

FRANCE

FRANCE

1. ENERGY, ECONOMIC AND ELECTRICITY INFORMATION

1.1. General Overview

France is situated in Western Europe and is nearly hexagonal in shape, with an extreme length from north to south of 965 km and a maximum width of 935 km. The total area of metropolitan France, including the island of Corsica in the Mediterranean, is 552 000 km². In addition to the European or metropolitan territory, the country includes several overseas “*départements*”, territorial “*collectivités*”, and overseas territories. The climate of metropolitan France is temperate, with wide regional contrasts. The average annual temperature is about 12 degrees. Precipitation is evenly distributed, averaging about 760 mm annually.

The total population is about 60 million in 2000 and the population density around 107 inhabitants per km² (Table 1). Population growth rate is around 0.5% per annum.

TABLE 1. POPULATION INFORMATION

	1970	1980	1990	2000	2001	2002	Average annual growth rate (%) 1990 To 2002
Population (millions)	50.8	53.9	56.7	59.3	59.6	59.8	0.4
Population density (inhabitants/km ²)	92.1	97.7	102.8	107.5	108.0	108.5	

Predicted population growth rate (%) 2002 to 2010	2.2
Area (1000 km ²)	551.5
Urban population in 2002 as percent of total	75.7

Source: IAEA Energy and Economic Database.

France has sizeable deposits of various metals and little fossil fuel resources. Owing to high recovery costs, production of fossil fuels has decreased to a rather low level and is not expected to provide a significant share of the country energy supply in the future. Most hydropower resources are already exploited. Therefore, the French energy policy places high emphasis on improving energy independence through the development of domestic technologies, including nuclear power, alternative energies and renewables, in order to alleviate the country vulnerability to the volatility of fossil fuel international markets and to meet the Kyoto commitments.

1.1.1. Economic Indicators

Table 2 shows the historical trend of Gross Domestic Product (GDP). GDP growth rates in France in the recent years, was 1.1% in 1996, 1.9% in 1997 and 3.4% in 1998, 3.2% in 1999 and 3.8% in 2000 and 1.8% in 2001.

TABLE 2. GROSS DOMESTIC PRODUCT (GDP)

	1980	1990	2000	2001	2002	Average annual growth rate (%)
						1990 To 2002
GDP (millions of current US\$)	682,078	1,215,893	1,294,245	1,330,876	1,371,623	1.0
GDP per capita (current US\$/capita)	12,659	21,438	21,827	22,344	22,918	0.6

Source: IAEA Energy and Economic Database.

1.1.2. Energy Situation

The French domestic energy reserves are listed in Table 3. Table 4 provides statistical data on energy and electricity supply and demand between 1960 and 2001. It illustrates the long term trend of substituting nuclear power to imported fossil fuels and the improvement of energy independence. Since 1993, primary energy consumption undergoes a slight but regular increase. Domestic production accounts for some 50% of that consumption. The energy balance improved in the last two decades, mainly due to the raise of electricity exports, that reached 68.4 TW·h in 2001. The energy intensity has lowered owing to structural changes in the economy, i.e. reduction in the share of energy intensive industries in total GDP, and to a lesser extent, to efficiency improvements.

TABLE 3. ESTIMATED ENERGY RESERVES

	Estimated energy reserves in (Exajoule)					
	Solid	Liquid	Gas	Uranium (1)	Hydro (2)	Total
Total amount in place	1.07	0.88	0.52	7.81	19.28	29.56

(1) This total represents essentially recoverable reserves.

(2) For comparison purposes a rough attempt is made to convert hydro capacity to energy by multiplying the gross theoretical annual capability (World Energy Council - 2002) by a factor of 10.

Source: IAEA Energy and Economic Database.

TABLE 4. ENERGY STATISTICS^(*)

	1970	1980	1990	2000	2001	2002	Average annual growth rate (%)	
							1970 To 1990	1990 To 2002
Energy consumption								
- Total (1)	6.62	8.39	8.81	9.91	10.03	10.37	1.44	1.36
- Solids (2)	1.79	1.70	1.09	0.86	0.82	0.83	-2.47	-2.27
- Liquids	3.84	4.44	3.52	3.58	3.65	3.76	-0.45	0.55
- Gases	0.38	1.00	1.22	1.63	1.66	1.76	5.96	3.10
- Primary electricity (3)	0.60	1.25	2.99	3.83	3.90	4.03	8.35	2.51
Energy production								
- Total	2.30	2.38	4.24	5.07	5.09	5.19	3.11	1.70
- Solids	1.30	0.81	0.56	0.31	0.26	0.22	-4.15	-7.29
- Liquids	0.12	0.05	0.14	0.20	0.21	0.21	0.70	3.34
- Gases	0.27	0.29	0.11	0.06	0.05	0.04	-4.33	-7.41
- Primary electricity (3)	0.61	1.22	3.43	4.50	4.57	4.71	9.05	2.67
Net import (Import - Export)								
- Total	4.69	6.41	5.39	6.02	6.10	6.26	0.70	1.25
- Solids	0.44	0.92	0.58	0.58	0.62	0.69	1.31	1.47
- Liquids	4.11	4.75	3.62	3.80	3.80	3.82	-0.64	0.46
- Gases	0.13	0.75	1.20	1.64	1.68	1.75	11.61	3.22

(1) Energy consumption = Primary energy consumption + Net import (Import - Export) of secondary energy.

(2) Solid fuels include coal, lignite and commercial wood.

(3) Primary electricity = Hydro + Geothermal + Nuclear + Wind.

(*) Energy values are in Exajoule except where indicated.

Source: IAEA Energy and Economic Database.

1.2. Energy Policy

During the post World War II reconstruction period, France's economic and social development relied mainly on the deployment of energy intensive industries. The rapidly increasing energy needs were partly met by domestic coal and hydropower resources. However, French domestic fossil fuel resources being limited and costly, the country had to rely heavily on imports for its energy supply. By 1973, imports were covering more than 75% of national energy consumption, compared to 38% in 1960. After the 70's oil crisis, the country was in need of better energy independence. At that time, implementation of a large nuclear power programme became a major element of France's energy policy, including also energy saving measures, efficiency improvement and research and development in the field of renewable energies. The share of nuclear power in primary energy supply increased from less than 2% in the late seventies to about one third in the mid nineties.

The main macro-economic impacts of France's energy policy are : drastic improvement in the energy trade balance, stabilization of domestic energy prices at a rather low level, increased competitiveness of French companies on international markets and deployment of a nuclear industry sector covering reactor construction and the whole of the fuel cycle. Increased awareness of environmental constraints reflects in the French energy mix, aiming to reduce the negative impacts of energy production on health and environment. In this regard, substitution of nuclear power to fossil fuel for electricity generation resulted in a drastic reduction of atmospheric emissions from the energy sector.

1.3. The Electricity System

1.3.1. Structure of the Electricity Sector

The European directives on the liberalization of the electricity market have been fully transposed into the French legislation. However the state-owned utility *Electricité de France* (EDF) remains the main operator for production and distribution. EDF owns and operates all nuclear and part of the fossil-fuel fired and hydro-power plants. The main other suppliers are CNR (*Compagnie Nationale du Rhône, 17 TWh production in 2001*) which operates most of the hydro plants along the Rhône river, SNET (*Société nationale d'électricité et de thermique, 2,600 MWe installed capacity, 8TWh produced in 2000*) for the coal-fired plants, SHEM (*Société Hydroélectrique du Midi, 770 MWe, 2 TWh*), a subsidiary of the national railway company SNCF now in trading agreement with Electrabel, and private manufacturers operating back-up or combined heat and power production units, as well as operators of small and medium size hydropower plants. More than fifty providers actually operate on the French market and fifteen percent of eligible consumers have already changed supplier.

