CFF OPET -

WP 3. Promotion of CCT implementation options in existing coal-fired power plants

Report on the current situation in Bulgarian solid fuel-fired power plants and the implementation possibilities of Clean Coal Technology

SOFIA ENERGY CENTRE

Bulgaria

1. Electricity generation

1.1. Energy balances

The overall energy balance of Bulgaria for the year 2000 is presented in diagram 1:

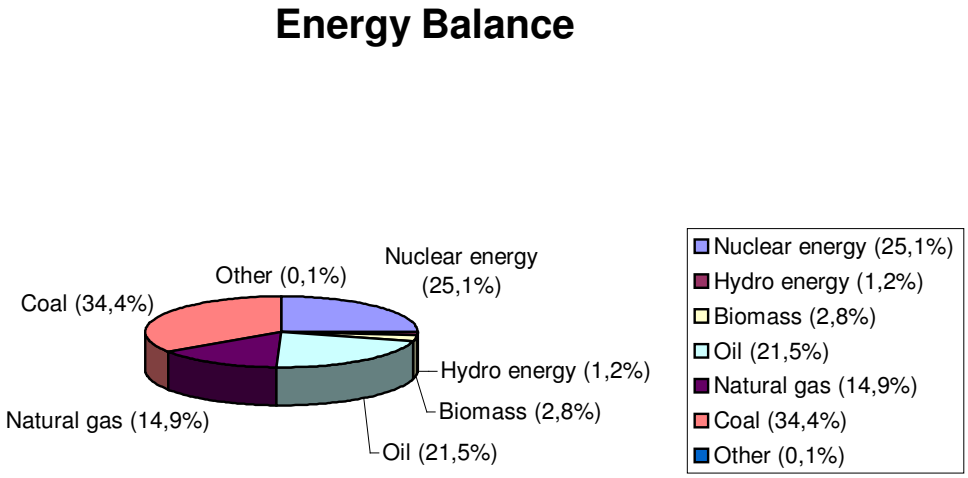

Figure 1.: Share of different energy sources in the overall energy balance of Bulgaria for the year 2000.

In the following table and figure are presented the different fuels used for electricity and heat production in power plants.

Table 1.: Fuel used for electricity and heat production in power plants.

			Thousand tons of oil equivalent
Year	**1998**	**1999**	**2000**
Total	11 613	10 478	11 043
Nuclear energy	4 727	4 354	4 924
Coal	5 552	4 686	4 851
Petroleum products	283	263	176
Natural gas	919	898	806
Other fuels	132	277	286

It is seen from the table that about half of the electricity produced in Bulgaria (excluding the HPP), on the base of the different fuels, is produced from solid fuels – lignite and coal.

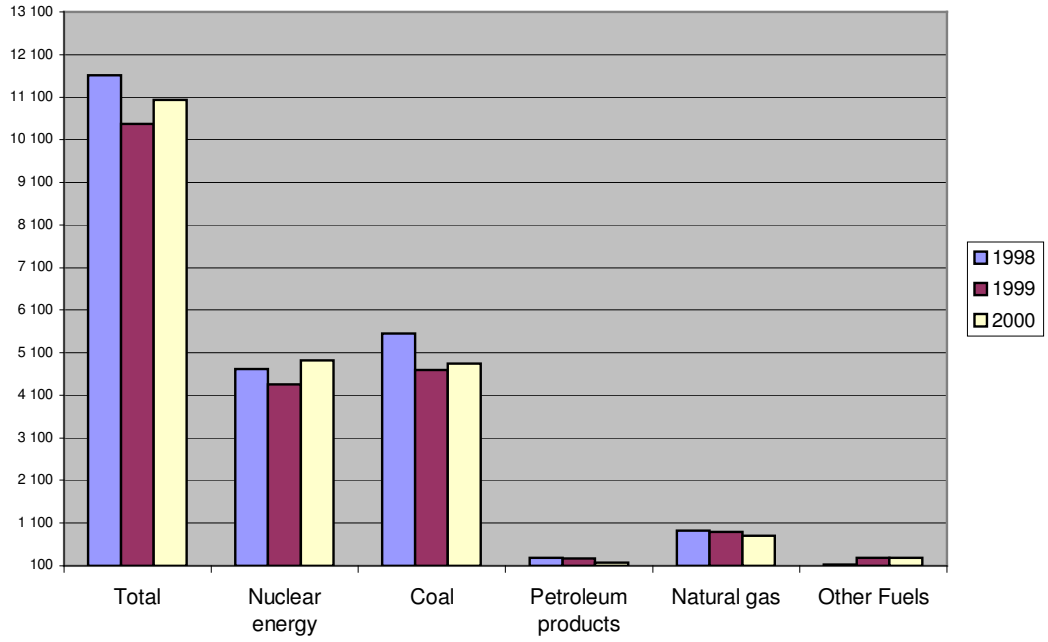

Figure 2.: Fuel used for electricity and heat production in power plants.

The following table presents in percents the distribution of the different types of fuels in the different power plants – Public electric plants, CHP plants, Auto-producers (Industrial Plants) and District heating plants.

Table 2.: Fuel structure in power and heat plants.*

	Total		**Public electric plants**		**CHP plants**		**Auto-producers**		**District heating plants**	
	1999	**2000**	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**
Total	**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	5.7	4.4	22.9	26.4	18.2	21.2	-	-
Total lignite	35.4	35.0	40.3	38.5	23.2	27.5	3.0	-	0.3	0.3
Other solid fuels	2.1	2.0	-	-	10.8	10.7	4.7	3.6	-	-
Petroleum products	2.5	1.6	0.2	0.2	2.7	1.6	35.9	28.3	15.0	12.0
Natural gas	8.6	7.3	-	0.0	40.4	33.8	28.5	33.0	84.7	87.7
Other gases	0.5	0.6	-	-	-	-	9.7	13.8	-	-
Nuclear energy	41.6	44.6	53.8	56.9	-	-	-	-	-	-

* Excluding Hydro-power Plants

It is seen from the table that hard coal is not utilized in district heating plants, while lignite is used in all types of plants, although their utilization in district heating plants is symbolical.

The production of primary energy in a country is also a very indicative factor. From the following table could be seen that the main energy source in Bulgaria is coal, and mainly low-grade brown coal and lignite.

Table 3.: Production of primary energy in Bulgaria.

