ARMENIA

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1. GENERAL INFORMATION.

1.1. General Overview

The Republic of Armenia, the smallest of the three Transcaucasian republics, is a landlocked mountainous country bounded on the north by the Republic of Georgia, on the east and southwest by Azerbaijan, on the south by Iran and on the west by Turkey. The northern border is 196 km long, the border with Azerbaijan is 913 km, the southern border has a length of 42 km and the western 280 km. The land area of the republic is 28 400 km^2. The terrain is defined by the high Armenian Plateau with mountains, little forest and fast flowing rivers. The average height above sea level is about 1 800 meters.

The climate is highland continental with hot and dry summers and cold winters. Annual average temperature varies from -2.7°C to 13.8°C. The coldest month is January (from 1.2°C to -12.8°C) and the hottest months are July and August (from 25.8°C to 8.7°C). Summer temperatures may rise up to 42°C, winter cold has maximum of 46°C below zero. Summer relative wetness is 32-45% (July-August), winter relative wetness is 80-90%. Annual rainfall varies from 220 mm (in winter) to 900 mm (May- June). The annual maximum sunshine is 2 780 hours (Lake Sevan area), and minimum 1 930 hours (Idgevan). The average intensity of solar radiation on the aclinic plane on a cloudless day is 700 kkal/m^2. The annual average wind velocity varies from 7.7 m/sec to 1.0 m/sec.

The population of Armenia is about 3.8 million, of which 70% lives in urban areas. Armenia is a densely populated country with a density of 135 person/km^2. The historical population information is shown in Table 1.

TABLE 1. POPULATION INFORMATION

	1970[a]	1979[a]	1989	1990	1998[b]	1999[b]	2000	2001	Growth rate (%) 1979 to 2001
Population (millions)	2.49	3.03	3.52	3.58	3.75	3.81	3.8	3.8	1.03
Population density (inhabitants/km²)	88	107	121	126	132	134	134	134	1.03
Urban population as percent of total	59	65	67	67	69	69	70	70	1.03
Area (1000 km²) 28.4									

[a] Formal data of the census of population. [b] Data & Statistics/The World Bank

Source: IAEA Energy and Economic Database; Data & Statistics/The World Bank; Country Information.

The population growth from 1990 to 2001is about 6%. The concentration of population is not equal in different areas of the republic. The Ararat Valley is the most populated territory of the country with the density of 245 person/km^2. Its area makes about 26.7% of the total territory and its population reach to 58.8% of the total population. Yerevan, the capital of the Republic of Armenia, lays in the Ararat Valley and is home to 1.2 million people, which is about one third of the total population. The highland areas have much less population with the density of 35 person/km^2.

1.2. Economic Indicators

After the disintegration of the Soviet Union, an economic crisis broke out, and Armenia suffered from sharp decline in production during the period 1990-1994. The country undertook great efforts to overcome it. Since then, the situation has been gradually stabilized, and the republic is coming out of the crisis following the transition to a market economy. During the period 1995-2001,

the Gross Domestic Product (GDP) has increased on 63%, and the average growth rate was 5.6% per year. The historical GDP information is shown in Table 2.

TABLE 2. GROSS DOMESTIC PRODUCT (GDP)

	1990	1991	1992	1993	1994	1995	1996[c]	1997[c]	1998[c]	1999[c]	2000	2001	Growth rate (%) 1990 to 2001
GDP[(a)]	4098.0	3077.0	323.7	492.2	643.3	1286.5	1620	1670	1790	1850	1960	2100	-5.9
GDP[(b)] per capita	1144.7	N/A	87.8	131.9	171.7	342.2	424	433	472	487	515	552	-6.4
GDP by sector (%) :													
-Agriculture	17	25	31	51	45	43	37	32	34	29	25	-	
-Industry	52	49	39	27	37	36	33	33	31	33	36	-	
-Services	31	26	30	22	18	21	31	35	35	39	39	-	

[(a)] Millions of current US$ at market prices
[(b)] Current US$ per capita at market prices
[(c)] Data & Statistics/The World Bank
Source: IAEA Energy and Economic Data Base; Data & Statistics/The World Bank; Country Information.

Armenia is not rich in mineral raw materials. There are only a few items of considerable industrial value: copper, bauxite, molybdenum, precious metals, perlite, diatomite and coal. This factor mainly determines the economic structure of the republic. There has traditionally been very little heavy industry. The manufacturing sector has a prevailing share in GDP.

1.3. Energy Situation

The main sources of energy, traditionally used in Armenia, are: oil products, natural gas, nuclear energy, hydropower and coal. Hydro and a small amount of brown coal are the only domestic sources of energy, which are exploited. The republic has no oil and some gas reserves (not exploited). There are no uranium resources either. The energy reserves are shown in Table 3. Primary energy sources, in thousand tonnes of oil equivalent, are summarized in Table 4. To meet its energy requirements, Armenia has to import gas, oil products and nuclear fuel.

TABLE 3. ESTIMATED ENERGY RESERVES

	Estimated energy reserves in 1999 (Exajoule)					
	Solid	**Liquid**	**Gas**	**Uranium (1)**	**Hydro (2)**	**Total**
Total amount in place			6.34		2.12	8.46

(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 Data Base

TABLE 4. PRIMARY ENERGY SOURCES

ktoe

Year	Coal and Wood	Petroleum Products	Gas (Natural + LPG)	Nuclear	Hydro	Electricity (Imp-Exp.)	Total
1996	22	411	900	606	135	N/A	2074
1997	16	437	1137	418	119	-5	2122
1998	17	477	1220	415	132	-32	2229
1999	8	380	1053	542	103	-21	2065
2000	2	322	1247	521	108	-40	2158

Source: Country Information.

Hydropower is based on the water resources of the republic, including Lake Sevan, one of the largest highland fresh-water lakes in the world (1 900 m above sea level), and the rivers: Arax, Arpa, Hrazdan, Debet and Vorotan. There are six hydropower plants of the Sevan-Hrazdan cascade (556 MW), three plants of the Vorotan cascade (400 MW) and a number of small hydropower plants (60 MW). During the last period of time, several small hydro power plants with the total capacity of 15 MW have been built. Hydro power plants of the Sevan-Hrazdan cascade are operating at a low level capacity, because, after the intense use of the lake water during the last crisis, the Government of Armenia decided to reduce releases from Lake Sevan to restore its potential. At the same time, Armenia has still an unused hydraulic potential of about 300 MW (or 1248 millions kWh of electric energy) that can be developed economically.

Natural gas is the most important source of energy covering up to 58% of the total energy supply. It is imported from Russia and used to operate two thermal power plants; a third thermal power plant is not operating, because it was built to supply thermal energy to an industrial factory, which is no longer in operation. However, the plans have been under discussion to restart this thermal power plant together with that industrial factory. The designed capacity of the high-pressure gas transportation network of Armenia is 17 billions m^3/year. In 1980, the maximum demand for natural gas in Armenia was above 5-6 billions m^3/year. There have been five main gas pipelines built, which ensured the gas delivery from three sides: Georgia, North and West Azerbaijan. Today, only the first one is operating. Nowadays, the natural gas demand is 1.5 billions m^3/year, but the expected demand by the year 2015 will be 5 billions m^3/year. There are underground storage facilities for natural gas with a maximal gas storage volume of 180 million m^3. Gas distribution in Armenia is performed through high, medium and low-pressure distribution networks.