The transmission grid operator RTE (*Réseau de transport d'électricité*) has been individualized inside EDF according to the European rules and manages the load dispatch system independently. An independent regulatory authority, CRE (*Commission de Régulation de l'Electricité*), guarantees equal access and competition to all market players. Regarding distribution activities, local authorities grant the concession of well-defined areas. There are about 200 distribution companies featuring municipality or joint ownership, with a 5% share of total electricity billing.

EDF is involved in activities in the European Union and abroad (Eastern European countries, Far East and Latin America) and is associated with foreign companies (e.g. electricity distributors in Argentina and thermal generators in Africa).

1.3.2. Decision Making Process

The General Directorate for Energy and Raw Materials (DGEMP), under the Ministry of Industry, is in charge of implementing the French government policy on energy within the framework of the European directives, in particular to ensure that public service obligations are respected. The Minister for Ecology and Sustainable Development and the Minister for Health are to control health and environmental impacts of industrial facilities, including energy production and transformation plants.

EDF is the main operator in the power sector. The respective commitments between the now industrial group EDF and the government are stated in the "*Contrat de Groupe*", setting the objectives to be met by EDF in a given time schedule. The French government also appoints EDF's chairman.

A regulatory reform has come into operation in the course of 2002. The new regulatory authority, the DGSNR (*Direction générale de la sûreté nucléaire et de la radioprotection*) is in charge of both nuclear safety and radioprotection. It has taken over the former DSIN (Directorate for Nuclear Installations Safety - *Direction de la Sûreté des Installations Nucléaires*) and the regulatory part of OPRI (Board for Protection against Ionizing Radiation - *Office de Protection contre les Rayonnements Ionisants*). At the same time a new independent expert institution, the IRSN (Institute for radio-protection and nuclear safety - *Institut de radioprotection et de sûreté nucléaire*) combining competence on nuclear safety and radiation-protection, has resulted from the merger of the former IPSN and OPRI. The secret (military) nuclear installations are also concerned by this reform.

1.3.3. Main Indicators

Table 5 shows the history of electricity production and Table 6 the energy related ratios from EEDB. At present, over 90% of France's electricity are of nuclear and hydraulic origin, the remaining 10% coming mainly from fossil fuels. Electricity demand grows in line with GDP, though at lower rate.

TABLE 5. ELECTRICITY PRODUCTION AND INSTALLED CAPACITY

	1970	1980	1990	2000	2001	2002	Average annual growth rate (%)	
							1970 To 1990	1990 To 2002
Electricity production (TW.h)								
- Total (1)	146.79	245.71	420.13	525.75	532.93	548.31	5.40	2.24
- Thermal	83.86	118.91	64.10	58.86	59.04	59.63	-1.33	-0.60
- Hydro	57.22	68.86	58.32	71.82	72.50	73.08	0.10	1.90
- Nuclear	5.71	57.95	297.70	395.00	401.30	415.50	21.86	2.82
- Geothermal								
Capacity of electrical plants (GWe)								
- Total	36.22	62.71	103.33	115.98	116.94	118.20	5.38	1.13
- Thermal	19.58	29.03	22.50	27.49	28.40	29.57	0.70	2.30
- Hydro	15.00	19.29	24.93	25.36	25.40	25.47	2.57	0.18
- Nuclear	1.65	14.39	55.89	63.07	63.07	63.07	19.27	1.01
- Geothermal				0.01	0.01	0.01		
- Wind			0.02	0.06	0.07	0.07		14.24

(1) Electricity losses are not deducted.

Source: IAEA Energy and Economic Database.

TABLE 6. ENERGY RELATED RATIOS

	1970	1980	1990	2000	2001	2002
Energy consumption per capita (GJ/capita)	130	156	155	167	168	173
Electricity per capita (kW.h/capita)	2,755	4,618	6,250	7,290	7,571	7,719
Electricity production/Energy production (%)	62	100	95	100	101	102
Nuclear/Total electricity (%)	4	24	71	75	75	76
Ratio of external dependency (%) (1)	71	76	61	61	61	60
Load factor of electricity plants						
- Total (%)	46	45	46	52	52	53
- Thermal	49	47	33	24	24	23
- Hydro	44	41	27	32	33	33
- Nuclear	40	46	61	71	73	75

(1) Net import / Total energy consumption.

Source: IAEA Energy and Economic Database.

2. NUCLEAR POWER SITUATION

2.1. Historical Development and current nuclear power organizational structure

2.1.1. Overview

Historically, the development of nuclear power fell into four phases. During the 1960's, in line with the overall target of industrial independence and domestic technological development, indigenous designs were promoted (mainly natural uranium - gas cooled reactors and fast breeders). However, a PWR unit (Chooz-A) was built jointly with Belgium and a heavy water reactor in Brittany (Brennilis).

International developments in the nuclear industry led in the late sixties to the recognition that the French reactor designs could not compete with light water reactors. In 1969 the decision was made to build LWRs under license, whilst restructuring the domestic industry to improve competitiveness. Subsequently, the French government envisaged a construction program of one or two PWRs a year.

From 1974 to 1981 emphasis was put on adaptation of the Westinghouse design for the development of a French standard. The nuclear programme accelerated the pace with the 1970's oil crisis. The unit-capacity of French reactors increased from 900 MWe to 1,300 MWe and later to 1,450 MWe. France developed and implemented, in parallel with the nuclear power plant program, a strong domestic fuel cycle industry, built upon the infrastructure originally established by CEA.

In 1981, Framatome terminated its license with Westinghouse and negotiated a new agreement, giving greater autonomy. Framatome developed a wide range of servicing expertise and capabilities in reactor operation and maintenance services. In the same year, France had to adapt its energy policy to a lower than expected economic growth, together with the occurrence of over-capacity in the national electricity supply system. The achievement of the 1450 MWe N4 model was the landmark for a totally autonomous French reactor design.

2.1.2. Current Organizational Chart(s)

Nuclear Power organizational Chart

Government authorities :

DGEMP (General Directorate for Energy and Raw Materials), Ministry of Industry

DGSNR (General Directorate for Nuclear Safety and Radioprotection), Ministries of Industry, Health and Ecology and Sustainable Development

DRIRE (Regional Directorates for Industry, Research and Environment)

Expert institution:

IRSN (Radioprotection and Nuclear Safety Institute)

Research and development:

CEA (Atomic Energy Commission)

Nuclear power plants operator:

EDF (Electricité de France)

Nuclear plants construction :

Framatome-ANP, Jeumont, Alstom

Fuel cycle industry, including engineering and services : AREVA group

Mining : Cogema

Conversion : Comurhex

Enrichment: Eurodif

Fuel fabrication : Framatome, (UO), Cogema (MOX)

Reprocessing and packaging: Cogema

Used fuel storage:

ANDRA

2.2. Nuclear Power Plants: Status and Operations

The share of nuclear power in the French electricity supply has reached its technical and economic maximum, amounting to about 63,000 MWe. It consists of fifty-nine units, fifty-eight being pressurized water reactors (thirty four 900 MWe, twenty 1300 MWe, and four 1450's), all constructed by the French manufacturer Framatome, and the 230 MWe fast breeder reactor, Phenix.