			Thousand tons of oil equivalent
Year	**1998**	**1999**	**2000**
Total	**10 541**	**9 411**	**10 282**
Coal	5 079	4 341	4 520
Crude oil	33	44	46
Natural gas	23	22	12
Other solid fuels	413	413	550
Nuclear and hydro-energy	4 993	4 591	5 154

In the following table is presented coal and coal fuels balance sheet for the year 2000, from which is seen that the mined, in the country, brown coal and lignite, are utilized mainly in the plants for electricity production.

Table 4.: Coal and coal fuels balance sheet for the year 2000.

		Thousand tons of oil equivalent
	Hard coal	**Brown coal and lignite**
Primary production	-	4 520
Imports	2 381	-
Stock change	- 101	- 74
Gross inland consumption	2 279	4 446
Thermal power plants	986	3 865
Incl.: - public	890	3 865
- industrial	95	-
Briquetting plants	-	432

From the data in the above mentioned tables is seen that the main energy source in Bulgaria is the low-grade brown coal and lignite. The Republic of Bulgaria disposes of limited hydro-energy potential. The renewable energy sources, mainly biomass, geothermal and solar energy are at an initial stage of their utilization.

1.2. Electricity Generation

On the map below are presented the main TPPs, HPPs and the nuclear power plant. Shown are also the main transmission lines on 750 kV, 400 kV, 220 kV and 110 kV.

Map1.: Map of the Electricity System of Bulgaria

Natsionalna Elektricheska Kompania EAD (NEK EAD) was established as a single-owner joint-stock company, 100% held by the State. Its seat of business is in Sofia. The main functions of the Company are detailed below:

- ✓ Generation and transmission of electric power;
- ✓ Centralised purchase and sale of electric power;
- ✓ Supply of electric power to customers connected to the transmission network;
- ✓ Import, export of electric power and energy resources;
- ✓ Construction and maintenance of power generation and transmission facilities;
- ✓ Investment;
- ✓ Introduction and promotion of energy efficiency in the generation and transmission of electric power;
- ✓ On-line control and supervision of the operation of the national power system through the National Dispatch Centre.

The single-owner rights are exercised by the Minister of Energy and Energy Resources.

The bodies managing the joint-stock company are the General Assembly, a five-member Board of Directors and a Procurator.

On the following figure could be seen, in the sequence of the last years, the development of the Electricity Generation and Demand in Bulgaria.

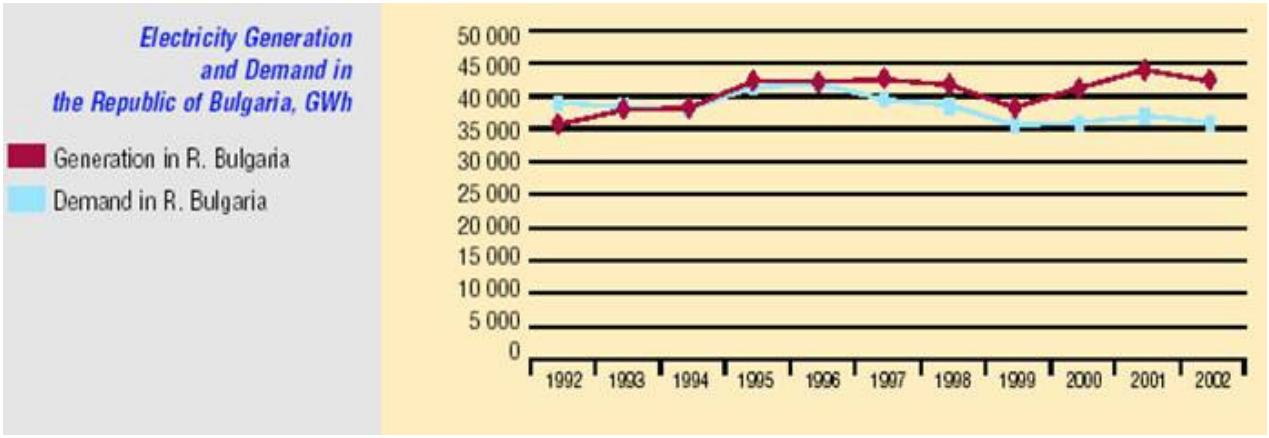

Figure 3.: Electricity Generation and Demand in Bulgaria

On the following figures is presented the structure of the Electricity Generation by the main types of plants, thermal, nuclear and hydro, during the last ten years, as well as the per cent distribution for the year 2002.

