementation of deep geological disposal solutions. The vision of IGD-TP is that by 2025, the first geological disposal facilities for spent fuel, high-level waste, and other long-lived radioactive waste will be operating safely in Europe.

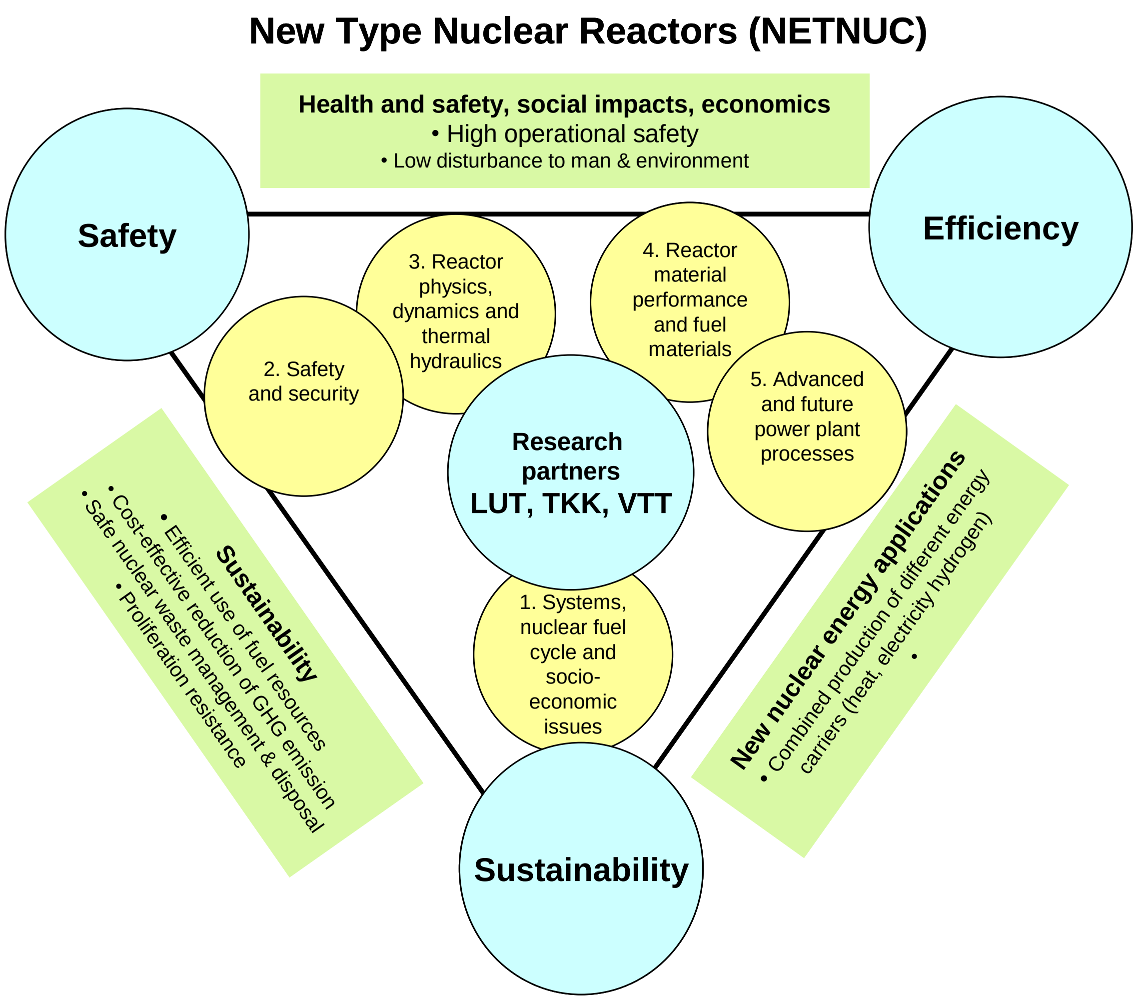


FIG. 20. Structure of the NETNUC consortium project with the main research hypotheses and tasks.

2.7.3 International co-operation and initiatives

General issues on the participation in international co-operation

Finland participates actively in the international co-operation regarding nuclear energy as the development and deployment of the next generation of nuclear power technology is increasingly becoming an international exercise. International collaboration is expected to create considerable efficiencies in developing and deploying new technologies worldwide.

In recent years, the recognition of these trends has led to the development of several multinational initiatives, both for research and other purposes, and call for still more initiatives. Major initiatives now underway or in the early stages of implementation include: the Generation IV International Forum (GIF) led by the USDoE, the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), the Global Nuclear Energy Partnership (GNEP), Multinational Design Evaluation Program (MDEP) and the Multinational Fuel Assurance Concept (MNA) proposed by the IAEA.

At European level, the latest Nuclear Illustrative Programme (PINC) from 2007 underlines the need to develop common instruments within the framework of nuclear safety. The European Commission has already launched a number of initiatives in the field of nuclear safety, waste management and decommissioning, such as recommendations on the financing of decommissioning activities, the establishment of a Sustainable Nuclear Energy Technology Platform (SNE-TP) and the establishment of the European Nuclear Safety Regulator´s Group (ENSREG) composed of national nuclear regulators for the further development of a common understanding and European rules in the field of nuclear safety and waste management.

As a result, Council Directive 2009/71/Euratom establishing a Community framework for the safety of nuclear installations was given in June 2009. In November 2010, the Commission proposed a Directive on spent fuel and radioactive waste management.

The Sustainable Nuclear Energy Technology Platform (SNE-TP), launched in September 2007, aims at coordinating Research, Development, Demonstration and Deployment (RDD&D) in the field of nuclear fission energy. It gathers together stakeholders from industry, research organisations including Technical Safety Organisations (TSO), universities and national representatives. Regarding joint infrastructures, the recently launched Jules Horowitz Reactor (JHR) material testing reactor project will, in the short term, support studies on generation II and III light water reactors on ageing and life extension, safety and fuel performances, and support material and fuel developments for generation IV reactors. The reactor will be located in Cadarache, France and VTT will be actively involved in the planning and design of this facility.

The Strategic Research Agenda and the Deployment Strategy of SNE-TP reflect a consensus among a large group of stakeholders on research priorities in the field of nuclear fission, addressing the renaissance of nuclear energy with the deployment of generation III reactors, and the development of generation IV systems, both fast neutron reactor systems with fuel multirecycling for sustainable electricity-generating capability and (Very) High Temperature Reactors for other applications, such as the production of hydrogen or biofuels.

Important issues such as the safety of nuclear installations and the responsible management of waste are also addressed, as well as other issues which are crucial to the success of nuclear energy in the 21st century: education and training, research infrastructures, material research and numerical simulation – and funding. The Strategic Research Agenda includes a roadmap for all European nuclear fission research until the year 2040.

In 2007, the European Parliament adopted the report “Conventional Energy Sources and Energy Technology”. The Report demonstrates a growing political consensus that nuclear energy “is indispensable if Europe’s medium and long-term energy needs are to be met.”

In November 2007, the European Commission published the Strategic Energy Technology Plan (SET-Plan). This plan aims at increasing the use of low-carbon technologies to meet the targets set up by the European Council in March 2007 of a 20% / 30% CO_2 emission reduction and a 20% renewable increase by 2020. These “Clean” technologies include not only renewables, but also sustainable nuclear fission energy and carbon capture and storage (CCS). The document recognises that nuclear power is a key part of EU energy policy and, alongside other low-CO_2 energy sources, contributes to forging the EU’s low-carbon economy.

In January 2008, the Commission proposed a legislative package (so called climate and energy package) including more detailed provisions on emission targets, emission trading scheme as well as promotion of renewable energy sources.