The nuclear plants accounts for 401 TWh in 2001 (over 75% of total electricity production), setting France the world's second largest nuclear power producer. Table 7 lists the status of the power plants as of year-end 2001. Nuclear power generation represents about one third of total primary energy supply, and over 80% of the domestic energy production, making EDF by far the number one nuclear operator and the first electricity producer in the world.

TABLE 7. STATUS OF NUCLEAR POWER PLANTS

Station	Type	Net Capacity	Operator	Status	Reactor Supplier	Construction		Criticality		Grid		Commercial		Shutdown	
						Date	Date	Date	Date	Date	Date	Date	Date		
BELLEVILLE-1	PWR	1310	EDF	Operational	FRAM	01-May-80	09-Sep-87	14-Oct-87	01-Jun-88						
BELLEVILLE-2	PWR	1310	EDF	Operational	FRAM	01-Aug-80	25-May-88	06-Jul-88	01-Jan-89						
BLAYAIS-1	PWR	910	EDF	Operational	FRAM	01-Jan-77	20-May-81	12-Jun-81	01-Dec-81						
BLAYAIS-2	PWR	910	EDF	Operational	FRAM	01-Jan-77	28-Jun-82	17-Jul-82	01-Feb-83						
BLAYAIS-3	PWR	910	EDF	Operational	FRAM	01-Apr-78	29-Jul-83	17-Aug-83	14-Nov-83						
BLAYAIS-4	PWR	910	EDF	Operational	FRAM	01-Apr-78	01-May-83	16-May-83	01-Oct-83						
BUGEY-2	PWR	910	EDF	Operational	FRAM	01-Nov-72	20-Apr-78	10-May-78	01-Mar-79						
BUGEY-3	PWR	880	EDF	Operational	FRAM	01-Sep-73	31-Aug-78	21-Sep-78	01-Mar-79						
BUGEY-4	PWR	880	EDF	Operational	FRAM	01-Jun-74	17-Feb-79	08-Mar-79	01-Jul-79						
BUGEY-5	PWR	900	EDF	Operational	FRAM	01-Jul-74	15-Jul-79	31-Jul-79	03-Jan-80						
CATTENOM-1	PWR	1300	EDF	Operational	FRAM	29-Oct-79	24-Oct-86	13-Nov-86	01-Apr-87						
CATTENOM-2	PWR	1300	EDF	Operational	FRAM	28-Jul-80	07-Aug-87	17-Sep-87	01-Feb-88						
CATTENOM-3	PWR	1300	EDF	Operational	FRAM	15-Jun-82	16-Feb-90	06-Jul-90	01-Feb-91						
CATTENOM-4	PWR	1300	EDF	Operational	FRAM	28-Sep-83	04-May-91	27-May-91	01-Jan-92						
CHINON-B-1	PWR	920	EDF	Operational	FRAM	01-Mar-77	28-Oct-82	30-Nov-82	01-Feb-84						
CHINON-B-2	PWR	920	EDF	Operational	FRAM	01-Mar-77	23-Sep-83	29-Nov-83	01-Aug-84						
CHINON-B-3	PWR	920	EDF	Operational	FRAM	01-Oct-80	18-Sep-86	20-Oct-86	04-Mar-87						
CHINON-B-4	PWR	920	EDF	Operational	FRAM	01-Feb-81	13-Oct-87	14-Nov-87	01-Apr-88						
CHOOZ-B-1	PWR	1455	EDF	Operational	FRAM	01-Jan-84	25-Jul-96	30-Aug-96	15-May-00						
CHOOZ-B-2	PWR	1455	EDF	Operational	FRAM	31-Dec-85	10-Mar-97	09-Apr-97	29-Sep-00						
CIVAUX-1	PWR	1450	EDF	Operational	FRAM	15-Oct-88	29-Nov-97	24-Dec-97	28-Jan-02						
CIVAUX-2	PWR	1450	EDF	Operational	FRAM	01-Apr-91	27-Nov-99	24-Dec-99	23-Apr-02						
CRUAS-1	PWR	915	EDF	Operational	FRAM	01-Aug-78	02-Apr-83	29-Apr-83	02-Apr-84						
CRUAS-2	PWR	915	EDF	Operational	FRAM	15-Nov-78	01-Aug-84	06-Sep-84	01-Apr-85						
CRUAS-3	PWR	915	EDF	Operational	FRAM	15-Apr-79	09-Apr-84	14-May-84	10-Sep-84						
CRUAS-4	PWR	915	EDF	Operational	FRAM	01-Oct-79	01-Oct-84	27-Oct-84	11-Feb-85						

Source: IAEA Power Reactor Information System as of 31 December 2002.

TABLE 7. CONTINUED, STATUS OF NUCLEAR POWER PLANTS

Station	Type	Net Capacity	Operator	Status	Reactor Supplier	Construction		Criticality		Grid		Commercial		Shutdown	
						Date	Date	Date	Date	Date	Date	Date	Date		
DAMPIERRE-1	PWR	890	EDF	Operational	FRAM	01-Feb-75	15-Mar-80	23-Mar-80	10-Sep-80						
DAMPIERRE-2	PWR	890	EDF	Operational	FRAM	01-Apr-75	05-Dec-80	10-Dec-80	16-Feb-81						
DAMPIERRE-3	PWR	890	EDF	Operational	FRAM	01-Sep-75	25-Jan-81	30-Jan-81	27-May-81						
DAMPIERRE-4	PWR	890	EDF	Operational	FRAM	01-Dec-75	05-Aug-81	18-Aug-81	20-Nov-81						
FESSENHEIM-1	PWR	880	EDF	Operational	FRAM	01-Sep-71	07-Mar-77	06-Apr-77	30-Dec-77						
FESSENHEIM-2	PWR	880	EDF	Operational	FRAM	01-Feb-72	27-Jun-77	07-Oct-77	18-Mar-78						
FLAMANVILLE-1	PWR	1330	EDF	Operational	FRAM	01-Dec-79	29-Sep-85	04-Dec-85	01-Dec-86						
FLAMANVILLE-2	PWR	1330	EDF	Operational	FRAM	01-May-80	12-Jun-86	18-Jul-86	09-Mar-87						
GOLFECH-1	PWR	1310	EDF	Operational	FRAM	17-Nov-82	24-Apr-90	07-Jun-90	01-Feb-91						
GOLFECH-2	PWR	1310	EDF	Operational	FRAM	01-Oct-84	21-May-93	18-Jun-93	01-Jan-94						
GRAVELINES-1	PWR	915	EDF	Operational	FRAM	01-Feb-75	21-Feb-80	13-Mar-80	01-Dec-80						
GRAVELINES-2	PWR	915	EDF	Operational	FRAM	01-Mar-75	02-Aug-80	26-Aug-80	01-Dec-80						
GRAVELINES-3	PWR	915	EDF	Operational	FRAM	01-Dec-75	30-Nov-80	12-Dec-80	01-Jun-81						
GRAVELINES-4	PWR	915	EDF	Operational	FRAM	01-Apr-76	31-May-81	14-Jun-81	01-Oct-81						
GRAVELINES-5	PWR	915	EDF	Operational	FRAM	01-Oct-79	05-Aug-84	28-Aug-84	15-Jan-85						
GRAVELINES-6	PWR	915	EDF	Operational	FRAM	01-Oct-79	21-Jul-85	01-Aug-85	25-Oct-85						
NOGENT-1	PWR	1310	EDF	Operational	FRAM	26-May-81	12-Sep-87	21-Oct-87	24-Feb-88						
NOGENT-2	PWR	1310	EDF	Operational	FRAM	01-Jan-82	04-Oct-88	14-Dec-88	01-May-89						
PALUEL-1	PWR	1330	EDF	Operational	FRAM	15-Aug-77	13-May-84	22-Jun-84	01-Dec-85						
PALUEL-2	PWR	1330	EDF	Operational	FRAM	01-Jan-78	11-Aug-84	14-Sep-84	01-Dec-85						
PALUEL-3	PWR	1330	EDF	Operational	FRAM	01-Feb-79	07-Aug-85	30-Sep-85	01-Feb-86						
PALUEL-4	PWR	1330	EDF	Operational	FRAM	01-Feb-80	29-Mar-86	11-Apr-86	01-Jun-86						
PENLY-1	PWR	1330	EDF	Operational	FRAM	01-Sep-82	01-Apr-90	04-May-90	01-Dec-90						
PENLY-2	PWR	1330	EDF	Operational	FRAM	01-Aug-84	10-Jan-92	01-Feb-92	01-Nov-92						
PHENIX	FBR	233	CEA/EDF	Operational	CNCLNEY	01-Nov-68	31-Aug-73	13-Dec-73	14-Jul-74						
ST. ALBAN-1	PWR	1335	EDF	Operational	FRAM	29-Jan-79	04-Aug-85	30-Aug-85	01-May-86						

