BULGARIA

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1. ENERGY, ECONOMIC AND ELECTRICITY INFORMATION

1.1. General Overview

Bulgaria is a country situated in the south-eastern Europe and it occupies the biggest part of the Balkan peninsula. The northern border of Bulgaria continues for 470 km on the Danube River and later in south-eastern direction to the Black Sea for about 139 km on land. In eastern direction, Bulgaria borders the Black Sea while to the south there is a 752 km long border with Turkey and Greece. To the west, the country has a border with the Former Yugoslav Republic of Macedonia and Yugoslavia. Within these borders, Bulgaria has 110 975 km^2 surface, including an altitude correction.

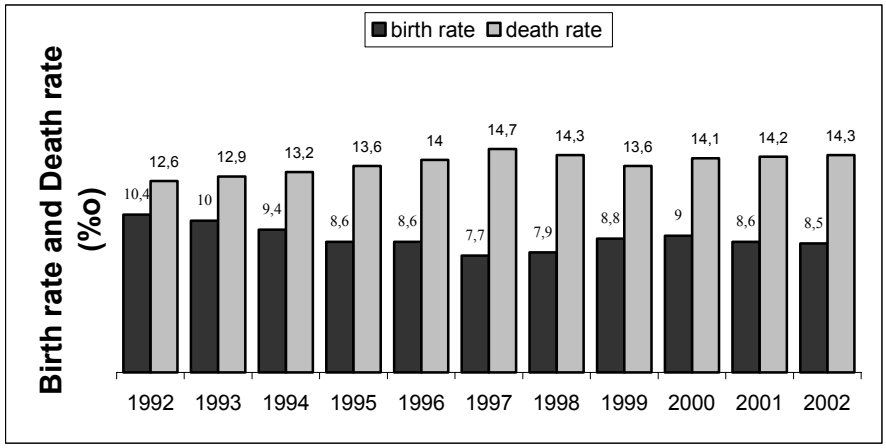
Bulgaria has four distinct seasons, which create changes in the demand for energy and in particular for electricity. The annual fluctuation of Bulgarian's electric power demand has one peak period in winter, which has been identified to be the result from using electricity for space heating. The average temperature of 12^{o}C, below which district heating is necessary, lasts about 200 days. The average temperature in November is 5.1^{o}C, in December – 0.0^{o}C, in January –1.8^{o}C, in February – 0.3^{o}C, in March 4.6^{o}C.

The demographic situation in the country is characterized with a clear tendency of decrease in the population (Table 1). For the period between 1989, when the number of population was highest, and 2002, the population has decreased by 1,146,459 people (12.7%). At the end of 2002, the population of the country numbered 7,845,841 million people and population density of 70 persons per square kilometer. There exists a negative trend in the change of the population, which was for 1990 -0.4%; for 1995 -0.5%, for 2000 -0.5%; for 2001 -3.4%; and for 2002 -0.6%; see Figure 1, which shows the birth and death rates from 1992 to 2002. The decrease is bigger for men than for women. In comparison with 2001 men have decreased by 25 thousand, or 0.7%, and women by 20 – 21 thousand, or 0.5%. According to the National Statistical Institute, there is negative trend for the population growth marked by low birth rate and relatively high death rate. In addition, the migration abroad directly and indirectly worsens the demographic situation in the county. (Table 2 and Figure 2).

TABLE 1. POPULATION INFORMATION

	1960	1965	1970	1975	1980	1985	1990	1999	2000	2001	2002
Population as of 31.12. (millions)	7.9	8.2	8.5	8.7	8.9	8.9	8.7	8,19	8,15	7,89	7,85
Population density (inhabitants/km^2)	71	74	77	79	80	81	78	73,8	73,4	71,1	70,7
Urban population as percent of total	38	47	53	58	63	65	67	68	68	69,4	69,6
Area (1000 km^2)	110.7	110.9	110.9	110.9	110.9	111.0	111.0	111.0	111.0	111.0	111.0

Source: Population and demographic processes 2001, National Statistical Institute, Sofia.



Source: Statistical Yearbook, 2002, National Statistical Institute, Sofia

FIG. 1. Birth and Death Rate of the Bulgarian Population

TABLE 2. POPULATION OF BULGARIA AS OF 31.12. (1993 - 2001)

Year	Inhabitants		
	Total	Men	Women
1993	8,459,763	4,151,638	4,308,125
1994	8,427,418	4,129,966	4,297,452
1995	8,384,715	4,103,368	4,281,347
1996	8,340,936	4,077,501	4,263,435
1997	8,283,200	4,044,965	4,238,235
1998	8,230,371	4,014,071	4,216,300
1999	8,190,876	3.991,161	4.199,715
2000	8,149,468	3.967,423	4.182,045
2001	7,891,095	3,841,163	4,049,932

Source: Statistical Yearbook, 1994-2002, National Statistical Institute, Sofia

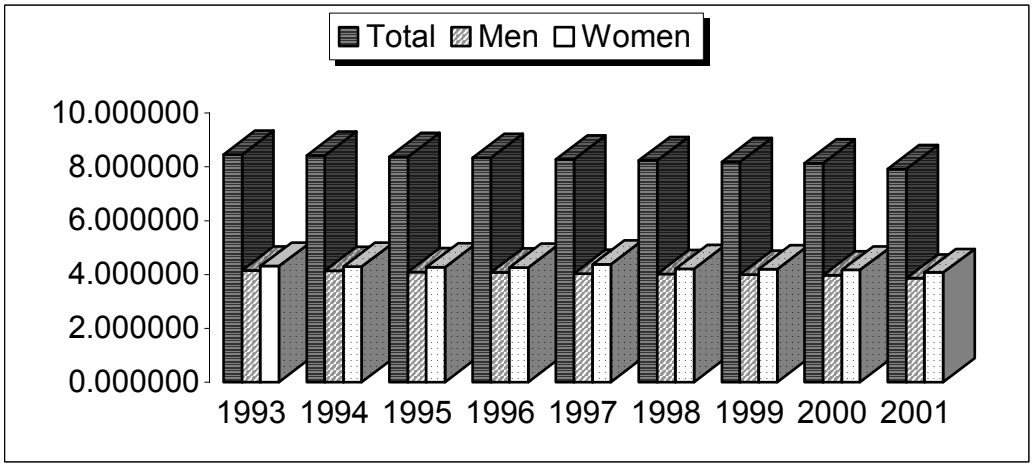


FIG. 2. Population of Bulgaria (1993 - 2001)

1.1.1. Economic Indicators

Table 3 shows the historical Gross Domestic Product (GDP) data from the IAEA Energy and Economic Database (EEDB) in USD. GDP in 1998 was 21 577 billion levs at current prices, which amounts to 115 558 million levs at 1991 prices. The economic crisis of 1996 and 1997 led to a decline in real GDP, which dropped by -9.4 % and -5.6% respectively. The economy picked up again in 1998, with real growth estimated at 4.0 % and remained on that level. Figure 3 shows the real GDP index for 1990 through 2006, where 1990 was taken as the base year.

TABLE 3. GROSS DOMESTIC PRODUCT (GDP)

	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
GDP[1]	20040	16755	8137	8605	10812	9688	13106	10017	10398	12736	12946	12596	13599	15563
GDP[2] per capita	2261	1922	943	1008	1276	1147	1559	1,198	1,251	1,543	1,577	1,542	1718	1978
GDP by sector (%):														
-Agriculture[3]	14.4	17.7	15.4	11.6	9.9	11.5	12.7	14.2	23,4	16.8	14.5	12.3	11.9	11.0
-Industry[3]	53.8	51.3	39.8	39.0	32.7	29.9	31.0	29.0	25,0	28.2	25.7	26.7	26.3	25.3
-Services[3]	31.8	31	51.2	45.9	50.8	51.9	51.1	51.2	41.0	44.4	48.9	49.6	50.6	51.9
Adjustments[4]			-6.4	3.5	6.6	6.7	5.2	5.6	10.6	10.6	10.9	11.4	11.2	11.8

[1] Millions of current US$.
[2] Current US$ per capita.
[3] Value added at basic prices
[4] Adjustments on total value added at basic prices to GDP at market prices
Source: National Statistical Institute

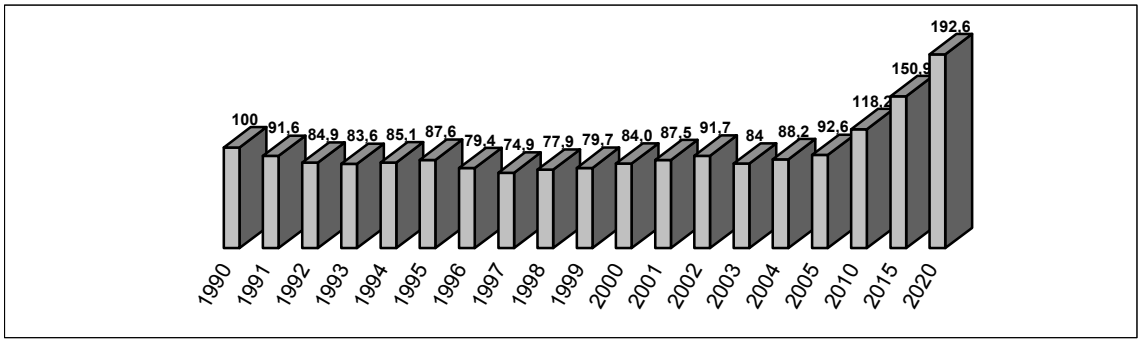


FIG.3 Index of the Gross Domestic Product of Bulgaria

1.1.2. Energy Situation

Current status

Bulgaria has very few domestic energy resources. Data in Table 4 indicate the national provision with domestic primary energy source. Proven oil and gas reserves for the country have declined for a number or years and are only about 5 million tons of oil equivalents. In fact, it is less than six months normal hydrocarbon consumption for Bulgaria. Hydropower potential is also limited since most of Bulgaria's rivers are small and the only large river, the Danube, has a small drop in altitude where it forms Bulgaria's northern border with Romania. Largely because of this constraint, hydro capacity accounts for about 23.4% (HPP – 16.3% and PSHPP – 7.1%) of the country's total installed generating capacity and an even smaller percentage of generation. The thermal power is 52.9%, and nuclear power is 23.7% of the country's total installed generating capacity.

TABLE 4. ENERGY INDEPENDENCE OF THE COUNTRY

Per cent (%)

	1998	1999	2000	2001
Total	51,13	50,18	53,50	53,97
Coal	69,26	66,69	67,21	63,16
Crude oil	0,58	0,76	0,84	0,62
Natural gas	0,74	0,82	0,41	0,66

Source: Statistical Yearbook, 2002, National Statistical Institute, Sofia.

The country has significant but very low-grade coal reserves (Table 5). The mineable reserve amount to about 2.2 billion tons including lignite, of which 2.1 billion tons are situated in the Maritsa East deposit. The production in 2001 amounted to about 27.3 million ton per year (Table 6 and Figure 4). About 90% of these reserves have a heating value of about 1500-1600 kcal/kg, which is 20-25% of the heating value of internationally traded, steam coal. In addition, these lignite reserves have very high sulphur content. Consumption of coal in Bulgaria reached its historically highest level in 1987.

In that year, 40.5 million tons of coals were consumed.

Bulgaria imports almost all of its petroleum since domestic production is negligible, for example in 1997 domestic production was 27.800 tons of oil and 35 million cubic meters of gas. Imported petroleum is in the form of crude oil and is being refined in Bulgaria or directly imported as products. Typically, about 90% of petroleum are imported as crude and most of the rest is imported as heavy fuel oil. Bulgaria has three refineries located respectively at Burgas, on the Black Sea Coast, and at Pleven and Ruse on the Danube plain in the northern part of the country. The Burgas refinery accounts for about 85% of the country refining capacity with the other two refineries being very small with insertion economics.

TABLE 5. BULGARIA COAL RESERVES

	Mineable Reserves (million tons)	Present Production (million tons/year)	Lifetime (years)
Lignite	2350	28	85
Sub-bituminous coal	210	5	40
Bituminous	10	<1	40
Anthracite	1	<1	20

Source: Country Information.