Besides the activities launched by the Commission, Finnish organisations participate actively in other international efforts furthering the international harmonisation of nuclear safety standards. The bases for this harmonisation should be enhanced co-operation conducted in association with the follow-up conferences on the two important IAEA conventions: the Nuclear Safety Convention and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management as well as the preparation of Nuclear Safety Guidelines and other documents by the IAEA. Other work currently being performed, such as that by the Western European Nuclear Regulators Association (WENRA), provides a vital additional contribution. In addition, new initiatives such as the Multinational Design Evaluation Programme (MDEP), may contribute to the convergence of national regulatory practices.

Research co-operation

Finland participates in IAEA work on all programme areas. The main emphasis is on nuclear safety and safeguards programmes. Finland also supports the IAEA's work through voluntary contributions. Finland is a party to all IAEA conventions except the Vienna Convention on third party liability.

When Finland joined the European Union from the beginning of 1995, it also became a member of the European Atomic Energy Community, Euratom. In March 1995, Finland made the first contract of association with the European Commission to participate in research on controlled thermonuclear fusion. Through this contract, Finland is also involved with the global International Thermonuclear Experimental Reactor (ITER) project. The contract has been renewed for the new research period 2007-2010.

As a member of the European Union, IAEA, OECD/NEA and Nordic Council of Ministers, Finland participates in most nuclear research and development activities conducted by intergovernmental organisations. Multilateral co-operation is supplemented by several bilateral projects and co-operation agreements that the Finnish research institutes, safety authorities and industrial enterprises have with foreign organisations.

The importance of international co-operation in reactor safety and nuclear waste management research and development is most evident in experimental research and development of large computer codes where large manpower and financial resources are involved.

Finnish nuclear safety authorities and nuclear research institutes take part in committees and expert groups established in OECD/NEA. Finland has been a member of the OECD Halden reactor project since its beginning in the late 1950's.

The five Nordic countries have carried out joint research programmes since 1977. The goal is to maintain a high level competence in the field of reactor safety, waste management and emergency preparedness as well as promoting a unified view on safety issues. The current seventh programme covers the years 2009–2011.

Nuclear safety co-operation in Eastern Europe

Political and economic changes in Eastern Europe have quickly led to extensive international co-operation, in order to improve the safety of nuclear power plants based on Soviet technology. Finnish organisations are involved in several international projects aimed at the improvement of radiation and nuclear safety and safeguards. Finland's bilateral technical and financial support is mainly allocated to its neighbouring areas. Finland's bilateral co-operation and support programme, co-ordinated by the Radiation and Nuclear Safety Authority (STUK), focuses on the safety of nuclear power plants, the control of nuclear materials, and nuclear waste management.

In addition to STUK, other participants in the co-operation include Fortum, the VTT Technical Research Centre of Finland and Teollisuuden Voima. Fortum has implemented commercial co-operation projects and the EU-funded improvement of nuclear safety. Other programmes funded by the Finnish Government operate in the areas of safeguards and long-term and responsible nuclear waste management. The power companies, VTT and STUK, are participating in joint programmes funded by the EU in Russia, Ukraine and Armenia. These programmes aim to improve the safety of nuclear facilities in practice and to give assistance to nuclear energy authorities in these countries in developing their regulatory organisation, practices and regulations.

2.8 Human resources development

The Nuclear Energy Act was amended in 2003 to establish the Nuclear Safety Research Fund. The objective of this Fund is to ensure the high level of national safety research and to maintain the national competence in the long run. A Fund for Nuclear Waste Safety Research was also established, respectively. These funds provide financing for the national research programmes on nuclear fission energy (cf. Section 2.6). A key objective of the national research programmes on nuclear energy is to train new nuclear experts to meet the requirements for additional human resources owing to the Olkiluoto 3 project as well as the new NPPs planned to be built by TVO and Fennovoima and to the large number of present experts retiring within the next decade. Changes in energy markets and the rapid development of technology will set new challenges with respect to the required knowledge, and this will require a special emphasis from all parties.

During 2003–2011, eight 5–6-week training courses on nuclear safety technology have already been provided in order to train newcomers in the nuclear field, in the form of specific co-operation between all nuclear related organisations. Around 460 young experts and newcomers have been trained during these eight courses. A decision has already been made to arrange the course for the ninth time in 2011/2012. Training materials that can be used by the organisations in their internal training programmes are developed as appropriate.

The licensee has the prime responsibility for ensuring that his employees are qualified and authorised to their jobs. Finnish nuclear power companies have training organizations and training facilities at NPP sites with the training staff around ten persons and full-scope plant-specific training simulators.

Both TVO and Fortum have a systematic approach to training. However, changes in energy markets and the fast development of technology will bring new challenges to the knowledge, and this requires special emphasis of all parties.

3. 3 NATIONAL LAWS AND REGULATIONS

3.1 3.1 Regulatory framework

3.1.1 Regulatory authorities

General safety regulations are issued by the Government. Detailed regulations and regulatory guides are issued by the Radiation and Nuclear Safety Authority (STUK). The licensing of nuclear installations in Finland (construction licence and operation licence) is the responsibility of the Government. A major nuclear facility also needs a positive Decision-in-Principle by the Government, subject to ratification by the Parliament. However, licences for small nuclear facilities (e.g., research reactors with thermal power below 50 MW(e)) are granted by the Ministry of Employment and the Economy (MEE), which has overall responsibility for control of nuclear energy in Finland.

In Finland, the Ministry of Employment and the Economy is responsible for the overall supervision of the use of nuclear energy. The drafting of legislation, the implementation of international agreements in Finland, the supervision of the planning and realisation of nuclear waste management, and the administration of the State Nuclear Waste Management Fund constitute a significant part of the Ministry's duties in the nuclear field. The Ministry supervises research and development work carried out in the field of nuclear safety. Its principal objective is to ensure a high level of safety and operating reliability at existing nuclear power plants and to support the safe and appropriately timed implementation of nuclear waste management. The Ministry represents Finland within the European Atomic Energy Community, the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency (NEA) of the OECD, and the Nordic Nuclear Safety Research Programme (NKS). The Energy Department of the Ministry prepares the Government's and Ministry's decrees and decisions on nuclear energy.

The Radiation and Nuclear Safety Authority (STUK) is the authority and expert in radiation and nuclear safety in Finland. It interprets requirements laid down by law and supervises their implementation. The objective of STUK's activities is to maintain Finnish radiation and nuclear safety at a high level and to act as a trendsetter in the development of a safety culture in society in general.

The power company operating a nuclear power plant is always responsible for the plant's safety. It is the duty of STUK to supervise all activities, from the design of the plants to their decommissioning. In this its objective is to ensure the safety of nuclear facilities so that their operation does not cause a radiation hazard to the health of workers or nearby residents, or other damage to the environment or property.

The key safety and quality target of nuclear safety control is to ensure that the safety level achieved in the use of nuclear energy is maintained, and increased as far as possible, and to contribute to the development of a good safety culture in the use of nuclear energy. These targets are aspired to, for example, by formulating detailed regulations, through the continuous assessment of the safety of operations, and by making inspection visits to the plants.

STUK also supervises Posiva's research, development and planning work for the final disposal of spent nuclear fuel and the activities of the nuclear power companies in the treatment, storage and final disposal of low- and intermediate-level reactor waste. In addition, STUK controls the safety of the transportation of nuclear waste and radioactive materials.

Furthermore, STUK supervises nuclear materials in order to ensure that they are not used for other than peaceful purposes. Nuclear materials in Finland are also controlled by the European Union and the International Atomic Energy Agency (IAEA).