Source: IAEA Power Reactor Information System as of 31 December 2002.

TABLE 7. CONTINUED, STATUS OF NUCLEAR POWER PLANTS

Station	Type	Net Capacity	Operator	Status	Reactor Supplier	Construction Date	Criticality		Grid Date	Commercial		Shutdown Date
							Date	Date		Date	Date	
ST. ALBAN-2	PWR	1335	EDF	Operational	FRAM	31-Jul-79	07-Jun-86	03-Jul-86	01-Mar-87			
ST. LAURENT-B-1	PWR	890	EDF	Operational	FRAM	01-May-76	04-Jan-81	21-Jan-81	01-Aug-83			
ST. LAURENT-B-2	PWR	890	EDF	Operational	FRAM	01-Jul-76	12-May-81	01-Jun-81	01-Aug-83			
TRICASTIN-1	PWR	880	EDF	Operational	FRAM	01-Nov-74	21-Feb-80	31-May-80	01-Dec-80			
TRICASTIN-2	PWR	880	EDF	Operational	FRAM	01-Dec-74	22-Jul-80	07-Aug-80	01-Dec-80			
TRICASTIN-3	PWR	880	EDF	Operational	FRAM	01-Apr-75	29-Nov-80	10-Feb-81	11-May-81			
TRICASTIN-4	PWR	880	EDF	Operational	FRAM	01-May-75	31-May-81	12-Jun-81	01-Nov-81			
BUGEY-1	GCR	540	EDF	Shut Down	VARIOUS	01-Dec-65	21-Mar-72	15-Apr-72	01-Jul-72		27-May-94	
CHINON-A1	GCR	70	EDF	Shut Down	LEVIVIER	01-Feb-57	16-Sep-62	14-Jun-63	01-Feb-64		16-Apr-73	
CHINON-A2	GCR	210	EDF	Shut Down	LEVIVIER	01-Aug-59	17-Aug-64	24-Feb-65	24-Feb-65		14-Jun-85	
CHINON-A3	GCR	480	EDF	Shut Down	GTM	01-Mar-61	01-Mar-66	04-Aug-66	04-Aug-66		15-Jun-90	
CHOOZ-A (ARDENNES)	PWR	310	SENA	Shut Down	A/F/W	01-Jan-62	18-Oct-66	03-Apr-67	15-Apr-67		30-Oct-91	
CREYS-MALVILLE	FBR	1200	NERSA	Shut Down	ASPALDO	13-Dec-76	07-Sep-85	14-Jan-86			31-Dec-98	
EL-4 (MONTS D'ARREE)	HWGCR	70	EDF	Shut Down	GAAA	01-Jul-62	23-Dec-66	09-Jul-67	01-Jun-68		31-Jul-85	
G-2 (MARCOULE)	GCR	38	COGEMA	Shut Down	SACM	01-Mar-55	21-Jul-58	22-Apr-59	22-Apr-59		02-Feb-80	
G-3 (MARCOULE)	GCR	38	COGEMA	Shut Down	SACM	01-Mar-56	11-Jun-59	04-Apr-60	04-Apr-60		20-Jun-84	
ST. LAURENT-A1	GCR	480	EDF	Shut Down	VARIOUS	01-Oct-63	07-Jan-69	14-Mar-69	01-Jun-69		18-Apr-90	
ST. LAURENT-A2	GCR	515	EDF	Shut Down	VARIOUS	01-Jan-66	04-Jul-71	09-Aug-71	01-Nov-71		27-May-92	

Source: IAEA Power Reactor Information System as of 31 December 2002.

2.3. Supply of NPPs

The leading companies in the nuclear plant construction industry are Framatome, which supplies the nuclear island, and Alstom for the conventional part. There have been changes in the ownership and scope of business of these companies as they expanded to meet the needs of the French programme in the last decade. In 1981, Framatome terminated its licence with Westinghouse and negotiated a new agreement to achieve greater autonomy. Framatome has developed a wide range of expertise and capabilities in reactor operation and maintenance services. After Alcatel withdrawal from Framatome's ownership, the decision has been taken in 1999 to transfer most of its shares to Cogema and CEA. In counterpart, Framatome have taken over Cogema's activities in uranium fuel manufacturing.

The nuclear sectors of Framatome and the German Siemens have merged into a new company called Framatome-ANP (Advanced nuclear power) owned at 64% by AREVA and 36% by Siemens.

2.4. Operation of NPPs

The electricity utility *Electricité de France* (EDF) was nationalized in 1946 along with the national coal, oil and gas companies. EDF owns and operates all the French nuclear power plants.

2.5. Fuel Cycle and Waste Management

AREVA, is the main shareholder of the *Compagnie générale des matières nucléaires* (Cogema) which controls most of the fuel cycle industry, with the exception of UO-fuel manufacturing (Framatome) and of waste management and disposal, run by the independent public agency ANDRA. Cogema is an industrial and commercial leader in all phases of the fuel cycle, including prospection and running of uranium mines, conversion (Comurhex), enrichment (Eurodif), MOX-fuel fabrication (Melox), reprocessing and waste packaging.

2.6. Research and Development

In 1945 the French government created a national agency, the *Commissariat à l'Energie Atomique* (CEA), for the development of all aspects of atomic energy, including both civil and military applications. Although its responsibilities changed through time, particularly with the transfer of some industrial activities to newly created subsidiaries, CEA has retained most of its early activities and interests in mean and long term R&D, notably in reactor design, fuel concepts, enrichment, waste transmutation and disposal as well as in technology transfer and fundamental research.

