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Role of hard coal and brown coal in Polish energy sector

Key words

Hard coal, brown coal, fossil fuels, reserves, electricity generation

Abstract

The energy problems must be considered globally, both with respect to the sources of energy and functioning markets and with respect to the environmental protection. The energy fossil raw materials, as compared with the remaining prime energy carriers, are decisive for the development of the word economy. The world reserves of the hard coal in 2001 were estimated to be equal to 5191 Gt, off which nearly half (2459 Gt) were located in Asia and Eastern Europe, including the Russian Federation. The enormous reserves of hard coal are found in North America (1202 Gt), which constitutes more than 23% of the world hard coal reserves.

The worldwide production of hard coal in 2000 amounted to 3639 Mt, including 3142 Mt of steam coal and 497 Mt of coking coal. The considerable increase in the production of hard coal occurred in Australia, Africa, Asia and North America. In Europe, for the period of 20 years of the last century, the drop in hard coal production by 292 Mt was reported. The consumption of coal in the work in 2000 amounted to 3738 Mt, including steam coal at the rate of 3220 Mt and coking coal at the rate of 518 Mt. Europe reduced the consumption of coal by 193 Mt, including 148 Mt of steam coal and 45 Mt of coking coal, which was due to the considerable restructuring of the mining industry in the EU countries.

The domestic reserves as at 2000 exceeded 39.3 Gtoe, off which more than 99.5% are the coal reserves. The remaining, primary energy carriers, i.e. crude oil and natural gas both constitute as little as 0.51% of the national reserves of energy carrying raw materials. The domestic balance reserves of hard coal as at December 31 1999 were equal to 18 152 Mt, including industrial reserves equal to 8 354 Mt.

The geology reserves of brown coal are found in 78 deposits and amount to the total of over 13 984.14 Mt, including the reserves recognized in detail (4455 Mt). The industry reserves of the developed deposits are equal to 1778.5 Mt.

The national power system is the largest and most significant system in Central Europe. The gross production of energy in Poland in 2000 amounted to 145 169 GW·h, including the total production of public utility power plants equal to 133.8 TW·h, off which hard coal fired power plants generated 84 153 GW·h, while public utility brown coal fired power plants produced 49 677 GW·h.

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The production of electricity from brown coal has been maintaining the relatively same level for a number of years, its share in the total production being anywhere between 35 and 40%.

The "Guidelines for energy policy of Poland until 2020" (2000) constitute the basic document with regard to determining the demand for the energy materials. Taking into consideration the significant uncertainty of the future statuses of economy, three scenarios of social and economic development have been prepared, notably the surviving scenario, the reference scenario and progress scenario.

The role of hard and brown coal in the fuel and energy balance will continue to be dominating in the short-term prospective, and will retain its significance in the long-term horizon.

Introduction

The energy problems must be considered globally, both with respect to the sources of energy and functioning markets and with respect to the environmental protection. No dramatic changes are anticipated to occur in the structure of demand and supply and the consumption of the primary energy carriers in the following two decades. The hard coal will continue to be one of the basic energy carriers owing to its reserves, considerably exceeding the reserves of other hydrocarbon energy carriers. The reserves of coal found on the particular continents are diversified, as is the case with respect to their recognition extent.

Dominating in the Polish energy raw materials reserves is definitely hard coal and brown coal. Currently, Poland realizes the hard coal mining restructuring program, involving the considerable drop of production and employment reduction. The power industry will continue to be the biggest market for hard coal in the future.

The share of brown coal in the Polish power industry determines the role of the mining in the long term horizon, at the same time determining the short-term tasks, depending on the demand for the fuels and electricity. The production of electricity from the brown coal has been at the relatively same level for a number of years. The share in question in 1995—2000 was anywhere between percent 36.5—34.3%.

More than half of coal rate extracted worldwide is intended for production of over 38% of the electricity generated on our planet. The production of electricity is strictly dependent on the production of coal in many countries. The (favorable) increase in the demand for the coal will be related to the removal of a number of nuclear power plants after 2010.

1. Hard coal in word economy

1.1. Hard coal reserves

The energy fossil fuels, as compared with the remaining prime energy carriers, are decisive for the development of the word economy. Table 1 shows the world reserves of energy fossil fuels (1999). The proved reserves of fossil fuels, except for the nuclear fuel, exceed 1134 Gtoe, and when the forecasted reserves are included, these amount to 4680 Gtoe. The proved and forecasted reserves of nuclear fuel, when the multiplication reactors are used, are equal to 8350 Gtoe. Therefore, the total reserves of fossil fuels and nuclear fuel exceed 13 000 Gtoe.

TABLE 1

The world reserves of energy fossil fuels, as of 1999

TABELA 1

Światowe zasoby surowców energetycznych, stan na 1999 r.

Raw material	Reserves [Gtoe]		
	proved	prognostic	total
Crude oil	143	145	288
Sand and bituminous shale	210	332	542
Natural gas	146	279	425
Coal	635	2 794	3 429
Uranium — for coping reactors application	1 850	6 500	8 350
Total	1 171—2 984	3 680—10 050	4 851—13 034

Source: Ney 2000

A number of factors have influenced the generation of coal deposits, such as the vegetation evolution, geotectonical conditions, paleogegraphy conditions and paleoclimatic conditions, which influenced the stratygraphic and geographic configuration of the basins and deposits of the hard coal on the particular continents.

TABLE 2

The distribution of hard coal proved reserves in geographical regions, as of the end of 2001

TABELA 2

Rozkład zasobów udokumentowanych węgla kamiennego w regionach geograficznych, stan na koniec 2001 r.

No	Geographic region	Reserves	
		Gt	%
1.	Middle East	17	0.33
2.	South and Central America	77	1.48
3.	Australia	426	8.21
4.	Europe	475	9.15
5.	Africa	552	10.63
6.	Former Soviet Union	974	18.76
7.	North America	1 202	23.16
8.	Asia Pacific	1 468	28.28
9.	Total World	5 191	100.00

Source: B P Statistical review of world energy. June 2002

The reserves of coal on the particular continents are characteristic of diversified sizes, as is their recognition extent.

The distribution of the documented reserves of the hard coal in the particular geographical regions of the world is shown in the Table 2 (BP Statistical... 2002).

The world reserves of the hard coal in 2001 were estimated to be equal to 5191 Gt, off which nearly half (2459 Gt) were located in Asia and Eastern Europe, including the Russian Federation. The enormous reserves of hard coal are found in North America (1202 Gt), which constitutes more than 23% of the world hard coal reserves.

South America and Central America are the continents where the reserves of hard coal are relatively small, as they are equal only to 77 Gt, which constitutes 1.48% of the worldwide reserves of this raw material. The reserves of the hard coal in Europe amount to 475 Mt, some 9.15% of the worldwide reserves.