TABLE 6. STRUCTURE OF THE COAL PRODUCTION IN BULGARIA
(IN THOUSAND TONS)

	1999	**2000**	**2001**	**2002***
Brown coal	2950	2602	2646	2766
Antracite	122	118	110	94
Lignite	22586	23712	23856	23158
Total	25298	26432	26611	26018

* Preliminary data
Source: National Statistical Institute, Sofia.

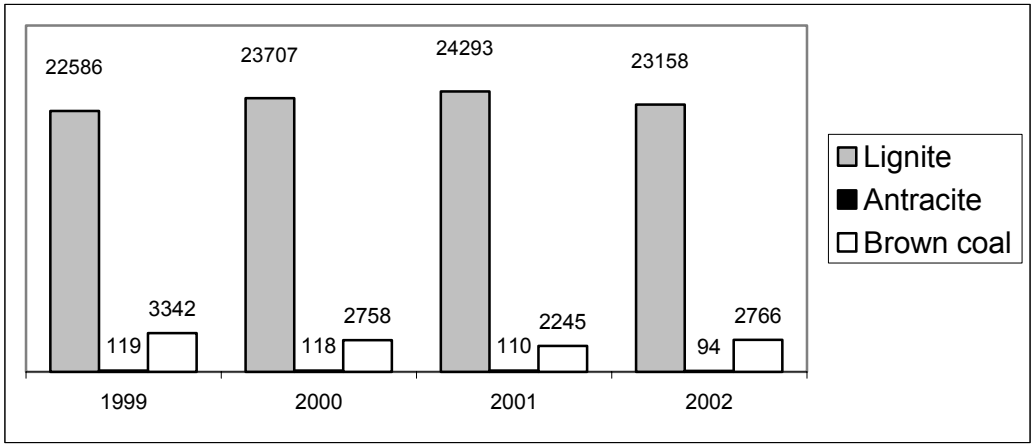


FIG.4 Structure of the coal production in Bulgaria

The average annual consumption of natural gas for the past five years (1997-2001) was around 3.5 bcm, which represents a considerable decrease compared to the highest demand in the country in 1989 and 1990 (6.8 bcm). The reduction of the share of natural gas in the structure of primary energy demand, however, is far less (18.3% in 2000 compared to 23.4% in 1990). That is due to the registered total drop of demand for energy resources over the past 10 or 12 years.

In order to fulfil Decree No 162, August 20, 1992, and Decree No 56, March 29, 1994 of the Council of Ministers, the technical liquidation of the uranium mining sites have been completed. The

liquidation of the processing plants has been finalised. By 2002, the projects of technical and biological re-cultivation of the uranium mining regions shall be completed, and by 2005 - sanitary treatment and safeguarding of the tailings ponds of the processing plants. Special attention is paid to the regions of Buhovo, Eleshnitza and Sliven, where the damages to the environment are most markedly pronounced, and where their effect on the population is the most direct. In parallel to performance of the re-cultivation and sanitary treatment projects, the required treatment facilities for purification of radionuclide polluted waters and monitoring networks will be built in the uranium mining regions. For performance of the projects in these regions, we depend on the co-operation and assistance of the European Union and the PHARE Programme, especially to avert the danger of cross-border water pollution. A project for engineering works for closing of uranium mines in Eleshnitza and Dospat under PHARE CBC 1999 Bulgaria-Greece programme is under implementation. Two other projects –regional monitoring network for radio-ecological monitoring in Mesta river valley and Smolian and feasibility study for the status of the uranium mines in Southern Bulgaria are going to be implemented under PHARE CBC Bulgaria-Greece programme 2001.

The energy intensity of Bulgarian Gross Domestic Product (GDP) does not appear to have decreased, with energy consumption and output roughly at the same rate. However, this pattern should start to change as the economic restructuring occurs and as relative energy prices continue to increase. Reduction of energy consumption and, therefore, of net energy imports is likely to be an important component of any improvement of Bulgaria's balance of trade. Table 7 shows the national primary energy data (production, primary energy balance and consumption) in their typical units and Table 8, Table 9 and Table 10 the Energy statistics.

TABLE 7. NATIONAL PRIMARY ENERGY DATA

		1998	**1999**	**2000**	**2001**
Production of Primary energy					
Coal	M toe	5,079	4,341	4,520	4,497
Crude oil	M toe	0,033	0,044	0,046	0,034
Natural Gas	M toe	0,023	0,022	0,012	0,018
Other solid fuels	M toe	0,413	0,413	0,550	0,532
Nuclear and hydroenergy	M toe	4,993	4,591	5,154	5,426
Total	M toe	10,541	9,411	10,282	10,507
Primary energy					
Production	M toe	10,54	9,41	10,28	10,51
Import	M toe	11,82	11,02	11,47	11,61
Export	M toe	1,64	2,00	25,99	2,76
Bunkers	M toe	0,07	0,008	0,064	0,096
Stock Changes (+. -)	M toe	-0,04	0,329	0,118	0,189
Total	M toe	**20,62**	**18,76**	**19,22**	**19,47**

Source: Statistical Yearbook, 2002, National Statistical Institute, Sofia.

TABLE 8. FINAL CONSUMPTION OF ENERGY SOURCES

		Total consumption				Energy				Non-energy			
		1998	**1999**	**2000**	**2001**	**1998**	**1999**	**2000**	**2001**	**1998**	**1999**	**2000**	**2001**
Total	Mtoe	10,920	9,786	9,568	9,500	9,676	8,744	8,436	8,413	1,244	1,042	1,132	1,087
Hard Coal and Lignite	Mtoe	0,289	0,317	0,278	0,326	0,289	0,317	0,278	0,326	-	-	-	-
Fuels from coal and lignite	Mtoe	0,986	0,744	0,707	0,611	0,986	0,744	0,707	0,611	-	-	-	-
Natural gas	Mtoe	1,667	1,246	1,545	1,379	1,326	0,880	0,937	0,778	0,341	0,366	0,608	0,601
Petroleum products	Mtoe	4,282	4,069	3,531	3,600	3,379	3.393	3,007	3,114	0,903	0,676	0,524	0,486
Biomass and industrial waste	Mtoe	0,409	0,407	0,555	0,541	0,409	0,407	0,555	0,541	-	-	-	-
Electricity	Mtoe	2,224	2,049	2,075	2,109	2,224	2,049	2,075	2,109	-	-	-	-
Heat	Mtoe	1,063	0,954	0,877	0,934	1,063	0,954	0,877	0,934	-	-	-	-

Source: Statistical Yearbook, 2002, National Statistical Institute, Sofia.

The pattern of energy use in Bulgaria is significantly different from the West. The main area of difference is in the direct use of gas. In most western industrial countries, households and the service sector use gas. In Bulgaria, gas is almost entirely used in the industrial sector and in power generation, including district heating plants (many plants being combined heat and power or CHP plants), with a negligible amount being used in services and households. Furthermore, this pattern of usage will not change rapidly since Bulgaria lacks a distribution network for gas so that it cannot currently be supplied to most households and commercial establishments. Indirectly, of course, the household and service sectors use some gas since a small part of the electricity they consume and most of the heat supplied by district heating plants, comes from gas. Even considering this indirect use, however, the use of natural gas in Bulgaria is still heavily skewed towards the industrial sector.

TABLE 9. FUEL STRUCTURE OF TRANSFORMATION INPUT IN POWER PLANTS AND HEAT PLANTS

Percent %

				Electric power stations									District heating plants		
	Total			Public electric plants			Combine Heating Public plants			Autoproducers					
	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Hard coal	9,4	8,9	11,3	5,7	4,4	7,6	22,9	26,4	27,6	18,2	21,2	18,1	-	-	-
Total lignite	35,4	35,0	34,3	40,3	38,5	37,1	23,2	27,5	27,5	3,0	-	-	0,3	0,3	-
Other solid fuels	2,1	2,0	2,1	-	-	-	10,8	10,7	12,3	4,7	3,6	2,4	-	-	-
Petroleum products	2,5	1,6	1,6	0,2	0,2	0,2	2,7	1,6	1,2	35,9	28,3	39,7	15,0	12,0	10,9
Natural gas	8,6	7,3	6,3	-	0,0	0,2	40,4	33,8	31,3	28,5	33,0	27,5	84,7	87,7	89,1
Other gas	0,5	0,6	0,4	-	-	-	-	-	-	9,7	13,8	12,3	-	-	-
Nuclear energy [1]	41,6	44,6	44,0	53,8	56,9	54,9	-	-	-	-	-	-	-	-	-

([1]) Excl. Hydro-power plants

Source: Statistical Yearbook, 2002, National Statistical Institute, Sofia.

TABLE 10. FUEL USED FOR ELECTRICITY AND HEAT PRODUCTION IN POWER PALNTS

		1998	1999	2000	2001
Coal	M toe	5,552	4,354	4,924	5,469
Petroleum products	M toe	0,283	0,263	0,176	0,197
Natural Gas	M toe	0,919	0,898	0,806	0,751
Other fuels	M toe	0,132	0,277	0,286	0,303
Nuclear energy	M toe	4,993	4,591	5,154	5,277
Total	**M toe**	**11,613**	**10,478**	**11,043**	**11,997**

Source: Statistical Yearbook, 2002, National Statistical Institute, Sofia.

TABLE 11. EXPECTED ENERGY CONSUMPTION

(million kW-h)

	2000	2005	2010	2015	2020
Minimum scenario	36,307	36,990	40,260	43,750	48,870
Maximum scenario	36,307	37,160	40,990	46,440	54,190

Sources: NEK Information

TABLE 12. RATIO OF EXPECTED ENERGY CONSUMPTION AND GDP

Year	Dimension	Basic scenario	Minimum scenario
1996	tones of reference fuel/million $	1978	1978
2000	tones of reference fuel/million $	1825	1927
2001	tones of reference fuel/million $	1788	1857
2005	tones of reference fuel/million $	1607	1665
2010	tones of reference fuel/million $	1256	1332

Sources: NEK Information

1.2. Energy policy

The energy strategy of the Republic of Bulgaria is based on the national priorities and corresponds to the new lasting positive political and economic trends in the country as well as to the requirements of the European guidelines, the principles of market mechanisms and the Government's Programme. It is determined by the requirements for ensuring sustainable economic growth, and raising the living standard. The strategy has been developed in conformity with the natural and geographic factors determining the inherent role of the country in this region, and the optimal mix of energy resources used in accordance with the specific conditions.

The main goals of the Bulgarian energy industry are focused in energy efficiency improvement, integration of the national energy system and energy market into the European ones, guaranteed nuclear safety and establishment of a competitive domestic energy market.

The energy sector is a determinative section of the Bulgarian industry, especially taking into account that its structure and development are based predominantly on imported energy sources and Bulgarian Lignite Coal. Moreover, the development of the sector is highly dependent on our geopolitical location on the Balkan Peninsula and in Europe. In this complicated stage of its development, Bulgaria unambiguously proves the willing to conform to the priorities of European Union and make the needed steps for technical and political integration with these structures.

During the transition period and according to the stated intention of the country to be a Member of the European Union, Bulgarian Energy Industry fulfils its main goal satisfying the fuel and energy needs of the population and industry at affordable social price. At the same time, a structural reform will start in all energy subsections following the goals of the European Union to stimulate the

competition, provide reliable power supply and protect environment. The main direction during the whole process of preparation for integration with the European Union is to harmonise the Bulgarian Energy Policy with the policy of the European Union and with the legislation and structural reforms as a way for closer relations and integration with the European structures.

As a country with limited energy resources, the basis of the energy sources of Bulgarian Energy Sector is too large - solid fuel, nuclear power, natural gas, hydro resources and utilisation of the new energy sources. This multiformity will be kept for the future and the specific priorities of the country will be determined as follows:

- Introduction of market relations, based on cost-reflective tariffs and free contracting;
- Creation of a clear and stable legal and regulatory framework;
- Implementation of new large-scale investment and privatisation projects;
- Improving the competitiveness of the economy, security of energy supply and environmental protection;
- Efficient social protection and introduction of socially-oriented tariffs;
- Positioning of Bulgaria as a reliable country for the provision of future transit of oil, natural gas and electric power and as a dispatching and market centre in the region.