Framatome-ANP has completed the basic design for a 1545 MWe European Pressurized Water Reactor (EPR) which meets European utility requirements. Framatome-ANP with international partners is also developing the basic design of the SWR-1000, an advanced BWR with passive safety features.

The CEA has joined the GIF (Generation IV International Forum) R&D programme to study promising technologies for future nuclear energy systems, addressing in the first place the issues of enhanced safety, sustainability, non-proliferation and economics. One reference concept is based on a gas-cooled fast reactor with on-site closed fuel cycle. France is also collaborating with other countries to develop a 280 MWe Gas Turbine-Modular Helium Reactor (GT-MHR) for electricity production and consumption of weapon grade plutonium.

2.7. International Co-operation and Initiatives

France is member of several international organizations, including the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency (NEA) of the Organization for Economic Co-

operation and Development (OECD) as well as other bilateral and multilateral organizations such as the World Association of Nuclear Operators (WANO).

As mentioned above, France is also member of the Generation IV International Forum (GIF), an international collective of 10 countries dedicated to the development of the next generation of nuclear reactors and fuel cycle technologies.

3. NATIONAL LAWS AND REGULATIONS ¹

3.1. Safety Authority and the Licensing Process

Nuclear legislation in France has developed in successive stages in line with technological advances and growth in the atomic energy field. Therefore, many of the enactments governing nuclear activities are to be found in the general French legislation on environmental protection, water supply, atmospheric pollution, public health and labour.

However, the French Parliament has adopted a number of specific enactments. Examples include Act No. 68-493 (30 October 1968), setting special rules as to third party liability in the field of nuclear energy, which is distinct from the ordinary French law on third party liability, the 19 July 1952 Act, now embodied in the Public Health Code, specifying licensing requirements for the use of radioisotopes, Act No. 80-572 of 25 July 1980 on the protection and control of nuclear materials, and more recently Act No. 91-1381 concerning research on radioactive waste management.

Although French nuclear law is characterized by its variety of sources, as in other countries where nuclear energy has developed, the original features of this legislation derive chiefly from international recommendations or regulations. For example, radiation protection standards are derived from the Recommendations of the International Commission on Radiological Protection (ICRP) and Directives issued by the European Union (formerly the European Community). Likewise, the French Act of 1968 on the liability of nuclear operators is directly derived from the Paris Convention of 29 July 1960.

French nuclear legislation began to develop from the time the Atomic Energy Commission (*Commissariat à l'énergie atomique* - CEA), the public agency set up by the State in 1945 [Ordinance No. 45-2563 of 18 October 1945] and formerly reporting directly to the prime minister, no longer held a monopoly for nuclear activities, in other words from the time nuclear energy applications entered the industrial stage, thus requiring the involvement of new nuclear operators. This development had several landmarks: in 1963, a system for licensing and controlling major nuclear installations was introduced, setting government responsibility in matters of population and occupational safety (Decree of 11 December 1963). Prior to this, procedures concerning the licensing and control of industrial activities were dealt with by the *Préfet* for each *Département*. In 1973, this system was expanded to cover the development of the nuclear power programme, and better define the role of government authorities. Finally, the decree of 20 June 1966 included Euratom Directives as part of the French radiation protection regulations.

In the course of the 1980's, the enactments setting up the CEA were amended so as to strengthen its inter-ministerial status and a tripartite Board of Administration including staff representatives was created. However governmental decisions are prepared by the Atomic Energy Committee, which acts as a restricted inter-ministerial committee on nuclear energy matters. CEA is now answerable to the Minister for Industry and to the Minister for Research [Decrees No. 93-1272 of 1 December 1993 and No. 93-796 of 16 April 1993]. The main task of CEA was laid down in September 1992 by the Government: concentrate on developing the control of atom uses for purposes of energy, health, defence and industry, while remaining attentive to the requests made by its industrial and research partners. More specifically, the inter-ministerial committee of 1 June 1999

requested CEA to “strengthen long-term research on future reactors capable of reducing, and even eliminate the production of long-lived radio-active waste”. In addition CEA was given a particular responsibility for R&D on alternative and renewable energies.

The regulations for large nuclear installations, referred to above, have been supplemented with regard to procedures by an Instruction of 27 March 1973 and a Decision of the same date (amended by a Decision of 17 December 1976), which are internal instruments issued by the Minister for Industry. The authorities primarily involved in the licensing procedure for the setting up of large nuclear installations are the Minister for Industry and the Minister for Ecology and Sustainable Development. For this purpose, the Central Service for Nuclear Installations Safety (SCSIN), set up in 1973 within the Ministry of Industry, has been reshuffled as the Directorate for Nuclear Installations Safety (*Direction de la Sûreté des Installations Nucléaires, DSIN*).

In the beginning of 2002, the DGSNR (General Directorate for Nuclear Safety and Radioprotection) has been created as a result of the merger of DSIN and the former Central Board for Protection against Ionizing Radiations (*Office de Protection contre les rayonnements ionisants, OPRI*). As a consequence, in addition to nuclear safety, DGSNR retains also the responsibilities of the former OPRI regarding radioprotection, ie carrying out measurements or analytical work in order to determine the level of radioactivity or ionizing radiation that might become hazardous to health in various environmental situations, for individuals as well as for the population as a whole. It also coordinates and defines controls for the radiation protection of workers and is involved in the safety plans to be put in action in case of radioactive incident. DGSNR reports to the Ministers for Industry, Health and Ecology and Sustainable Development.

The licensing procedure is governed by Decree No. 63-1128 of 11 December 1963. Under this procedure the decree authorizing the setting up of an installation lays down the technical requirements and other formalities which its operator must comply with. For nuclear reactors, for instance, there are generally two stages: first, fuel loading and commissioning tests, and second, entry into operation - both conditional on joint approval by the Ministers for Industry and for Ecology and Sustainable Development. The consent of the Minister for Health is requested.

DGSNR is mainly responsible for:

- i) studying problems raised by site selection;
- ii) establishing the procedures for licensing large nuclear installations (licenses for setting up, commissioning, disposal, etc.);
- iii) organizing and directing the control of these installations;
- iv) drafting general technical regulations and following their implementation;
- v) establishing plans in the event of an accident occurring in a large nuclear installation;
- vi) proposing and organizing public information on nuclear safety.

At the local level, DGSNR’s actions are relayed through the nuclear divisions of the Regional Directorates for Industry, Research and Environment (DRIRE). These Directorates are in charge of the survey of nuclear installations and monitoring reactor shutdowns and all pressurized components. They also provide technical support to the “*préfet*”, the Government local representative, in particular in case of accident.

DGSNR is assisted in decision making by the Institute for Radio-Protection and Nuclear Safety (*Institut de Radio-Protection et de Sûreté Nucléaire - IRSN*), itself resulting from the merger of the former IPSN (*Institut de Protection et de sûreté nucléaire*) and part of the OPRI (*Office de protection contre les rayonnements ionisants*). The IRSN can also undertake studies or research on protection and nuclear safety problems on request of any concerned ministerial department or agency (Law n°2001-398 AFSSE of 9 May 2001).