STUK operates under the auspices of the Ministry of Social Affairs and Health. The safety authority maintains close contacts with the Ministry of Employment and the Economy, other government bodies, research institutes, universities and power companies. STUK is assisted by the Advisory Committee on Nuclear Safety (YTN) in major nuclear safety issues and by the Advisory Committee on Nuclear Security.

3.2.1 Licensing process

The decision-making process for the construction of a nuclear facility (e.g. a power plant or a final disposal facility) includes several stages (Fig. 21). First, the operator carries out an environmental impact assessment (EIA) on the construction and operation of a nuclear facility. Thereafter, the operator files an application to the Government to obtain a Decision-in-Principle (DiP) on a new nuclear facility. In case the DiP is affirmed, in due course the operator applies for a construction licence (CL) from the Government. Towards the end of the construction, the operator applies for an operating licence for the facility. After it has received the necessary official statements, the Government decides on whether to issue such an operating licence. The safety aspects of all the licence applications are assessed by STUK.

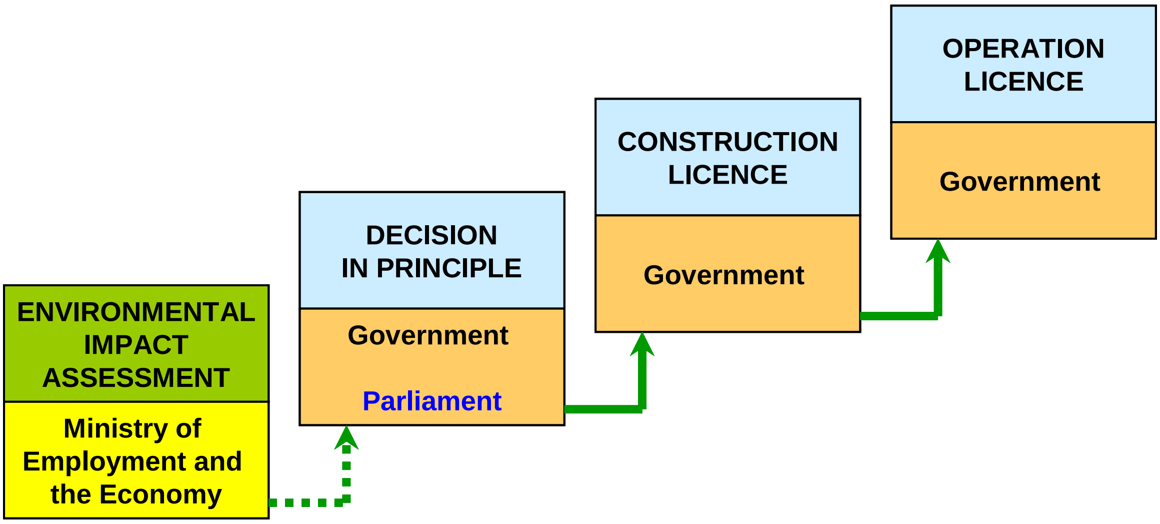


FIG. 21. Licensing stages for nuclear facilities in Finland.

All use of nuclear energy must meet the following prerequisites:

i. it shall be generally beneficial for society;

ii. it shall be safe and it shall not cause any detriment to human beings, the environment and property;

iii. physical security, emergency preparedness and other arrangements shall be sufficient to mitigate nuclear accidents and to protect the use of nuclear energy against illegal actions; and

iv. the import of nuclear explosives or the manufacture, possession or exploding of such explosives in Finland is prohibited.

The application for the Government's Decision-in-Principle (see Figs. 21 and 22) may concern one or more alternative nuclear installation projects. The application shall include as an annex the final report of the Environmental Impact Assessment (EIA) procedure conducted according to the requirements set in the corresponding law. In handling the DiP application, the Government requests a preliminary safety appraisal from the Radiation and Nuclear Safety Authority (STUK) and a statement from the municipality intended as the site of the planned nuclear facility.

Before the DiP is made, an overall description of the installation including environmental effects and safety plans are made available to the public. Public and local authorities are given the opportunity to present their opinions in a public hearing. If the general prerequisites are met and if the municipal council of the site in question is in favour (the host municipality has binding right of veto) of the construction of the installation, the Government may make the Decision-in-Principle. The decision is submitted to the Parliament, which either confirms or rejects it (political consideration).

The applications for the construction and operation licences are submitted to the Government. The application for a construction licence is more detailed than the application for the Decision-in-Principle and includes safety analysis reports and security plans. On behalf of the Government, the Ministry of Employment and the Economy then asks several statements. The most important one is the statement of the Radiation and Nuclear Safety Authority (STUK) on safety of the facility. The documents to be included in Construction Licence application to be submitted to STUK for approval in this phase are defined in Nuclear Energy Decree § 35. After receiving all statements for the Construction Licence application, the Government will make its decision.

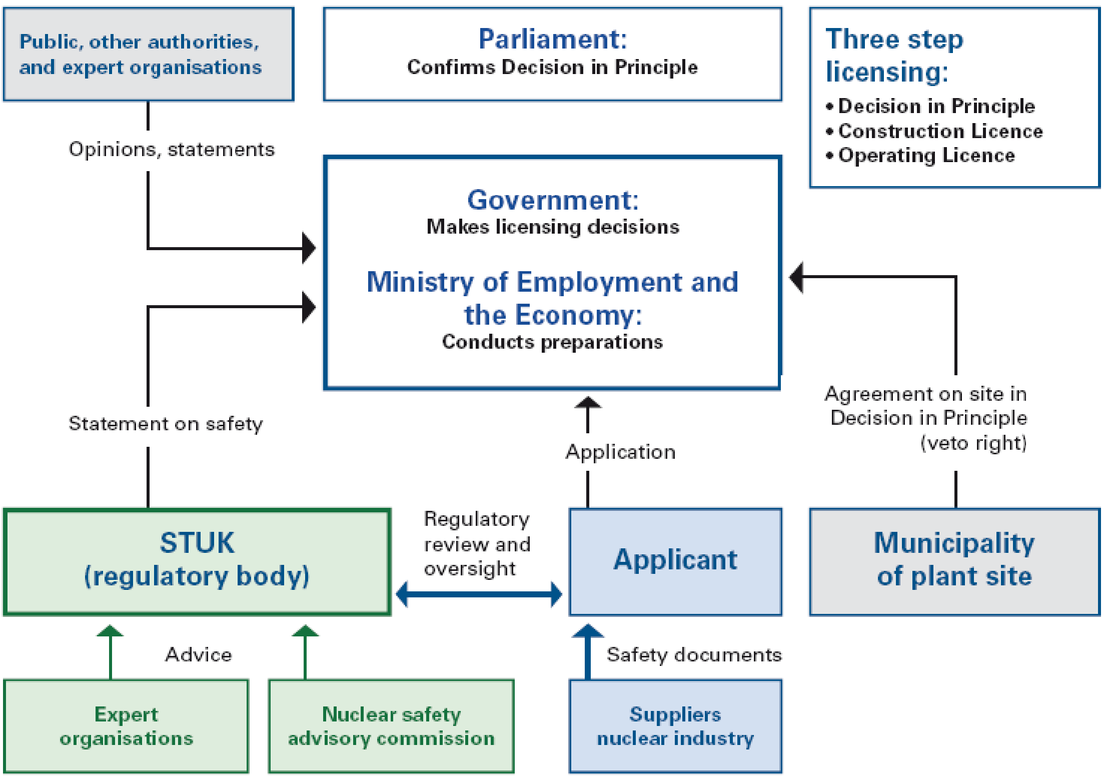


FIG. 22. Licensing of nuclear facilities in Finland (e.g. nuclear power plants and nuclear waste management facilities)

The application for an operating licence must be accompanied with detailed construction information of the facility and cover the facility's operation plans. The licence can be granted only for a fixed period.