The government policy in tender procedures will continue the good traditions and will rely on two main sources:

- Nuclear energy and
- Local lignite coal.

1.3. The Electricity System

1.3.1. Structure of the Electricity Sector

The structure of the energy sector is shown in Figure 5.

1.3.2. Decision Making Process

The energy policy of Bulgaria is developed and implemented by the Ministry of Energy and Energy Resources (MEER). The MEER has obligations to propose a strategy of energy development and efficient utilisation of energy and energy resources to be carried by the Council of Ministers and passed with a resolution of the National Assembly. The MEER manages the “Radioactive Waste” Fund and the “Nuclear Facility Decommissioning” Fund.

The State Energy Efficiency Agency is an executive agency to the MEER. It implements the state energy efficiency policy. The Agency participates in the development of a National Strategy of Energy and Energy Efficiency Development, for the improvement of energy efficiency, for promotion of the utilisation of renewable sources of energy.

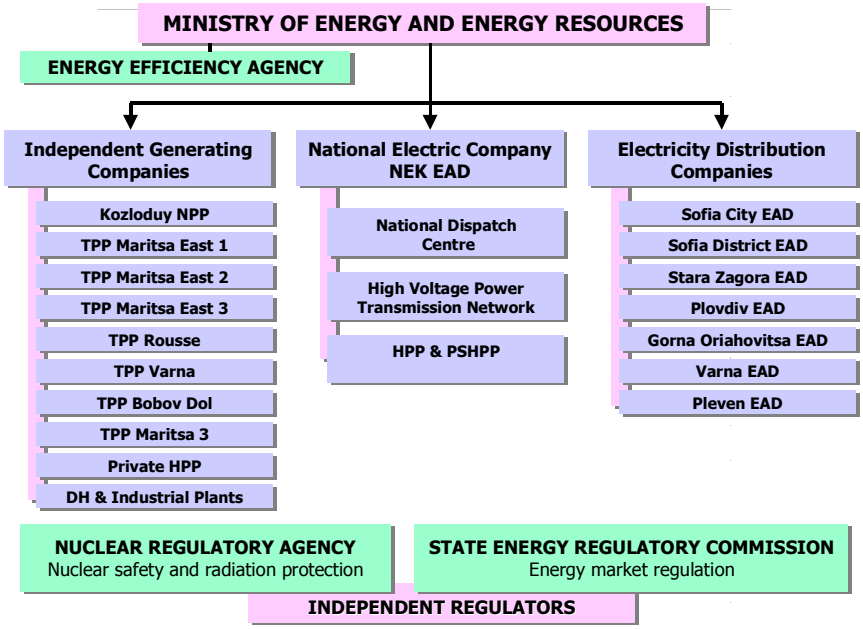


FIG.5 Organisation of the Energy Sector

State regulation in the field of energy is carried out by the State Energy Regulatory Commission (SERC). The Commission has obligations for developing instruments and take the required steps to issue the licenses provided by the Energy and Energy Efficiency Act. The SERC issues licenses for construction of generation capacities, heat transmission systems, gas transmission systems, natural gas storage facilities, direct power lines and gas pipelines, and for decommissioning of energy facilities. In the process of performing its regulatory functions under the Act, the Commission is guided by several basic principles, as achievement of energy efficiency, environmental protection, etc.

1.3.3. Main Indicators

The domestic electrical production amounted to 43.89 TW-h in 2001. The main producers of electricity are the TPPs – 22.2 TW-h and Kozloduy NPP plc – 19,55 TW-h, which is the operator of the six nuclear units at the Kozloduy site. The PSHPP and HPPs produced – 2.14 TW-h (Table 13 and Table 14 and Figure 6).

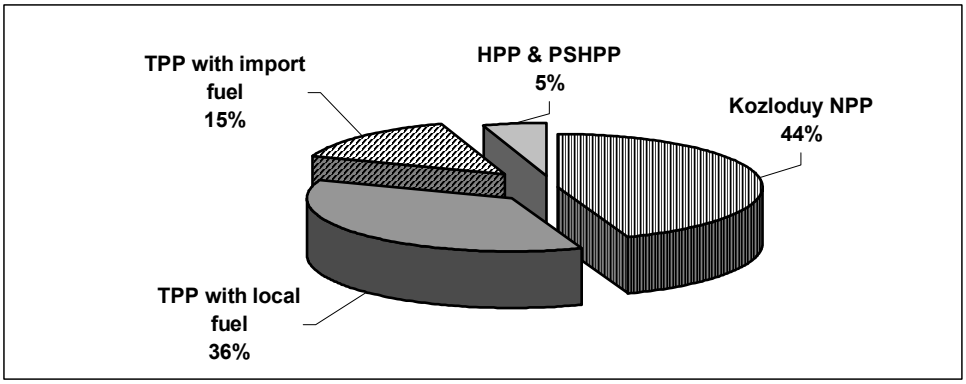
The total electrical installed capacity in 2001 amounts to 13, 245 MW of which 6, 628 MW are thermal, 3, 760 MW nuclear, 1, 993 MW hydro and 864 pumped storage.

The 87 hydropower plants, built between 1912 and 1984 have an installed capacity of around 2,000 MW but the available capacity in all hydropower plants is estimated at 1 400 MW. Since 1991 several small hydropower plants have been returned to their previous private owners. Most or the power plants (58) are of the run-of-river type with total capacity 177 MW. There are 12 power plants with total capacity 237 MW connected to seasonal, storage reservoirs and 17 power plants with total capacity 1,560 MW connected to multi-annual storage reservoirs. The majority of hydropower plants (89%) have been in operation for more than 30 years now. In 1994 was finishing the first stage of pump-storage hydro power plant Chaira, with 2 turbines having 432 MW generation capacity and 395 MW pump capacity. In the period 2001 – 2003 37 small HPP with total capacity 252 MW have been privatised.

TABLE 13. NATIONAL ELECTRICITY DATA

Electricity generation and demand in GW-h							
	1992 г	**1994 г**	**1996 г**	**1998 г**	**1999 г**	**2000 г.**	**2001 г.**
Generation incl.:	35 570	38 176	42 801	41 711	38 253	40 927	43 969
KNPP	11 552	15 335	18 082	16 899	15 814	18 178	19 553
TPP incl.:	21 954	21 333	21 736	21 496	19 472	19 791	22 368
Maritza East	10 862	11 509	12 251	11 747	10 534	11 582	12 705
HPP&PSHPP	2 063	1 509	2 984	3 315	2 967	2 958	2 047
Imports/Exports	2 705	-72	-449	-3 647	-1 957	-4 620	-6 926
Demand	38 275	38 104	42 352	38 064	36 296	36 307	37 043
own consumption	4 082	4 173	4 281	4 356	3 955	4 040	4 351
Transportation consumption	4 960	4 731	5 596	5 595	6 469	6 290	6 126
Electrical grid systems consumption	246	339	494	344	351	491	767
Country demand	28 987	28 861	31 981	27 769	25 521	25 486	25 800

Sources: NEK, Annual report, 2001



Sources: NEK, Annual report, 2001

FIG.6 Electricity Production Structure in 2001

TABLE 14. ELECTRICITY PRODUCTION

Generation in GW-h	**1992 г**	**1995 г**	**1998 г**	**1999 г**	**2000 г**	**2001 г**
Generation by NEK	30 887	37 443	37 179	33 896	12 005	6 385
Generation by independent producers	4 683	4 560	4 532	4 357	28 922	37 505
Total generation	35 570	42 003	41 711	38 253	40 927	43 890