Oil products are imported from the neighbouring countries, mostly utilized for transport, industry, residential sector (heating) and as secondary fuel (mazut) in thermal power plants. During the last several years, mazut was not imported into the republic. As to the renewable sources of energy (geothermal, wind, solar and waste burning), they are under study and not yet available.

Armenia has a considerable potential of geothermal energy, but a programme has to be developed to explore the geothermal resources and to carry out drilling activities. Wind power projects (the construction of power stations) are still under discussion. The most worth-while regions suitable for the construction are: Vanadzor, Aragats, Lake Sevan basin and Sisian, where the wind velocity reaches 7 m/s. Armenia is a sunny republic with a high level of solar radiation. Nevertheless, it is too expensive to utilize the solar energy, and the republic, which appears to have very good solar radiation potential, cannot afford using it. A waste burning facility project (the construction of a station with a capacity of 10 MW in Yerevan) is under discussion as well.

Nuclear energy played a crucial role during the period of recovery from the economical crisis. There is one Armenian nuclear power plant (ANPP), which has two reactor units. Unit 1 is not operating and unit 2 has been re-commissioned in 1995, after 6.5 years of outage. The fuel is supplied by the Russian Federation.

In Armenia, the primary energy per capita is around 0.55 toe/capita compared with 0.55 in Georgia, 2.4 in Belarus and 3.2 Toe/capita in Ukraine. The energy statistics are shown in Table 5. The country total energy consumption shows a steady increase at a rate, which is significantly greater than the increase of GDP. Table 6 shows the historical energy consumption data.

The data on energy consumption by sector (Table 7) do not show the major changes during the years shown. The energy consumption by region is shown in Table 8. The energy consumption by region shows a prevalence of Yerevan city, which is responsible for about 50% of the total consumption.

1.4. Energy Policy.

In 1997-1998, the Government of RA and the Ministry of Energy started the implementation of a stabilization policy: institutional development and objectives to overcome the energy crisis. The main objectives of that stage were as follows:

- restructuring the sector to overcome financial crisis and creating premises for further development;
- developing plans for improvement of the sector taking into consideration the economy as a whole;
- improvement of the management structure of the Ministry of Energy with the purpose of elimination of the sector operational management and increasing the enterprise independence;
- minimization of bartering in energy sales and elimination of cross subsidizing of separate enterprises and sectors;
- carrying out a suspended and targeted privatization policy;
- participation and encouraging major investments in the energy sector.

The following results were achieved during that period:

- the "Energy Law" and the "Law on Responsibility for the Violations in the Area of Utilization of Nuclear Energy" have been adopted;
- number of laws affecting investment in energy were adopted:
  - the Law on Foreign Investment;
  - the Law on Enterprises and Entrepreneurial Activities;
  - the Law on Privatization and Demonopolization;
  - the Law on Real Estate;
  - the Law on Taxes (enables more favourable treatment for foreign investors);
- the Energy Regulatory Commission was established in 1997;
- high voltage transmission line Iran-Armenia has been commissioned and the intersystem HVL 220 kV with Georgia was rehabilitated;
- 11 regional distribution enterprises have been consolidated into 4 companies;
- measures on modernizing the accounting, billing and collecting systems have been implemented;
- HV Transmission Company has been established;
- dispatch and wholesale functions were assigned to "Armenergo" State Closed Joint Stock Company;
- 15 small HPPs have been privatized till 1997, two of which are the property of French citizens;
- normative schedules of major overhaul are renewed;
- Joint-Venture Stock Company - "ArmRosgasprom" has been founded;
- central heating and gas-supply to the consumers has been restored;
- Armenia became a member of European Energy Charter, Black Sea Economic Co-operation and others.

During the period of 1999 – 2001, changes were made in the Armenian legislation with respect to the country's energy policy. The Ministry of Energy was preparing the new edition of Law "On Energy of the Republic of Armenia" which was to replace the previous one that was in use since 1997. The National Assembly, in March 2001, adopted the new edition of Law "On Energy of the Republic of Armenia". In March 2000, the National Assembly adopted the Law "On Amendments and Additions to the Law On safe Use of Nuclear Energy for Peaceful Purposes". In particular, one of the amendments reads: "Those objects which are of safety importance shall be constructed and decommissioned by the law, being submitted to the Government".

The level of electricity average tariff was increased from 12 drams in 1995 to 21.6 drams, and the residential tariff to 25 drams (US $1= 560 Dram now). The energy sector cost analysis has shown that in short-term perspective it is possible to stabilize the level of costs and restrain the increase of tariffs through promotion of the efficiency of power generation, transmission and distribution, extension of the electricity market, loss reduction and other measures.

TABLE 5. ENERGY STATISTICS

Exajoule

	1995	1996	1997	1998	1999	2000
Energy consumption						
- Total [1]	0.08	0.09	0.09	0.09	0.09	0.09
- Solids [2]	N/A	0.001	0.001	0.001	0.00	0.00
- Liquids	0.02	0.02	0.02	0.02	0.013	0.016
- Gases	0.04	0.04	0.05	0.05	0.052	0.044
- Primary electricity [3]	0.02	0.03	0.02	0.02	0.026	0.027
Energy production						
- Total	0.02	0.03	0.02	0.02	0.026	0.027
- Solids	N/A	0.001	0.001	0.001	0.00	0.00
- Liquids	-	-	-	-	-	-
- Gases	N/A	N/A	N/A	N/A	0.00	0.00
- Primary electricity [3]	N/A	0.03	0.02	0.02	0.026	0.027
Net import (import - export)						
- Total	0.06	0.06	0.07	0.07	0.064	0.06
- Solids	0.00	0.00	0.00	0.00	0.00	0.00
- Liquids	0.02	0.02	0.02	0.02	0.013	0.016
- Gases	0.04	0.04	0.05	0.05	0.051	0.043

[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.
Source: IAEA Energy and Economic Database and Country Information.

TABLE 6. TOTAL FINAL ENERGY CONSUMPTION

		1996	1997	1998	1999	2000	2001
Total final consumption	Ktoe	984	1 087	1 186	1 009	1122	-
Consumption increase	%		10.6%	9.0%	-14.9	11.2	-
GDP increase	%	5.8%	3.1%	7.2%	3.3%	6.0%	7.2%

Source: Country Information.

TABLE 7. ENERGY CONSUMPTION BY ECONOMY SECTOR

ktoe

Economy Sector	1996	1997	1998	1999	2000
Industry	240	295	291	203	276
Transport	310	350	379	319	280
Agriculture	59	62	65	77	74
Commerce and public service	84	84	118	132	216
Residential	261	250	295	229	223
Non–specified	-	-	10	-	-
Non-energy use	30	45	29	49	54
Total energy consumption	984	1 087	1 186	1009	1123

Source: Country Information.