3.2. Main National Laws and Regulations in Nuclear Power

Organization and structure

- Decree 70-878 of 29 September 1970 setting the powers and duties and organization of the *Commissariat à l'Énergie Atomique* (CEA) and the Regulatory Authority.
- Decree 72-1158 of 14 December 1972; further amended in 1982, 1984 and 1994; decree 82-734 of 24 August 1982; decree 84-279 of 13 April 1984 and decree 94-451 of 3 June 1994.
- Decree 73-278 of 13 March 1973 providing for the creation of the Higher Council of Nuclear Safety and Central Service for Safety of Nuclear Installations, further amended in 1977, 1981, 1982, 1985 and 1987 : decree 77-623 of 6 June 1977; decree 81-978 of 29 October 1981; decree 82-531 of 22 June 1982; decree 82-918 26 October 1982; decree 85-140 of 28 January 1985 and decree 87-137 of 2 March 1987.
- Decree 75-713 of 4 August 1975 providing for the formation of an Inter-ministerial Committee of Nuclear Safety, amended in 1978 : decree 78-1193 of 18 December 1978.
- Decree 81-300 of 1981 authorizing CEA and COGEMA activities in matters of mineral substances and fossils.
- Decree n° 92-1391 of 30 December 1992 creating a national agency for radioactive waste management (ANDRA)
- Determination of Jurisdiction of the Ministry for Industry in nuclear matters : decree 93-1272 of 1st December 1993 and decree 97-710 of 11 June 1997.
- Decree n° 95-19 of 9 January 1995 determining the powers and duties and the organization of the General Delegation for Armament (DGA).
- Decree n° 97-715 of 11 June 1997 related to the powers and duties of the Minister for Regional Development and Environment.
- Decree n° 97-728 of 18 June 1997 related to the powers and duties of the Secretary of State for Industry.
- Law n° 98-217 of 27 March 1998 authorizing the ratification of the CTBT.
- Law n° 2001-398 of 9 May 2001. Establishing the French agency for environmental health safety (AFSSE) and the institute for radio-protection and nuclear safety (IRSN).
- Decree n°2002-254 of 22 February 2002 creating the institute for radio-protection and nuclear safety (IRSN).
- Decree n°2002-255 of 22 February 2002 creating the general directorate for nuclear safety and radio-protection (DGSNR).

Radio-protection

- Resolution of 24 August 1967 providing for the creation of the Commission for Protection against Ionizing Radiation.
- Decree 69-50 of 10 January 1969 concerning survey procedures to monitor contamination levels of surface waters.
- Decree 72-819 of 1st September 1972 related to the creation of a Defence Body for Civil Protection, amended by decree 90-670 of 31 July 1990.
- Decree 75-306 of 28 April 1975 related to the protection of workers against ionizing radiation hazards in basic nuclear installations (Regulatory decrees). Further amended by decrees of 1988, 1997 and 1998: decree 88-662 of 6 May 1988, decree 97-137 of 13 February 1997 and decree 98-1185 of 24 December 1998.
- Decree n° 86-1103 of 2 October 1986 related to protection of workers against ionizing radiation hazards. This decree was amended in 1991, 1995 and 1998: , decree 91-963 of 19 September 1991, decree 95-608 of 6 May 1995 and decree n° 98-1186 of 24 December 1998
- Resolution of 2nd October 1990 dealing with the definition of control methods established by decree 86-1103 2nd October 1986 related to protection of workers against ionizing radiation hazards.

- Directive 96/29 Euratom of 13 May 1996, establishing the basic rules related to health protection against radiation hazards for population and workers.
- Decree of 26 January 1998 listing the institutions appointed to control the efficiency of radio-protection devices, as required by decree n° 86-1103 of 2nd October 1986, and decree n° 75-306 28 April 1975 on the protection of workers against ionizing radiation hazards.
- Order of 27 August 1998 related to the test use of microprocessor cards by the employees of an external company intervening in a nuclear basic installations, in the purpose of transmitting data between works doctors.
- European Council directive 98/83/CE of 3rd November 1998, dealing with the cleanness of human consumption water.
- Order of 23 March 1999 fixing the rules of external dosimetry for workers under radiation conditions as required by decree of 28 April 1975 modified and decree of 2 October 1986 modified.
- Order of 23 March 1999, setting the rules applied by the Board of Protection against Ionizing Radiation (OPRI) for licensing some persons to access to personal data regarding workers exposure to ionizing radiation.
- Order of 27 April 2000 authorizing some installation managers to assume the individual survey of occupational exposure to ionizing radiation.
- Order of 27 April 2000 authorizing some installations to assume the individual survey of occupational exposure to ionizing radiation.
- Ordinance 2001-270 of 28 March 2001 on the implementation of EU directives in the field of protection against ionizing radiation
- Decree n° 2002-460 of 4 April 2002 related to the general personal safety against ionizing radiation.

Regulatory regime for nuclear installations

- Decree 67-964 of 24 October 1967 revising the nomenclature of hazardous, unhealthy and uncomfortable facilities.
- Decree 70-440 of 22 May 1970 repealing the authorization regime for nuclear plants and thermoelectric plants authorized by decree of 30 October 1935.
- Decree 63-1228 of 11 December 1963 related to basic nuclear installations, further amended by decrees in 1973, 1985, 1990 and 1993 : decree 73-405 of 27 March 1973, decree 85-449 of 23 April 1985, decree 90-78 of 19 January 1990, decree 93-816 of 12 May 1993 and decree n° 2001-529 of 5 July 2001.
- Circular dated 26 February 1974 related to the application of regulations on pressure equipment for pressurized water nuclear reactors. Amended by resolution dated 6 December 1974 and further amended by circular of 5 August 1977.
- Law 76-663 of 19 July 1976 related to the Installations Classified for Environment Protection (*Installations Classées pour la Protection de l'Environnement - ICPE*).
- Resolution and circular of 10 August 1984 concerning building concept and operation of Basic Nuclear Installations (*Installations Nucléaires de Base - INB*).
- Decree of 11 March 1996 setting the limit beyond which factories dealing with radioactive matters, as well as those intended for storage of such matters, including wastes, are classified as Basic Nuclear Installations.
- Decree n° 96-197 of 11 March 1996 modifying the list of classified installations.
- Decree n° 96-972 of 31 October 1996 dealing with the publication of the Nuclear Safety Convention, signed in Vienna, 20 September 1994.
- Decree n° 97-1116 of 27 November 1997 modifying the list of classified installations
- Note of 20 May 1998 dealing with licensing demands, enforcing decree n° 95-540 of 4 May 1995 related to liquid and gas effluent emissions and to water pumping by Basic Nuclear Installations.
- Order of 26 November 1999 setting out general technical rules on the limits and conditions governing samples and waste subject to licensing, carried out by major nuclear installations.

- Order 31 December 1999 setting out general technical rules to prevent and limit pollution and external risks resulting from the operation of major nuclear installations.

Nuclear installations classified as secret

- Order of 31 December 1999 setting out general technical rules to prevent and limit pollution and external risks resulting from the operation of major nuclear installations.
- Decree n° 2001-147 of 11 May 2001 on the special commission for major nuclear installations classified as secret.
- Decree n° 2001-592 of 5 July 2001 governing the safety and radiation protection of nuclear activities and installations used for defence purpose.