2. Production and consumption of coal

The worldwide production of hard coal in 2000 amounted to 3639 Mt, 829 Mt more than hard coal rates extracted in 1980 (see Table 3). The growth in question amounted 29.5% compared

TABLE 3

Total production and consumption of (T) steam (S) and coking (C) hard coal in the particular geographical regions in 1980 and 2000 [Mt]

TABELA 3

Produkcja i zużycie węgla kamiennego ogółem (O) energetycznego (E) i koksowego (K) w poszczególnych regionach geograficznych w latach 1980 i 2000 [mln ton]

Year	Coal type	Europe	Former Soviet Union	North America	South America	Asia	Australia and NZ	Africa	World
Production									
1980	S	402	409	599	9	710	31	108	2 268
	C	98	144	135	2	108	43	12	542
	T	500	553	734	11	818	74	120	2 810
2000	S	163	221	849	50	1 495	136	228	3 142
	C	45	101	87	2	154	105	3	497
	T	208	322	936	52	1 649	241	231	3 639
Consumption									
1980	S	432	398	561	8	724	29	84	2 236
	C	140	131	73	8	177	7	9	545
	T	572	529	634	16	901	36	93	2 781
2000	S	284	193	880	16	1 622	60	159	3 220
	C	95	96	36	17	262	5	7	518
	T	379	295	916	33	1 884	65	166	3 738

Source: Coal Information 2001

with the production in 1980. By contrast, the increase in the production of the steam coal during this period amounted to 874 Mt, which constitutes the 38.5% growth. However, with regard to the coking coal, the drop of production can be seen by 45 Mt during this period, which is due to the advent of the steam coal with more stringent quality parameters so as to enable acting as the additive to the iron blast furnace in the Pulverized Coal Injection process, a.k.a. as PCI.

The significant growth of production of hard coal in 2000, compared with 1980, occurred in Australia (by 167 Mt or 225.7%), Africa (by 111 Mt or 92.5%), Asia (831 Mt or 101,6%), North America (by 202 Mt or 27.5%) and in South America (by 41 Mt or 272.7%).

The largest producers of coal in 2000 were the following countries: China — 1171 Mt, USA — 899 Mt, India — 310 Mt, Australia — 238 Mt, South Africa — 225 Mt, Russia — 169 Mt, Poland — 102 Mt, Ukraine — 81 Mt, Indonesia — 79 Mt and Kazakhstan — 71 Mt.

During the period of 20 years of the last century, Europe reduced the consumption of coal by 292 Mt, including the consumption of the steam coal at the rate of 239 Mt and the consumption of the coking coal by 53 Mt. The production of coal in Europe in 2000 amounted to 208 Mt and was lower by 8.3% with relation to the 1999 levels (227 Mt), the reasons for production reduction being predominantly laid in the increasing costs of coal extraction and the reductions of subsidies for this industry.

Table 3 presents the consumption of steam and coking coal by the particular geographical regions in 1980 and 2000. The consumption of coal in the work in 2000 amounted to 3738 Mt, including steam coal at the rate of 3220 Mt and coking coal at the rate of 518 Mt. In this period, the growth in the consumption of the hard coal occurred by 957 Mt, which constitutes 44.0%, including the increase of the steam coal consumption by 984 Mt (44%) and the reduction of the coking coal consumption by 27 Mt (4.9%).

The definite increase of the consumption of hard coal in 2000, as compared with 1980 data, was reported in Asia, where the growth amounted to as many as 983 Mt (109.1%), including steam coal (the growth by 898 Mt or 124%), and coking coal (the growth by 85 Mt or 48%), as well as in Africa, where the rate extracted in 2000 was bigger than extracted in 1980 by 73 Mt or 78%, in Australia (by 29 Mt or 80.6%), in North America (by 282 Mt or 44.5%), including steam coal, whose production increase was equal to 319 Mt or 56.9%, and finally in South America, where the production levels of 2000 were bigger by 17 Mt or 106.2% from the levels reported in 1980.

Europe reduced the consumption of coal by 193 Mt (33.7%), including the consumption of the steam coal at the rate of 148 Mt (34.2%) and the consumption of the coking coal by 45 Mt, which corresponds to 32.1%. In the light of the international market under dynamic development, at the beginning of the '80s of the last century, the European Union coal industry was forced to undertake restructuring processes. The coal market in the European Union countries in 1980—2000 was characteristic of the decreasing coal consumption. The factors such as permanently worsening geological conditions, gradual expiration of the coal deposits that are relatively easily accessible and finely, the relatively low level of coal prices on the international markets made the EU coal industry uncompetitive on the international markets.

The drop of the coal consumption by as much as 234 Mt (44.2%) occurred in the former Soviet Union countries. This was the result of the lowered economic activities, associated with the system transformations of these countries (the abandonment of the command economy to the benefit of the market economy).

3. Hard coal and brown coal mining in Poland

3.1. Hard coal reserves and hard coal production

Table 4 presents the domestic reserves of energy minerals (status as at 2000). The domestic reserves as at 2000 exceeded 39.3 Gtoe, off which more than 99.5% are the coal reserves. The remaining, primary energy carriers, i.e. crude oil and natural gas both constitute as little as 0.51% of the national reserves of energy raw materials.

TABLE 4

Domestic reserves of energy minerals, as of 2000

TABELA 4

Krajowe zasoby surowców energetycznych, stan na 2000 r.

Energy carrier	Reserves [Gtoe]		
	proved	prognostic	total
Crude oil	0.01093	0.0031	0.01403
Natural gas	0.06330	0.1222	0.18550
Coal	5.76800	33.3570	39.12500
Total	5.84233	33.4823	39.32453

Source: Karbownik, Turek 2001

The hard coal is found in three basins, notably Upper Silesia Basin, Lower Silesia Basin and Lublin Basin. The Upper Silesia Basin had created itself in the fore-mountain depression, the Lower Silesia basin is the mid-mountain basin, while the Lublin basin is found on the bank of the Eastern European platform. The deposits of hard coal formed in upper Carboniferous. Currently, the Lower Silesia Basin is no longer in operation due to the fact that the reserves have expired.

The literature regarding the domestic reserves of hard coal is very rich (Jawień and others 1985; Kicki, Wacławski 1992a, b; Kicki and others 1996; Ney 1998a, b; Blaschke, Gawlik 1999; Gabzdyl 1999a, b; Kicki, Sobczyk 1999; Sobczyk 2000; Darski and others 2001).