Sources: NEK, Annual report, 2001

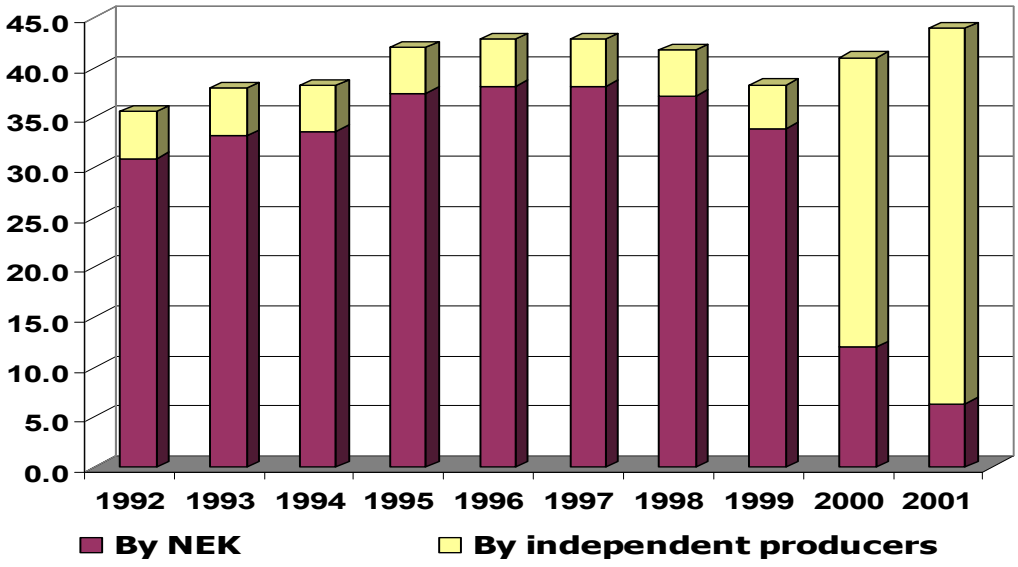


Figure 7. Electricity generation by NEK and independent power producers in TW-h

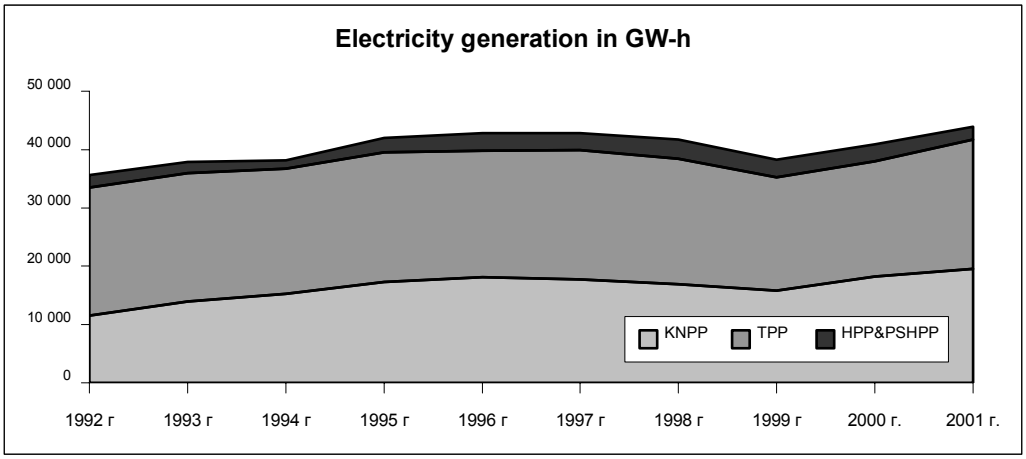


Figure 8. Electricity generation and demand in GW-h

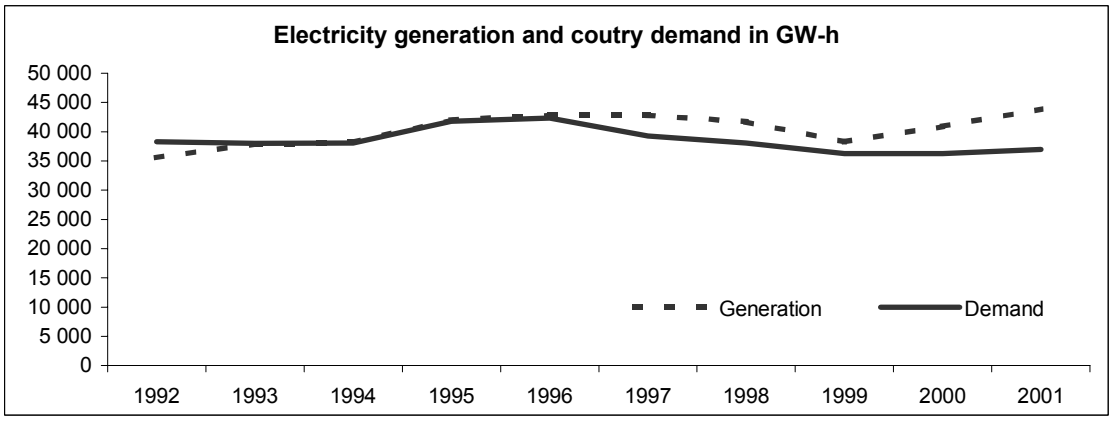
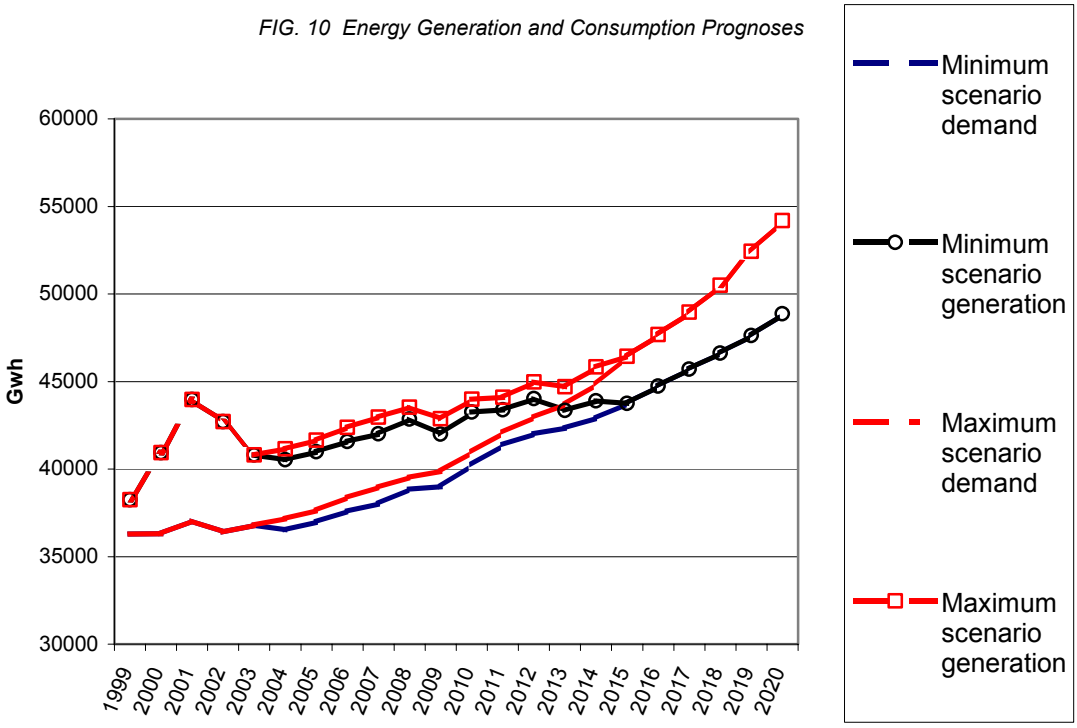


Figure 9. Generation and demand in GW-h

Prognoses

Since 1991, the energy consumption in the Republic of Bulgaria is characterised by large fluctuations determined by the unstable and dynamic social and economic conditions. The prognosis for development of the energy consumption is based on the policy for economical stabilisation and development. The forecast was elaborated according to two scenarios: maximum and minimum, which correspond to the maximum and minimum scenarios of energy efficiency development in the country (see Figure 10).

FIG. 10 Energy Generation and Consumption Prognoses



Energy Generation and consumption prognoses, millions kWh (data for fig.10)

Year	Minimum scenario		Maximum scenario	
	Gross consumption in the country	Generation in the country	Gross consumption in the country	Generation in the country
1999	36297	38254	36297	38254
2000	36307	40927	36307	40927
2001	37043	43969	37043	43969
2002	36406	42701	36406	42701
2003	36800	40800	36800	40800
2004	36530	40530	37160	41160
2005	36990	40990	37650	41650
2006	37580	41580	38380	42380
2007	38020	42020	38960	42960
2008	38850	42850	39530	43530
2009	39000	42000	39870	42870
2010	40260	43260	40990	43990
2011	41390	43390	42100	44100
2012	42020	44020	42970	44970
2013	42340	43340	43690	44690
2014	42900	43900	44840	45840
2015	43750	43750	46440	46440
2016	44740	44740	47670	47670
2017	45700	45700	48950	48950
2018	46620	46620	50490	50490
2019	47630	47630	52440	52440
2020	48870	48870	54190	54190

2. NUCLEAR POWER SITUATION

2.1. Historical Development and current nuclear power organizational structure

The nuclear development of Bulgaria started after the Geneva conference "Atoms for peace" in 1956 and was the favoured strategy of the political leadership ever since. The first step was the construction and the start of operation of IRT-2000 research reactor and a large programme of isotope applications and scientific research. Later, in 1966, an agreement was signed with the Soviet Union to deliver commercial reactors for electricity production. This agreement laid down the foundations of the Bulgarian nuclear power programme. The main articles of this agreement described the role of the reactor manufacturer and designer as well as the participation of the Bulgarian organisations and industry.

The Soviet nuclear industry was designing and supplying the nuclear island as well as the conventional part of the plants, while the architect engineer of the conventional plant and the auxiliary systems was the Bulgarian Company "Energoproekt". The Soviet safety rules and norms were supposed to be used as long as there was no special Bulgarian legislation available. During the construction and start up period, the Russian representatives at the site adopted the role of supervisors, but later they have only taken the position of manufacturer and supplier representatives. A number of Russian organisations also carried out all of the important assembly operations.

The first two units, which are a typical WWER 440/230 model, were built and put into operation for a period of less than 5 years. The second pair of reactors was completed and connected to the grid in 1980 and 1982 accordingly. By that time, the model 230 developed towards model 213, which is the reason why Units 3 and 4 incorporate many of the safety characteristics of the 213's. The further increase in the demand for electricity resulted in the construction of additional two units of 1000 MW each from the model known as WWER-1000/320. A second site was chosen in the early eighties near the city of Belene. The site was prepared with the entire necessary infrastructure to host six 1000 MW units. Completion of the first unit reached about 40% on view point construction, and 80% on delivery of equipment, in 1990, when due to lack of financial resources and some opposition from the near by communities the construction was frozen.

2.2. Nuclear Power Plants: Status and Operations

2.2.1. Status of nuclear power plants

Bulgaria has six nuclear power units at Kozloduy operation of which started between 1974 and 1991 comprising four WWER-440 units, net capacity 408 MW(e) and two WWER-1000 units, net capacity of 953 MW(e), all imported from the former USSR (Table 15). The first two units were shut down on 31.12.2002.

The output of the Kozloduy Nuclear Power Plant was 19.553 TW-h in 2001 (gross generation), 20.222 TW-h in 2002. For the last 10 years the electricity share of KNPP in Bulgaria has been 44-46 %.

TABLE 15. STATUS OF NUCLEAR POWER PLANTS

Station	Type	Net Capacity	Operator	Status	Reactor Supplier
KOZLODUY-1	WWER	408	"Kozloduy NPP"-plc	Shut down	AEE
KOZLODUY-2	WWER	408	"Kozloduy NPP"-plc	Shut down	AEE
KOZLODUY-3	WWER	408	"Kozloduy NPP"-plc	Operational	AEE
KOZLODUY-4	WWER	408	"Kozloduy NPP"-plc	Operational	AEE
KOZLODUY-5	WWER	953	"Kozloduy NPP"-plc	Operational	AEE
KOZLODUY-6	WWER	953	"Kozloduy NPP"-plc	Operational	AEE

Station	Construction Date	Commissioning Date	Criticality Date	Commercial date	Shut down Date
KOZLODUY-1	April, 1970	25-Oct-74	30-Jun-74	28-Oct-74	31-Dec-2002
KOZLODUY-2	April, 1970	07-Nov-75	22-Aug-75	10-Nov-75	31-Dec-2002
KOZLODUY-3	October, 1973	17-Jan-81	04-Dec-80	20-Jan-81	
KOZLODUY-4	October, 1973	17-Jun-82	25-Apr-82	20-Jun-82	
KOZLODUY-5	09.07.1980	21-Jun-88	05-Nov-87	23-Dec-88	
KOZLODUY-6	01.04.1982	13-Aug-92	29-May-91	30-Dec-93	

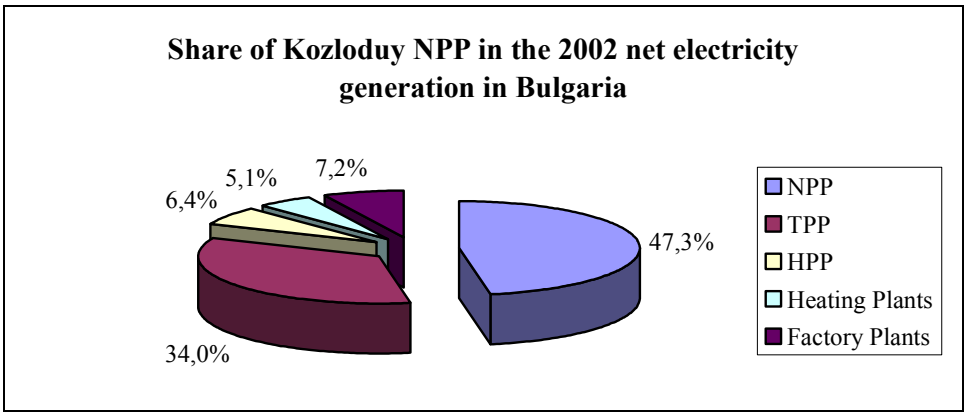
Source: IAEA Power Reactor Information System as of 31-Dec-2002

During the 70's, a site for the construction of a second nuclear power plant was selected near the town of Belene. In 1980, the Ministry of Energy started its construction. Initially the construction of 4 units with WWER-1000/V320 reactors was envisaged with a possibility for exceeding this capacity with additional new facilities. The engineering works on the site and the construction of the infrastructure started at the end of the year 1980. The construction of unit 1 started in 1987. In the year 1991 the Belene NPP construction was stopped with Decision № 288 of the Council of Ministers. At that time the first unit was 40% complete. According to Decision № 853 the Minister of Energy and Energy Resources should arrange safety assessment of nuclear safety, environmental consequences, radiation and physical protection, radioactive waste and management of RAW and spent nuclear fuel at Belene site. This regards the possibilities for construction to be continued.

2.2.2. Performance of NPPs

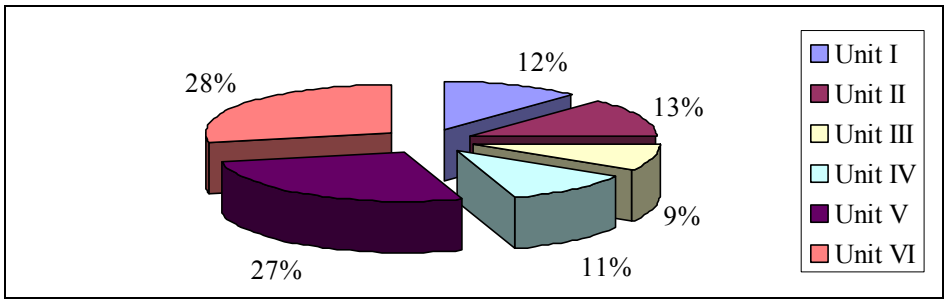
During the year 2002 Kozloduy NPP generated 20 221 719 MWh of electricity, in full compliance with the nuclear safety and radiation protection requirements. In Kozloduy NPP operational history, this is the highest result achieved.

The electricity production program for 2002 is fulfilled at 105,95%. The share of Kozloduy NPP Plc in the total electricity generated in Bulgaria in 2002 is 47,3% which is by 2,66% more as compared to 2001 share. Thus, the trend is maintained of the KNPP share increase in the country electricity generation. In 2002, similar to the last years production, the electricity generation was proportionally distributed between VVER-440 and VVER-1000 units.