During the operation, a nuclear power plant is subjected to three types of regulatory inspections: periodic inspections; inspections that the operating organisation must pass in order to continue operation; and, continuous re-evaluation of the safety level of the operating plant. Operating licences are granted for a limited period. When renewing a licence, an overall evaluation of the safety of the plant is carried out by STUK.

3.2 Main national laws and regulations in nuclear power

The Nuclear Energy Act (990/1987) and the Nuclear Energy Decree (161/1988) give Parliament final authorisation to permit the building of new major nuclear installations, including final disposal facilities for nuclear waste. The Act and the Decree also define the licensing procedure and conditions for the use of nuclear energy, including waste management, as well as the responsibilities and powers of the authorities. Each producer of nuclear waste in Finland is responsible for the safe handling, management and disposal of waste and for meeting the costs of the related operations. The funds required for future nuclear waste management must be raised gradually during the plant's operating period.

The requirements provided in the Nuclear Energy Act and Decree are specified in several general regulations laid down by specific Decrees issued by the Government. During 2007–2008, major amendments to legislation related to nuclear energy were prepared. The amended Nuclear Energy Act is in force since June 2008 after the approval by the Parliament. The amended Nuclear Energy Decree has been in force since December 2008. The main reason for the changes has been the requirement under the amended constitutional law that certain key requirements be presented within the Nuclear Energy Act in place of the previous practice, based on which many of these requirements were set in lower level regulations, such as Government decisions. These decisions have now since December 2008 been replaced by Decrees issued by the Government.

The detailed Finnish licensing requirements for nuclear installations are outlined in the STUK regulatory guidelines (YVL Guidelines). The YVL guides have included more than 70 guidelines in the following eight series: general guides, systems, pressure vessels, civil engineering, equipment and components, nuclear materials, radiation protection and radioactive waste management. An amendment process for these regulatory guides is now underway and both the general structure of the guideline system and the topics and number of individual regulatory guidelines are undergoing major changes. The aim is to complete this amendment process by the end of 2011

The Radiation Act (592/1991) establishes the conditions for preventing and limiting the harmful effects of radiation on the health of workers and the general public. The latest amendments to the Radiation Act and Decree were made at the end of 2005, to reflect the EU Directive on the control of high activity sealed radioactive sources.

The Nuclear Liability Act (484/1972 & 588/1994) implements the Paris Convention on the Third Party Liability in the Field of Nuclear Energy and the Brussels Supplementary Convention. Furthermore, the amendment of 1994 adopts the Joint Protocol bridging the Paris and Vienna Conventions. Due to the negotiations for the updating of the Paris and Brussels Conventions on Nuclear Liability and their successful completion in early 2004, the Finnish Nuclear Liability Act was also reviewed. The review process began with the examination of amendments required by a special governmental committee and was followed by the drafting of a bill to amend the Nuclear Liability Act by the Government. The bill was approved by Parliament in the spring of 2005. These amendments include unlimited financial liability to licensees and a requirement that the licensee have to acquire insurance to cover damages up to EUR 700 million. The entry into force of this bill has been pending the ratification by the Parties of the 2004 Protocol to Amend the Paris Convention. Meanwhile, the Finnish Parliament has approved amendments to the law, increasing the amount of insured damages up to EUR 700 million and introducing unlimited financial liability nationally. These amendments will come into force on 1 January, 2012.

The Act on Environmental Impact Assessment (468/1994) provides that environmental impact assessment (EIA) be compulsory for nuclear facilities.

Several other laws under general legislation also affect nuclear power production, e.g.

- The Electricity Market Act (386/1995) opened up access to distribution networks and allows foreign ownership in electricity supply.
- The Act on Competition Restrictions (480/1992) is compatible with the EC law on competition.
- The Land Use and Building Act (132/1999) requires a land use plan for power plants and other facilities to be built on plant sites and provides guidelines for their planning.
- The Environmental Protection Act (86/2000) lays down various requirements relating to environmental protection.
- Completely revised Mining Act has been accepted by the Parliament on 15 March, 2011 and will enter into force 1 July 2011.

The requirements presented in the Nuclear Energy Act and Decree are specified in several general regulations laid down by the Decrees of the Government. These Decrees cover the following topic areas:

1. General safety regulations for nuclear power plants (733/2008);
2. General regulations concerning the physical protection in the use of nuclear energy (734/2008);
3. General regulations concerning emergency preparedness for nuclear power plants (735/2008);
4. Safety of the final disposal of nuclear wastes (736/2008).

4 CURRENT ISSUES AND DEVELOPMENTS ON NUCLEAR POWER

3.2 4.1 Nuclear energy and climate change

Finland has been successful in reducing its amounts of sulphur dioxide and nitrogen dioxide emissions that acidify the environment. However, preventing the growth of carbon dioxide emissions remains a very challenging task. The most important emissions reduction options are energy conservation, the use of renewable energy sources, nuclear power, and natural gas. Energy-efficiency is at a very high level in Finland, and any significant further increase in energy conservation would prove expensive.

In accordance with the targets for reducing greenhouse gas emissions, as agreed in the Kyoto Protocol, the EU countries have committed themselves to reducing their greenhouse gas emissions by a total of 8% from the 1990 level, by the first commitment period of 2008–2012. In accordance with burden sharing within the EU, Finland’s commitment is to return its emissions to their 1990 level. Meeting emission limits cost-effectively – especially those of carbon dioxide – will prove to be a challenging task without the expanded use of nuclear power and renewable energy sources.

In the years 1991 to 1993, CO_2 emissions decreased slightly below the level of 1990 and exceeded it only slightly in 2000, when hydro power production and net electricity imports had a large share in electricity production. On the other hand, in 2003 CO_2 emissions from fuel combustion were at their highest (30% above the reference level) due to record low hydro power production in Finland during the period beginning in 1970, and much lower net electricity imports.

In 2005, emissions again dropped fleetingly below the Kyoto target, owing to the high share of net electricity imports. Thereafter the emissions temporarily grew above the target but dropped again below the Kyoto target during the economic recession period 2008 – 2009. During 2010 the emissions from energy sector returned to the level of the year 2001.

In general the main actions in Finland have aimed at restricting emissions growth have been increasing the use of wood-based fuels, wind power and natural gas as a substitute for coal, as well as upgrading the nuclear power plants. Energy conservation has also played a role.

Since the energy sector accounts for nearly 80 per cent of greenhouse gas emissions, the greatest potential for reductions in these emissions will be found in this sector. Greenhouse Gas emissions will also have to be reduced in other sectors. The updated Climate and Energy Strategy of Finland was presented to the Parliament by the Government in November 2008. In addition to the climate change policy, the new National Climate and Energy Strategy takes account of the energy policy goals. The Government has also drawn up a long-term climate and energy strategy. The strategy defines the principal objectives and means of Finland's energy and climate policy for the next ten years in the context of the European Union. It suggests measures to facilitate adaptation to the change. To steer the preparation of the strategy, a ministerial working party on climate and energy policy was established under the leadership of the Ministry of Trade and Industry (now Ministry of Employment and the Economy).

The National Climate and Energy Strategy and its supplementary programmes determine the energy policy lines to be followed. On the other hand, while drafting the Climate and Energy Strategy, account was taken of the principles underlying energy policy. According to the Strategy, Finland should continue to rely on a diverse supply of energy sources, ensuring maximum self-sufficiency.

The EU's role in steering energy policy has increased in recent years. The core framework of Europe's Energy and Climate Policy is based on decisions taken in December 2008. These include reducing greenhouse gas emissions by 20%, raising the share of renewable energy to an average of one fifth of total consumption (38% for Finland), while improving energy efficiency by 20% by 2020.