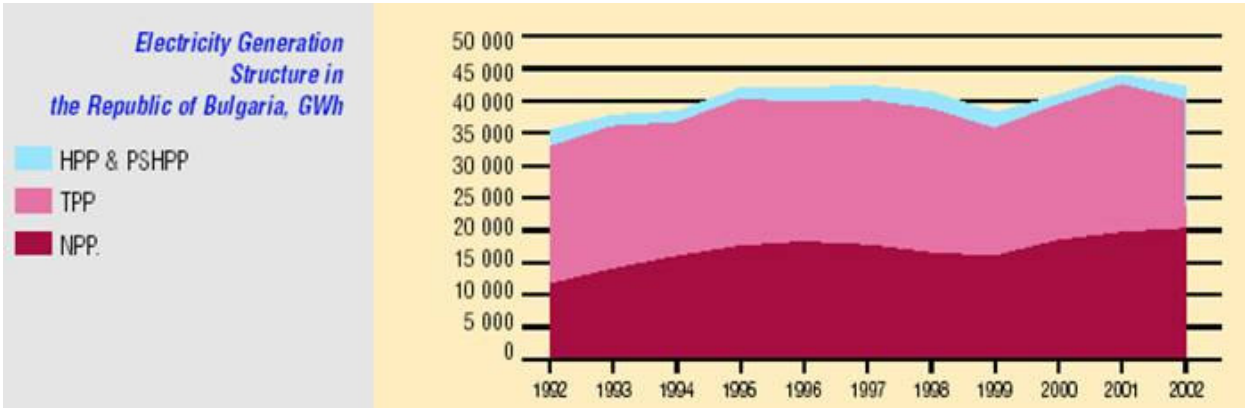

Figure 4.a.: Electricity Generation Structure in Bulgaria

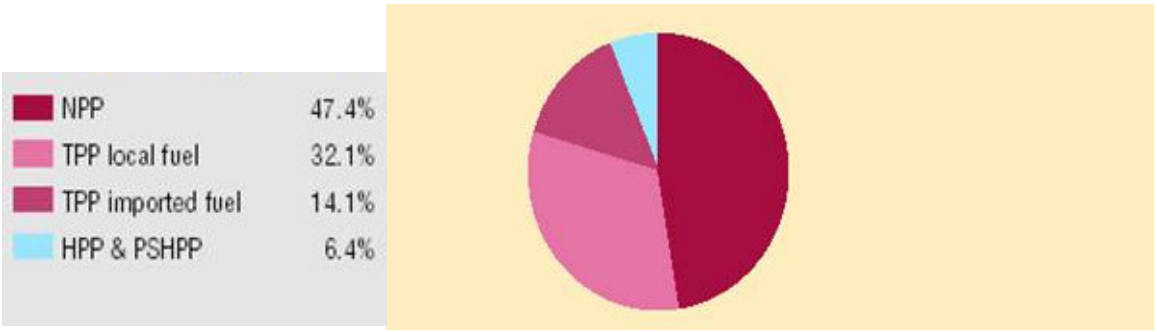

Figure 4.b.: Electricity Generation Structure in %

On the following figure could be seen the electricity generation of the plants of NEK Jsc. and of Independent Power Plants (IPP). The year 2000 is characteristic, when the main Thermal Power Plants and the NP Plant Kozloduy were separated as independent economy units.

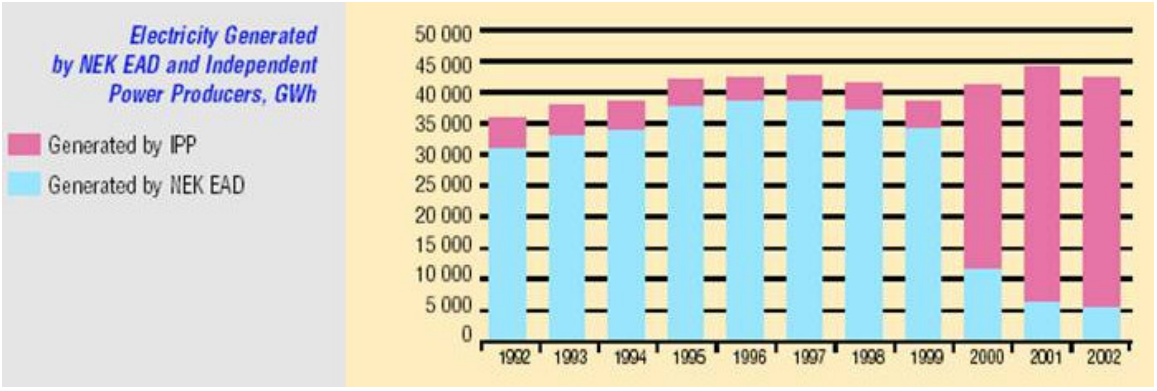

Figure 5.: Electricity Generated by NEK and Independent Power Producers.

2. Thermal Power Plants in Bulgaria

In the following table 5 are presented the Coal-fired power plants in Bulgaria:

Table 5.: Coal-fired power plants in Bulgaria

No	Name of Power Plant	Ownership	Location / Region	Installed Units	Commissioning year	No of Units	Total capacity MW	Comments
1.	TPP Maritza East 1	Public	Galabovo	4x50	1960 – 1962	4	200	
2.	TPP Maritza East 2	Public	Radnevo	4x150 2x210 2x215	1966-1969 1985-1990 1995	8	1450	
3.	TPP Maritza East 3	JVC	Mednikarovo	4x210	1978-1981	4	840	
4.	TPP Maritza 3	Public	Dimitrovgrad	2x25 1x120	1951-1954 1971	3	170	
5.	TPP Bobov dol	Public	Bobov dol	3x210	1973-1975	3	630	
6.	TPP Varna	Public	Varna	6x210	1968-1970 1977-1979	6	1260	
7.	TPP Russe	Public	Russe	2x30 2x110 2x60	1964-1966 1971-1983-1984	6	400	
District Heating Plants								
1.	TPP Republica	Public	Pernik	1x50 2x25		3	100	Indigenous coal
2.	TPP Sliven	Public	Sliven	1x30		1	30	Indigenous coal
3.	TPP Gabrovo	Public	Gabrovo	3x6		3	18	Indigenous coal; fuel oil

On figure 6 are given the installed capacity (MW) of the coal-fired power plants in Bulgaria.

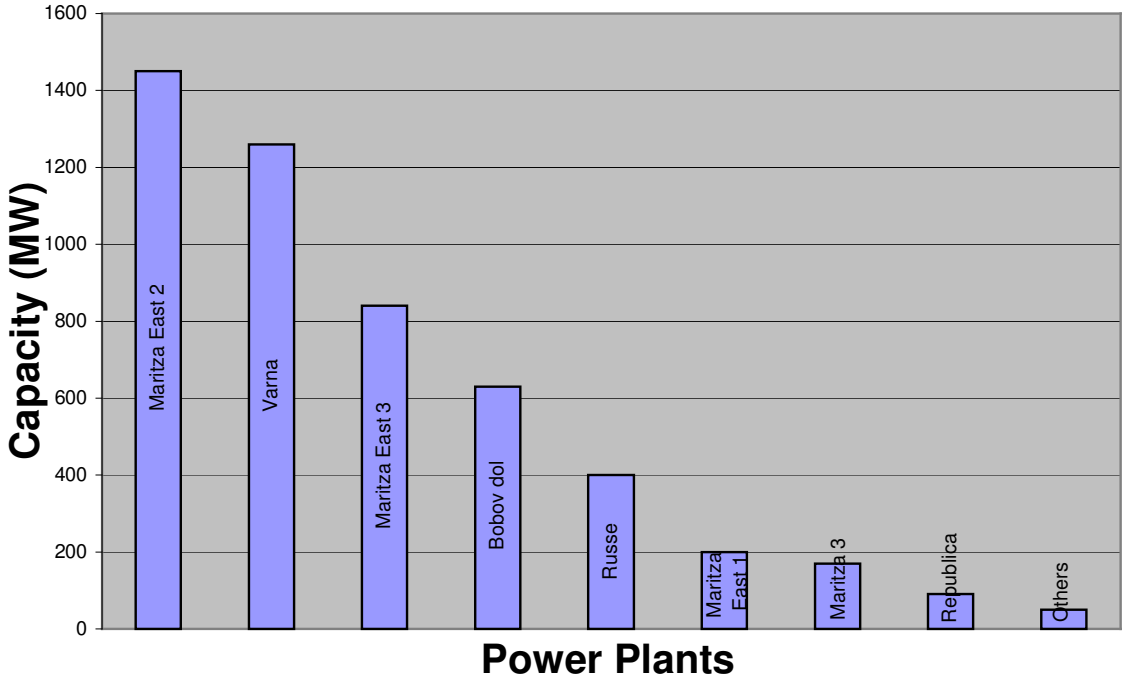

Figure 6: Installed capacity (MW) of the coal-fired power plants in Bulgaria.