Source: Kozloduy NPP Annual Report, 2002

Figure 11. Share of KNPP in the 2002 net electricity generation in Bulgaria



Source: Kozloduy NPP Annual Report, 2002

Figure 12. Share of Kozloduy NPP units in 2002 net electricity generation in Bulgaria

The actual availability of Kozloduy NPP in 2002 is 23 206 509 MWh, against the planned 23 152 800 MWh, which is with 0,23% higher than the planned for the year. Compared to the previous year 2001, the increase is 6,21%. The steady trend of lowering the share of the energy losses (planned and unplanned) continues, as the values are comparable to the average indicators of the nuclear plants in the world. The energy loss decrease is 8,77%, as compared to the year 2001. The trend of increasing the load factor of the installed capacities is preserved.

2.2.3. Plant upgrading and plant life management

In order to ensure compliance with the enhancing safety standards, Kozloduy NPP units designed according to the requirements of the respective period of their stage-by-stage commissioning were subjected to extensive modernization programs. In the frames of the 2002 outages, a number of modifications aiming at nuclear safety and radiation protection enhancement have been implemented. All the activities were implemented according to the optimized schedule.

Units 1 & 2

In fulfillment of the decision of the Government of the Republic of Bulgaria, Kozloduy NPP Units 1 and 2 were shut down on December 31, 2002. In order to maintain the high level of their operational safety, during 2002 all scheduled activities were accomplished and a major part of the Complex Modernization Program PRG-97A was completed.

Units 3 & 4

During the last 12 years units 3&4 have gone through huge modernization programs. In the units' safety have been invested over 300 M€. These safety improvements led to a safety level commensurable and even beyond that of the same type units worldwide.

After upgrade, the safety systems of the units are brought in full compliance with the current safety regulations and standards. The utilization of equipment designed and manufactured by leading companies ensures the reliability enhancement of different elements and systems up to the level of recent vintage nuclear plants. As a result of the localisation system modernization, by the installation of a jet vortex condenser, at Units 3 and 4 a reliable functioning was provided of the fourth, last barrier against the spread of radioactive fission products, including the cases of a maximal diameter pipeline break at the Primary Circuit. New microprocessor systems for improving the safety systems equipment control were implemented. The seismic stability of the buildings, premises and equipment was assured by seismic qualification and by additional anchoring. The installation of new controllers and new system for steam generators level control provided enhancement of operational reliability and efficiency. New filters and ball-cleaning installations were installed at turbine generators (TG) 5, 6, and 7, which led to the significant increase of the technological cycle effectiveness.

In the beginning of 2002 Kozloduy NPP submitted to NRA a modern Safety Analysis Report (SAR) developed according to the international practice. This new SAR is a basis for the issued licenses for operation of units 3 and 4 for 8 and 10 years respectively.

New Symptom Based Emergency Operating Procedures (SB EOPs) have been introduced. The SB EOPs accounting in the updated Probabilistic Safety Analysis showed that their implementation reduces the reactor core damage frequency approximately by one grade. A set of studies and analyses was performed as well in order to test the main equipment and implement measures to ensure its residual lifetime for a minimum of 35-40 years of Units 3 and 4 operation. The analyses results proved the high effectiveness of the implemented modernizations and confirmed that the damage probability of the reactor core and the Primary Circuit main equipment is comparable to the results of the same vintage pressurized water reactors.

The results from the analyses, assessments made and licenses issued by NRA were confirmed by a number of international missions in Kozloduy NPP, like IAEA Expert mission to review the results of safety upgrading activities of the KNPP units 3&4, 24-28 June 2002; Atomic Questions Group within the European Commission - Peer Review of the European Union at Units 3 and 4 of the Kozloduy NPP, 6-19 November 2003.

It was concluded that the plant operational safety is a priority for KNPP management and that in the process of its improvement the plant has reached a level that corresponds to the level of plants of the same vintage worldwide and that the approach of KNPP technical staff and management to safety and quality has significantly evolved over the past decade which is a fundamental tool for maintaining plant safety in all aspects of KNPP operation in compliance with IAEA Safety Standards and current international practice.

Some of the specific comments made by IAEA Expert Mission are:

- Regarding Units 3 and 4, in the course of the Modernization Programme, the main safety functions were improved to the level, or in some cases beyond the level, which meets the IAEA initial recommendations of TECDOC-640;
- Controlling reactor power in all operational states and accident conditions has been realized to meet the safety objectives of the extended design basis for KNPP Units 3 and 4;
- Cooling the core in all conditions is now based on successive layers of defense-in-depth going beyond initial expectations in some cases;
- Since a jet vortex condenser has been installed in the confinement, the core cooling and confinement functions are now fulfilled for the whole spectrum of primary pipe breaks up to Dn 200 with conservative assumptions, and, for the largest one (Dn 500) using realistic assumptions;
- Leak tightness of the confinement was also largely improved using the experience of other plants of this type;
- Concerning primary circuit integrity, all baseline information on material composition, mechanical properties and in-service inspection is of good quality. A comprehensive international project for a more precise assessment of RPV embrittlement after annealing (Unit 3) is under way.

UT ISI qualification programme for critical weld areas is a high priority for the management. The results of investigations indicate that the RPV integrity is maintained and that its remaining lifetime is at least equal to the design lifetime;

- The LBB concept application on the primary piping including surge lines provides solution for the primary piping integrity. It also eliminates the leading PTS scenario due to a double ended break of the pressurizer surge line;
- Significant improvements were also implemented in the safety function support systems such as I&C, Electrical Power, Service Water and Air-conditioning;
- Due to the significant improvement in plant's defense in depth and protection against all sources of common cause failures (fire, flooding, etc.) the safety functions can now be performed with a high level of reliability in all plant conditions including shutdown states; etc.

The Safety Review Mission team noted that management expectations are well understood at all level in the organization, and high quality standards were observed in all areas dealing with operational safety. The SRM team made particular note of the improvements observed in the areas of training and qualification, implementation of symptom-based emergency operating procedures, and in the quality of management processes in the technical support area. The team also noted significant improvements in the material condition and housekeeping of the plant. In several of the areas where improvements were identified, the issues were already evaluated as 'resolved' by a previous IAEA review team and OSART missions. The willingness of the plant to invite a second review to ensure that there was no decline in performance is an indication of the commitment by Kozloduy management and staff towards continuous improvement in operational safety. The team also recognized the effort by KNPP to implement a strong self-assessment program. The team noted that significant improvements have been made to complete the maintenance training facilities and the second Emergency Control Centre as well as upgrading associated training materials. The team further supports the plant activities to continue to explore methods to enhance team training for control room staff on the use of abnormal and symptom based emergency operating procedures. During the entire SRM the team noted the professionalism of the control rooms staff and their willingness to provide open and frank discussions with the team.

In the majority of the operational issues the team recognized meaningful improvements, revealing the aim of Kozloduy management and staff to continuously improve operational safety. Many examples of these relevant improvements are in the areas of quality and control of the plant documentation.

Units 5 & 6

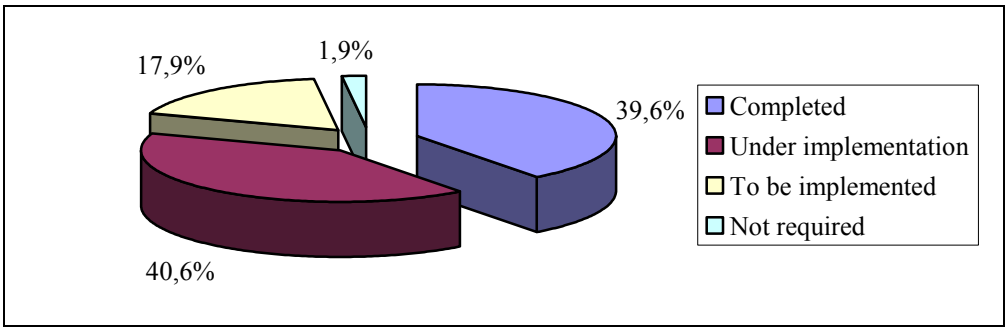
The main objective of Units 5 and 6 Modernization Program is to implement the improvements necessary to meet all international requirements to NPP in terms of safety and reliability, which will lead to units' lifetime extension by 15 years. The implementation of the main scope of measures is contracted to leading European companies united in the European Consortium Kozloduy (ECK), and to the US company Westinghouse. At the Modernization Program development, it was accounted for the recommendations of the Main Designer and international missions held at the plant and the positive operational experience of other plants with VVER-1000/V-320 reactors. The Program is based on IAEA recommendations described in Safety issues and their ranking for VVER-1000 model 320 NPPs (IAEA-EBP-VVER-05). In this document, the safety issues of VVER-1000 reactors are divided in two main groups – design and operational issues. Units' 5&6 Modernization Program solves these issues and comprises 212 measures, each including one or more issues. The identified measures adequacy towards the list of unresolved safety issues was reviewed by IAEA in 2000. The IAEA expert mission concluded that for all safety issues, the process of their resolving was started and relevant measures are completely or partially implemented, in accordance with Safety issues and their ranking for VVER-1000 model 320 NPPs (IAEA-EBP-VVER-05).

The Modernization Program is expected to be completed by the end of 2006. The total investments for this program are about 400 M€. Kozloduy NPP will undertake all of the expenses by own resources and loans form international credit institutions.

TABLE 16. THE IMPLEMENTATION STATUS OF UNITS 5 AND 6 MODERNIZATION PROGRAM BY THE END OF 2002

Total number	Completed	Under implementation	To be implemented	Not required
212	84	86	38	4
	39.6%	40.6%	17.9%	1.9%

Source: Kozloduy NPP Annual Report, 2002



Source: Kozloduy NPP Annual Report, 2002

Figure 13. The implementation status of Units 5&6 Modernization Program by the end of 2002

2.2.4. Nuclear power development projections and plans

The nuclear power sector is crucial for Bulgaria's energy and capacity balance. Moreover, it is on a state-of-the-art technological level and its productive efficiency is very high. The introduction of market conditions in the energy sector and the resulting from that increased competition represent factors which are external to the already adopted programs aiming to achieve a high level of nuclear safety of the existing nuclear facilities. Bulgaria appreciates the achievements of *acquis communautaire*, including the Treaty of the European Atomic Energy Community, as fundamental instruments for the improvement of the living standard in the Member States and the development of relations with other countries. Bulgaria will continue to harmonize its national legislation with Community law in the area of nuclear energy in the light of the EU enlargement.

A legal, regulatory and pricing framework will be set for the implementation of every single new project on a fair and genuinely competitive basis, taking into consideration such factors as the specific site, created infrastructure, nationwide training system, maintenance of qualifications of the staff and its certification, as well as capacity building in the organizations providing technical support in the field of nuclear energy.

To discharge its obligations in the area of environmental protection and reduction in CO_2, SO_2, NO_x emissions and fly ash, Bulgaria will continue to rely on nuclear energy and to develop it further in compliance with the up-to-date requirements to safety, cost efficiency and reliability, nuclear safety and radiation protection.

In connection with the shutting down of units in Kozloduy NPP, the Belene site more often attracts the attention. At present a feasibility study for the necessity of continuing construction of Belene NPP and the applicable technology is being developed. It is expected in 2004 the Government of Republic of Bulgaria to come up with decision about Belene NPP.

2.2.5. Decommissioning information and plans

Bulgaria has undertaken the deferred dismantling approach. The plan for removing the spent fuel from the site is for 2007-2008 (according to the safety requirements the spent fuel should be stored in the near reactor pools for 4-5 years before transportation in storage facility).

2.3. Supply of Nuclear Power Plants

Bulgaria does not supply nuclear power plants and/or equipment for nuclear power plants. The equipment for the existing plants have been purchased from Russia, but some parts and systems have been supplied from western suppliers like Siemens, Westinghouse, Sempel, Sebim, Framatome and others.