Table 5 shows the proved reserves of hard coal in Poland, status as at 31 December 1989 and 31 December 1999. It should be stated that the transformation from the command economy into the market economy, as well as adjustments of mining industry to the new market conditions, produced essential changes in the reserves base. In 1990—1999, the reserves reduced by 11.5 billion ton (Darski, Kicki, Sobczyk 2001). In Poland 102 912 769 tons of hard coal were extracted, including 85 723 834 tons of steam coal and 17 188 935 tons of coking coal. The structure of coal production total, and the coking coal production data, in the particular mining companies in 2001, have been presented in Table 6. The Katowicka Coal Company extracted the largest rate of coal, amounting to 19 045 015 ton, the entire rate being steam coal. The second-largest extraction company was the Nadwiślańska Coal Company, where the rate of

TABLE 5

Proved reserves of hard coal in Poland [Mt]

TABELA 5

Udokumentowane zasoby węgla kamiennego w Polsce [mln ton]

Coal basin	Status on 31.12.1989		Status on 31.12.1999	
	recoverable	developed	recoverable	developed
Upper Silesia				
— total	57 679	16 850	38 458	8 002
— developed deposit	29 468	16 450	17 513	8 002
Lower Silesia				
— total	461	251	93	3
— developed deposit	389	251	22	3
Lublin Coal Basin				
— total	7 710	455	8 295	348
— developed deposit	763	455	617	348
Total	65 838	17 555	46 846	8 354
Developed deposit	30 620	17 156	18 152	8 354

Source: Darski, Kicki, Sobczyk 2001

TABLE 6

Qualitative characteristics of hard coal extracted at coal companies in 2001

TABELA 6

Charakterystyka ilościowa produkowanego węgla kamiennego w spółkach węglowych w 2001 roku

No	Company	Production total [Mg]	Production of steam coal [Mg]	Expedition to power industry [Mg]
1.	Bytomska Coal Company and its dependent joint stock companies	8 107 000	8 107 000	2 418 390
2.	Rudzka Coal Company and its dependent joint stock companies	10 394 450	9 460 698	3 881 721
3.	Gliwicka Coal Company	13 062 781	11 082 641	5 469 135
4.	Katowicka Coal Company	19 045 015	19 045 015	9 331 624
5.	Nadwiślańska Coal Company	15 814 400	15 680 400	6 257 917
6.	Rybnicka Coal Company	13 586 715	11 073 082	2 086 461
7.	Jastrzębska Coal Company	13 315 800	1 931 697	1 254 711
8.	Total Coal Company and its dependent joint stock companies	93 326 161	76 380 553	30 699 659
9.	Independent coal mines	9 586 608	9 343 301	2 090 217*
10.	Total	102 912 769	85 723 834	32 790 175

* Expedition from Budryk Mine.

Source: Worked out on the base of: Information bulletin... 2002

15 814 400 tons were produced, including 15 680 400 ton of steam coal. The whole of coal extracted at the Bytomska Coal Company, at the rate of 8 107 000 ton, was also steam coal only.

4. The reserves of brown coal and production

The Polish brown coal deposits, significant for the national economy, are found in the tertiary formations. The lower Miocene brown coal, occupying the area of some 61 132 km^2, as well as Mid-Miocene brown coal, found in the area of some 70 203 km^2, have both particular economic significance.

The deposits of brown coal in Poland have been grouped in 8 deposit regions, namely Western and Northwestern region, the Legnica region, Wielkoposki region, Konin region, Łódź region, Bełchatów region and Radom region. The geological reserves of brown coal have been presented in Table 7; these reserves found in 78 deposits amount to the total of 13 984.14 Mt,

TABLE 7

Recognized reserves of brown coal in Poland, as of 31 December 2000 [Mt]

TABELA 7

Rozpoznane zasoby węgla brunatnego w Polsce, stan na 31.12.2000 [mln ton]

Specification	Number resources	Geological reserves				Developed reserves
		recoverable			unrecoverable	
		A+B+C1	C2	total		
Total reserves	78	4 454.90	9 529.24	13 984.14	4 879.02	1 779.50
Including developed deposit						
Active mines	10	1 178. 50	170.63	1 349.13	148.61	1 112.08
Mines under construction	2	764.69	22.53	787.22	62.61	667.42
Total	12	1 943. 18	193.15	2 136.33	211.22	1 779.50
Including undeveloped deposit						
Developed reserves	30	2 459.34	316.31	2 775.65	705.52	—
Prognostic reserves*	31	43.75	9 019.14	9 062.89	3 958.01	—
Total	61	2 503.08	9 335.45	11 838.53	4 663.53	—
Including abandoned deposit						
Total	5	8.64	0.64	9.28	4.27	—

* Including reserves in the so-called Poznań Trench, volume 3 690 Mt.
Source: Przeniosło S. and others 2001

including the reserves thoroughly explored (B-C1 category), amounting to 4454.90 Mt and reserves explored preliminarily (C2 category) that amount to 9529.24 Mt (68%), including 3.7 billion ton of geological reserves found in the so-called Poznań Trench.

As the industrial reserves of the developed deposits amount to 1778.50 Mt, the balance geological reserves utilization coefficient is equal to k = 0.83. Out of the total of 78 proved deposits, ten deposits are under operation, while further two are being prepared for operation.

The proven balance reserves of brown coal (Table 7) found in 61 undeveloped deposits constitute the reserve reserves base for the development of the mining and power industry. These reserves amount to 11.80 billion tons, out of which 2.5 billions ton being proved in detail (B-C1 category).

The national brown coal industry is the world fifth-largest, after Germany, United States, Australia and Greece. Currently, the brown coal is extracted in four brown coal extraction pits, namely: Adamów, Bełchatów, Konin and Turów. In the year of 2001, these pits produced 59.451 Mt of brown coal, out of which 59.131 Mt were delivered to the power plants. The extraction of such rate of brown coal was associated with the removal of some 251.5 million m^3 of overlay and pumping out of more than 410 million m^3 of water. As can be seen, the extraction of one ton of brown coal required the removal of 4.2 m^3 of overlay and pumping out of some 6.9 m^3 of water (Pietryszczew 2002) .

4.1. The Adamów extraction pit

The Adamów extraction pits complex was established in 1959—1964 on the Adamów deposit. Currently, the brown coal is extracted from three extraction pits, notably Adamów, Koźmin and Władysławów. The extraction pits production capacity is 4.5—5.20 Mt of brown coal annually. The pits deliver the fuel to the Adamów power plant, with 600 MW of installed power. The extraction of such rate of brown coal was associated with the removal of some 32.0—34.0 Mt and pumping out of water at the rate of 90—100 million m^3 per year. The pits lifetime is expected to end in 2022. The extraction of brown coal in 2001 amounted to 4.319 Mt, out of which 4.31 Mt of brown coal were delivered to the power plant.

4.2. The Bełchatów strip mine

The Bełchatów open pits complex is one of the world largest, with capacity of some 38.5 Mt of brown coal per year. The fuel is delivered to the Bełchatów power plant, with total power of 4340 MW. For the purposes of maintaining and the development of the Bełchatów power plant production capacity, the Szczerców open pit is made accessible, whose geological and mining conditions are similar to Bełchatów pits. The lifetime for the complex is expected to end in 2030, and if the satellites are operated, the deposits are expected to expire in the year of 2035. The extraction of brown coal in 2001 amounted to 34.664 Mt, out of which 34.578 Mt of the fuel were delivered to the power plants.

4.3. The Konin strip mine

The Konin strip mine is the multiplant enterprise, currently extracting brown coal from three open pits, notably Kazimierz, Jóźwin and Lubstów. The complex production capacity is equal to 15 Mt of brown coal extracted per year. The fuel is delivered to the Konin power plant, with installed power 538 MW and the Pątnów power plant, with installed power 1200 MW. The economic life of the complex is planned to end in the year of 2040. The extraction of brown coal in 2001 amounted to 11.381 Mt, out of which 11.191 Mt of brown coal were delivered to the power plants.