Figure 7 shows the distribution of units in three ranges of capacity. The maximum value of a unit is 215 MW (there are two of them) and there are other 15 units with capacity of 210 MW, so that the total power is 3580 MW (72,3 % of the total installed capacity). There are seven units between 100 and 200 MW covering 21,4% of the total installed capacity and 10 units less than 100 MW covering 6,3 %.

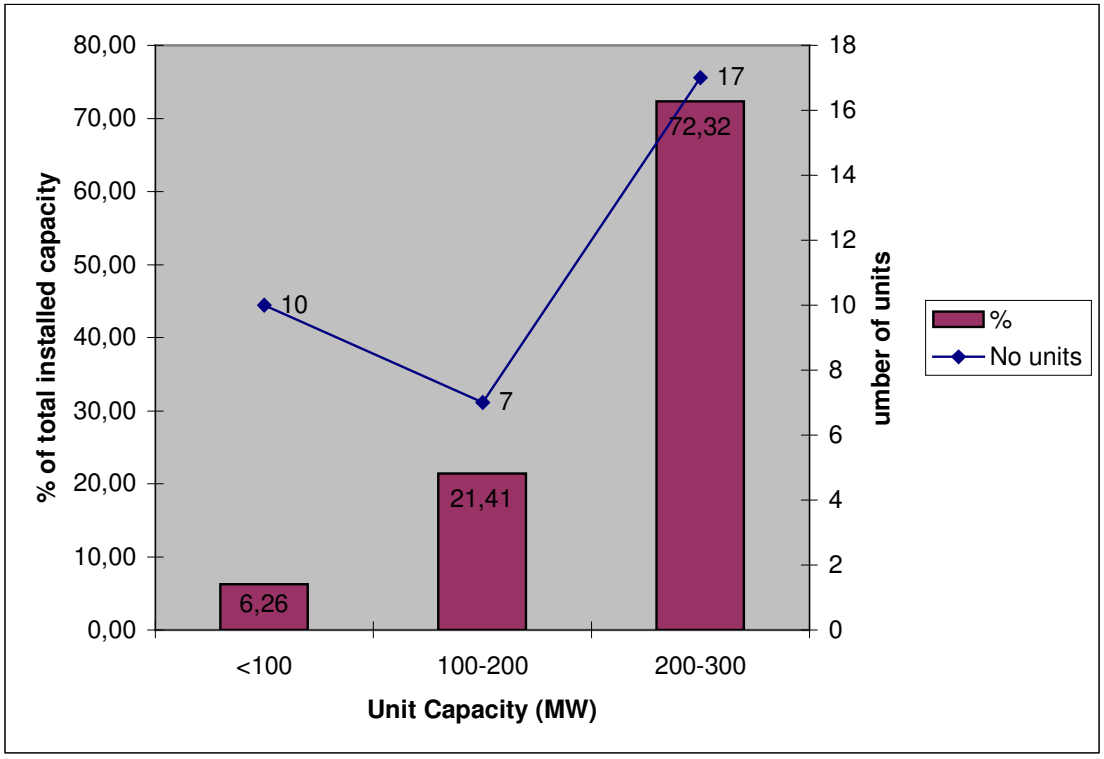

Figure 7.: Distribution of units by capacity in three ranges of the Bulgarian coal-fired power plants for electricity production

3. Ownership of Power Stations

Until the year 2000, NEK was a state-owned monopoly utility responsible for generation, transmission and distribution throughout Bulgaria.

In the year 2000 were made organizational changes, comprising decentralization of the vertically integrated Nationalna Elektricheska Kompania EAD and establishment of 15 independent companies: generating, transmitting and electricity distributing.

NEK owned the seven big thermal power plants in Bulgaria, and namely: Maritza East 1, Maritza East 2, Maritza East 3, Bobov dol, Maritza 3, Varna and Russe. Now, all the big thermal power plants are independent legal entities.

The energy sector needs significant investments for the improvement of the existing infrastructure whose current status is a result of low levels of investments during the past decade. Privatization represents a powerful instrument through which this goal can be achieved. For this reason, the government intends to step up to the maximum the pace of the privatization process in all energy sectors, including TPPs.

During the year 2002 Maritza East 3 Power Company AD was established and was granted a license as a joint venture with the majority stake belonging to the US company Entergy, which represents the first large-scale privatization deal in the energy sector. The joint venture has entered into a fifteen-year power purchase agreement with the Nationalna Elektricheska Kompania (NEK). The privatization of TPPs will continue with the key power plants and will involve strategic investors. In 2004 sub-peak power plants in Bobov dol, Russe and Varna will be privatized.

With regard to the District Heating Plants, they are to the respective District Heating Companies. The District Heating Companies, with the exception of Sofia DH Company are state-owned.

4. Technical Data of the Thermal Units (Age, Efficiency, Availability, Environmental performance)

The Thermal Power Plants in Bulgaria are designed for normal life of exploitation of 30 years. It is foreseen after that, through rehabilitation, their life to be extended.

In table 6 are presented the coal-fired power plants ordered by age. From the table could be clearly seen the age of the separate units of the Coal-fired power plants in Bulgaria.