2.4. Operation of Nuclear Power Plants

The Council of Ministers of Republic of Bulgaria adopted Resolution No.70 dated 20 February 2001, according to which all nuclear power plants and other equipment on "NPP Kozloduy" PLC are defined as one nuclear installation and "NPP Kozloduy" PLC is its operator according to the Vienna Convention on Civil Liability for Nuclear Damage.

"NPP Kozloduy" PLC as "nuclear installation operator" according to the Vienna Convention on Civil Liability for Nuclear Damage is the bearer of the corresponding civil responsibility. As "license holder" according to Nuclear Safety Convention, the company bears the responsibilities for nuclear safety. This is reflected in the NPP "Kozloduy" PLC Statute (art.2, para 2 and para 3) and in Corporate Structure and Activities Code (art. 5 and art. 6). In this respect, the company holds a license, given by the State Energy Regulation Committee on production of electrical and thermal energy (Verdict No. 049 dated 11.12.2000 of SERC).

As the operating organisation is responsible for ensuring fulfilment of safety requirements, "NPP Kozloduy" PLC rights and obligations are defined in the Statute, Corporate Structure and Activities Code, company structural subdivision and sections activity organisation regulations, as well as in the personnel job descriptions for the whole hierarchy managing chain.

"NPP Kozloduy" PLC responsibilities and obligations are summarised in art. 7 of Corporate Structure and Activities Code and are performed through "implementation of activities for nuclear safety maintenance and enhancement, radiation protection, physical protection, emergency preparedness, technical safety, preserving the health of personnel and population and environment."

In "NPP Kozloduy" PLC Corporate Structure and Activities Code" (art.8) the implementation of overall company activity, the following principle is of top priority: "Following the requirements for nuclear safety, radiation protection, as well as preserving the life and health of personnel, population and environment has priority over operational and other public needs."

"NPP Kozloduy" PLC is a separate corporate body, registered according to Commercial Law, which has an independent balance and bank accounts. General Meeting and Board of Directors manage the Company. "NPP Kozloduy" PLC organises and manages its commercial activities in accordance with the Statute and "NPP Kozloduy" PLC Corporate Structure and Activities Code".

For ensuring safe operation, the Kozloduy NPP management:

- develops and implements an administrative structure, assigns responsibilities and powers within the structure and exercises the overall management;
- develops, introduces and supervises the implementation of the programmes for administrative control (guiding documents for systematic implementation of planned works-schedules. procedures, inspections and revisions provided with adequate resources for their implementation);

- establishes a system for the accomplishment and control of the license conditions and terms of duration;
- establishes and maintains openness and correctness with the Regulatory Body, other state control bodies, organisations and the public, concerning the supervision, inspections and discussions on the fulfilment of the prescribed and universally accepted safety requirements;
- for exchange of experience and information, keeps in contact with the design, engineering, maintenance, mantling and construction organisations, and the manufacturers of equipment for nuclear power plants;
- ensuring the necessary resources and services for safe operation.

2.5. Fuel Cycle and Waste Management

Bulgaria utilises a "once through" fuel cycle. Nuclear fuel is supplied from Russia. At present, the JSC TVEL company is the only foreign supplier of nuclear fuel, licensed by the NRA. Kozloduy NPP - plc has been given the authority to purchase, use and handle special nuclear material. According to an agreement between Bulgaria and Russia, the spent fuel shall be returned to the manufacturer for reprocessing.

2.5.1. Management of the Spent Fuel

The SF removed from the reactors is stored in pools situated near by the reactors. In 1990, the construction of a pool type spent fuel storage facility (SFSF) on the site of the Kozloduy NPP was accomplished. It is situated in a separate building on the territory of the Kozloduy NPP, nearby units 3 and 4. According to the design, the SFSF is to be filled in 10 years and the assemblies can be stored in it for a period of 30 years. After 3-5 years storage in the near reactor pools, the SF is transported to the SFSF. In 1991, a programme for enhancement of the SFSF safety was elaborated which is now being updated. In 1992, the new seismic characteristics of the Kozloduy NPP site were taken in account in the Programme.

Two independent ecological assessments of the SFSF were carried out: an expertise made by a team from the Risk-Engineering company as well as a complete report of the impact on the environment made by a group of specialists from the Sofia University "Kliment Ohridski". The results of these assessments do not show any considerable negative impact on the environment from the SFSF operation.

In March 2001, the NRA has licensed the SFSF.

In July 1999, the Government adopted The National Strategy on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Major measures include:
- Construction by stages of new dry storage facility for spent fuel of the VVER-440 and VVER-1000 reactors;
- Investigation of the possibilities for increasing the storage capacity of the storage pools at reactors 3 and 4 and the exist SFSF;
- Partial shipping back of spent fuel to Russia;
- Investigation of the possibilities for long term storage of spent fuel in regional storage facilities.

2.5.2. Management of Low and Intermediate Level RAW

The generated from the NPP operation RAW are stored in auxiliary buildings (AB), one for two units. In recent years, the NPP generates annually average of about 400 m^3 liquid RAW. 360 m^3 solid RAW and 20 m^3 low and intermediate ion exchange resins.

Extensive work on the completion of construction of the RAW Treatment and Storage Facility for LILW at the Kozloduy NPP site is carried out. Westinghouse delivered the main equipment and technology. This treatment facility is extremely useful for the future operation of the NPP as the capacity for storage of RAW is nearly completed by using the treatment facility the stored RAW are expected to be treated, conditioned and stored on-site until a national RAW repository is constructed. The Treatment and Storage Facility is in the process of commissioning.

A fund for Safe Management of Radioactive Waste is established by the ASUNE. All waste generators shall pay a special fee to the fund: currently for NPP Kozloduy it is 3% of the average market price of energy sold to the National Electric Company. The Minister of Energy and Energy Resources through relevant Steering Committees manages the funds.

According to the National Strategy on RAW and SF Management, under preparation are:

- A programme on development of complete legislation on the safety of the RAW and SF management. This programme is part from the National Programme for Adoption of the Acquis (NPAA).

- A draft of the amended Basic Safety Standards is under preparation in compliance with the EC Directive 96/29.

The programme has to consider also:

- the development of regulations on the Safety of the RAW management and safe storage of SF;
- the ratified by Bulgaria Joint Convention;
- the established by the Act Radioactive Waste Management Organisation (in force from 1 Jan. 2004);
- Construction of a National RAW disposal facility;
- Partial shipping back of spent fuel to Russia; etc.

2.6. Research and Development Activities

Nuclear research and development activities in Bulgaria are carried out in several institutes, the most important of which are:

- The Institute of Nuclear Research and Nuclear Energy at the Bulgarian Academy of Sciences;
- The University of Sofia Department of Nuclear Physics, Dept of Nuclear Technology and Nuclear Power Engineering and the Radiochemical laboratory;
- Technical University of Sofia, Department of Power and Nuclear Engineering;
- Engineering companies: ENERGOPROEKT, EQE Bulgaria, ENPRO (Consult and Risk) Engineering;
- Institute of Radiation Protection, at the Ministry of Health;
- Plovdiv University, Department of Nuclear Physics; and
- Other smaller Institutes and research organisations.

2.7. International Co-operation and Initiatives

An important part of the Research and Development activities is being carried out through co-operation with international organisations like: the Joint Institute of Nuclear Research in Dubna, Russia; the Institute of Theoretical Physics, Trieste; CERN and other foreign institutes.

From January 1st 2004 NRA will be part of the OECD Halden Reactor Project. The research and experimental programme covers studies on reactor fuel and materials, which make extensive use of the Halden reactor and its experimental facilities, and in the area of Man, Technology, Organisation for which the Man-Machine Laboratory, HAMMLAB, and related infrastructure are the main tools.

On a number of nuclear safety issues, the NRA receives technical support from Bulgarian engineering organisations and institutes. The NRA receives technical support from the IAEA, European Union, United States and Japan for getting acquainted with the methodologies and existing practices of the developed countries in the areas of control, licensing and inspection practices.

2.8. Human Resources Development

At the basis of the programme for training NPP personnel is the Bulgarian education system, the structure of which has not been changed after 1998. Basic factor for the training and qualification of the personnel at Kozloduy NPP is the effective operational training. The Executive Director of Kozloduy NPP plc, the heads of the respective structural units and the Personnel Department at the Training Centre are responsible for the training of the personnel. The Training Centre at Kozloduy NPP is located on the site at the plant. The construction of the Training Centre was completed in 1993 and it has been functioning since then. In 2000 the simulator complex was built, with a full size simulator of WWER-1000, multifunctional simulator of WWER-440 and demonstration halls.

Qualification Requirements for Different Groups of Personnel

The requirements to the personnel, working in the field of the use of atomic energy are specified in the Regulation No. 6 of CUAEPP, dated 1989. The basic document, which regulates the organisation, management, performance and the control on training, retraining, maintaining and increasing qualification, recognising competence and qualification control of the Kozloduy NPP plc personnel is the updated in 2000 “Regulations for Training and Qualification of Kozloduy NPP plc Personnel". From the point of view of the qualification requirements to the personnel, in 2000 the existing 5 groups of personnel were transformed into 3, as follows:

- Group A – operative and management personnel, subjected to testimony by the State Qualification Commission (SQC) (the positions, specified in correspondence with Regulation No.6 of CUAEPP);
- Group B – managers, specialists and employees in the structural units at Kozloduy NPP plc, subjected to exams on technical operation and not included in group A;
- Group C – managers, specialists, employees and supporting personnel in the structural units of Kozloduy NPP plc.

The qualification requirements for assignment for each position in Kozloduy NPP plc are described in detail in the respective job descriptions. NRA agrees the job descriptions of the personnel, directly involved in the use of nuclear power. The simulator training of the operators at Units 1-4 at the full size simulator is done at the Training Centre of Novovoronej NPP-Russia, and since 2000 additional training is carried out, as well, at the multifunctional simulator of WWER-440 at the Training Centre of Kozloduy NPP plc. Since 2000 the training of the operators of Units 5-6 at the full size simulator is carried out at the Training Centre of Kozloduy NPP plc.

3. NATIONAL LAWS AND REGULATIONS

3.1. Safety Authority and the Licensing Process

The National Regulatory Authority in the field of safe use of nuclear energy is the Nuclear Regulatory Agency (NRA). The legal framework in respect of the NRA is provided for in the Act on the Safe Use of Nuclear Energy (ASUNE - in force from July 2002). According to Article 4 (1) of the Act, *“State regulation of the safe use of nuclear energy and ionising radiation, the safety of radioactive waste management and the safety of spent fuel management is implemented by the Chairman of the Nuclear Regulatory Agency” and “the Chairman is an independent specialised authority of the executive power”.* Article 4 (2) specifies: *“The NRA Chairman shall be designated by*

a decision of the Council of Ministers and shall be appointed by the Prime Minister for a mandate of five years and may be selected for one more term of office (mandate)". The functions of the NRA are effectively separated from those of the bodies and organisations involved in promotion or use of nuclear technology.

3.1.1. Safety Authority

Pursuant to Article 5 of the ASUNE, the Nuclear Regulatory Agency shall have the following powers:

- Grant, amend, supplement, renew, suspend and revoke licences and permits;
- Control the fulfilment of safety requirements and standards, as well as the conditions of licences and permits granted;
- Issue and withdraw individual licenses;
- Undertake enforcement measures and impose administrative penalties;
- Assign (contract) nuclear safety and radiation protection related external expertise, researches and studies;
- Implement the interactions with other competent authorities of the executive power vested with some regulatory and control functions and propose to the Council of Ministers measures for co-ordination of the activities;
- Implement the international co-operation of the Republic of Bulgaria in the field;
- Provide individuals, legal persons and state bodies with objective information referring to nuclear safety and radiation protection;
- Submit annually to the Council of Ministers a report on the status of nuclear safety and radiation protection, as well as on the operation of the Agency;
- Organise and co-ordinate the drafting process and submit to the Council of Ministers the reports for implementation of country obligations under the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management;
- Organise and co-ordinate implementation of the obligations of the Republic of Bulgaria arising from the Agreement Between the People's Republic of Bulgaria and the International Atomic Energy Agency for the Application of the Safeguards in Connection with the Treaty on the Non-proliferation of Nuclear Weapons, as well as from the Additional Protocol to the Agreement;
- Perform the functions of a competent authority and a contact point for notification of an accident and for provision of assistance according to the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency;
- Develop and submit for adoption to the Council of Ministers regulations for the application of the ASUNE;
- Exercise other powers as may be entrusted thereto by the national legislation.