TABLE 8. ENERGY CONSUMPTION BY REGION

	Macro Regions				
Year	North	Centre	South	Yerevan	Total Final Consumption
1996	155.9	205.7	168.4	454.3	984.3
1997	163.5	222.2	177.9	523.1	1 086.7
1998	164.2	279.2	208.2	534.1	1 185.7
1999	140.3	294.1	160.6	414.0	1009
2000	151.4	346.3	173.6	451.4	1122.7

Source: Country Information.

A programme for improvement of metering, billing and collection of payments for electricity, heat and natural gas is being implemented, together with the transfer of accounting to international norms and standards and annual auditing of the company's financial reports by independent auditors. A programme has been implemented to organize collections through banks. Though there are difficulties in the whole economy of the country, the Government gives priority to budget payments for the electricity provided to budget organizations as well as compensation for the electricity consumed by irrigation, drinking water, industry and electrical transport companies.

In the district heating sector there are number of problems concerning physical wear of heating networks equipment, lack of industrial heat consumption and low level of payment collection in the residential sector. The Government of the Republic of Armenia and the WB are developing a project for district heating rehabilitation.

The following measures were undertaken in the year 2001:

- fully commercialized and transparent relationships between the enterprises;
- creation of the wholesale market of energy and power;
- rehabilitation and modernization of transmission and distribution networks;
- modernization of the metering system, which will exclude the non-measured losses and decrease the technical losses.

The results of asset revaluation show that the sector's main assets resources have already expired. The equipment is worn out and requires major overhaul, 38% of installed capacities are already over 30 years old. It is necessary to take all due measures to renew the energy sector of Armenia. The strategy for the National Energy Sector development is based on:

- three-level energy diversification policy:
  - Generation side: - HPP, TPP, NPP;
  - Fuel supply side: - natural gas, oil, nuclear fuel;
  - Fuel transportation side: - gas pipelines, oil product delivery;
- domestic fuel resource exploration;
- regional co-operation.

The Development Programme specifies:

- In Hydro power:
  - rehabilitation of the existing Hydro Power Plants (HPP);
  - development of economically feasible new hydro potential on the base of small HPPs with private investments;
  - establishment of Pump Storage Plants with comparatively small investments.
- In Thermal power:

  - operation of existing aggregates and units to complete exhaustion of their technical resource;
  - commissioning of new Unit N5 on Hrazdan TPP;
  - refurbishment of Yerevan TPP on the basis of modern Combined Cycle units.
- Development of the nuclear power sector using modern technologies;
- Development of renewable energy with participation of private investments;
- Implementation of planned energy efficiency campaign.

Along with the refurbishment and development of generating capacities, the main attention is paid to rehabilitation of transportation and distribution networks, interconnections, implementation of dispatch control and communication devices in the Power Sector.

2. ELECTRICITY SECTOR.

The total installed capacity of the Armenian Power System is about 3600 MW, which includes:

- the installed capacity of the Thermal Power Plants (TPPs) - 1800 MW;
- Nuclear Power Plant (NPP) with designed capacity of 815 MW, which was decommissioned after the earthquake in 1988 and recommissioned with 407.5 MW in 1995;
- two HPPs cascades of 1000 MW.

The high-voltage transmission network of Armenia consists of 220-110 kV lines. There are 14 substations of 220 kV and 119 substations of 110 kV. The capacity of the existing high voltage network is considered sufficient for the current and forecasted loads. The high-voltage transmission network has the interconnections with the all neighbouring countries: Azerbaijan: 330 and 220 kV, Georgia: 220 kV, Turkey: 220 kV, Iran: 220 kV.

2.1. Structure of the Electricity Sector.

At present, aiming to increase operation efficiency and profitability of energy enterprises, the following structure of the Energy Sector has been elaborated :

- 11 regional distribution enterprises have been consolidated to 4 companies;
- transmission function was separated from “Armenergo” and HV Transmission Company has been created;
- dispatch and wholesale functions were assigned to “Armenergo” State Closed Joint Stoke Company.

Thus, a basis for the creation of a real energy wholesale market was established. The Energy Commission is responsible for the antimonopoly regulation. The key functions of the antimonopoly regulation are tariff regulation and licensing of entities in the energy sector. “Armenergo” is a wholesale buyer-reseller of generated electricity and takes responsibility to realize dispatching with the purpose of efficient delivery of the electricity. The structure of the energy sector is shown in Figure 1.

2.2. Decision Making Process

Privatization of state companies was implemented to encourage market competition. For this purpose, separation of generation, transmission, and distribution systems was established. Within this framework, the Ministry of Energy is responsible for:

- defining the policies for the electricity sector;
- establishing the rules with which the electricity supply industry must comply;
- authorizing the allocation of funds to state companies;

- deciding on the respective awards during the privatization process.

Presently Armenia plans to develop an integrated resource planning and decision-making process aiming in co-ordinating the functions of its diverse institutional system and assuring thorough participation of all sectors, public and private. Mechanisms related to the electrical system expansion, economic management and regulation with mitigating impact on the environment have not been defined.