4.4. The Turów strip mine

The Turów strip mine is the oldest, large brown coal open pit, with annual production capacity of 15 Mt. The fuel is delivered to the Turów power plant, with installed power equal to 2000 MW. The strip mine lifetime is planned to end in the year of 2035, with the possibility of extension to 2045. The extraction of brown coal in 2001 was equal to 9.177 Mt, including 9.052 Mt being delivered to the power plants. The extraction levels in these mines are well below production capacity, which is associated with the technical capabilities of collecting the fuel by the particular power plants.

5. The National Power System

The National Power System is the largest and most significant system in Central Europe and comprises three separate subsystems, notably the generation subsystem, the transmission subsystem and the distribution subsystem. The system brown coal fired and hard-coal fired power plants have the main share in the production of energy. The gross electricity generation in Poland in 2000 amounted to 145 169 GW·h, including the production of:

— public utility hard coal fired power plants — 84 153 GW·h,
— public utility brown coal fired power plants — 49 677 GW·h,
— industrial power plants — 7 192 GW·h,
— public utility water power plants — 3960 GW·h,
— small power plants — 187 GW·h.

In addition to the above, some 3290 GW·h of energy was imported. The portion of electricity is used for power purposes, pumping out of water in the pump storage power plants and station service requirements. The losses and the balance differences in the National Power System (KSE) in 2000 amounted to 14 315 GW·h (Soliński 2002; www.pse.pl).

5.1. The generation sector

The following power plants are operated as system power plants in Poland, notably the Bełchatów power plant, Chorzów power plant, Halemba power plant, Kozienice power plant, Łagisza power plant, Łaziska power plant, Opole power plant, Połaniec power plant, Pomorzany power plant, Rybnik power plant, Stalowa-Wola power plant, Turów power plant, The Dolna

Odra Power Plant Complex and Pątnów-Adamów-Konin Power Plant Complex. In addition to the system power plants, the electricity is generated by a number of industrial power stations, as well as power and heat generation plants located beside the various enterprises.

The Polish power system installed power in 2000 amounted to 34 552 MW. The structure of the installed power share is as follows: hard coal fired power stations — 20 386 MW (59%), brown coal fired power stations — 9329 MW (27%), industrial power plants — 2764 MW (8%) and water power plants — 2073 MW (6%).

The advantage of the power plants using the solid fuels, i.e. brown coal and hard coal, can be seen. This is a result of the accessibility of these raw materials in the country.

5.2. The transmission sector

The transmission of power is handled by:

— Transmission Subsystem Operator (OSP), which is the PPGC (Polish Power Grid Company),

— Distribution Subsystems Operators, i.e. the particular Distribution Companies.

The PPGC is a holder of the concession for transmission and distribution and the turnover of electricity. The company mission is the effective use of transmission system so as to provide for the conditions of development and functioning of the open market of the electricity in the country, including the international exchange. The objective of the PPGC operations is to provide for the safe and economic operation of the national power system in the market economy and the unencumbered development of competition.

The length of the transmission lines constituting the property of the Transmission Subsystem operator in 2001 was as follows:

— 750 kV lines — 114 km,

— 400 kV lines — 4660 km,

— 220 kV lines — 8116 km,

— 110 kV lines — 32 332 km.

By contrast, the length of the medium and low voltage lines, constituting the property of the Distribution Grids Operators in 2001, was equal to:

— medium voltage lines — 278 319 km (including 54 321 km of cable lines),

— LV lines — 425 037 km (including 103 370 km of cable lines),

— LV terminals length — 145 270 km.

5.3. Distribution sector

As already mentioned, the Distribution Companies as the Distribution Subsystems Operators, are the owners of the local distribution networks. Their duties include maintaining the distribution networks owned so that the reliable delivery of electricity to the recipients, as well as the electricity sales to the recipients connected to the distribution networks, is made possible.

Currently, 33 Power Authorities operate in Poland, dealing with the distribution of the electricity. In 2001, the Power Authorities delivered 101 239 GW·h of electricity for 15 291 243 recipients throughout the entire country. The biggest number of recipients, i.e. 15 265 226, took advantage of the LV lines and purchased 44 469 GW·h of electricity. The

second-largest number of recipients, i.e. 25 764, took advantage of the medium voltage lines and bought 29 565 GW·h of electricity. The HV power recipients, in the amount of 253, constituted the fewest group, purchasing 27 205 GW·h in 2001 (www.ptpiree.com.pl).

6. The consumption of coal in the power industry

Table 8 presents the production of electricity in Poland in 1991—2000. The production of electricity in 2000 amounted to 145.2 TW·h, including 133.8 TW·h generated by the public utility power stations, out of which 84.2 TW·h was produced by the hard coal fired plants and 49.7 TW·h by the brown coal fired stations. The electricity from the brown coal constituted some 34.3% of the domestic electricity production. The Table 9 shows the qualitative characteristic of coal delivered in the particular quarters to the public utility power stations in 2000—2001. This table also provides the rate of coal and average prices of coal intended for the power industry.

TABLE 8

The production of electricity in Poland in 1991—2000

TABELA 8

Produkcja energii elektrycznej w Polsce w latach 1991—2000

Specyfication	Unit	Year						
		1991	1995	1996	1997	1998	1999	2000
Total electricity production	TW·h	134.7	139.0	142.7	142.8	142.8	142.1	145.2
Thermal power station	TW·h	122.7	126.5	130.5	131.0	130.9	130.6	133.8
— hard coal — fired	TW·h	67.3	75.8	79.7	80.2	79.2	79.8	84.2
— brown coal — fired	TW·h	55.4	50.7	50.8	50.8	51.8	50.7	49.7
Electricity from brown coal for total production	%	41.1	36.5	35.6	35.6	36.2	35.7	34.3
— for the production of thermal power stations	%	45.1	40.1	38.9	38.8	39.6	38.8	37.1

Source: Czapla and others 2002

The business plans based outlook for the extraction and the sales of the hard coal have been presented in Table 10. The quantities provided in this table show that the extraction of hard coal by 2005 will be around 102 Mt. The sales of hard coal throughout the entire country will amount to 77 Mt, off which 64 Mt will be the steam coal, while the remaining 13 Mt will be the coking coal. The exports of coal will amount to 23 Mt.