Table 6.: Coal-fired power plants ordered by age

No	Power Plant	Identification unit	Capacity (MWt)	Commissioning year	Age
1.	**Maritza 3**	1	25	1951	52
2.	**Maritza 3**	1	25	1954	49
3.	**Maritza East 1**	1	50	1960	43
4.	**Maritza East 1**	1	50	1961	42
5.	**Maritza East 1**	2	50	1961	42
6.	**Russe**	1	30	1964	39
7.	**Russe**	1	30	1964	39
8.	**Maritza East 2**	1	150	1966	37
9.	**Maritza East 2**	1	150	1966	37
10.	**Maritza East 2**	1	150	1967	36
11.	**Varna**	1	210	1968	35
12.	**Maritza East 2**	1	150	1969	34
13.	**Varna**	1	210	1969	34
14.	**Varna**	1	210	1970	33
15.	**Maritza 3**	1	120	1971	32
16.	**Russe**	1	110	1971	32
17.	**Bobov dol**	1	210	1973	30
18.	**Bobov dol**	1	210	1974	29
19.	**Bobov dol**	1	210	1975	28
20.	**Varna**	1	210	1977	26
21.	**Varna**	1	210	1979	24
22.	**Maritza East 3**	1	210	1978	25
23.	**Varna**	1	210	1979	24
24.	**Maritza East 3**	1	210	1979	24
25.	**Maritza East 3**	1	210	1980	23
26.	**Maritza East 3**	1	210	1981	22
27.	**Russe**	1	110	1984	19
28.	**Russe**	2	60	1985	18
29.	**Maritza East 2**	1	210	1985	17
30.	**Maritza East 2**	1	210	1990	13
31.	**Maritza East 2**	2	215	1995	8

From the attached figure 8 could be seen, that only 8.69% of the coal-fired power plants in Bulgaria are under the age of ten. The main part, 42.42% are

between 20 and 30 years old, and 35.76% are over 30 years. That is why for most of them are foreseen the respective rehabilitations. In the oldest plant TPP Maritza 3 are led out of exploitation two small units of 25 MW, and the rehabilitation is completed for the boiler and the turbine of the unit with capacity of 120 MW, while new investments are not foreseen. For TPP Maritza east 1 is foreseen after the year 2005 the old units to stop operating. A new company has been established "AES-3C" – TPP Maritza East 1. The new plant will be constructed as an entirely independent administrative unit with capacity of 670 MW.

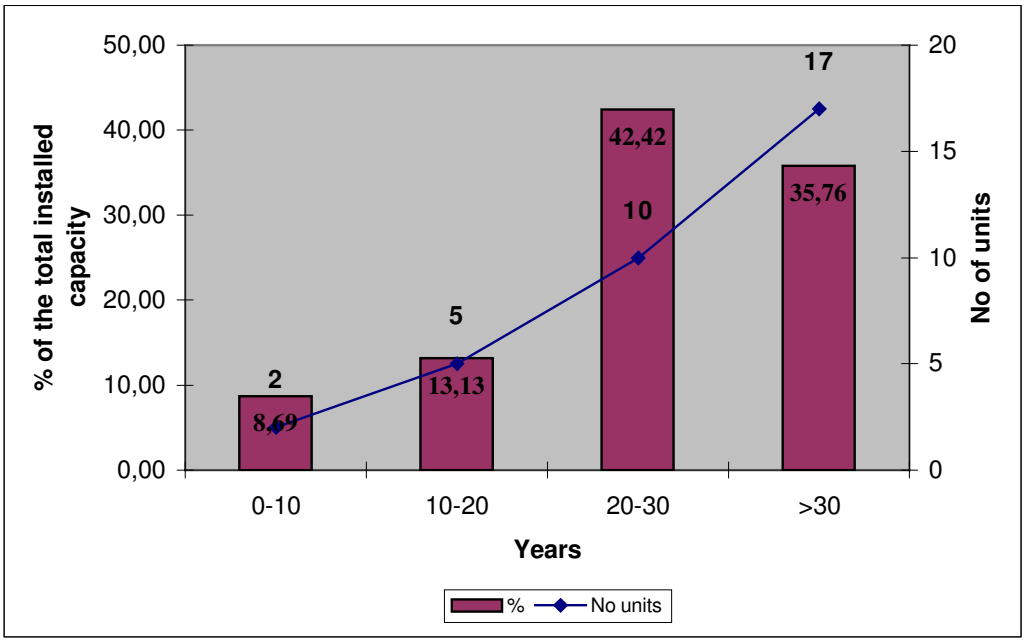

Figure 8.: Distribution of Bulgaria coal-fired power plants according to their age, in four ranges, below 10 years, between 10 and 20 years, between 20 and 30 years and over 30 years.

Efficiency of Coal-fired Power Plants in Bulgaria

In the following table 7 are presented the summarized data for the coal-fired power plants in Bulgaria in the year 2000. The installed electrical capacity is presented, as well as the installed heating capacity for the separate plants, since in some plants the heating capacity is not a block one, but collector one, i.e. all operating boilers feed simultaneously the operating steam turbines and it is impossible to make distinction between the separate electricity generating capacities.

Table 7.: Efficiency of Coal-fired Power Plants in Bulgaria for 2000:

No	Name of power plant	Installed electrical capacity MW	Installed heating capacity MW_t	Generated electrical energy GWh	Generated heat energy GW_th	Total energy generated GWh	Input energy of fuels GW_th	Gross efficiency coefficient %
1.	**TPP Maritza East 1**	200	865,2	1045,1	1032,0	2077,1	4348,5	47,77**
2.	**TPP Maritza East 2**	1450	4312	3901,6	-	3901,6	14191,0	27,49
3.	**TPP Maritza East 3**	840	2420	4186,4	-	4186,4	13120,3	31,91
4.	**TPP Maritza 3***	120	403	201,6	-	201,6	764,1	26,38
5.	**TPP Bobov dol**	630	1404	1547,0	-	2041,0	6467,0	31,56
6.	**TPP Varna**	1260	3582	2041,0	-	1547,0	4560,0	33,93
7.	**TPP Russe**	400	1333	385,0	418,0	803,0	1852,0	43,36**

** The two units of 25 MW are decommissioning.*

*** TPP Maritza East 1 and TPP Russe have higher efficiency, since they are CHP Plants.*

From the table could be seen, that TPP Maritza East 1 and TPP Russe have the greatest total gross efficiency since they are CHP Plants. The efficiency of the rest of the plants in 2000 has been determined not only by the commissioning year, but mainly by the degree of loading of the separate plants during the year, and also by the quality of the coal or the lignite they work with.