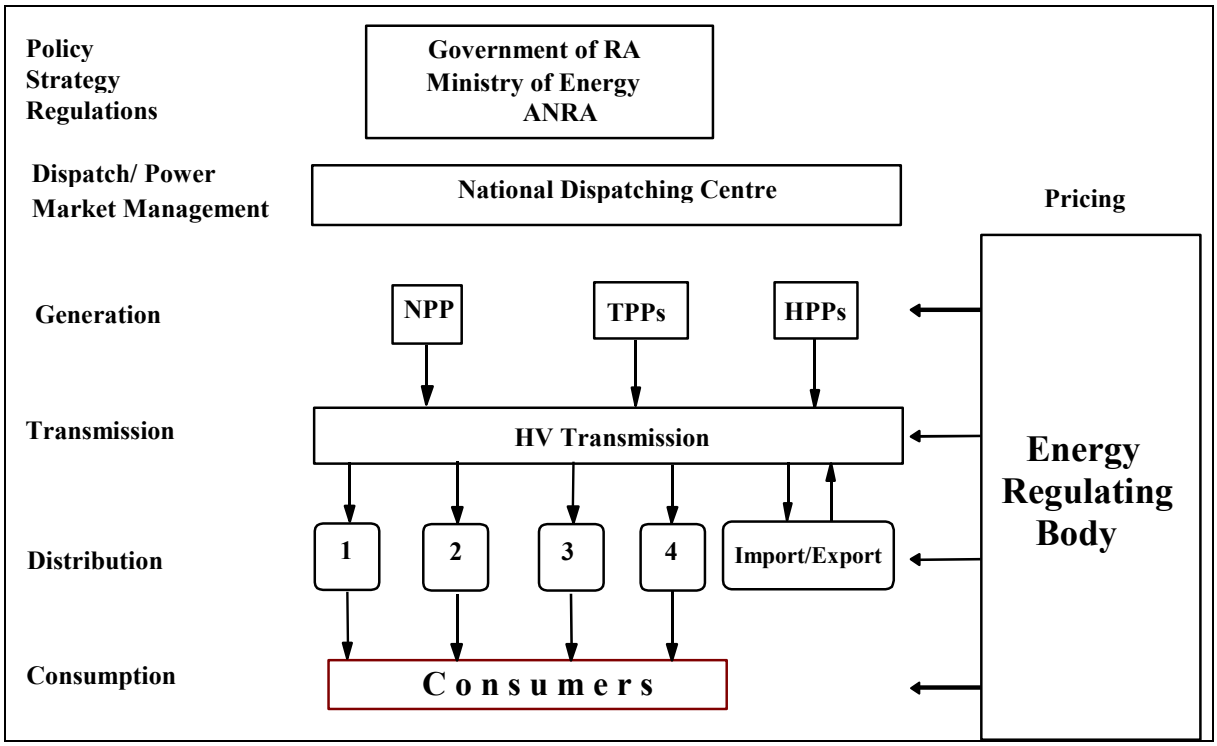

FIG. 1. Structure of the Energy Sector

Foreign interconnected utility companies have to apply for authorization from the Ministry of Energy to participate in the wholesale electricity market. In this way they are assured of their reserve and do not resort to sell at dumping prices. Payment to transmission companies includes a charge for the energy actually transmitted. Distributors and large users may enter into supply contracts at the prices defined in their contracts.

2.3. Main Indicators

In 2001, the total installed capacity of the generating stations in Armenia was 3 060 MW. The annual electricity production was 5.74 billion kWh. Table 9 shows the historical statistics of the electricity production balance and Table 10 - the energy related ratios. In addition, Figures 2 to 5 show the total electricity production, the electrical energy balance, the annual electrical energy consumption per capita and the share of the electricity in the total energy consumption.

2.4. Impact on Open Electricity Market in the Nuclear Sector

Before the disintegration of the USSR, Armenia, as a part of the Soviet Union, was under the unified All-Union energy policy. The electricity generated by Armenian Power Plants joined the Transcaucasien Energy System before being distributed to the consumers in accordance with the existing plans.

After becoming an independent state, Armenia had to meet the open market requirements in all the branches of the industry. The energy sector and the nuclear sector in particular were deeply affected by the economic difficulties during the market transition and were in need of reorganization and de-regulation.

TABLE 9. ELECTRICITY PRODUCTION AND INSTALLED CAPACITY

	1988	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Electricity production (TW·h)											
- Total [1]	15.28	9.00	6.29	5.66	5.57	6.22	6.03	6.19	5.72	5.96	5.74
- Thermal	8.94	5.96	2.00	2.14	3.34	2.33	3.03	3.06	2.44	2.69	2.79
- Hydro	1.52	3.04	4.29	3.51	1.93	1.57	1.40	1.54	1.20	1.26	0.97
- Nuclear	4.82	-	-	-	0.30	2.32	1.60	1.59	2.08	2.01	1.98
Capacity of electrical plants (GW(e))											
- Total	2.76	2.76	2.76	2.76	2.76	3.05	3.05	3.13	3.14	3.06	3.06
- Thermal	1.75	1.75	1.75	1.75	1.75	1.66	1.66	1.75	1.75	1.67	1.67
- Hydro	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
- Nuclear	0.76	0.0	0.0	0.0	0.0	0.38	0.38	0.38	0.38	0.38	0.38

[1] Electricity losses are not deducted.
Source: IAEA Energy and Economic Database; Country Information.

TABLE 10. ENERGY RELATED RATIOS

	1995	1996	1997	1998	1999	2000	2001
Energy consumption per capita (GJ/capita)	22.17	27.6	23.6	24.9	22.9	24.2	-
Electricity per capita (MW·h/capita)	1.46	1.62	1.62	1.64	1.53	1.58	1.51
Electricity production/Energy production (%)	-	82	111	108	75	81	-
Nuclear/total electricity (%)	0.0	36.4	26.5	25.7	36.4	33.7	34.5
Ratio of external dependency (%) [1]	76.9	63.9	74.5	75.6	67	68	-
Load factor of electricity plants							
- Total (%)	23	23.6	22.6	22.6	20.8	22.3	21.4
- Thermal	21.8	16.0	20.8	20.0	15.9	18.4	19.1
- Hydro	21.6	17.7	15.9	17.4	13.6	14.3	11.0
- Nuclear	N/A	63.6	48.5	48.2	63	61	60

[1] Net import / Total energy consumption.
Source: IAEA Energy and Economic Database; Country Information.