Table 11 shows the selected technical and economical coefficients for the public utility hard coal fired power plants in 1999—2000. The calorific value of the coal fired in the process of producing electricity in 2000 was at the level of 21 109 kJ/kg. The net coefficient of coal

TABLE 9

Qualitative characteristics of coal delivered to the public utility power industry in 2000—2001

TABELA 9

Charakterystyka jakościowa węgla dostarczonego do energetyki zawodowej w latach 2000—2001

Specification	Unit	Quarter			
		I	II	III	IV
Year 2000					
Calorific value Q	MJ/kg	21 352	21 200	21 350	21 259
Ash content A	%	20.7	21.4	21.0	22.1
Sulphur content S	%	0.88	0.93	0.91	0.87
Volume	Mg	8 997 957	7 641 463	8 625 952	11 623 971
Price	zł/Mg	126.05	118.87	119.07	124.69
Year 2001					
Calorific value Q	MJ/kg	21 425	21 097	20 956	21 459
Ash content A	%	21.0	21.3	21.5	21.7
Sulphur content S	%	0.88	0.90	0.89	0.87
Volume	Mg	10 002 681	6 928 128	8 818 162	11 194 923
Price	zł/Mg	131.64	126.59	127.08	133.98

Source: Worked out on the base of:: Information bulleting... 2000 and 2001

TABLE 10

Business plans based on the outlook for the extraction and the sales of the hard coal [Mt]

TABELA 10

Prognoza wydobycia i sprzedaży węgla kamiennego na podstawie biznesplanów i PTE spółek węglowych i kopalń [mln ton]

Specification	Year					
	2000	2001	2002	2003	2004	2005
Production	102.2	102.8	103.4	102.9	102.8	101.5
Domestic sale, including:	78.2	76.9	77.2	77.4	77.6	77.0
— steam coal	66.3	63.4	64.0	64.5	64.7	64.2
— coking coal	11.8	13.6	13.3	12.9	12.8	12.8
Export	23.0	25.4	24.6	23.6	23.7	23.1
Sale — in total	101.2	102.3	101.9	101.0	101.3	100.1

Source: Evaluation... 2002

consumption per electricity production in 2000 was equal to 9566 kJ/kW·h. The time of utilization the maximum output capacity was equal to 4143 hours.

As the primary energy carrier, the brown coal is used for electricity generation by a number of countries having the reserves of this raw material. Table 12 provides the consumption of brown coal for electricity generation and heat generation in the selected countries in 1998—1999. According to Coal Information 2001 data, Germany is the world largest country to utilize the brown coal, consuming 149.7 Mt in 1999, before the second-largest brown coal user, the US, with annual consumption of 75.7 Mt. Poland occupies the fifth position in this list.

Having analyzed this classification of countries extracting brown coal, this energy carrier can be seen to be extracted both in well-developed countries and in developing countries. Brown coal is extracted in countries where, basically, it is the only energy source, as well as in the countries

TABLE 11

Technical and economic indexes of thermal public utility hard coal — fired power plants in 1999—2000

TABELA 11

Wskaźniki techniczno-ekonomiczne elektrowni cieplnych zawodowych na węglu kamiennym w latach 1999—2000

Specification	Unit	Year	
		1999	2000
Total electircity generation brutto	GW·h	79 874	84 153
Heat generation	TJ	176 719	165 410
Consumption of hard coal, including	kt	41 232	42 576
— for electricity	kt	32 383	34 217
Average calorific value, included	kJ/kg	21 534	21 346
— for electricity	kJ/kg	21 272	21 109
Total consumption, including	GJ	912 183	936 922
— for electricity	GJ	705 115	744 234
— for heat	GJ	207 068	192 688
Index of fuel consumption for electricity generation			
— total	kJ/kW·h	8 828	8 844
— net	kJ/kW·h	9 562	9 566
Index of fuel consumption for heat generation	MJ/GJ	1 172	1 165
Index of internal fuel consumption	%	7.68	7.55
Use of power arailable	hour	4 020	4 143
Stocks of hard coal	kt	7 813	7 389
Stocks of hard coal	days	69	64

Source: Situation in Power Industry 2001

TABLE 12

Consumption of brown coal for electricity and heat generation in selected countries [Mt]

TABELA 12

Zużycie węgla brunatnego do produkcji energii elektrycznej i ciepła w wybranych krajach [mln ton]

Country	Year	
	1998	1999
Germany	153.6	150
USA	72.8	76
Australia	65	66
Greece	60	61
Poland	62.1	60
Turkey	52.1	54
Canada	39.1	38
Czech Republic	40.9	36
Hungary	14.3	15
Spain	12.6	12.2
Mexico	9.3	10
Slovak Republic	3.8	4
Austria	0.8	1
France	1.1	0.9

Source: Coal Information 2001

with rich and various reserves of other energy sources. Greece displays the biggest share of brown coal in the production of electricity (68%); the brown coal contribution in the generation of electricity is also considerable for the Czech Republic (63%), Bulgaria (36%), Germany (36%) and Australia (25%) (according to Uberman, Kozioł 1998).

It should be stressed here that the production of electricity from the brown coal in Poland has been maintaining relatively the same level for a number of years, its share in the total production being between 35 and 40%. The brown coal fired power plants are located near the deposits of brown coal, which provides for the continuousness of the deliveries of brown coal from the strip mines to the power plants irrespective of the weather conditions, and has the significant impact on reducing the transportation costs of this fuel (Kasztelewicz 2002; Kozioł, Tajduś 2002).

The share of hard coal and brown coal in the production of electricity in 1999 was as follows: Poland — 96%, South Africa Republic — 90%, Australia — 86%, China — 80%, Czech Republic — 71%, Greece — 69%, India — 66%, USA — 56%, Denmark — 52%, Germany — 51%, EU — 27%, world — 38% (Borkowski, Białas 2002).

The calorific value of the brown coal fired in the process of generating electricity in 2000 was at the level of 8525 kJ/kg. The net coefficient of coal consumption per electricity production

in 2000 was equal to 10 723 kJ/kW·h. The time of utilization the maximum output capacity was equal to 5889 hours (Table 13). The cost of producing the electricity per unit was equal to zł 96.48 per MW·h, including the variable costs amounting to zł 56.54 per MW·h (Pietryszczew 2001).

Table 14 presents the technical and economical indexes for the public utility thermal power plants in 1999—2000. The net index of fuel consumption per electricity generation in 2000 was equal to 9995 kJ/kW·h, while the net index of fuel consumption per heat generation was equal to 1166 MJ per GJ of heat.

The outlook for extraction of brown coal in the currently operable strip mines, as well as in the prospective Legnica strip mine, has been provided in Table 15. The deposits of brown coal in the region of Legnica are characteristic of considerable rate, twice as large as the rates of deposits currently under operation. In addition to the above, the use of these deposits will constitute the alternative solution to the economic problems of the Lower Silesia, as the copper ores extraction will be declining. Five operation fields can be found in the Legnica deposits, notably Legnica West, Legnica East, Legnica North, Ścinawa and Ruja (Kozłowski 2000, 2001a, b, 2002; Bednarczyk, Szatan 2001; Weil 2001).