According to the trend outlined in the strategy, the share of indigenous energy, and that of renewable energy in particular, will increase markedly over current levels. The share of renewable energy will increase to 38 per cent of total final energy consumption, the efficiency of the energy system will improve, and greenhouse gas emissions will begin to fall on a permanent basis. Furthermore, the share of coal and oil on Finnish energy balance sheet will decrease, and the diversity of our energy system will further improve, while the risk to our energy supply posed by crises originating outside our country will diminish. To an extent, our energy system would be based on greater use of electricity than before.

Meeting increasing demand for energy and replacing fossil-fuel-fired power plants with entirely renewable energy sources may prove difficult. The Government considers that energy production in Finland needs to remain diverse and as self-sufficient as possible. No emission-free, low-emission or other form of generation that is neutral with respect to emissions and also sustainable and cost-efficient can be ruled out, including nuclear power; on the contrary, all forms of energy must be assessed on the basis of the overall interests of society.

The most significant greenhouse gas, carbon dioxide (CO_2), accounts for over 80% of all green-house gas emissions in Finland. However, CO_2 emissions from electricity generation alone are relatively small, owing to the significant share of combined heat and power production, and the use of biofuels, hydropower and nuclear power.

Fig. 23. shows the development of carbon dioxide emissions from the energy sector in Finland since 1970. The biggest single CO_2-source of primary energy is oil. In the overall picture, the emissions from the electricity production are quite small reflecting the high efficiency of electricity production.

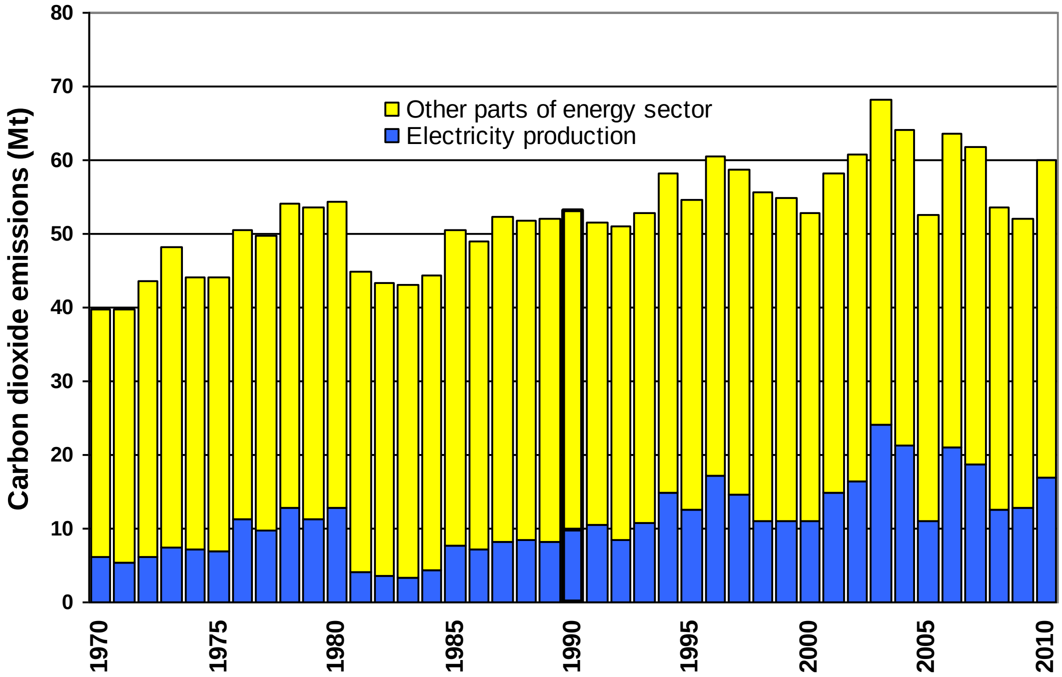


FIG. 23. Development of carbon dioxide emissions from energy sector in Finland. The share of CO_2 emissions in domestic electricity production was 10 Mt in 1990, 24 Mt in 2003, 18.6 Mt in 2007, 12.6 Mt in 2008 , 12.7 Mt in 2009 and 16.9 Mt in 2010.

The share of CO_2-neutral electricity generation is shown in Fig. 24. Trends of greenhouse gas emissions in EU-15 countries relative to their targets set in the EU burden sharing are shown in Fig. 25. The emission trends in the new member states are shown as well.

Carbon dioxide emissions were reduced significantly in the early 1980s, when the current Finnish nuclear power plants were commissioned in 1977–1982. Nuclear power replaced condensing power production, which was mainly based on coal. To curb greenhouse gas emissions, the Government has issued in November 2008 a new Climate and Energy Strategy, which will take account of developments since the first and second climate strategies of 2001 and 2005, such as the Emissions Trading Directive and the entry into force of the Kyoto Protocol. In parallel with domestic emission-cutting measures, Finland will also explore the use of the Kyoto mechanisms under the new strategy. The variability of Finnish emissions is high for climatic reasons (i.e. hydro power availability and space heating needs in the winter as well as the amount of nert electricity imports to Finland).

Considerable emission cuts are expected from the new nuclear power plant Olkiluoto 3, which is expected to be commissioned in 2013. Because the plant is delayed compared to the original schedule, Finnish producers need to buy emission allowances on the EU market. Emission trading prices in the EU area have been rather volatile. Initially, prices were much higher than expected but settled to rather low values. With the realisation of the Kyoto emission reductions during the second period 2008-2012, prices are expected to increase from the low level prevailing up to the end of 2007. Emission trading has thus created a competitive advantage for carbon-free energy production forms, as intended.

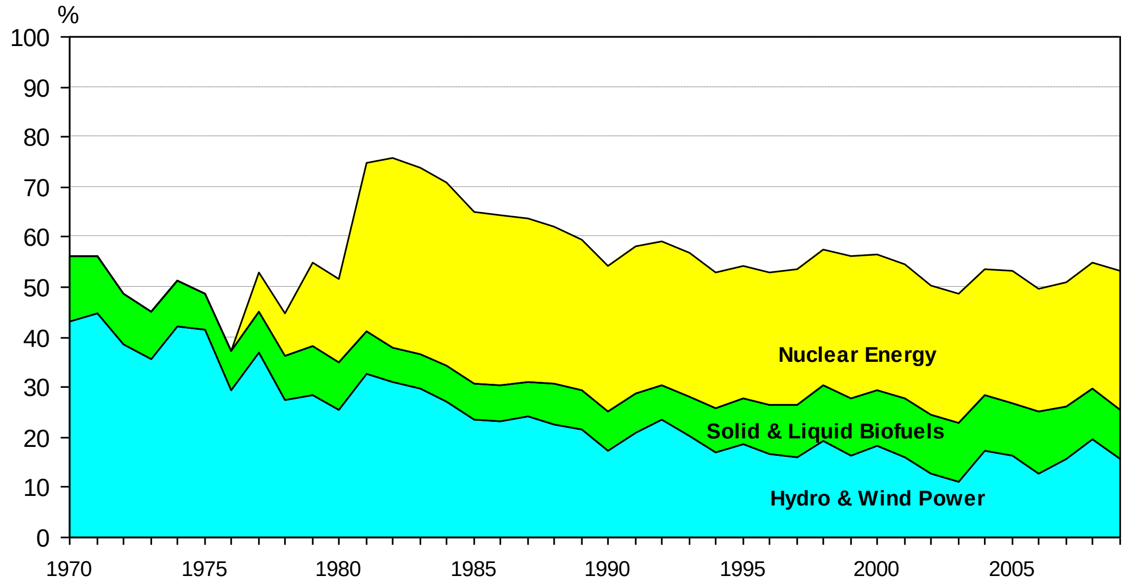


FIG. 24. The percentage of CO_2 free and neutral electricity generation of total electricity consumption (1970 - 2009).