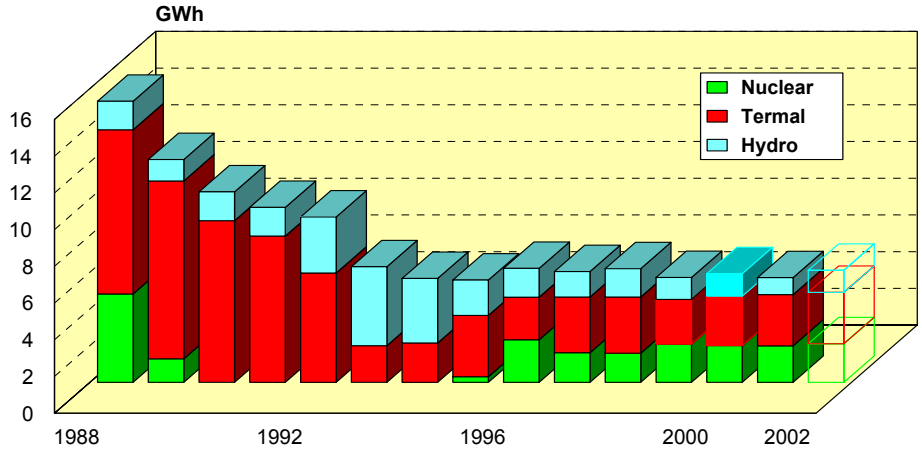

FIG. 2. Total Electricity Production

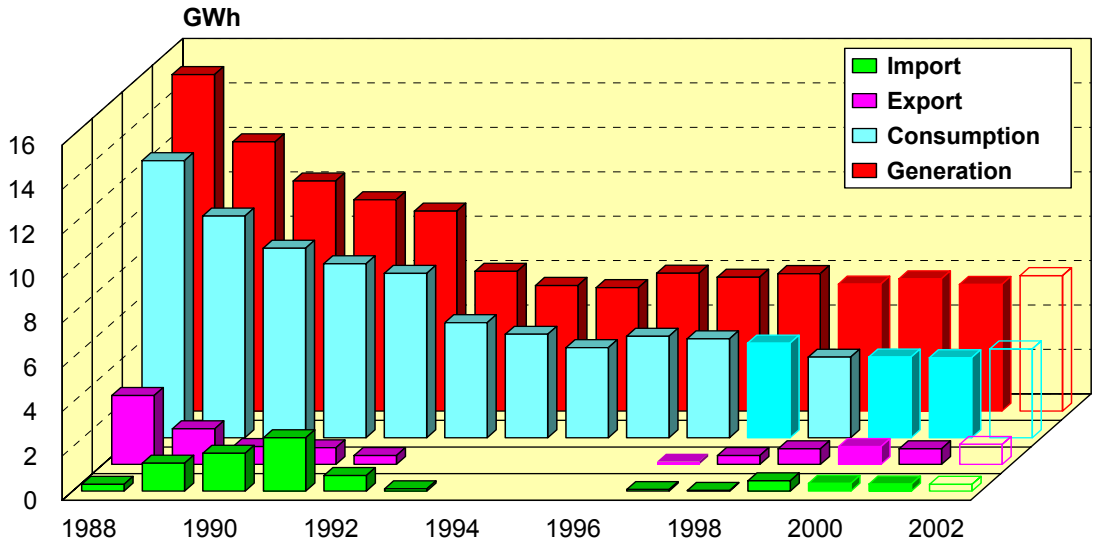

FIG. 3. Electrical Energy Balance

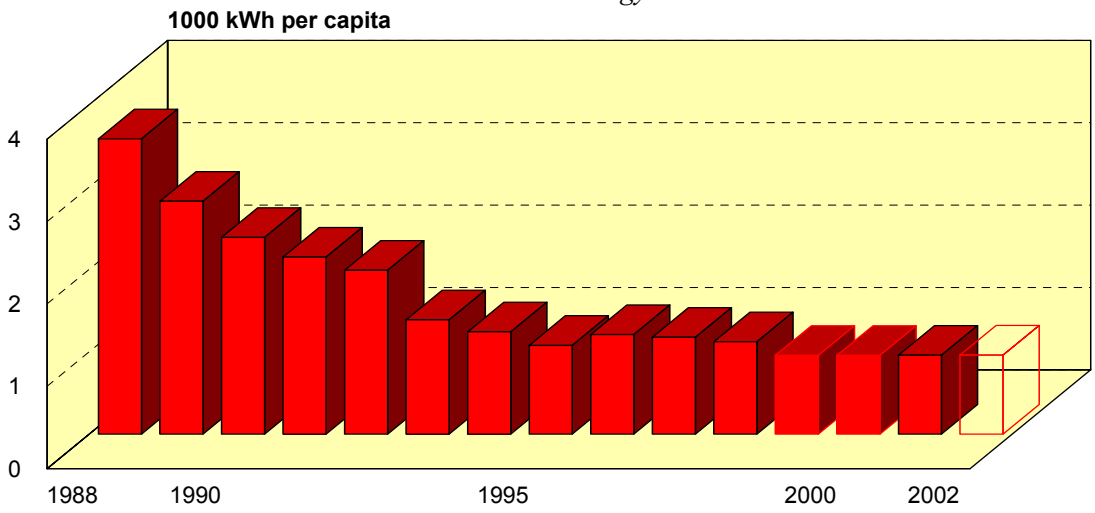

FIG. 4. Electrical Energy Consumption

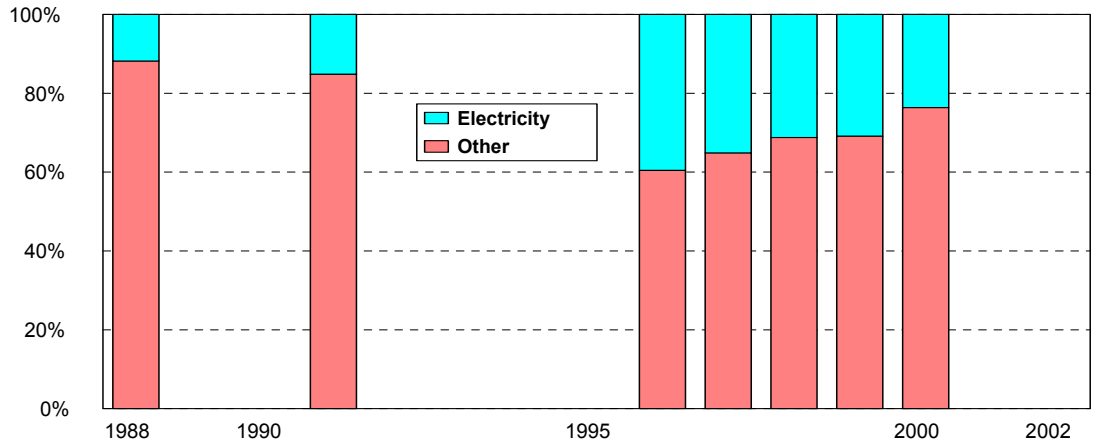

FIG. 5. Share of Electricity in Total Energy Consumption

A new energy policy was developed by the Government of Armenia, with the evaluation of the National Energy Balance as a main factor and a starting point for a National Energy Strategic Plan. Special attention was paid to restructuring the energy sector. A number of laws in energy were adopted. Several small HPPs have been privatized. The implementation of a stabilization policy with the crucial role of restarting the ANPP allowed the country to overcome the energy crisis of the post-Soviet period. Now Armenia is covering its electricity demand completely and can ensure the export of power to neighbouring countries. In the nearest future, however, additional energy sources may be required as the economy of the republic is recovering and the living standard is increasing steadily.

3. NUCLEAR POWER SITUATION

3.1. Historical Development

The Armenian Nuclear Power Plant was commissioned in 1976, with achieving the initial criticality for Unit 1 on 22 December, 1976, and for Unit 2 - on 5 January, 1980. The units were put into commercial operation on 6 October 1977 and on 3 May 1980, respectively. The units are of the WWER type, and the design of the ANPP was developed between 1968 and 1969. It was based on the project of Units 3 and 4 of the Novovoronezh NPP. The plant was constructed under the industry documentation of Mechanical Engineering Ministry of the former USSR, the permissions for site selection and construction were formalized in accordance with the acting at that time normative documents.