Availability of Coal-fired Power Plants in Bulgaria

In table 8 are given for the separate plants the operation hours for the year 2000 and the availability, as well as the Total Gross Efficiency in %.

Table 8.: Coal-fired Power Plants in Bulgaria and their operational characteristics in the year 2000.

No	Power Plant	Capacity (MW_t)	Operation in 2000 (hours)	Availability (%)	Total efficiency (%)
1.	**TPP Maritza East 1**	200	5225	59,6	47,77
2.	**TPP Maritza East 2**	1450	2691	30,7	27,49
3.	**TPP Maritza East 3**	840	4984	56,9	31,91
4.	**TPP Maritza 3**	120	1680	19,2	26,38
5.	**TPP Bobov dol**	630	3240	37,0	31,56
6.	**TPP Varna**	1260	1228	14,0	33,93
7.	**TPP Russe**	400	963	11,0	43,36

From the table could be seen that the thermal power plants in Bulgaria are not quite utilized in the year 2000. This is due to the reduced consumption of electrical energy, which is a consequence mainly to the drop in the industry. TPP Russe and TPP Varna have operated the least, since they work with imported coal.

After them follows TPP Maritza 3 with 1680 hours, as its unit of 120 MW is 32 years old.

Environmental performance

The energy industry is the main source of emissions of carbon dioxide and sulphur oxides in the country. Thermal power plants within the energy sector are also a relatively significant source of nitrogen oxides, non-toxic dust, dioxins and furans.

The coal-fired Thermal Power Plants (TPPs) emit about 80% of the country's emissions of sulphur oxides and about 60% of the emissions of carbon dioxide.

In 1995 Bulgaria ratified the UN Framework Convention on Climate Changes. In accordance with the Kyoto Protocol signed under the Convention in December 1997, Bulgaria made the commitment to reduce anthropogenic emissions of greenhouse gases by 8% compared to the emissions of 1998.

In case of the Kyoto Protocol ratification, in conformity with the commitments arising from the Protocol, strategy provides for the provisions to undertake in the following areas.

- ✓ Increase in the share in the national balance of the electric and thermal power plants, using natural gas.
- ✓ Priority construction of cogeneration plants.
- ✓ Increase in the share of energy generated by renewable energy sources in the national energy balance through implementation of a preferential policy for their development.
- ✓ Implementation of the rehabilitation of energy capacities in major TPPs which will operate after 2010 more than 20 000 hours.

In tables 9 to 15 are determined and presented for every separate boiler, in each of the plants, the heat capacity (MW_t), the operation hours in 2000 and the fired coal and mazut. Presented are also the emissions of SO_2 , NO_x, dust, CO_2 and CO (in tons), during the same year. This corresponds to the requirement of the Directive 2001/80 of the European Commission.

It should be mentioned that for every plant are elaborated technological and investment programs, with view to reduction of the harmful emissions after the year 2007 to the levels determined in the Directives of the European Union. These programs have been approved by the Ministry of Environment and Waters, Ministry of Energy and by the Ministry of Industry.

Table 9.: TPP Maritza East 1 – Environmental performance of Steam Generators, year 2000:

Steam generator No	Thermal capacity (MW_t)	Operated hours (hours/year)	Fired coal (tons/year)	Fired mazut (tons/year)	Emssions of SO_2 (tons/year)	Emissions of NO_x (tons/year)	Emissions of dust (tons/year)	Emssions of CO_2 (thousands tons/year)	Emissions of CO (tons/year)
1.	144.2	3659	200896	236	11416	344	586	200	29
2.	144.2	5008	274928	215	15622	470	801	273	39
3.	144.2	6122	336098	141	19100	574	981	334	47
4.	144.2	3363	184629	123	10492	317	538	184	26
5.	144.2	5750	315675	161	17939	540	919	314	145
6.	144.2	6347	348434	160	19800	595	1015	347	49

Table 10.: TPP Maritza East 2 – Data on the Steam Generators, year 2000:

Steam generator No	Thermal capacity (MW_t)	Operated hours (hours/year)	Fired coal (tons/year)	Fired mazut (tons/year)	Emssions of SO_2 (tons/year)	Emissions of NO_x (tons/year)	Emissions of dust (tons/year)	Emssions of CO_2 (thousands tons/year)	Emissions of CO (tons/year)
1.	236	5704	710313	305	24904	1185	724	436	62
2.	236	5912	736217	271	25810	1227	1073	452	64
3.	236	1542	188621	82	6613	315	275	116	17
4.	236	1485	181649	160	6373	1105	265	112	16
5.	236	5613	663476	256	23261	1106	97	407	58
6.	236	5095	602241	300	21117	1005	88	370	53
7.	236	4653	570879	356	20021	953	166	350	50
8.	236	5026	616647	215	21618	1028	449	378	54
9.	606	2504	2408326	1290	80597	4021	352	1410	201
10.	606	6419	1221055	657	40864	2039	357	715	102
11.	606	6827	1931397	1040	64637	3225	282	1131	161
12.	606	6028	2132270	1145	71359	3560	312	1249	178

Table 11.: TPP Maritza East 3 - Data on the Steam Generators, year 2000:

Steam generator No	Thermal capacity (MW_t)	Operated hours (hours/year)	Fired coal (tons/year)	Fired mazut (tons/year)	Emssions of SO_2 (tons/year)	Emissions of NO_x (tons/year)	Emissions of dust (tons/year)	Emssions of CO_2 (thousands tons/year)	Emissions of CO (tons/year)
1.	605	5264	1659593	1123	52100	2868	935	912	130
2.	605	5255	1628133	1102	51113	2814	918	894	127
3.	605	5745	1837029	1243	57671	3175	1035	1009	144
4.	605	6194	1980807	1340	62185	3423	1116	1088	155

Table 12.: TPP Maritza 3 - Data on the Steam Generators, year 2000:

Steam generator No	Thermal capacity (MW_t)	Operated hours (hours/year)	Fired coal (tons/year)	Fired mazut (tons/year)	Emssions of SO_2 (tons/year)	Emissions of NO_x (tons/year)	Emissions of dust (tons/year)	Emssions of CO_2 (thousands tons/year)	Emissions of CO (tons/year)
4.	300	2332	382870	1157	20814	730	233	192	27

Note: Steam generators No 1,2 and 3 together with two steam-turbines of 25 MW_t are led out of exploitation due to their full amortization and falling off of the industrial consumers of heat energy.