However, it remains unclear how emissions trading will affect investment decisions in low- or zero-carbon energy sources. Emissions trading will bring competitive advantages to carbon-free energy production forms. On the other hand, the present emissions trading system, with specifications extending only a few years ahead, has considerably increased the current uncertainty over investment decisions. In most EU countries, the basis on which emission-free allowances will be allocated to operators during the next phases of the system remains unknown. There is a concrete risk that emission reductions realised during the first phase of the system will decrease the amount of free emission allowances obtained in the second phase. Through the EU emissions trading system, the benefits for all carbon-free or low-carbon electricity producers selling electricity to the stock market will increase. In Finland, nuclear energy produced by Teollisuuden Voima Oyj (TVO) is sold to its shareholders at production cost price. Thus, emissions trading brings a competitive advantage to TVO’s shareholders in the form of cheaper electricity.

4.2 Other issues

4.2.1 Public acceptability of nuclear power

An independent university group has conducted public opinion surveys on energy alternatives since 1983. Fig. 26 indicates how the attitudes towards nuclear power have evolved through the years. It can be seen that the public attitude was rather favourable towards nuclear power before the Chernobyl disaster. The survey taken immediately after the accident showed a drastic change in opinions. At that time only 14% were in favour of increasing nuclear capacity. The confidence lost in 1986 quickly returned by 1988 and the trend has been slowly improving since that. The latest poll in 2009 showed that 44% favoured expanded use of nuclear energy and 29% considered that present situation should be maintained or had no opinion, while 26% were of the opinion that the share of nuclear energy should be reduced. The change after the Decision-in-Principle of the fifth Finnish reactor is clear.

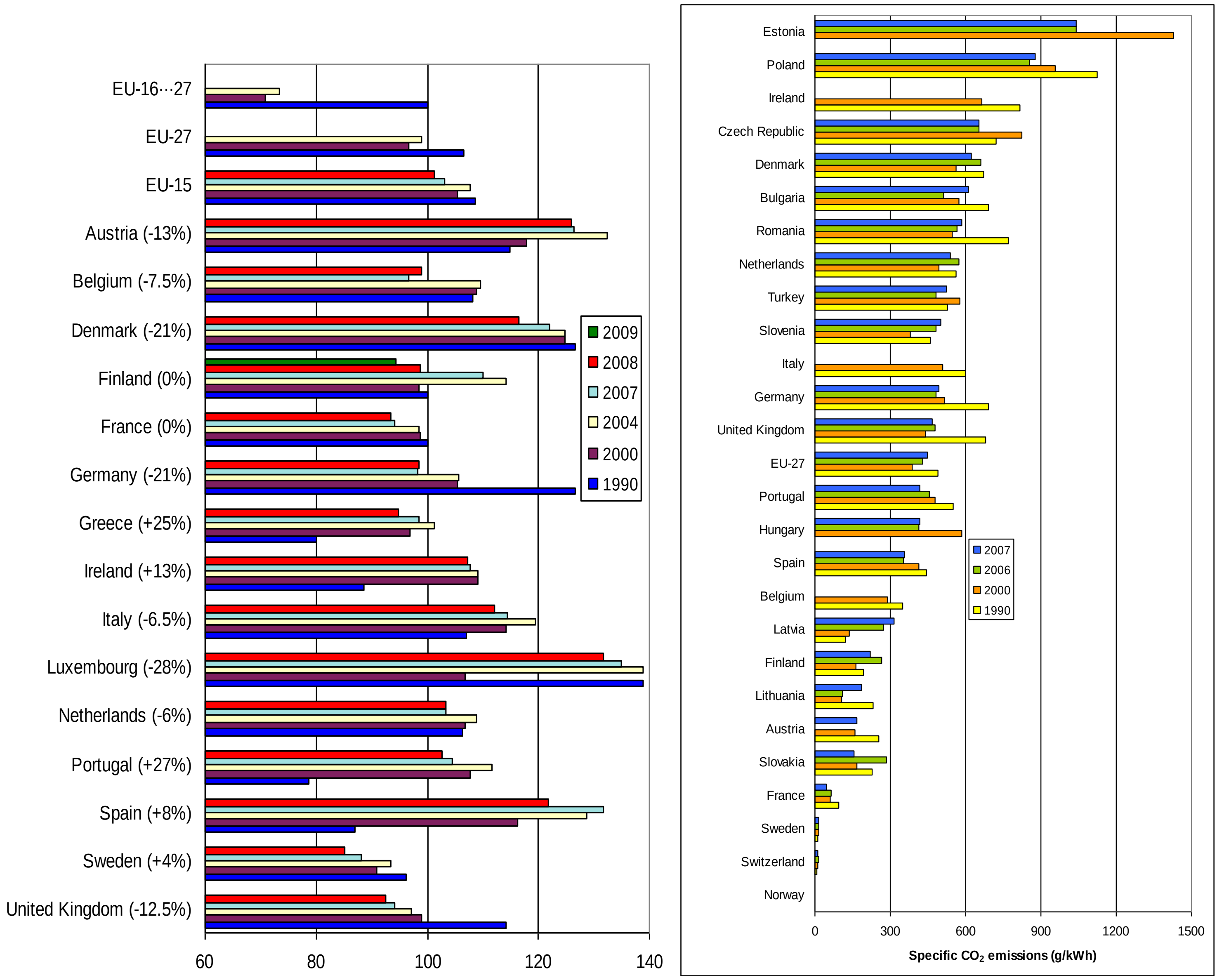


FIG. 25. Trends in greenhouse gas emissions (left) in EU-15 countries relative to the targets (=100) set in the burden sharing and the GHG emission trends in new member states relative to the emission levels of 1990 (European Environment Agency, Statistics Finland). Specific CO_2 emission (right) from electricity production in Europe in 1990, 2000 and 2006 (Eurelectric, EURPROG)

The biggest uncertainty seems to concern nuclear waste. In the national level, the latest opinion poll of 2009 showed that 48% did not agree that it is safe to dispose of nuclear wastes in the Finnish bedrock, while 32% were confident on the safety of geological disposal of nuclear waste. Locally the attitudes are more favourable. A question put in the opinion poll in spring 1999 - when the application for Decision-in-Principle for the spent fuel disposal facility was submitted to the Government - concerned especially the opinion of the inhabitants living in those municipalities that were the candidate host communities for a spent fuel repository in Finland. The results showed that a clear majority of the people in Loviisa and Eurajoki agreed that a spent fuel repository could be sited in their home community, provided that studies can show that the encapsulation and disposal facility is safe.