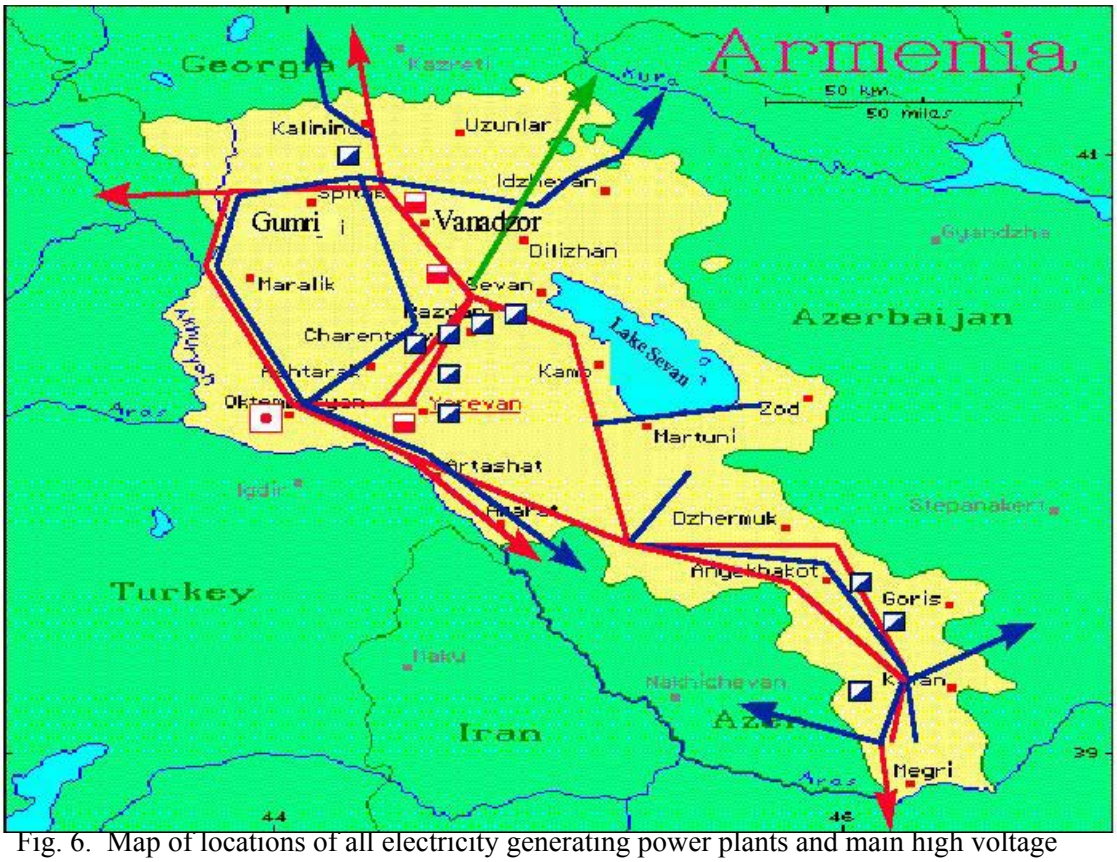

Fig. 6. Map of locations of all electricity generating power plants and main high voltage interconnections with the neighbouring countries

After the 1988 earthquake, though the Power Plant was not damaged, the Council of the USSR Ministers decreed to shut down the ANPP as a precautionary measure. Unit 1 was shut down on 25 February 1989 and Unit 2 on 18 March 1989. The units were not decommissioned but kept in prolonged shut down condition. As mentioned earlier, the Government of Armenia decided in April 1993 to restart Unit 2 of the ANPP, in order to overcome the severe economic crisis and taking into

account the lack in national energy resources. After 6.5 years of outage, with the technical and financial help of the Russian Federation, Unit 2 of the ANPP was restarted in November 5, 1995. Unit 1 remains in a stand still regime for the time being.

Locations of all electricity generating power plants and main high voltage interconnections with the neighbouring countries are shown in Figure 6.

3.2. Status and Trends of Nuclear Power

Only Unit 2 of the ANPP is currently in operation. The installed gross capacity is 407.5 MW. The total production of electricity in Armenia during 2001 amounted to 5740 billion kW·h. The nuclear share in overall production along with comparative figures for the other power plants are shown in Table 9. Table 11 shows the status of the nuclear power plants.

TABLE 11. STATUS OF NUCLEAR POWER PLANTS

Station	Type	Net Capacity	Operator	Status	Reactor Supplier
ARMENIA-2	WWER	376	JSC	Operational	MNE
ARMENIA-1	WWER	376	JSC	Shut Down	MNE

Station	Turbogenerator Supplier	Construction Date	Criticality Date	Grid Date	Commercial Date	Shutdown Date
ARMENIA-2	KHTP	01-Jul-75	05-Jan-1980	05-Jan-1980	31-May-1980	
ARMENIA-1	KHTP	01-Jan-73	22-Dec-1976	28-Dec-1976	06-Oct-1979	25-Feb-1989

Note: Armenia 2 was shutdown in 1989 and restarted operation in November 1995
Source: IAEA Power Reactor Information System as of 31 December 2001

In 1999, Unit 2 of the ANPP had one emergency shutdown and one event of level "1" on the International Nuclear Event Scale (INES). In 2000, there were 3 events reported, one event was rated level "1", and two events were rated level "0". In 2001, there were 7 emergency events occurred at the ANPP, including: 3 – of level "1", 4 of level "0" on the INES scale. During the last two years, Unit 2 operated without any emergency shutdown.

The following safety upgrading measures were implemented within the period of 1999 – 2001:

- Completion of the nuclear service water system project. This is a highly reliable system for cooling safety related loads, which were previously cooled by the cooling towers. It eliminates seismic concerns for cooling. These loads allow cooling in an autonomous regime, separately from the cooling towers. This system is intended to endure earthquakes of high magnitude. Also seismic pumps and other equipment have been installed;
- 7 Fast closing main steam isolation valves (MSIV) were installed. They will provide better control in the event of a steam line accident and will reduce the risk of a more serious accident involving overcooling of the primary coolant system and reactor vessel;
- 12 Steam generator safety valves (SGSV) were replaced by new ones;
- 2 Safety valves of the pressurizer were replaced by new ones;
- A new fire detection and alarm system was put into operation. 700 Smoke/fire type detectors were installed, of which 70 are blow resistant;
- An analysis of the material structure of the reactor vessel and primary circuit piping has been carried out by using various modern methods;
- The installation of a leak detecting system from the primary to the secondary circuit was implemented;
- The bearing metallic structures (columns) in the turbine hall building and in the emergency diesel-generator room have been coated with fire-resistant material;

- A seismic safety related re-evaluation programme for Unit 2 has been developed;
- A multifunctional simulator, for training the operators, was put into operation.
- Reconstruction of feed-water distribution headers inside the SG 1 and 6.
- Review of "SIAZ" logic and scope in regard with the Service Water System implementation.
- Replacement of emergency condenser tubing in low-pressure cooling system (AK).
- Commissioning of new system for RCP shaft seal.
- Installation and commissioning of diesel-pump for feeding SG in the event of full de-energizing.
- Reconstruction of TG-3 shaft seal system.
- Development and implementation of Feed-and-Bleed procedure.
- Scenario development for reactor transfer to safe controlled condition in seismic event. The activity completed and is in a stage of approval.
- Installation of a compressor for annual pressure tests of SG and RCP compartment tightness.
- Replacement of DG start-up oil pumps.
- Implementation of automatic cold overpressure protection equipment for Reactor Vessel cold overpressure protection. The equipment has been installed, but the system has not yet been commissioned.
- Implementation of automatic cold overpressure protection equipment for RV cold overpressure protection.

All these measures were carried out with the assistance of the US DOE and EC TASIC Technical Assistance programmes, which began early 1997 and were completed during 2000 - 2001. These measures assure that the safety of the ANPP increased one level and that the plant can withstand emergency situations without failures.

3.3. Current Policy Issues

Apart from the short period of regaining independence, there have been no strong antinuclear movements in Armenia. The current sentiment of the public can be explained not by lack of awareness of the risks involved by the utilization of nuclear energy, but, in the face of the difficult economic conditions, by the considerably lower price of "nuclear electricity" which outweighs its possible risks. Before independence, the ANPP had a status of State Enterprise. Now there are strong opinions against its partial privatization, so the status of the plant has remained the same.

The safety level of the ANPP during the times of very limited financial resources is one of the main concerns of the Armenian Government. After numerous consultations with Western, Russian and Armenian experts, a safety-upgrading programme has been developed. Currently, a new list called "List of measures for Unit 2 of the Armenian NPP safety and reliability upgrading for the period of 2001 - 2004", replaced the previous list. Special attention is focused on financing for spent fuel and radioactive waste storage and funding for decommissioning of the nuclear power plant.