An administration helps the NRA in implementation of its authorities, assures technically its activity, and performs activities on administrative service provided to legal persons and citizens. In its activities, the NRA and its administration is guided by the adopted by the Council of Ministers Organisational Rules of Procedure. The administration is organised in a general department and 4 departments, distributed into general and specialised administration.

3.1.2. Organizational Structure of the NRA

A Chairman supported by two Deputy Chairmen and an Executive Secretary governs the NRA. The permanent number of the NRA staff is 102 persons (4 – management team, 19 positions in the general administration and 79 experts and inspectors). Eight inspectors work permanently at the Kozloduy NPP site. 95% of inspectors have university education and more than 60% of them have over 15 years of experience in the nuclear field. Six NRA employees have Ph.D. degree, including the

Chairman and one of the deputies. The organisational structure of the NRA is shown in Figure 14.

The NRA is forming its own budget within the overall state budget. In accordance with Art. 10, p. 1 of ASUNE the Agency operation is financed by the national budget and by income from the fees collected under the Act provisions.

Priority order for the expenditure of Agency financial resources is the following:

- financing of studies, analyses and expertises connected with the assessment of nuclear safety and radiation protection and financing of regulatory activities under the Act;
- capital expenditures on development of the Agency infrastructure;
- training and qualification of Agency staff;
- additional financial motivation of the Agency personnel.

Each year, the incomes and the expenditures at NRA budget and its relations to the central state budget, subsides or donations are defined by the annual Act of the State Budget. The draft budget is developed by the Agency following the Act on the State Budget Organization. The Ministry of finance considers the budget, proposed by NRA and defines the final version, which is included in the bill of the Act on the State Budget (ASB) for the next year. The ASB is passed in accordance with the order of the Acts passing in the Republic of Bulgaria.

The organisational structure and duties of the NRA structural units are described in the Statute of the NRA (Rules of Procedure), adopted by the Council of Ministers Decree No.199 dated 29 August 2002, as shown in Figure 14.

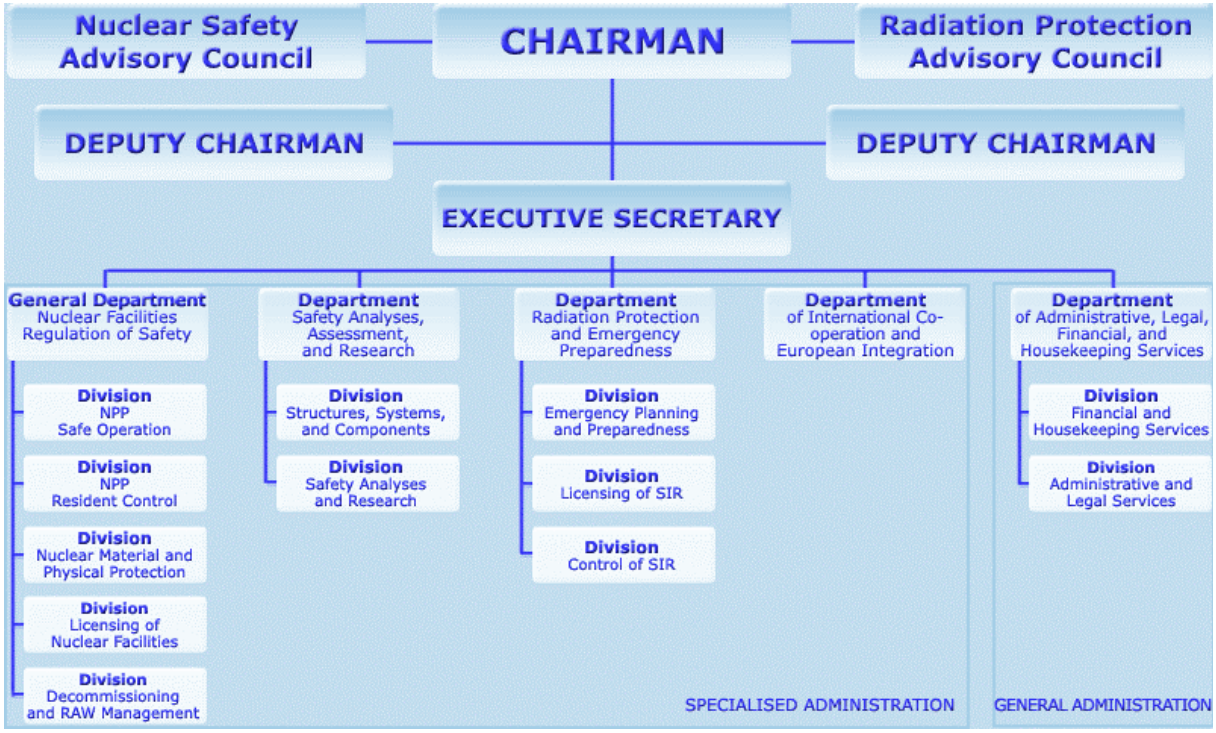


FIG. 14 Organisational Structure of the NRA

3.1.3. Licensing Process

The main legal provisions for the licensing of nuclear installations in Bulgaria are outlined in the ASUNE. The Act specifies a two years period for development and adoption of new regulations. The Act specifies the conditions, the order, terms and time-limits for issuance of licenses and permits. The NRA Chairman based on a written application by the applicant shall issue licenses and permits for utilisation of nuclear energy. Until the adoption of a new licensing regulation, the applicant should

follow the procedure established by the Act and Regulation No 5 (when it is not in contradiction with the Act). Regulation No 5 specify the documentation required for the issuance of the requested license/permit. All documentation submitted in respect of requested license issuance shall be in Bulgarian language. Submission of the original documents in a foreign language is permissible if a notarised translation into Bulgarian language is thereto attached.

According to ASUNE Article 20 (1), A licence shall be issued for a term of validity not exceeding ten years.

Regulation No. 6 governs the criteria and requirements in respect of training, qualifications and capacities of human resources employed in the field of nuclear energy utilisation to the end of acquiring, sustaining and advancement of their professional qualifications and assurance of the requisite capacity.

3.2. Main National Laws and Regulations in Nuclear Power

The following fundamental acts of legislation are currently applicable in the matter of safe utilisation of nuclear energy and in respect of nuclear material procurement, accountability, storage and transport:

- Act on the Safe Use of Nuclear Energy (Promulgated in the Official Journal No. 63 of 28 June 2002);
- Regulation No. 2 on the Cases and Procedures for Notification of the Nuclear Regulatory Agency about Operational Changes, Events and Accidents relating to Nuclear and Radiation Safety (Promulgated OJ No. 26 of 1988, amended OJ No. 28 of 1988);
- Regulation No. 3 on Nuclear Power Plants Safety during Design, Construction and Operation (Promulgated OJ No. 27 of 1988);
- Regulation No. 4 on Accounting, Storage and Transportation of Nuclear Material (Promulgated OJ No. 66 of 1988; amended OJ No. 83 of 1993, updated April 2001). The name of the updated Regulation is "Accounting, Storage and Transportation of Nuclear Material and Application of Safeguards in connection with the Treaty on the non-proliferation of Nuclear Weapons;
- Regulation No. 5 on the Licence Issuance Procedure for Utilisation of Atomic Energy (Promulgated OJ No. 13 of 1989; amended and supplemented OJ No. 37 of 1993);
- Regulation No. 6 on the Criteria and Requirements for Training, Qualifications and Certification of Personnel working in the field of Atomic Energy (Promulgated OJ No. 47 of 1989; amended OJ No. 43 of 1991);
- Regulation No. 7 on Collecting, Storage, Processing, Keeping, Transport and Disposal of Radioactive Waste on the Territory of the Republic of Bulgaria (Promulgated OJ No. 8 of 1992);
- Regulation No. 8 on the Physical Protection of Nuclear Facilities and Nuclear Material (Promulgated OJ No. 83 of 1993);
- Regulation No. 10 on Safety during Decommissioning of Nuclear Facilities (Promulgated OJ No 12 of February 2001);
- Regulation No. 11 on Safety of Spent Fuel Storage Facilities (Promulgated March 2001);
- Regulation for Emergency Planning and Preparedness for Action in Case of Radiation Accident (Promulgated OJ No. 33 of 1999);
- Regulation on Basic Standards for Radiation Protection – 2000 (Promulgated OJ No. 5 of 2001)
- Rules of Procedure of the Nuclear Regulatory Agency (Promulgated OJ № 86 of 10.09.2002)

The above-mentioned regulations shall be replaced in two years time, as from 2 July 2002. Until replacement the regulations are in force when they are not in contradiction with the Act.

4. CURRENT ISSUES AND DEVELOPMENTS ON NUCLEAR POWER

4.1. Energy Policy

New energy strategy

To fulfill the task of the implementation of rapid reforms in the energy sector, it is necessary to develop a new energy strategy that will be capable of reflecting the changed environment and the new vision in the following aspects:

- Bulgaria's energy sector is transforming from a closed system into a part of the dynamically integrating energy market
- The key measure will be the competitiveness of Bulgaria's energy on the regional Balkan market, as well as on the future integrated European energy market
- The efforts aimed at specific, reliable and environmentally-friendly energy supply will be successful only if combined with measures for the utilization of the huge potential for energy efficiency
- The regulatory body should take its due dominating position among the energy institutions and assume an active role in the development and implementation of regulatory and market rules and structures.

The government intervention will be creating transparent and unbiased rules encouraging commercial activity and safeguarding public interests, while investment decisions will be determined by the expected demand and investors will be those to shoulder the large share of market risks.

4.2. Privatisation and deregulation

The policy of joining the European Union conducted by the Government, as well as the need to attract foreign capital into the energy industry require radical organisational restructuring of the country's energy in conformity with the EU energy policy. That policy conforms to the EU policy of economic and social closing up based on market integration, limited Government intervention reduced to what is absolutely necessary in order to safeguard the public interest, consumer protection and welfare.

The main prerequisite and condition for the implementation of the structural reform and privatisation in the energy sector is the creation of new, modern energy law harmonised with the law of the European Union, as well as appropriate institutional base. In order to achieve the aims stated, it is necessary to institutionalise legally the governmental bodies responsible for the development and implementation of the government policy and regulation in energy.

Through consistent actions that will be undertaken in 2002-2004, the energy sector will be transformed from a sector with predominant state property into a sector with a large share of private property managed by strategic investors in line with up-to-date standards. The sector will also be significantly represented on the capital market. The revenues from privatization will be earmarked on a priority basis for social protection of consumers, of those laid-off as a result of the restructuring and for the funding of projects with high social and economic impact.

4.3. Role of the government in the nuclear R& D

- The Institute of Nuclear Research and Nuclear Energy at the Bulgarian Academy of Sciences;
- The University of Sofia Department of Nuclear Physics, Department of Nuclear Technology and Nuclear Power Engineering and the Radiochemical laboratory;
- Technical University of Sofia, Department of Power and Nuclear Engineering;
- Institute of Radiation Protection, at the Ministry of Health;

- Plovdiv University, Department of Nuclear Physics;

All these organisations are financed by the national budget. Each year the Government donates them with the Act of the State Budget.

In addition, in the nuclear R&D, Bulgaria is in co-operation with international organisations like: the Joint Institute of Nuclear Research in Dubna, Russia; the Institute of Theoretical Physics, Trieste; OECD Halden Reactor Project, CERN and other foreign institutes. NRA pays the membership fee in these organisations.