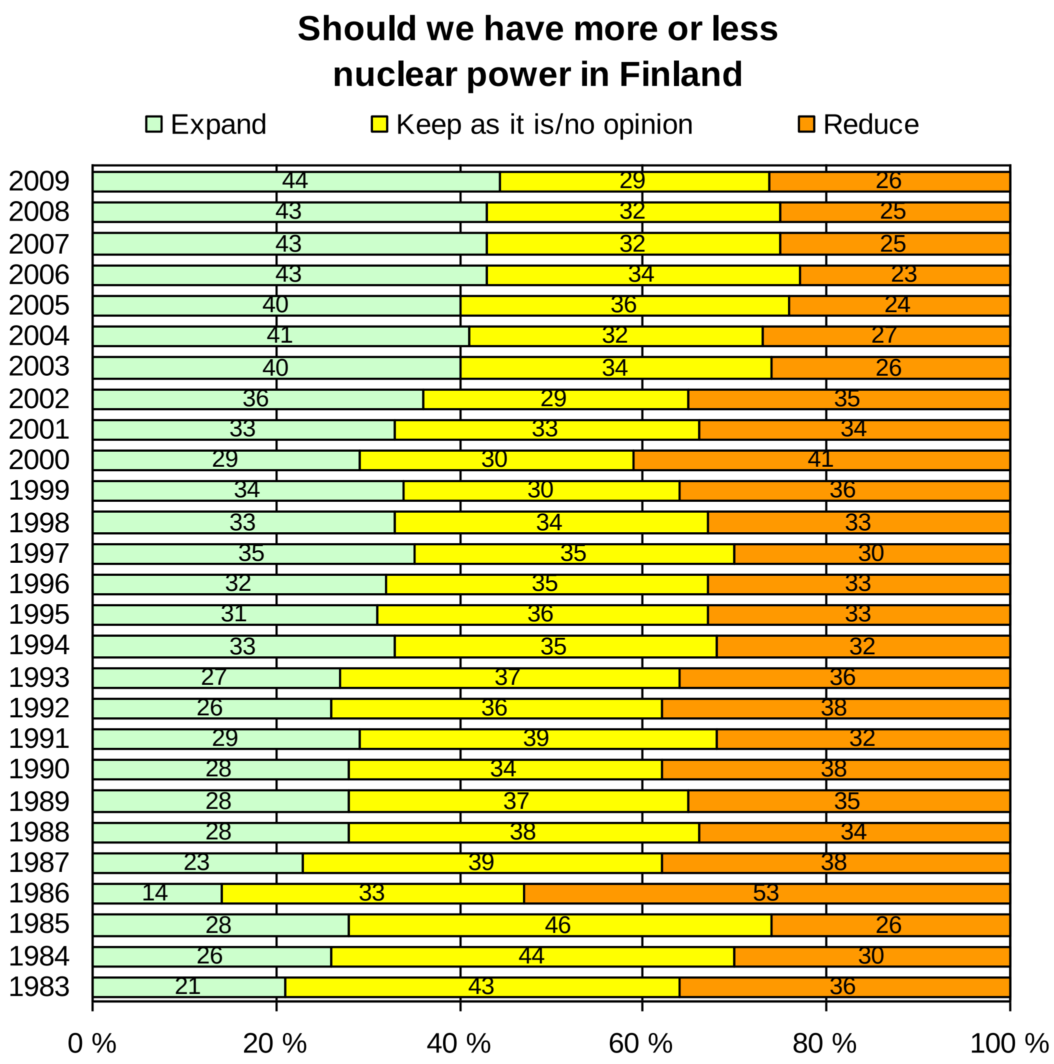


FIG. 26. Attitudes in Finland towards the use of nuclear power.
The development of the acceptance of nuclear power 1983–2009.
Source: Energy Attitudes, Yhdyskuntatutkimus Oy, Finnish Energy Industries.

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APPENDIX 1

INTERNATIONAL, MULTILATERAL AND BILATERAL) AGREEMENTS

Finland is a member state, e.g. of the following intergovernmental organisations:

- International Atomic Energy Agency (since 1958),
- Nuclear Energy Agency of the OECD (since 1976),
- International Energy Agency (since 1992).

AGREEMENTS WITH THE IAEA

• Statute of the International Atomic Energy Agency [FTS 2/1958, 37/1963, 18/1976, 13/1990]	Entry into force:	7 January 1958
• Amendments of Article VI & XIV.A of the IAEA Statute	Ratified:	14 June 2000
• Agreement on privileges and immunities of the IAEA; INFCIRC/9 [FTS 27/1960]	Entry into force:	29 July 1960
• Application of safeguards in connection with the NPT; INFCIRC/155 [FTS 2/1972]	Entry into force: Suspended:	9 February 1972 1 October 1995
• Agreement between the non-nuclear weapon States of the European Community, the European Atomic Energy Community and the IAEA in connection with the NPT; INFCIRC/193 [FTS 55/1995]	Entry into force:	1 October 1995
• Additional Protocol to the Agreement between the non-nuclear weapon States of the European Community, the European Atomic Energy Community and the IAEA in connection with the NPT [FTS 52-53/2004]	Entry into force:	30 April 2004
• Improved procedures for designation of safeguards inspectors	Accepted on:	25 April 1989
• The Agency's assistance to Finland in establishing a research reactor project; INFCIRC/24	Entry into force:	23 December 1960
• The Agency's assistance to Finland in establishing a sub-critical assemblies project; INFCIRC/53	Entry into force:	30 July 1963
• Nordic mutual emergency assistance agreement in connection with radiation accidents; INFCIRC/49 [FTS 39-40/1965]	Entry into force:	23 June 1965

OTHER RELEVANT INTERNATIONAL TREATIES

• Treaty on the non-proliferation of nuclear weapons; INFCIRC/140 [FTS 10-11/1970)	Entry into force:	5 March 1970
• Convention on physical protection of nuclear material; INFCIRC/274 [FTS 72/1989]	Entry into force:	22 October 1989
• Convention on early notification of a nuclear accident; INFCIRC/335 [FTS 98/1986]	Entry into force:	11 January 1987
• Convention on nuclear safety; INFCIRC/449 [FTS 74/1996]	Entry into force:	24 October 1996
• Joint convention on the safety of spent fuel management and on the safety of radioactive waste management; INFCIRC/546 [FTS 36/2001]	Entry into force:	18 June 2001
• Vienna convention on civil liability for nuclear damage		Non-Party
• Protocol to amend the Vienna convention on civil liability for nuclear damage		Not signed

• Convention on supplementary compensation for nuclear damage		Not signed
• Paris convention on on third party liability in the field of nuclear energy on 29 July 1960 [FTS 20/1972, 1/1990]	Entry into force:	16 June 1972
• Supplementary convention to the Paris convention of 29 July 1960 on third party liability in the field of nuclear energy, Brussels and Paris [FTS 4/1977, 85/1991]	Entry into force:	14 April 1977
• Joint protocol relating to the application of the Vienna and Paris conventions; INFCIRC/402 [FTS 98/1994]	Entry into force:	3 January 1995
• Convention relating to civil liability in the field of maritime, carriage of nuclear material in Brussels [FTS 62/1991].	Entry into force:	4 September 1991
• Zangger Committee; Communication received from Members regarding the export of nuclear material and of certain categories of equipment and other material; INFCIRC 209.	Dated:	22 August 1974
• Nuclear Suppliers Group, NSG; Communication received from Member States regarding the export of nuclear material, equipment or technology; INFCIRC/254 /Part 1, INFCIRC/254 /Part 2.	Dated: Dated:	March 1980 July 1992
• Communication received on behalf of the European Community regarding transfers of nuclear material, equipment and technology; INFCIRC 322.	Dated:	21 December 1995
• Statements on full-scope safeguards adopted by the adherents to nuclear suppliers guidelines; INFCIRC/405.	Adopted:	3 April 1992
• Communication received from the Member States of the European Community regarding the provision of certain additional information; INFCIRC/415.	Dated:	8 February 1996
• Acceptance of NUSS Codes	Summary: Codes are considered to be useful guidance. Finnish regulations are in general consistent with revised codes. (Letter of 18 May 1990)	
• Agreement on common Nordic guidelines on communication concerning the siting of nuclear installations in border areas, [FTS 19/1977].	Entry into force:	15 November 1976
• Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	Entry into force:	26 February 1987
• Agreement on the Exchange of Radiation Monitoring Data (FTS 52-53/2002)	Entry into force:	19 June 2002
• The Statute of the OECD Nuclear Energy Agency (NEA), subsequently amended (FTS 24/1976)	Entry into force	1 January 1976