3.4. Organizational Chart

The Armenian NPP has been under the State ownership. It is under subordination of the Ministry of Energy, and the Government of Armenia has designated the ANPP with the rights of operator organization.

4. NUCLEAR POWER INDUSTRY

4.1. Supply of NPPs.

Both units of the ANPP with the WWER- 440 (V-270) type reactors, were designed and constructed by organizations of the former Soviet Union, under the supervision of the Ministry of Energy and Electrification of the USSR. The first phase design was developed in 1969-1970. The main operator of the project was All-Union Scientific Research and Design Institute for Power Technologies (VNIAEP). The chief scientific supervisor was Kurchatov Institute of Atomic Energy (Moscow). Now it is called RNC "Kurchatov Institute". The chief design organization was Thermoelectroproject (TEP), Gorki. Now it is called NIAEP, Nizhny Novgorod. The main reactor construction organization was OKB "Gidropress", Podolsk. The building-construction work was realized by the " Gidroenergostroy", Yerevan.

4.2. Operation of NPPs

The Republic of Armenia through the Ministry of Energy owns the Armenian NPP. At the present time, the ANPP entitles the rights as operator of a nuclear installation. For other purposes, such as liability to foreign countries, the State is assumed to be the operator. The electricity produced by the ANPP is sold to the "Armenergo" Joint Stock Company.

4.3. Fuel Cycle, Spent Fuel and Waste Management Service Supply

Armenia has no fuel cycle industry. Up to now, all the nuclear fuel has been supplied by Russia. Originally, spent nuclear fuel from the ANPP was to be managed by central Soviet agencies for reprocessing and final disposal of the radioactive wastes. The recovered uranium and plutonium were to be retained by the central agencies in the Soviet Union. However, with the disintegration of the Soviet Union, Armenia had to find other solutions.

In 1998, the construction of the first stage of spent fuel dry storage was completed. The spent fuel dry storage facility has eventually been put into operation, and all the transportations of spent fuel are fulfilled according to the requirements of the license given by the ANRA (Armenian Nuclear Regulatory Authority). During the ANPP outage in 2000, the first portion - six fuel canisters containing 336 fuel assemblies, was successfully transferred to and stored in the facility.

4.4. Research and Development Activities

There are no major R&D activities in the country.

4.5. International Co-operation in the Field of Nuclear Power Development and Implementation

Armenia has multilateral and bilateral projects, mostly concerning safety of the ANPP, with the highly developed counties, including Italy, Germany, France, Russian Federation and USA. Armenia also participates in several international projects developed in framework of co-operation under the aegis of TACIS (EC), IAEA and USAID.

Very close co-operation is established with the IAEA. Armenia has become a member of this organization since 1993. IAEA experts have been participating in many various assistance projects since then. When in April of 1993 the Government of Armenia made the decision to restart Unit 2 of the ANPP, the IAEA experts participated actively in pre-commissioning investigations and evaluation of the condition of plant equipment. Moreover, they elaborated the whole concept of Unit 2 recommissioning. Armenia has also collaborated with the IAEA in the field of ensuring nuclear safety. At present, several national programmes of the ANPP Unit 2 safety upgrading are in different phases of implementation.

The Russian Federation is also an active partner of Armenia. There are many joint projects within the framework of the Nuclear Safety Assistance Programme, realized in close co-operation with the Russian experts. They also took active part in pre-commissioning and restart of Unit2 of the ANPP. In 1996, an agreement was signed between the ANPP and ROSENERGOATOM on industrial and technical-scientific co-operation.

In 2000, the agreement was signed between the Governments of RA and RF on "Cooperation in the field of peaceful use of nuclear energy".

Since 1996, the ANPP is a member of WANO.

Since 1996, the EC started, within the framework of TACIS Assistance Programmes, the implementation of projects aiming in modernization of the technological equipment, construction of a multifunctional simulator, technical assistance for upgrading a level of operation of the ANPP, etc.

There are a number of projects financed by the US Department of Energy (US DOE). Since 1996/97, in the framework of a Nuclear Safety Assistance Programme for Armenia, the USA specialists have implemented many technical assistance projects at the ANPP aiming to improve, in particular, the fire protection systems, purchase of equipment for the new cooling system, computerization of the safety system and procurement of the equipment for its safety operation. The experts from US DOE are also participating in the development of a programme for future decommissioning of the ANPP.

French experts from FRAMATOM were involved in a joint project of constructing the first stage of the spent fuel dry storage system, which started in 1996 and has been completed.

The Armenian Nuclear Regulatory Authority (ANRA) has agreements for co-operation with Nuclear Regulatory Authorities of the following countries: Russia, USA, Argentina and Ukraine. The ANRA is member of the organization FORUM, which members are the nuclear regulatory authorities from the countries operating WWERs. The ANRA participates also in the work of the CONCERT Group.

In 2000, the implementation of joint projects with the Department of Trade and Industry (DTI) of the United Kingdom started. They covered an assistance programme relevant to the ANPP safety upgrading. This includes, in particular, the elaboration of plant operational procedures and development of a quality assurance programme.

In 2001, the Italian Government allocated its grant for the development of a part of the Probability Safety Analysis.

5. REGULATORY FRAMEWORK.

5.1. Safety Authority and Licensing Process

The state authority for regulation of issues of nuclear and radiation safety - Armenian Nuclear Regulatory Authority (ANRA) - was established by a resolution of the Government of the Republic of Armenia in November 1993. The ANRA Statute was approved by Government decree N573 of 16 November 1993. It was further reviewed and approved by Government decree N385, dated 22 of June, 2000. The main responsibilities of the ANRA are:

- development of principles and criteria of safe utilization of atomic energy, nuclear and radioactive materials, their transportation and storage;
- development and introduction of safety rules and regulations;

- implementation of licensing activities and licensing of physical persons, implementing activities and holding posts important for safety provision aspect in the area of atomic energy utilization;
- conduction of safety assessment of activities, objects and equipment in the area of atomic energy utilization;
- supervision on compliance with the requirements of the legislation in the area of atomic energy utilization and of the issued licenses by the legal and physical persons and applying sanctions where the requirements are not complied with;
- supervision on preparedness of enterprises and operating organizations included on the national emergency response system to extreme situations at the objects of atomic energy utilization and mitigation of the consequences;
- controlling the fulfilment of the commitments by Armenia on ratified international agreements jointly with a state authority entitled by the government with issues of international relations;
- controlling the safeguarding of nuclear and special material, special equipment and technologies;
- fulfilling freely inspection of objects of atomic energy, implemented activities and so on.

The ANRA is under a direct subordination of the Armenian Government and independent from those organizations responsible for development and utilization of atomic energy. According to its Statute, the ANRA organizes and performs state supervision and inspections over utilization of nuclear energy, as well as its regulation.

On 24 of May, 2001, according to the Government decision N 452, the ANRA was awarded with the authorisation for the regulatory activity on protection against the irradiation from ionisation sources and their safety.