4.4. Nuclear Energy and Climate Change

The impact of Kozloduy NPP operation upon the environment components is subject to detailed and systematic studies since the plant commissioning in 1974. The organization of radio-ecological monitoring is regulated by long-term programs, agreed with the country regulatory authorities – Nuclear Regulatory Agency, the Ministry of Environment and Water, the Ministry of Health. The programs comply with the IAEA recommendations and the good international practices. The continuous radiation monitoring within the 3 km area around the plant is performed by an automated information system for off-site monitoring, integrated into the National System for Radiation Control. Within the 100 km surveillance area around Kozloduy NPP, numerous samples are taken of air, soil, flora, Danube river, drinking water sources and radiation gamma background is measured. The utility radiation monitoring results are annually verified by independent radio-ecological studies in the frames of the relevant programs of the Ministry of Environment and Water and the National Centre for Radiobiology and Radiation Protection. Joint comparative analyses are conducted as well of the radiation status at the region. The radiation parameters of the ecological components are within the limits of the values, typical for the region. It is confirmed that the radio-ecological status around Kozloduy NPP complies with the requirements of the radiation protection legislation in force and the environmental status information is available to the public.

In 2002 Bulgaria ratified the Kyoto protocol, which is a serious step to the emission limitation of 6 greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6). The electricity production technology at Kozloduy NPP in practice does not generate any greenhouse gases and considerably contributes to the environment protection. By the annual electricity production of the nuclear power plant, the harmful impact of more than 29 million tons of carbon dioxide (CO_2) has been avoided, 1,3 million tons of sulphurous dioxide (SO_2) and 54 thousand tons of dust, containing natural radioactivity have not been released to the environment. In June 2002 Kozloduy NPP was awarded by the Ministry of Environment and Water of the Republic of Bulgaria for the significant contribution to the protection of environment reproduction and natural resources.

4.5. Safety and waste management issues

The radioactive waste management activities are carried out in compliance with the requirements of Vienna Convention on Safety of Spent Nuclear Fuel Management and on Safety of Radioactive Waste Management, the IAEA radioactive waste management principles being applied.

At Kozloduy NPP site, a facility was constructed for treatment, conditioning and storage of low-level and intermediate-level liquid and solid radioactive waste. This facility is unique in Eastern Europe in terms of purpose and technology. A program of step-by-step commissioning is under implementation, in compliance with the licensing procedure regulated by the Act on the Safe Use of Nuclear Energy. The commissioning of this facility gives a long-term solution of the radwaste reliable storage issue and significantly contributes to the environment protection. The achieved reduction factor of the solid radioactive waste volume is about 7.

4.6. Other issues

NOVI HAN RADIOACTIVE WASTE REPOSITORY (NHRWR)

Operational Status

The RAW generated from the use of radioactive substances in medicine, industry and research is stored at the Novi Han Permanent Radioactive Waste Repository (NHRWR).

In 1994, an ISUAE inspection identified degradation of the income RAW facilities and the operation of the repository temporally stopped till its upgrading to meet the safety requirements. In 1997, a program was started for NHRWR safety upgrading, including studies for safety justification of the facility and the adjacent site.

At the end of 2002, the NHRWR operational status is characterised by the following basic features:

- RAW for final disposal are not accepted;
- RAW for temporary storage are accepted in the facilities, constructed in the period 2000-2002;
- The implementation of the safety improvement program continues.

Reconstruction

In 2002, a number of activities for bringing of the NHRWR in conformity with the corresponding NRA requirements were completed. The implementation of the NHRWR safety improvement activities were discussed at a workshop "Upgrading of Novi Han repository for re-licensing", Sofia, 28-30 October 2002, organised jointly by the IAEA and the NRA.

To assurance conditions for safe storage of highly radioactive gamma sources from irradiation facilities and sealed sources containing long-lived alpha emitters, the INRNE carries out a program for site evaluation of the "Gabra"site and utilisation of the deep shaft of the same site. The site is located closely to the NHRWR (1.5km).

The safety upgrading of the NHRWR is supported by an IAEA Technical project. For the period 2003-2004, the project focuses on the development of the necessary documents for the NHRWR licensing as well as studies of the "Gabra"site. The NRA actively participates in the process through review of the developed licensing documents, expert missions, etc.

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[12] IAEA Energy and Economic Data Base (EEDB).

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

Appendix 1

INTERNATIONAL, MULTILATERAL AND BILATERAL AGREEMENTS

AGREEMENTS WITH THE IAEA

• NPT related safeguards agreement INFCIRC/178	Entry into force:	29 February 1972
• Additional Protocol	Entry into force:	10 October 2000
• Improved procedures for designation of safeguards inspectors	Entry into force:	16 October 1988
• Supplementary agreement on provision of technical assistance by the IAEA	Entry into force:	18 August 1980
• Agreement on privileges and immunities	Entry into force:	17 June 1968

OTHER RELEVANT INTERNATIONAL TREATIES, etc.

• NPT	Entry into force:	5 September 1969
• Convention on physical protection of nuclear material	Entry into force:	8 February 1987
• Convention on early notification of a nuclear accident	Entry into force:	26 March 1988
• Convention on assistance in the case of a nuclear accident or radiological emergency	Entry into force:	26 March 1988
• Vienna convention on civil liability for nuclear damage and joint protocol	Entry into force:	24 November 1994
• Protocol to amend the Vienna convention on civil liability for nuclear damage	Not signed	
• Convention on supplementary compensation for nuclear damage	Not signed	
• Joint convention on the safety of spent fuel management and on the safety of radioactive waste management	Entry into force:	18 June 2001
• Convention on nuclear safety	Entry into force:	24 October 1996
• Convention on Black Sea contamination protection		
• ZANGGER Committee	Member	
• Nuclear Export Guidelines	Adopted	
• Acceptance of NUSS Codes	No reply	
• Nuclear Suppliers Group	Member	

BILATERAL AGREEMENTS

- Agreement between the Government of the Republic of Bulgaria and the Government of the United States of America on Co-operation in the Field of Peaceful Uses of Nuclear Energy.
  - By way of this Agreement the Contracting Parties reaffirmed their commitment that they would ensure international development in the peaceful utilisation of nuclear energy in compliance with all agreements which to the maximum possible extent contribute to the objectives of the Treaty on non-proliferation of Nuclear Weapons

- Agreement between the Government of the Republic of Bulgaria and the Government of the Russian Federation on Co-operation in the Field of Peaceful Uses of Atomic Energy.
  - The Agreement reaffirms the Republic of Bulgaria's membership to the United Institute of Nuclear Research in the city of Dubna, regulates the mutually advantageous co-operation of the Parties in the field of peaceful utilisation of atomic energy. The Parties guarantee their strict adherence to their obligations in respect of the Treaty on non-proliferation of Nuclear Weapons and the continued endeavours towards nuclear safety amelioration.
  - The Agreement covers a rather broad scope of possible joint research domains, such as nuclear physics, controlled thermonuclear fusion and plasma physics, condensed-matter physics (physics of the solids), radiochemistry, radiation chemistry, atomic energy

engineering, inclusive of safe and reliable operation decommissioning of nuclear power plants, fuel cycle management, control and issuance of licences, betterment of nuclear fuel storage and transport technologies, prospective nuclear energy sources, nuclear safety and radiation protection, radiological protection from nuclear irradiation, normative and technical documentation, etc.

- Agreement between the Government of the People's Republic of Bulgaria and the Government of the Republic of Greece on Early Notification of a Nuclear Accident and Exchange of Information on Nuclear Facilities.
  - This Agreement governs the technical aspect of extended operational reporting and notification between the Contracting Parties in case of a nuclear accident after the Convention on Notification in Case of a Nuclear Accident, signed in Vienna on 26 September 1986.

- Financing Protocol between the Government of the Republic of Bulgaria and the Government of the French Republic.
  - To the end of strengthening the friendly relations that have traditionally linked them, the Government of the Republic of Bulgaria and the Government of the French Republic have agreed to conclude this Protocol with the purpose to contribute to the economic development of Bulgaria. 21/2 million French francs shall be lent to assist financing of the purchase from France of full-scale nuclear power plant simulators and the installation thereof.

- Agreement between the Committee for the Use of Atomic Energy for Peaceful Purposes with the Council of Ministers of the Republic of Bulgaria and the Federal Ministry of the Environment, Protection of Nature and the Reactor Safety of Germany on Issues of Mutual Interest Relating to Nuclear and Technical Safety and Radiation Protection.
  - The Contracting Parties shall notify and inform each other forthwith and directly of accidents under Article 1 of the Convention on Notification in Case of a Nuclear Accident, signed in Vienna on 26 September 1986. The Agreement also provides for the exchange of information and experience in nuclear and technical safety and radiation protection, favourable co-operation between the Parties and also provides that the Federal Ministry of the Environment, Protection of Nature and the Reactor Safety of Germany shall, upon request, endeavour within the limits of possibilities available under the national law to provide assistance on technical aspects of safety by way of attracting German consulting and expert organisations.

- Agreement between the Government of the Republic of Bulgaria and the Government of Romania on Early Notification of a Nuclear Accident and Exchange of Information on Nuclear Facilities.
  - The Agreement governs the technical aspect of extended bilateral operational reporting and notification to the Parties in case of a nuclear accident following the Convention on Notification in Case of a Nuclear Accident, signed in Vienna on 26 September 1986.

- Agreement between the Government of the Republic of Bulgaria and the Government of the Argentine Republic on Co-operation in the Field of Peaceful Use of Nuclear Energy.
  - The Contracting Parties shall collaborate in the development of scientific research and practical utilisation of atomic energy for peaceful purposes. Specific fields of co-operation are listed. Co-operation shall be based on agreements between institutes, organisations and legal entities of the Parties in compliance with the national law.

- Agreement between the Government of the Republic of Bulgaria and the Government of the Republic of Turkey on Early Notification of a Nuclear Accident and Exchange of Information on Nuclear Facilities.
  - The Agreement shall apply in respect of activities on the subject of notification in case of a nuclear accident after Article 1 and Article 3 of the IAEA Convention.

- Agreement between the Nuclear Regulatory Agency of the Republic of Bulgaria and the Federal Nuclear and Radiation Safety Authority of the Russian Federation on Co-operation in Nuclear and Radiation Safety.

  - The Agreement provides for exchange of information on the organisation of activities of the regulatory authorities, exchange of regulatory documentation as well as experience in conducting nuclear and radiation safety inspections, training of inspectors, etc.

- Agreement between the Nuclear Regulatory Agency of the Republic of Bulgaria and the Ministry of Environmental Protection and Nuclear Safety of Ukraine on Co-operation in the Field of the State Regulation and Control of Safety in the Use of Atomic Energy for Peaceful Purposes.
  - The Agreement provides for exchange of information on the organisation of activities of the regulatory authorities, exchange of regulatory documentation as well as experience in conducting nuclear safety inspections, training of inspectors, etc. It also provides for exchange of information on control of the physical protection of nuclear material and facilities and of the system of accounting for and control of nuclear material.

- Agreement between the Committee on the Use of Atomic Energy for Peaceful Purposes of the Republic of Bulgaria and the Ministry of Economy of the Slovak Republic on Co-operation in the Field of the State Regulation and Control of Safety in the Use of Atomic Energy for Peaceful Purposes.
  - The Agreement provides for exchange of information on the organisation of activities of the regulatory authorities, exchange of regulatory documentation as well as experience in conducting nuclear safety inspections, training of inspectors, etc. It also provides for exchange of information on control of the physical protection of nuclear material and facilities and of the system of accounting for and control of nuclear material.

Appendix 2

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

NATIONAL ATOMIC ENERGY AUTHORITIES

Nuclear Regulatory Agency
69 Shipchenski Prokhod Blvd.
1574 Sofia, Bulgaria
Tel: +359-2-9406800
Fax: +359-2-9406919
http://www.bnsa.bas.bg/

Ministry of Energy and Energy Resources
8 Triaditza str., 1040 Sofia, Bulgaria
Tel: +359-2-9878425
Fax: +359-2-9865703
http://www.doe.bg/

OTHER NUCLEAR ORGANIZATIONS

Bulgarian Academy of Sciences (BAS)
Institute of Nuclear Research and Nuclear Energy (INRNE)
72 Tzarigradsko shosse Blvd., 1784 Sofia, Bulgaria
Tel: +359-2-7144616
Fax: +359-2-9753619
http://www.inrne.bas.bg/

Bulgarian Academy of Sciences
Institute of Metallurgy
53 Shipchenski Prokhod Blvd.
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http://www.bas.bg/

National Electric Company
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