TABLE 13

Technical and economic indexes of thermal public utility brown coal fired powerplants in 1999—2000

TABELA 13

Wskaźniki techniczno-ekonomiczne elektrowni cieplnych zawodowych na węglu brunatnym w latach 1999—2000

Specification	Unit	Year	
		1999	2000
Total electircity generation brutto	GW·h	50 741	49 677
Heat generation	TJ	5 817	5 548
Consumption of brown coal, including	kt	60 306	58 173
— for electricity	kt	59 522	57 422
Average calorific value, included	kJ/kg	8 632	8 525
Consumption energy from fuels, including	TJ	522 344	497 600
— for electricity	TJ	515 412	491 015
— for heat	TJ	6 932	6 585
Index of fuel consumption for electricity generation, total	kJ/kW·h	10 158	9 884
— net	kJ/kW·h	10 970	10 723
Index of fuel consumption for heat generation	MJ/GJ	1 192	1 187
Index of internal fuel consumption	%	7.40	7.83
Use of power available	hour	5 690	5 899

Source: Situation in Power Industry 2001

TABLE 14

Technical and economic indexes of thermal public utility power stations in 1999—2000

TABELA 14

Wskaźniki techniczno-ekonomiczne elektrowni cieplnych zawodowych w latach 1999—2000

Specification	Unit	Year	
		1999	2000
Total electircity generation	GW·h	130 615	133 830
— including CHP	GW·h	15 825	16 724
Heat generation	TJ	182 536	170 958
— including CHP	TJ	159 780	153 042
Index of fuel consumption for electricity total	kJ/kW·h	9 344	9 230
— including CHP	kJ/kW·h	4 521	4 580
Index of fuel comsumption for electricity net	kJ/kW·h	10 110	9 995
Index of fuel consumption for heat generation	MJ/GJ	1 172	1 166
Eficiency of electricity generation	%	38.53	39.00
Eficiency of heat generation	%	85.30	85.79
Index of internal consumption	%	7.57	7.65
Time of use power	hour	4 538	4 658

Source: Situation in Power Industry 2001

TABLE 15

Outlook for brown coal mining production in the currently operating mines and projected Legnica mine (2-face system) [Mt]

TABELA 15

Prognoza wydobycia węgla brunatnego w kopalniach czynnych i kopalni perspektywicznej Legnica (układ 2-frontowy) [mln ton]

Year	Mines					Total
	Adamów	Bełchatów	Konin	Turów	Legnica	
2005	4.8	36.0	11.4	13.5		65.7
2010	5.4	39.2	11.7	12.2		67.5
2015	4.6	43.4	11.9	11.4		70.3
2020	4.6	36.4	11.8	10.7	8.1	70.6
2025		36.5	10.3	11.5	21.7	80.0
2030		22.6	4.5	10.9	57.7	80.0
2035		6.7	4.5	10.0	60.5	75.0
2040			0.5	10.0	59.5	70.0
2045				9.6	60.4	70.0
2050					60.0	60.0
2060					60.0	60.0
2070					60.0	60.0
2073					2.1	2.1

Source: Czapla and others 2002

The real possibility for starting the extraction of brown coal from Legnica strip mine cannot take place earlier than in 2016. The deposits may be developed by means of one operation front with extraction capacity of 30 Mt or by means of two operation fronts with extraction capacity of 60 Mt. The single front operation will provide the fuel for the future power plant with installed power 4000—4500 MW, while the twin front operation will deliver the fuel for the future power plant with installed power total of 8000—9000 MW (Czapla and others 2002).

7. The forecasts for demand for the coal in the world and in Poland

The recent years' forecasts regarding the demand for energy show the problem of expiring of fossil fuels. There is no unambiguous answer to the question of how much crude oil, natural gas and coal has remained in the earth. At the current consumption of these energy carriers, their supply would be sufficient for 42, 63, 223 years, respectively.

The complex forecasts, as well as scenarios regarding the consumption of energy, by regions, are prepared, inter alia, by International Energy Agency, World Energy Council, US Department of Energy, Australian Bureau of Agriculture and Resource Economies, European Commission, etc.

The contemplations regarding the energy prospects of the world by 2050 and later, with the incorporation of such factors as global climatic changes, air pollution, accessibility of land and water reserves, have led to preparing six possible scenarios for the power industry development. These scenarios assume the efficiency of the processes of generating, converting and the use of energy to improve or to remain unchanged, and are characteristic of the following features, notably:

— A1 scenario is based chiefly on the use of hydrocarbon fuels and the restriction in the use of the coal and other primary energy carriers;

— A2 scenario is based chiefly on coal and partially on natural gas, with the restriction of the use of the crude oil reserves, nuclear energy and renewable energy sources;

— A3 scenario assumes the use of the new energy technologies from the area of the nuclear energy and renewable energy sources, the use of coal reserves and crude oil being restricted, however the higher share of natural gas being maintained during the transient period;

— B scenario assumes the continuation of the trends to date with regard to the fuels structure;

— C1 scenario assumes the use of the sources of renewable energy, the nuclear energy being restricted at the same time;

— C2 scenario is based on the increase share of the nuclear energy through the use of the new and safe small and medium power reactors, in the order of 100—300 MW.

Table 16 shows the outlook for the production of the primary energy carriers, as well as final consumption of the energy in the world in 2020 and 2050. As can be seen, all scenarios anticipate the considerable rates of consumption of liquid fuels and gas fuels, at the cost of solid fuels. As mentioned above, the A2 scenario assumes the use of coal, whose production in 2020 will amount to 180.4 EJ (1 EJ = 10^{18} J), i.e. 197.6% compared with 1990 (91.3 EJ). With regard to the outlook for 2050, the coal production in accordance with the A2 scenario is considerable, as it is expected to amount to 327.8 EJ, which corresponds to the growth of 360% as compared with the 1990 data.

TABLE 16

Outlook for production of primary energy and final consumption in the world in 2002—2050, EJ*

TABELA 16

Prognoza produkcji energii pierwotnej i zużycia finalnego w świecie w latach 2002—2050, EJ*

No	Specification	Year 1990	Scenario in 2020						Scenario in — Year 2050					
			A1	A2	A3	B	C1	C2	A1	A2	A3	B	C1	C2
1.	Primary energy	375.5	643.5	643.5	642.7	566.9	478.6	478.5	1 039.6	1 039.9	1 032.1	830.6	596.2	596.5
	— coal	91.3	155.3	180.4	121.8	141.9	95.9	95.5	158.7	327.8	93.8	173.3	62.8	61.5
	— oil	128.1	195.1	188.4	178.4	158.3	126.4	126.4	330.8	200.1	181.3	169.1	111.8	109.7
	— natural gas	70.3	151.6	142.8	160.8	133.1	128.1	123.9	196.8	228.6	331.2	188.4	164.1	139.8
	— nuclear	18.8	38.1	24.3	43.1	37.7	28.1	35.6	121.4	45.6	118.1	114.7	21.8	74.1
	— renewables	67.0	103.4	107.6	138.6	95.9	100.1	97.1	231.9	237.8	307.7	185.1	235.7	211,4
2.	Final energy	270.0	477.7	477.6	474.8	422.0	358.0	357.1	714.2	731.4	718.5	593.7	420.8	414.1
	— solids	80.8	111.0	116.8	113.9	109.3	99.2	98.4	113.4	139.8	131.5	134.0	82.1	82.1
	— liquids	105.9	184.6	180.4	171.7	147.8	116.4	117.2	302.3	262.5	235.3	197.2	143.2	141.1
	— electricity	34.7	68.2	70.7	72.0	60.7	51.1	50.7	120.6	131.5	126.9	98.0	74.9	72.0
	— others (heat, gas, hydrogen)	48.6	113.9	109.7	117.2	104.2	91.3	90.8	177.9	197.6	224.8	164.5	120.6	118.9

* EJ — eksajoule (10^{18}J).