On 25 of April, 2001, according to the Government decision N 342, the Science-Research Centre of Nuclear and Radiation Safety was established at the ANRA.

On the basis of the Governmental decree issued in 1994, all regulations, norms, etc. applicable to nuclear power in Russia have been accepted in Armenia. The ANRA is aware of the fact that many of these regulations need revision. This process is to a limited extent underway. Armenia has a single stage licensing process for NPPs and the licensing authority is the ANRA. The ANRA is reporting to the Vice Premier once a month on the safety of the licensed facilities. The licensee is responsible for the safety of the NPP. The licensee is obliged by the license to:

- Guarantee the keeping of principles, criteria and requirements on the nuclear and radiation safety, as well as the conditions or acts of the temporary exploitation permission;
- Inform ANRA about the deviations of the conditions of the temporary exploitation permission, as well as the incidents and emergencies during NPP Unit exploitation.

5.2. Main National Laws and Regulations

The following laws and governmental decrees concerning the activities in the field of atomic energy use are in force in Armenia:

- Law on “Implementation of modifications and additions both in the Code of RA on administrative and criminal legal violations”, entered into force on 30 November 1996.
- Law on “Energy of the Republic of Armenia”, entered into force on 1 July 1997.
- The new Law on “Energy of the Republic of Armenia” entered into force in March, 2001, and replaced an old one which entered into force on 1 July 1997.
- Law on “Safe Use of Nuclear Energy for Peaceful Purposes” entered into force on 1 March 1999.

- The amendment to the law on "Safe Use of Nuclear Energy for Peaceful Purposes" entered into force on 21 March 2000.

- The Government Decree N-389, 22.08.1994, on the "Implementation in Armenia of Regulations and Standards on Nuclear and Radiation Safety which are in force in the Russian Federation".
- The Government Decree N-401, dated 04.07.1995 on "Introduction of Additions in the Government Decree N-161, dated 05.03.1991" (about the types of activities that are subject to licensing).
- The Government Decree N-331, dated 08.12.1995 on "Restart of the ANPP Unit 2, and the Measures for Ensuring its Further Safe and Uninterrupted Operation".
- The Government Decree N 465, dated 19.07. 1999, approved the list of objects, which are of safety importance in the field of nuclear energy use.
- The Government Decree N 769, dated 22.12. 1999, approved the list of operations and work positions, which are of safety importance in the field of nuclear energy use.
- The Government Decree N-746, dated 13.12.1999, approved the "Order of Evacuation of Population from the Contaminated Territories".
- The Government Decree N-679, dated 25.10.2000, approved the "Order of Providing the Population with the Individual Protection Means".
- The Government Decree N-640, dated 12.07.2001, approved the "Rules for Organizing and Conducting the Safety Expertise in a field of Nuclear Energy Utilization".
- The Government Decree N-1263, dated. 24.12.2001, approved "Special Rules for Nuclear and Radioactive Materials Transportations".
- The Government Decree N-765, dated. 16.08.2001, approved the "Order of State Registration of Ionisation Irradiation Sources".
- The Government Protocol N-51, dated 13.12.2001, adopted the "Principal Positions on Planning and Realisation Activities for the Nuclear and Radiation Accidents Resistance".

5.3. International, Multilateral and Bilateral Agreements

AGREEMENTS WITH THE AGENCY

• NPT related agreement INFCIRC No: 455	Entry into force:	5 May 1994
• Additional protocol GOV/2948	Signed:	29 September 1997
• Improved procedures for designation of safeguards inspectors		No reply
• Supplementary agreement on provision of technical assistance by the IAEA	Signed:	30 September 1999
• Agreement on privileges and immunities		Non-Party

RELEVANT INTERNATIONAL TREATIES OR AGREEMENTS

• NPT	Acceded:	15 July 1993
• Convention on the physical protection of nuclear material	Entry into force:	23 September 1993

• Convention on early notification of a nuclear accident	Entry into force:	24 September 1993
• Convention on assistance in case of a nuclear accident or radiological emergency	Entry into force:	24 September 1993
• Vienna convention on civil liability for nuclear damage	Entry into force:	24 November 1993
• Joint protocol		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
• Convention on nuclear safety	Entry into force:	20 December 1998
• Joint convention on the safety of spent fuel management and on the safety of radioactive waste management		Not signed
• ZANGGER committee		Non-Member
• Nuclear export guidelines		Not adopted
• Acceptance of NUSS codes		No reply
• Comprehensive nuclear-test-ban treaty		1 October 1996

BILATERAL AGREEMENTS

• Agreement with the Russian Federation on restarting operation of ANPP	Entry into force	17 March 1994
• Agreement with Republic of Argentine on co-operation for the peaceful uses of nuclear energy	Entry into force:	22 April 1999
• Agreement with the Government of the Russian Federation on co-operation in the field of peaceful use of nuclear energy	Signed:	26 September 2000

REFERENCES

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[2] Investment Guide of Armenian Development Agency (1998).

[3] Specifics and Phases of the Economic Reforms in Armenia in 1991-1998, Ministry of the State Statistics.

[4] Manual on the Climate Data for the Construction Design in Armenia.

[5] Data & Statistics/The World Bank, www.worldbank.org/data.

[6] IAEA Energy and Economic Database (EEDB).

[7] IAEA Power Reactor Information System (PRIS).

Appendix

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

NATIONAL ATOMIC ENERGY AUTHORITY

Ministry of Energy Government House 2, Republic Square 375010 Yerevan, Republic of Armenia	Tel: 374 1 52 19 64 Fax: 374 1 15 16 87 E-mail: minenr@arminco.com
Atomic Energy Department	Tel: 374 1 56 27 76 Fax: 374 1 505 439 E-mail: atomen@freenet.am
Armenian Nuclear Regulatory Authority Tigran Mets av. 4 375010 Yerevan, Republic of Armenia	Tel: 374 1 58 19 62; 56 31 24 Fax: 374 1 90 68 74 E-mail: head@asas.asrmenia.su

MAIN POWER UTILITY

Armenian Nuclear Power Plant Metsamor, 377766 Armavir region 6 Republic of Armenia	Tel: 3741 28 85 80 Fax: 3741 15 18 60 E-mail: Lmusoyan@arm.r.am

MANUFACTURES AND SERVICES

Armatom Admiral Isakov, 50 375114 Yerevan, Republic of Armenia	Tel: 374 1 74 21 30 Fax: 374 1 15 16 87 E-mail: armatom@freenet.am
Atomservice Metsamor, 377766 Armavir region 6 Republic of Armenia	Tel/Fax: 3741 28 55 32

HIGH ENERGY RESEARCH INSTITUTES, UNIVERSITIES AND OTHER ORGANIZATIONS

Institute of Energy Amaranotsayin, 127, 375147 Yerevan, Republic of Armenia	Tel: 374 1 65 54 49
Atomenergoseysmoproject Hrazdan Defile, YerGes-2 375015 Yerevan, Republic of Armenia	Tel: 374 1 58 06 49 Fax: 374 1 151 805
Yerevan Physics Institute	http://www.yerphi.am/
Yerevan State University	http://www.ysu.am/
National Academy of Sciences of Armenia	http://www.sci.am/