Table 13.: TPP Bobov dol - Data on the Steam Generators, year 2000:

Steam generator No	Thermal capacity (MW_t)	Operated hours (hours/year)	Fired coal (tons/year)	Fired mazut (tons/year)	Emssions of SO_2 (tons/year)	Emissions of NO_x (tons/year)	Emissions of dust (tons/year)	Emssions of CO_2 (thousands tons/year)	Emissions of CO (tons/year)
1.	468	3900	782801	315	25601	1882	1035	630	56
2.	468	2974	597058	240	19526	1435	789	480	42
3.	468	5352	1074361	433	35136	2583	1420	864	77

Table 14.: TPP Varna - Data on the Steam Generators, year 2000:

Steam generator No	Thermal capacity (MW_t)	Operated hours (hours/year)	Fired coal (tons/year)	Fired mazut (tons/year)	Emssions of SO_2 (tons/year)	Emissions of NO_x (tons/year)	Emissions of dust (tons/year)	Emssions of CO_2 (thousands tons/year)	Emissions of CO (tons/year)
1.	597	85	5910	272	59	10	2	4	0.2
2.	597	455	32064	414	315	61	8	21	9
3.	597	79	5319	152	53	10	2	4	0.2
4.	597	2378	174020	504	1721	333	45	117	15
5.	597	3888	280800	401	2778	538	73	189	18
6.	597	2489	165365	990	1642	318	43	112	5

Table 15.: TPP Russe - Data on the Steam Generators, year 2000:

Steam generator No	Thermal capacity (MW_t)	Operated hours (hours/year)	Fired coal (tons/year)	Fired mazut (tons/year)	Emssions of SO_2 (tons/year)	Emissions of NO_x (tons/year)	Emissions of dust (tons/year)	Emssions of CO_2 (thousands tons/year)	Emissions of CO (tons/year)
1.	158	1262	27232	204	825	204	68	54	2.3
2.	158	810	17480	130	530	131	43	35	1.5
3.	273	-	-	-	-	-	-	-	-
4.	273	297	11688	181	361	88	29	24	1.0
5.	157	3995	86209	639	2614	644	214	173	74.0
6.	Dismantled	-	-	-	-	-	-	-	-
7.	157	1278	27579	215	837	206	68	55	2.3
8.	157	3853	83133	639	2522	621	206	166	71.0

Note: Steam generator No 3 has been led out of exploitation, due to a forthcoming rehabilitation, and steam generator No 6 has been dismantled after a great failure.

5. Fuels used for Power Generation (Fuel Type/Characteristics)

The Republic of Bulgaria is poor in energy resources. The deposits of oil and natural gas discovered so far are without any practical significance to the national economy. The extraction of uranium has been 100% terminated. From the point of view of the energy potential of the country, coal occupies an important place as far as long-term own energy resources are concerned. The deposits of coal in the operating mines amount to about 3 billion tons, of which 88.7% are lignite, 10.9% are brown and 0.4% are black and hard.

In the following table are presented the proven reserves.

Table 16.: Lignite and coal reserves in Bulgaria:

No	**Type of coal**	**Proven reserves in the year 2000, in 10^3 tons**	
		In operation	**Without operation**
1.	**Lignite**	2 667 260.7	3 612 282.9
2.	**Brown coal**	421 869.5	12 697.9
3.	**Black coal**	25 246.7	417 603.9
4.	**Hard (Antrazit)**	23 082.8	1 124.4

In the following table are presented the fuels used for the Power Plants.

Table 17.: Fuels used in Thermal Power Plants in Bulgaria

No	**Power plant**	**Fuel type**	**Location / Region**	**Mine name or lignite type**	**Source (indigenous or imported)**	**Proven reserves in 10^3 tons**
1.	TPP Maritza East 1	Lignite	Galabovo	Maritza East	Indigenous	Total for Maritza East Coal Field – 1640000
2.	TPP Maritza East 2	Lignite	Kovachevo	Maritza East	Indigenous	
3.	TPP Maritza East 3	Lignite	Mednikarovo	Maritza East	Indigenous	
4.	TPP Maritza 3	Lignite	Dimitrovgrad	Marbas	Indigenous and imported	104 500
5.	TPP Bobov dol	Brown coal	Bobov dol	Bobov dol	Indigenous and imported	190 000
6.	TPP Varna	Imported coal, gas	Varna	-	Imported	
7.	TPP Russe	Imported coal	Russe	-	Imported	

The lignite coal mining in the Maritza East Coal Field is carried out in three mines – Troyanovo-1, Troyanovo-North and Troyanovo-3, which comprise the Maritza East Mines Plc. They are equipped with the necessary mechanization for the extraction of coal to reach the amount of more than 30 million tons/year. This potential is currently being used only at a level of 65%. In the last few years, coal output varies within the range of 20.5 – 22.1 million tons/year. The consumption of electricity on a national scale has decreased considerably, because of the shut-down of the majority of the industrial enterprises and now it depends primarily on the household sector. As a result, the coal-fired power plants in the region of Maritza East, which are the main consumers of lignite, utilize up to about 60-65% of their capacity.

The perspectives of the mines with underground extraction are associated with Bobov dol TPP, which was built with equipment and technology for burning of local brown coal with calorific value of 2400-2800 Kcal/kg. Given an annual utilization of the power plant at a level of 3000-3300 hours and installed capacity of 630 MW, about 2.5 million tons/year of energy coal, including brown and lignite, are necessary. They can be extracted by the Bobov dol Mines, the Pirin Mine, Vitren Mine and the lignite mines from the Sofia basin.

On the following tables are presented the data for the fuel characteristics.