BILATERAL AGREEMENTS

- As of 1 January 1995, Finland has been a member of the European Atomic Energy Community (EAEC or Euratom). Consequently, e.g. the following agreements are applied in Finland:
  - Agreement between the European Atomic Energy Community and the Government of Canada for cooperation in the peaceful uses of atomic energy, 6 October 1959
  - Agreement between the Government of Australia and the European Atomic Energy Community concerning transfers of nuclear material from Australia to the European Atomic Energy Community; 21 September 1981
  - Agreement for cooperation in the peaceful uses of nuclear energy between the European Atomic Energy Community and the United States of America, 12 April 1996.
  - Agreement for cooperation in the peaceful uses of nuclear energy between the European Atomic Energy Community and the Republic of Argentina, 29 October 1997**.**
  - Agreement for cooperation in the peaceful uses of nuclear energy between he European Atomic Energy Community and the Government of the Republic of Uzbekistan, 6 October 2003
  - Agreement between the European Atomic Energy Community and the Cabinet of Ministers of Ukraine for cooperation in the peaceful uses of nuclear energy, 28 April 2005
  - Agreement for cooperation in the peaceful uses of nuclear energy between the European Atomic Energy Community and the Government of Japan, 27 February 2006
  - Agreement for cooperation in the peaceful uses of nuclear energy between the European Atomic Energy Community and the Government of the Republic of Kazakhstan, 4 December 2006
- Agreement for cooperation between the Government of Finland and the Government of Sweden concerning peaceful uses of atomic energy, 15 October 1968 [FTS 40-41/1970].
- Agreement between Finland and Sweden on the guidelines to be followed while exporting nuclear material, technology or equipment, 4 March 1983 [FTS 20/1983].
- Agreement between Finland and Denmark on the Exchange of Information and Reporting Relative to Nuclear Plants and Nuclear Events in Finland and Denmark, 25 February 1987 [FTS 27/1987].
- Agreement between Finland and Sweden on the Exchange of Information and Reporting Relative to Nuclear Plants and Nuclear Events in Finland and Sweden, 25 February 1987 [FTS 28/1987].
- Agreement between Finland and Norway on the Exchange of Information and Reporting Relative to Nuclear Plants ad Nuclear Events in Finland and Norway, 25 February 1987 [FTS 46/1987].
- Agreement between the Government of the Federal Republic of Germany and the Republic of Finland concerning the Early Notification of a Nuclear Accident and the Exchange of Information and Experience Relative to Nuclear Safety and Protection Against Radiation, 21 December 1992 [FTS 35/1993].
- Agreement between the Government of Finland and the Government of the Russian Federation on the Rapid Reporting on Nuclear Accidents and the Exchange of Information Relative to Nuclear Plants, 19 January 1995 [FTS 38/1996].
- Agreement between the Government of the Republic of Finland and the Government of Ukraine on Early Notification of Nuclear Accidents and on Exchange of Information and Experience in the Field of Nuclear Safety and Radiation Protection, 8 February 1996 [FTS 66/1997].

APPENDIX 2

MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

NATIONAL NUCLEAR ENERGY AUTHORITIES

Ministry of Employment and the Economy (MEE) Energy Department P.O. Box 32 FI-00023 GOVERNMENT	Tel. +358 10 606 000 Fax. +358 9 1606 2664 www.tem.fi
Radiation and Nuclear Safety Authority (STUK) P.O. Box 14 FI-00881 HELSINKI	Tel. +358 9 759 881 Fax. +358 9 7598 8500 www.stuk.fi/english/

NUCLEAR ADVISORY BODIES

Advisory Committee on Nuclear Safety (YTN) c/o Radiation and Nuclear Safety Authority (STUK) P.O. Box 14 FI-00881 HELSINKI	Tel. +358 9 759 881 Fax. +358 9 7598 8500
Advisory Committee on Nuclear Security c/o Radiation and Nuclear Safety Authority (STUK) P.O. Box 14 FI-00881 HELSINKI	Tel. +358 9 759 881 Fax. +358 9 7598 8500

OTHER NATIONAL AUTHORITIES

Ministry for Foreign Affairs (*Non-proliferation of nuclear weapons and international agreements)*	www.formin.finland.fi
Ministry of Social Affairs and Health *(Administrative authority for the use of radiation)*	www.stm.fi
Ministry of the Environment *(Protection of the environment in normal and accident situations)*	www.ymparisto.fi
Ministry of the Interior *(Protection of population in emergency situations)*	www.intermin.fi

NUCLEAR ENERGY INDUSTRY

Fortum Power and Heat Oy (FPH) *(Operator of Loviisa Nuclear Power Plant)* P.O. Box 23 FI-07901 LOVIISA	Tel. +358 10 455 5011 Fax. +358 10 455 4435 www.fortum.com/loviisa
Teollisuuden Voima Oyj (TVO) (Operator of Olkiluoto NPP) FI-27160 EURAJOKI	Tel. +358 2 83811 Fax. +358 2 8381 2109 www.tvo.fi/eng
Posiva Oy *(Company for disposal of spent fuel)* FI-27160 EURAJOKI	Tel. +358 2 8372 (31) Fax. +358 2 8372 3709 www.posiva.fi/englanti
Fennovoima Oy Salmisaarenaukio 1 FI-00180 HELSINKI	Tel. +358 20 757 9200 Fax. +358 9 870 1818 www.fennovoima.fi
Talvivaara Sotkamo Oy FI-88120 Tuhkakylä	Tel. +358 20 712 9800 www.talvivaara.com

RESEARCH INSTITUTES

VTT Technical Research Centre of Finland
P.O. Box 1000
FI-02044 VTT
Tel. +358 20 722 111
Fax. +358 20 722 5000
www.vtt.fi/nuclear

Geological Survey of Finland (GTK)
P.O. Box 96
FI-02151 ESPOO
Tel. +358 20 550 11
Fax. +358 20 550 12
http://en.gtk.fi

Finnish Meteorological Institute
P.O. Box 503
FI-00101 HELSINKI
Tel. +358 9 192 91
Fax. +358 9 179 581
www.fmi.fi/en

UNIVERSITIES

Lappeenranta University of Technology (LUT)
P.O. Box 20
FI-53851 LAPPEENRANTA
Tel. +358 5 621 11
Fax. +358 5 621 2799
www.lut.fi/en

Aalto University School of Science and Technology,
Department of Applied Physics
P.O. Box 14100
FI-00076 AALTO
Tel. +358 9 47001
www.tkk.fi/en/

University of Helsinki,
Laboratory of Radiochemistry (HYRL)
P.O. Box 55
FI-00014 University of Helsinki
Tel. +358 9 191 50120
Fax. +358 9 191 50121
www.helsinki.fi/kemia/radiokemia/english/

University of Jyväskylä
Department of Physics
P.O. Box 35 (YFL)
FI-40014 University of Jyväskylä
Tel: +358 14 260 2350
www.jyu.fi/fysiikka/en

OTHER ORGANISATIONS

Finnish Funding Agency for Technology and Innovation (Tekes)
P.O. Box 69
FI-00101 HELSINKI
Tel. +358 10 191 480
Fax. +358 9 694 9196
www.tekes.fi/eng

Academy of Finland
P.O. Box 99
FI-00501 HELSINKI
Tel. +358 9 774 881
Fax. +358 9 7748 8299
www.aka.fi/eng

Finnish Energy Industries (ET)
www.energia.fi

Finnish Nuclear Society
www.ats-fns.fi

FinNuclear c/o Prizztech Ltd
tel. +358 44 710 5336
www.finnuclear.fi