Source: Worked out on the base of: Nakićenović and others 1998

With regard to the share in the consumption of the final energy, the solid energy carriers go after liquid energy carriers.

The European Union presented its energy future in the report entitled "The European Union Energy Outlook to 2020", published at the end of 1999 (Table 17).

TABLE 17

Outlook for consumption of primary energy carriers in the EU countries, in accordance to basic scenario

TABELA 17

Prognoza zużycia nośników energii pierwotnej w krajach Unii Europejskiej według scenariusza bazowego

Year	Unit	Carrier of primary energy					
		coal	oil	natural gas	nuclear	other	total
1999	Mtce	294.0	903.0	467.0	319.0	41.0	2 024.0
	%	14.5	44.6	23.1	15.8	2.0	100.0
2010	Mtce	260.0	935.7	572.9	324.3	125.7	2 218.6
	%	11.7	42.2	25.8	14.6	5.7	100.0
2020	Mtce	311.4	947.1	615.7	284.3	142.9	2 301.4
	%	13.5	41.2	26.7	12.4	6.2	100.0

Source: European Union Energy Outlook to 2020, 1999

The scenario in question assumes that:

— the number of EU residents will increase from 371 million in 1995 to 384 million in 2020;

— the economic growth will be around 2% per annum;

— the supply problems on the primary energy carriers markets do not occur;

— the significant changes in the nuclear energy sector do not occur, the nuclear power plants lifetime being estimated to last 40 years;

— the processes with regard to energy conversion will continue;

— the electricity and gas market liberalization will advance.

The following phenomena are expected to occur in the structure of consumption of primary energy carriers, notably:

— following the reducing shares in the electricity generation, the coal after 2010 will gain its significance as a result of stopping nuclear power plants and the natural gas price hikes. The coal will continue to be the main feedstock for electricity generation processes by the year of 2030, i.e. to the time horizon of the European Commission forecast — Table 18;

— currently, natural gas is the universal raw material, used in a number of technologies for electricity generation. The crude oil will maintain its role in transport, however, its share in electricity generation will be on the decline;

— the renewable energy carriers show the slight increase in the production of electricity (Table 18). The fact should be taken into consideration that the water reserves in the EU countries have expired to a significant extent.

TABLE 18

Outlook for consumption of primary energy carriers and renewable energy carriers for electricity generation in the EU countries [Mtce]

TABELA 18

Prognoza zużycia pierwotnych nośników energii i odnawialnych źródeł energii do produkcji energii elektrycznej w Unii Europejskiej [mln tpu]

Specification	Years			
	1995	2010	2020	2030
Coal	246	196	261	397
Crude oil	94	71	59	48
Natural gas	150	277	317	341
Renewables	30	46	51	57
Total	520	590	688	843

Source: European Union Energy Outlook to 2000, 1999

The European Union is the world largest net importer of the crude oil, natural gas and hard coal.

8. The role of coal based mining in the National Power System

The "Guidelines for energy policy of Poland until 2020" (2000) constitute the basic document with regard to determining the demand for the energy materials. Taking into consideration the significant uncertainty of the future statuses of economy, three scenarios of social and economic development have been prepared, notably the surviving scenario, the reference scenario and progress-plus scenario.

Based upon the forecasted consumption of final energy, the outlook for demand for primary energy carriers has been prepared. Table 19 shows the outlook for the demand for hard coal and brown coal by 2020. Each of the variants presented anticipates the reduction of demand for hard coal. This reduction in 2020 will reach the level of about 80 Mt of hard coal. With regard to the brown coal, the demand in the period in question will continue to maintain the level of about 66 Mt.

The forecasted demand for fuels and energy by 2005 in Poland has been presented in the "Evaluation of Realization and Correction of the Assumptions of the Polish Energy Policy by 2020" (2002). The calculations for the two variants were performed there, notably the reference variant and efficiency variant, the difference between the variants meaning the assumption of additional reduction of demand for final energy by 1% per year.

Table 20 presents the forecasted balance of hard coal by 2005. The annual demand for steam hard coal by 2005 will be reduced by some 5 Mt in the reference variant and by nearly 9 Mt in the efficiency variant, compared with 1999 data. The significant reduction is expected to occur in the heat generation, industrial power system and households.

The forecast based brown coal production (Table 15) is associated with the technical capabilities of the power plants. The extraction for the entire period will maintain the level of

TABLE 19

Forecasted demand for hard coal and brown coal

TABELA 19

Prognoza zapotrzebowania na węgiel kamienny i węgiel brunatny

Scenario	Specification	Unit	Years				
			1997	2005	2010	2015	2020
Survive	hard coal	Mt		92.9	87.9	86.0	83.5
	brown coal	Mt		66.8	67.2	66.1	65.6
	domestic demand	Mtce		106.2	108.6	110.7	112.2
Basic	hard coal	Mt	104.5	91.3	84.3	83.9	81.9
	brown coal	Mt	65.4	66.8	67.4	66.2	65.6
	domestic demand	Mtce	107.3	106.4	109.1	112.4	116.2
Progress--plus	hard coal	Mt		85.5	84.6	84.5	82.4
	brown coal	Mt		66.4	67.2	66.2	65.6
	domestic demand	Mtce		103.7	109.7	114.7	121.3

Source: Guidelines... 2000

TABLE 20

Forecasted balance of hard coal by 2005

TABELA 20

Prognozowany bilans węgla kamiennego do roku 2005

Specification	1999	2000	Basic scenario		Eficiency scenario	
			2003	2005	2003	2005
Domestic supply	110.2	102.8	103.9	102.5	103.9	102.5
Import	2.4	1.5	2.2	2.2	2.2	2.2
Export	24.1	23.2	20.3	20.1	23.0	24.5
Domestic demand. incluging:	88.5 *	83.4 *	85.8	84.6	83.1	80.2
— coal-fired power station	43.4	44.5	41.1	42.4	40.4	41.5
— heat generation plant	7.7	6.7	7.0	6.2	6.4	5.4
— industrial electric power utility**	11.3	10.7	9.5	9.1	10.2	9.6
— coking plants	11.4	12.3	11.1	10.9	10.7	10.3
— households***	12.2	9.0	12.1	11.4	11.3	10.3

* Including losses and balance differences.
** Industrial electric power utility including power and heat stations.
*** Including agriculture.
Source: Evaluation... 2002

around 61 Mt, with some possibility of increasing to 65 Mt, at the cost of brown coal consumption rate.

Summary

1. The world coal production continues to the characteristic of the supply in excess, thereby leading to further reductions of the coal prices and extraction levels. In spite of the fact that the coal reduced its share in the international market to the benefit of such energy sources as crude oil, natural gas and nuclear energy, coal still remains the main source of energy, particularly for electricity generation.