Regulatory regime for radioactive matters

- Resolution of 28 March 1977 related to the assistance regime for uranium prospecting.
- Law 80-572 of 25 July 1980 on control and protection of nuclear matters. Further amended by law 89-434 of 30 June 1989.
- Decree 81-512 of 12 May 1981 related to the control and protection of nuclear matters.
- Decree 81-558 of 15 May 1981 related to nuclear matters control and compatibility.
- Resolution of 14 March 1984 related to nuclear elements subject to be declared.
- Decree of 11 March 1996, repealing decree of 24 November 1977 establishing the characteristics of radioactive matters under special forms.
- Decree of 24 September 1996 setting the conditions for the assignment of nuclear matters to military use.

Radioactive waste management

- Decree 82-193 of 18 February 1982, related to the publication of amendments to Annexes I and II of the 24 September 1972 London Convention.
- Law of 31 December 1991 on high level waste management.
- 1994 Decree on the import, export and transit of radioactive waste between Community member states.
- 1995 Decree on releases of liquid and gaseous effluents, and on water samples, from major nuclear installations.
- 1999 Decree authorizing the operation of an underground laboratory.
- Decree n° 99-686 of 3 August 1999 implementing article 14 of the act of 30 December 1991 related to research on radioactive waste management.
- Decree n° 99-687 of 3 August 1999 to implement article 6 of the act of 30 December 1991 related to research on radioactive waste management.
- Law n° 2000-174 of 4 March 2000 authorizing approval of the Common Convention on safety and management of used fuel and radioactive waste.

Civil Liability

- Law 68-943 of 30 October 1968 on nuclear civil liability.; further amended in 1990 : law 90-488 of 16 June 1990.
- Decree 69-154 of 6 February 1969 related to the publication of the Paris Convention.
- Main reinsurance fund : articles L. 431-4 to 431-7 and articles R. 431-27 and 29 of Insurance Code.
- Constitution of cover funds by insurance companies in case of exceptional expenses related to atomic risk coverage : article R.331-6 of Insurance Code.
- Decisions of exclusion from the AEN Committee of Directors, 10 October 1977:
 - Exclusion of small quantities of nuclear matters out of a nuclear installation [NE/M (77) 2];

- Exclusion of certain classes of nuclear matters [NE/M (77)2].
- Decree 91-355 of 12 April 1991 related to the characteristics of reduced risks/safe installations (1991).

4. CURRENT ISSUES AND DEVELOPMENTS ON NUCLEAR POWER

4.1. Energy Policy

The main objectives are presently to optimize the utilization of existing equipment, i.e., power plants and fuel cycle facilities, design and implement a policy with regard to final disposal of high level radioactive waste, and develop the next generation of reactors improving the use of natural uranium and minimizing waste production.

4.2. Privatisation and deregulation

In the wake of successive legislations, the role of public authorities has changed.

The European directives on electricity market liberalization have been implemented in the French legislation through law n° 2000-108 of 10 February 2000 on the modernization and development of the public electricity service. This law states in its first article :

“The purpose of the public electricity service is to guarantee electricity supplies throughout the country, having due regard to general interest.

In the context of the energy policy, the public electricity service contributes to the independence and security of supply, air quality and combating the greenhouse effect, optimum management and development of national resources, control of demand for energy, economic competitiveness and control of technical choices for the future, as well as efficiency in energy use.

It furthers social cohesion, by ensuring the universal right to electricity, contributes to combating exclusion, a balanced spatial development, having due regard to the environment, research and technological progress as well as defence and public order.

A concrete application of the universal right to electricity, a product of primary necessity, the public electricity service shall be managed with due consideration for principles of equality, continuity and adaptability, and in accordance with optimum conditions of security, quality, cost, price and economic, social and energy efficiency.

The public electricity service shall be organized by the State and the local authorities or their public co-operation establishments, each for its part.”

It follows from this article that the government retains the responsibility of establishing objectives regarding security of energy supply or regional planning. In addition it remains responsible for defining and enforcing adherence to the rules within which the various market players must act. Of course, public authorities retain the traditional governmental activities such as preparation and development of regulations, energy taxation, public service obligations, personnel and installation safety, environment protection, in particular implementation of the European directives regarding greenhouse gases emissions and the share of renewable energies in electricity production. They also keep the general responsibility of insuring long term supply by supporting R&D efforts when private companies would not engage by themselves appropriate involvement. In addition, through the procedure of call for bids or the authorization required for the new production plants (decree n° 2000-877 of 7 September 2000), the government keeps the ability to set conditions for new power units, including the energetical, technical,

economic, financial and geographical characteristics of the installation. (for instance regarding greenhouse gas emissions or other pollutants, long term supply stability or use of domestic energy resources), and thus influence the choice of the energy sources.

Regarding public service obligations, the law of 10 February 2000 has created a specific fund (*Fonds du service public de la production d'électricité, FSPPE*) intended for compensating the excess costs attributable to public service obligations (purchase obligation for green electricity, power production in non-connected zones such as overseas *départements*, etc.). This fund is supplied by the different electricity producers established in the French territory including auto-producers as well as by the electricity importers.

Regarding the European directive on renewable energy, France is due to raise the share of renewable electricity from the actual value of about 15% to 21%. To this aim, the hydro power availability being already used almost at full, special effort is made to increase the contribution of wind energy.

The public companies are now widely open to the private sector : ENDESA owns a 30% share in the coal fired plants operator SNET (*Société Nationale d'Electricité et de Thermique*), Electrabel holds a 49% share in the company *Energie du Rhône*, that trades the electricity production of the hydropower stations of CNR (*Compagnie Nationale du Rhône*). According to an agreement signed between SHEM and Electrabel, the whole of the production of SHEM will be purchased by Electrabel. RTE has launched a call for tender for compensating the losses in the transmission grid, considered as the second French electricity consumer and EDF is making available through auction access to 6000 MW of generation capacity.

Pluri-annual planning of investments in power generation capacities

A report on medium-term power generation capacity investment planning (PPI, *Programmation pluriannuelle des investissements*) prepared for submission to the Parliament was officially released by the Government in January 2002, as requested by the French law on electricity market liberalization, which requires a ministerial decision, followed by an energy orientation law to be voted by the parliament. The report says the current French production park is at least adequate to cover base-load and semi-base load demand up to 2010. It proposes that renewable energy sources -including hydro-should increase their share in consumption from 15% to 21% by 2010 in accordance with the European directive. It stresses the competitive advantages enjoyed by France's current power generation park, which is attributed in large part to the low generating cost of its 58 nuclear power units. It also adds that France's relative dependence on nuclear power protects it to a large extent against exchange rate fluctuations vis-à-vis the USD and against fuel price volatility.

The section dealing with long-term policy examines the five generation options: nuclear, coal, gas, renewables, and new technologies. With regard to nuclear, it makes the following main points:

There is no need for a new nuclear unit before 2010. However, "keeping the nuclear option open in the long term will mean being ready if and when the question of renewing the park arises".

The lead time for licensing and construction of a first unit (for the new generation of nuclear plants which would renew the present fleet) is at least 7 years. Which means that the decision whether or not to build a lead unit of the EPR type will have to be taken within the next 2 to 3 years in close co-ordination with national representatives.

The future role of nuclear should be the subject of a national debate, which would "allow the consequences of possible choices to be examined and all the arguments to be weighed up". The debate in parliament on a draft "energy orientation law", scheduled to take place beginning of 2003, "could be the natural opportunity for a first debate on this subject".