Table 18.: Fuel characteristics:

No	Power plant	Fuel type	Mine name	Fuel characteristics – Proximate analysis (% as received)			Low heating value (MJ/kg)
				Moisture	Ash	Fixed carbon	
1.	**Maritza East 1**	Lignite	Maritza East	56.4	29.6	20.4	6.5
2.	**Maritza East 2**	Lignite					
3.	**Maritza East 3**	Lignite					
4.	**Maritza 3**	Lignite	Marbas	40.4	33.7	27.3	6.8
5.	**Bobov dol**	Brown coal	Bobov dol	13.1	38.6	39.2	11.3
6.	**Varna**	Black coal	Imported	7.5-10.2	22.0-17.1		24.0-26.0
7.	**Russe**	Black coal	Imported				

Table 19.: Fuel characteristics:

	Fuel Characteristics – Ultimate analysis (% dry)						
No	**Power plant**	**Fuel type**	**Carbon**	**Hydrogen**	**Oxygen**	**Nitrogen**	**Sulphur**
1.	**Maritza East 1**	Lignite (Maritza East)	20	1.7	7.3	0.3	1.7
2.	**Maritza East 2**						
3.	**Maritza East 3**						
4.	**Maritza 3**	Lignite (Marbas)	19.6	1.7	5.8	0.4	3.5
5.	**Bobov dol**	Brown coal	29.4	2.4	8.5	0.6	2.2
6.	**Varna**	Imported black coal	67.5	1.3	1.1	0.6	1.7
7.	**Russe**	Imported black coal	67.0	3.1	1.6	1.1	1.7

6. Problems Encountered in Power Plants and Projects for Rehabilitation of the Thermal Plants

All thermal power plants in Bulgaria use conventional technology of pulverized coal combustion. Besides, the seven coal-fired power plants have electrostatic precipitator (ESP). The projected life of the thermal power plants in Bulgaria is 30 years, while it is foreseen through rehabilitation, that it is extended. It is seen from diagram 8 that 35.76% of the total installed capacity of the coal-fired power plants are over 30 years and therefore are subject to rehabilitation. For the oldest TPP Maritza 3, the two units of 25 MW have already been led out of exploitation. The steam generator and the turbine of the unit of 120 MW have already been rehabilitated, and no more investments are foreseen.

For TPP Maritza East 1 is foreseen, that after 2005 the present units will stop operating and new capacities of 670 MW will be constructed (two units of 335 MW each).

For TPP Maritza East 2 is foreseen rehabilitation of the four units of 150 MW each, with increase in the capacity from 150 to 177 MW. The rehabilitation will comprise replacement of the turbines, generators and the whole regenerative system by the Japan Company "Toshiba". The rehabilitation of units 5 and 6 and the increase of the capacity from 210 MW to 225 MW, through entire replacement of the blade apparatus of rotors high, medium and low pressure, as well as improvement of the cooling of generators. In parallel with the rehabilitation of units 1 to 6 is foreseen the construction of 3 desulphurisation systems.

For the rehabilitation of TPP Maritza East 3, in the beginning of the year 2003, started a project for refurbishment and modernization of the four generation units of the plant and construction of flue-gas desulphurisation facilities to each of them. Its total cost amounts to 600 million Euro. The project will be managed by Maritza East 3 Power Company AD – a joint-venture company between Energy Power Holdings Maritza BV (the shareholders are ENEL Produzione S.p.A. holding 60%, and Entergy – 40%) and NEK EAD. Entergy Power Holdings Maritza BV owns 73% and NEK EAD – 27% of the JVC share capital.

For the rest of the old units is also foreseen respective rehabilitation.

7. Future trends in the Power Sector

In the energy sector, Bulgaria is confronted with a series of major challenges stemming from both objective causes and circumstances and the delay in carrying out the reforms during the years of transition.

Bulgaria is heavily dependent on energy as it imports more than 70% of its primary energy sources. The only significant domestic energy source is low-quality lignite coal with high content of sulphur.

Unlike in many EU Member States and applicant countries where the local coal-mining industry has no perspectives in economic terms, in Bulgaria the **local lignite coal has a strong position as a resource for electricity generation.** This, combined with its importance for the security of energy supply, determines the significant role of the *Maritza-East* complex of mines and power plants in the future development of the energy sector.

The energy industry is the main source of emissions of carbon dioxide and sulphur oxides in the country. Thermal power plants within the energy sector are also a relatively significant source of nitrogen oxides, non-toxic dust, dioxins and furans.

The coal-fired Thermal Power Plants (TPPs) emit about 80% of the country's emissions of sulphur oxides and about 60% of the emissions of carbon dioxide.

The energy strategy of Bulgaria, taking into consideration the above stated, provides for the following provisions:

- All new coal-fired power units to be supplied with desulphurisation facilities and low-NO_x burners with the appropriate efficiency;
- All energy units subject to rehabilitation to be supplied with desulphurisation facilities and low-NO_x burners with the appropriate efficiency;
- Development of a Plan for Reduction of Emissions of Sulphur and Nitrogen Oxides by the existing TPPs by 2016, in compliance with the EU Directive 2001/80/EC.

At the present moment under the existing market model (single buyer), foreign investors have no direct access to end-users and hence insist on long-term power purchase agreements guaranteed by the government. The actions by the former government, when contracts for big investments were concluded before the introduction of market relations, concentrated the price and market risks entirely on the state, respectively on end-users. As a result, in case of negative developments on the electricity market the end price for electricity will inevitably grow. Moreover, the long-term agreements signed for the new *Maritza East 1* power plant (670 MW) and for the rehabilitation of *Maritza*

East 3 plant (860 MW) limit the future market segment to 40% of the total electricity consumption (taking into account also the base-load capacities of the nuclear power plant and cogeneration plants).

The philosophy behind the new energy law envisages the introduction of authorization regime for construction of new capacities under which the role of the government is limited to issuance of permits for construction of new capacities without assumption of any commitments to purchase this energy for the regulated segment. In parallel with the introduction of the authorization regime, a clear and legally regulated schedule of opening the external and internal electricity market should be developed as well. Thus the investor will be free to make independent decisions and shoulder the market risk resulting from them.

Concurrently with the authorization regime, a tender procedure will continue to apply to the construction of new capacities. The government policy in tender procedures will continue the good traditions and will rely on two main sources: Nuclear energy and Local lignite coal.

Due to the unreliable nature of long-term projections for demand and the dynamically changing electricity market, the government will be striving for deferment of large-scale projects and, at the same time, for preservation of the key role of Bulgaria in the region through a policy that does not require big investments as extension of the economic life-cycle of key power plants and thermal power plants through privatization with the involvement of strategic investors.

Privatization of power plants will start from the key power and thermal power plants and will involve strategic investors. After the year 2003 sub-peak power plants in Bobov Dol, Rousse and Varna will be privatized. Once clear regulatory and market rules are put in place, no obstacles will exist to an open and fair process of selling of all plants without exception.