2. The hard coal will continue to be the important source of primary energy, in addition to crude oil, natural gas and other renewable sources of energy. At the current level of coal consumption, its reserves will be sufficient for the period of 228 years, whereas the reserves of crude oil as per the outlooks will be sufficient only for the period of 42 years, and the reserves of natural gas, for the period of 65 years only.

3. The considerable role of coal in the world energy industry, as well as in other industries, is justified, inter alia, by the fact that:

— 23% of the demand for the world primary energy is satisfied by coal;

— some 38% of the world electricity is generated from coal;

— 70% of world steel production depends on the coal feedstock;

— the world coal production in 2000 amounted to 3639 Mt;

— a number of countries out of the largest coal exporters are the developing countries, which obtain significant gains from the coal production and distribution activities.

4. The energy outlooks anticipate the share of coal in the production of electricity at the level exceeding 37% in the years of 2010 and 2020. The share of coal in the global consumption in 2020 is estimated to be at the level of 24.9% (23.2% in 1998). The share of coal in the production of electricity in EU in 1998 was equal to 30%, this value being expected to amount to 16.5% in 2010 and to 23.1% in 2020.

5. In European Union, due to high costs of extracting hard coal and reducing its production costs, the natural gas and crude oil will be the more important primary energy carriers. However, coal will remain the basic carrier for electricity generation. The considerable portion of demand for the hard coal will be satisfied by the imports.

6. The restructuring processes in the Polish coal mining are considerably advanced. Poland plans to reduce the coal extraction level from 116 Mt in 1998 to 88 Mt in 2010, and 77 Mt in 2020. As can be seen, the coal role in the immediate perspective will continue to be dominating in the fuel and energy balance of Poland, and will still be significant in the long-term horizon.

7. A number of factors call for maintaining the strategic role of brown coal in the country production of electricity, notably:

— the necessity of maintaining the country energy safety;

— considerable reserves;

— considerable economic competitiveness of brown coal compared with other primary energy carriers assisted electricity generation;

— modern and safe operational techniques;

— dedicated scientific, design and production backup for machines and equipment intended for open pit operation.

8. The preparation of a new mining and energy basin complex, which will replace in the future the production of electricity where it is generated currently is of the strategic significance; the deposits located in the region of Legnica are the most suitable for this purpose.

9. The accession of Poland to the EU is associated with the adoption of the standards and norms applicable in the EU countries. One of the most difficult problems will be the restriction of the adverse environmental impact of coal use. This will require the considerable reductions of pollutants rates generated in the process of coal burning (NO_x, SO_2, CO_2 and dusts), as well as the increase in the efficiency of coal conversion in the power plants.

10. The surplus of supply over the demand for the electricity restricts the use of the installed power capacity. However, the introduction of the exchange market, in accordance with the requirements of EU, will lead to the significant reduction of prices, which will hinder the obtaining of the funds intended for modernizing both mines and power plants.

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ROLA WĘGLA KAMIENNEGO I WĘGLA BRUNATNEGO W KRAJOWEJ ENERGETYCE

Słowa kluczowe

Węgiel kamienny, węgiel brunatnu, paliwa pierwotne, zasoby, wytwarzanie energii elektrycznej

Streszczenie

Problemy energetyczne muszą być rozpatrywane globalnie ze względu na źródła energii, funkcjonujące rynki oraz ochronę środowiska przyrodniczego. Kopalne surowce energetyczne, w porównaniu do pozostałych nośników energii pierwotnej, mają decydujące znaczenie dla rozwoju gospodarki energetycznej świata. Światowe zasoby węgla kamiennego w 2001 r. szacowane są na około 5191 mld ton, z tego niemal połowa, tj: 2459 mld ton przypada na Azję i Europę Wschodnią z Federacją Rosyjską. Ogromne zasoby węgla kamiennego występują również w Ameryce Północnej — 1202 mld ton, co stanowi 23% światowych zasobów węgla.

Produkcja węgla kamiennego w świecie w 2000 r. wynosiła 3639 mln ton, w tym węgla energetycznego 3142 mln ton, a węgla koksowego 497 mln ton. Zdecydowany wzrost produkcji węgla kamiennego nastąpił w Australii, Afryce, Azji i Ameryce Północnej. W Europie w okresie dwudziestu lat ubiegłego wieku odnotowano spadek produkcji węgla kamiennego o 292 mln ton.

Zużycie węgla na świecie w 2000 r. wyniosło 3738 mln ton, w tym węgla energetycznego — 3220 mln ton, a węgla koksowego — 518 mln ton. Zdecydowany wzrost zużycia węgla kamiennego wystąpił w krajach Azji, Afryki, Australii oraz w Ameryce Północnej. Europa zmniejszyła zużycie węgla o 193 mln ton, w tym węgla energetycznego o 148 mln ton i węgla koksowego o 45 mln ton. Spowodowane to było głęboką restrukturyzacją przemysłu węglowego w krajach Unii Europejskiej.

Krajowe zasoby surowców energetycznych w 2000 r. wynosiły ponad 39,3 Gtoe. W tej wielkości prawie 99,5% (99,49%) stanowią zasoby węgla kamiennego i brunatnego. Pozostałe 0,51% ogółu krajowych zasobów surowców energetycznych stanowią ropa naftowa i gaz ziemny. Zasoby bilansowe węgla kamiennego (stan na 31.12.1999 r.) wynosiły 18 152 mln ton, w tym zasoby przemysłowe — 8354 mln ton.

Zasoby geologiczne węgla brunatnego skupione są w 78 złożach i wynoszą ogółem ponad 13 984, 14 mln ton, w tym zasoby rozpoznane szczegółowo wynoszą około 4455 mln ton. Zasoby przemysłowe złóż zagospodarowanych wynoszą 1778,5 mln ton.

Polski system elektroenergetyczny jest największym i najbardziej znaczącym systemem w Europie Środkowej. Produkcja krajowa energii brutto w 2000 r. wynosiła 145,2 TW·h, w tym zawodowe elektrownie cieplne — 133,8 TW·h, z tego na węglu kamiennym — 84,2 TW·h, a na węglu brunatnym — 49,7 TW·h. Produkcja energii elektrycznej z węgla brunatnego w Polsce od wielu lat utrzymuje się mniej więcej na stałym poziomie i jej udział w ogólnej produkcji zawiera się w przedziale 35—40%.

Podstawowym dokumentem w zakresie ustalania potrzeb na surowce energetyczne kraju są „Założenia polityki energetycznej Polski do 2020 roku". Ze względu na znaczną niepewność przyszłych stanów gospodarki, opracowano trzy scenariusze rozwoju kraju: przetrwania, odniesienia i postępu — plus.

Rola węgla kamiennego i węgla brunatnego w bilansie paliwowo-energetycznym Polski będzie w najbliższej perspektywie dominująca, a w dalszym horyzoncie czasowym — nadal znacząca.