In the longer term, energy-policy makers should pay particular attention to the development of a number of technologies, including high temperature gas-cooled reactors, super-critical water-cooled reactors, and designs using liquid sodium or lead (or lead alloys) as a coolant. In addition, “several solutions can be envisaged for the replacement of current fuels”, with the goal of improving the efficiency of Pu recycling.

REFERENCES

- [1] IAEA Energy and Economic Data (EEDB).
- [2] IAEA Power Reactor Information System (PRIS).
- [3] Data & Statistics, the World Bank, www.worldbank.org/data

Appendix 1

INTERNATIONAL, MULTILATERAL AND BILATERAL AGREEMENTS

AGREEMENTS WITH THE IAEA

- Agreement on privileges and immunities Non-Party
- Voluntary offer: Agreement with the European Atomic Energy Community for the application of safeguards in France; INFCIRC No: 290 Entry into force: 12 September 1981
- Additional protocol to the Agreement with the European Atomic Energy Community for the application of safeguards in France Signature: 22 September 1998
- Safeguards Agreement under the additional protocol I to the Tlatelolco Treaty; GOV/1998/31 Signature: 21 March 2000
- Tlatelolco Treaty
- Additional protocol n°1 Entry into force: 24 August 1994
- Additional protocol n°2 Entry into force: 23 March 1974
- EURATOM Member

OTHER MULTILATERAL SAFEGUARDS AGREEMENTS WITH IAEA

- Japan / France
INFCIRC/171 Entry into force: 22 September 1972
Modified 1990
- Republic of Korea / France
INFCIRC/233 Entry into force: 22 September 1975
- Pakistan / France
INFCIRC/239 Entry into force: 18 March 1976
- Exchange of letters between the governments of France and the Republic of Iraq supplementary to the Franco Iraqi co-operation agreement for the peaceful utilization of nuclear energy
INFCIRC/172/add.1 Entry into force: 4 November 1976
- South Africa / France
INFCIRC/244 Entry into force: 5 January 1977

MAIN INTERNATIONAL TREATIES

- | | | |
|--|---------------------|-----------------|
| • NPT | Entry into force: | 3 August 1992 |
| • Convention on physical protection of nuclear material
INFCIRC/274 | Entry into force: | 6 October 1991 |
| • Convention on early notification of a nuclear accident
INFCIRC/335 | Entry into force: | 6 April 1989 |
| • Convention on assistance in the case of a nuclear accident or radiological emergency; INFCIRC/336 | Entry into force: | 6 April 1989 |
| • Vienna conventions on civil liability for nuclear damage | Non Party | |
| • Paris conventions on third party liability in the field of nuclear energy | Entry into force of | 9 March 1966 |
| • Joint protocol relating to the application of the Vienna and Paris conventions | Signature: | 21 June 1989 |
| • Protocol to amend the Vienna convention on civil liability for nuclear damage | Not signed | |
| • Convention on supplementary compensation for nuclear damage | Not signed | |
| • Convention on nuclear safety | 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 | Entry into force: | 18 June 2001 |

OTHER UNDERTAKINGS

- | | | |
|---------------------------------|-------------------|-------------------|
| • Antarctic treaty | Entry into force: | 16 September 1960 |
| • London Convention | Entry into force: | 5 March 1977 |
| • OSPAR Convention | Entry into force: | 25 March 1998 |
| • Rarotonga Treaty | Signature: | 25 March 1996 |
| • Comprehensive Test Ban Treaty | Ratification: | 6 April 1998 |
| • Zangger Committee | Member | |

- Improved procedures for designation of safeguards inspector Accepted on: 26 April 1989
- Nuclear Suppliers Group Member
- Acceptance of NUSS Codes Summary: Generally positive; will be taken into account for own regulations; compatible with national regulations. (Letter of 9 August 1988)
- Nuclear Export Guidelines Adopted

BILATERAL AGREEMENTS

- France / Russian Federation Signature: 26 November 1996
- France / Ukraine Signature: 3 September 1998
- France / Belgium Signature: 8 September 1998
- France / Russian Federation Signature: 12 January 1999
- France / Turkey Signature: 21 September 1999
- France / Russian Federation (on civil nuclear liability) Signature: 20 June 2000

Appendix 2

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

Direction Générale de l'Energie
et des matières Premières
DGEMP (Ministry of Industry)
61 Boulevard Vincent Auriol
F-75703 Paris Cedex 13

Tel: +33 (0)1 44 87 17 17
<http://www.industrie.gouv.fr/>

ATOMIC ENERGY COMMISSION

Commissariat à l'Energie Atomique (CEA)
31-33 rue de la Fédération
F-75752 Paris Cedex 15

Tel.:+33 (0)1 40 56 1000 or ext.
<http://www.cea.fr/>

Institut National des Sciences et Techniques
Nucléaires (INSTN, National Institute for
Nuclear Science and Technology;
also under the Ministry of Education)

<http://www.instn.fr/>

OTHER NUCLEAR ORGANIZATIONS

Direction Générale de la Sûreté Nucléaire
et de la Radioprotection
(DGSNR, under Ministries for Industry, Health
and Ecology and Sustainable Development)
99, rue de Grenelle
F-75353 Paris 07
or:
60-68 av. du Général-Leclerc B.P. 6
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Institut de Radioprotection et de Sûreté Nucléaire
(IRSN, Nuclear Safety and Radioprotection Institute)
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Or
77-83, avenue du Général-De-Gaulle
F-92140 Clamart

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Comité Interministériel de la Sécurité Nucléaire
13, rue de Bourgogne
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Agence Nationale pour la Gestion
des Déchets Radioactifs (ANDRA)
Parc de la Croix Blanche
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<http://www.andra.fr/>

OTHER ORGANIZATIONS IN THE NUCLEAR INDUSTRY

Electricité de France (EDF)
22 -30, avenue de Wagram
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Fax: +33 (0)1 40 42 13 32
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<http://www.cogema.fr/>

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<http://www.framatome.com/>

HIGH ENERGY INSTITUTES

Centre National de la Recherche Scientifique (CNRS)

<http://www.cnrs.fr/>

European Synchrotron Radiation Facility – Grenoble
(ESRF)

<http://www.esrf.fr/>

Institut National de Physique Nucléaire
et de Physique des Particules (IN2P3)

<http://www.in2p3.fr:80/>

Laboratoire pour l'Utilisation du Rayonnement
Electromagnétique - CNRS (LURE)

<http://www.lure.u-psud.fr/>

Synchrotron SOLEIL

<http://www.synchrotron-soleil.fr/>

DRFC-CEA Cadarache
(Département de Recherches sur la Fusion Contrôlée)

<http://www.cad.cea.fr/r50.htm>

INTERNATIONAL ORGANIZATIONS

European Science Foundation

<http://www.esf.org/>

European Space Agency (ESA)

<http://www.esa.int/>

IEA International Energy Agency

<http://www.iea.org/>

Nuclear Energy Agency of the OECD (NEA)

<http://www.nea.fr/>

Organization for Economic Co-operation
and Development (OECD)

<http://www.oecd.org/>

OTHER ORGANIZATIONS

Société Française de l'Energie Nucléaire
(SFEN)

<http://www.sfen.org/>

World Council of Nuclear Workers (WONUC)

<http://www.wonuc.org/>

