COAL-MINING IN POWER ENGINEERING OF THE EUROPEAN SOCIALIST COUNTRIES

by
ANTONI WRZOSEK
Department of Economic Geography, Jagiellonian University, Cracow, Poland

and

IMRE MIKESY
Department of General Economic Geography, Eötvös Loránd University, Budapest, Hungary

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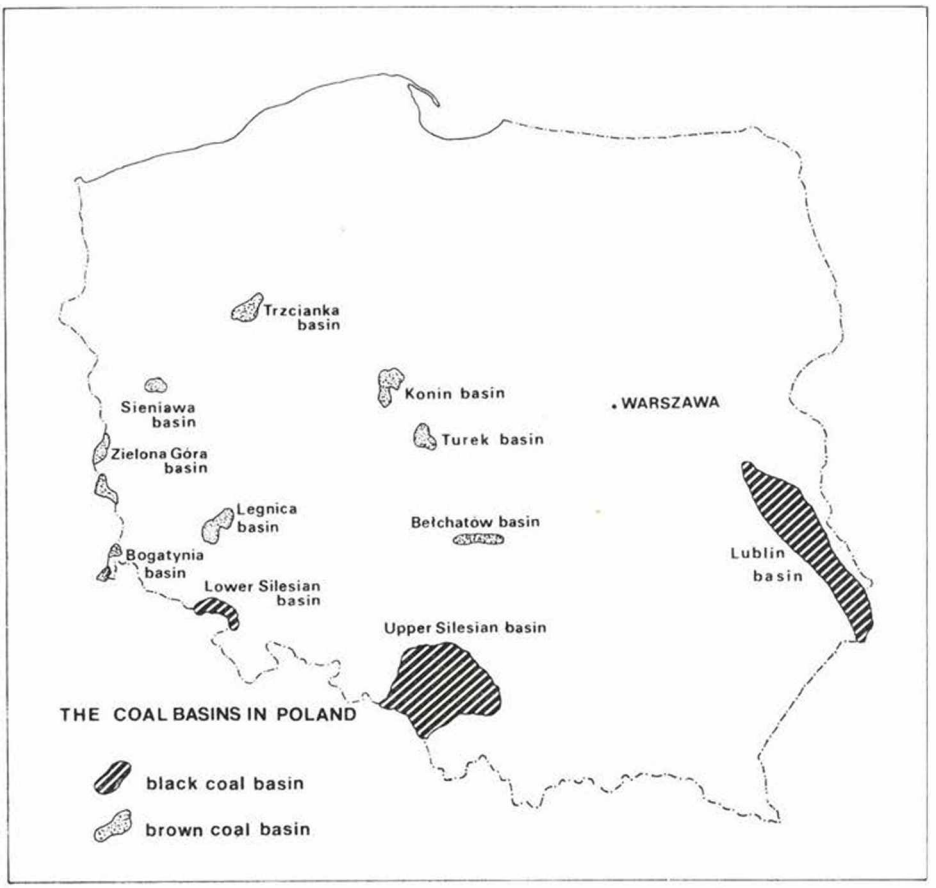
A common feature of the European socialist countries as opposed to countries of Western Europe is that their power engineering after World War II was developing mainly on the base of their own raw materials. Besides, the lower level of economic development (especially in the first years after the war) and the tendencies understandable in the socialist conditions towards the more even raising of living standard of all the inhabitants, in addition to the unsatisfactory road infrastructure were the reasons for the poorer development of motor transport and its lower intensification as compared with Western Europe. Last but not least, the European socialist countries are in possession of only inconsiderable resources of oil and natural gas (with the exception, to a certain degree, of Romania) although they possess resources of solid fuels. In these conditions their economy had turned mainly towards these resources so that no coal crisis so typical of Western Europe appeared. The position of individual socialist countries of Europe with regard to power engineering varies considerably. The only country in this group with surpluses of energy reserves, but with reference to solid fuels only is Poland. At the same time it suffers a heavy shortage of oil and natural gas as well as experiences some troubles on account of its small water power resources. The German Democratic Republic is nearly completely devoid of hard coal although it possesses copious reserves of brown coal. With reference to hydrocarbons and water power German Democratic Republic is as poor as Poland which makes this country still more dependent on the supplies of energy from abroad. Czechoslovakia has fairly abundant although insufficient reserves of solid fuels, not too much water power, and still less bitumens than Poland. Romania displays considerable although inadequate resources of petroleum, fairly much gas, and modest resources of coal and water power. Yugoslavia holds considerable reserves of water power, now only in part utilized, insufficient resources of coal and of hydrocarbons. The most modest total power resources are distinctive of Bulgaria and Hungary. Bulgaria has inconsiderable quantities of brown coal and of water power, but is nearly devoid of petroleum. Hungary is in possession of small resources of coal and hydrocarbons, being nearly

completely short of water power. In addition, a common feature of Bulgaria, Yugoslavia and Hungary is the domination of their reserves by brown coal, with hard coal being in short supply.

A brief discussion of the position of particular countries with respect to hard coal and brown coal will be presented below.

The most important in this respect is the position of POLAND. It comes fourth in the world as a coal producer, its share being 7.4% of world production (after the USA, USSR and China), and fifth in the output of brown coal (after GDR, USSR, German Federal Republic and ČSSR) with 4.5% of world production. The share of hard coal in the production of energy from the primary sources in Poland is 87.4% and amounts to 94.7% together with brown coal. The share of natural gas is 4.2%, of petroleum 0.7%, and of the water power 0.4%. Atomic energy is not yet utilized in Poland. The share of coals in the power balance of Poland is probably the highest in the world.



There are three hard coal basins in Poland: the Upper Silesian, Wałbrzych and Lublin one. The most important of them and one of the largest in Europe (after the coal basins of Donets and the Ruhr) is that of Upper Silesia, its surface being some 5,400 sq. km (4,450 sq. km im Poland), with the remaining part in Czechoslovakia. The basin in question lies in a triangle between the cities of Tarnowskie Góry (in the north), Cracow (in the east) and Ostrava (Czechoslovakia, in the south-west). The reserves of this coal district are more than 80 thousand million tons, including 23 thousand million tons of workable resources. The basin is paralic in character, being derived from the Carboniferous. Its exploitation conditions are favourable and the beds display high spatial concentration of the resources. The average thickness of coal strata is 2.8 m and the thermal value is 4,800 – 7,800 calories. There dominate fiery, gaseous and gas-coking sorts of coal. The share of coking coal is estimated at 38%. Exploitation there was started in the mid-eighteenth century and since then some 5 thousand million tons of coal were extracted. Coking coals occur in the western part of the basin in the region of the towns Wodzisław, Rybnik and Gliwice, this constituting the most developmental part of the basin with a number of new collieries opened, in that 7 in the environs of Rybnik. In the eastern part of the basin there dominates fiery and gas coal which is lower in calorific value and with a considerable admixture of sulphur. These coals are burnt chiefly in power stations. In the oldest exploited northern part of the basin the number of collieries diminished due to their joining in major units and to the closing down of the worked out mining fields. In this way the total number of coals mines in the district decreased from 75 in 1960 to 61 in 1977 and the average output per mine rose from 1.4 mln tons to 3 mln tons. The average depth of coal extraction continues to grow while amounting recently to nearly 500 m, with a maximum of 1,100 m. The Upper Silesian Coal Basin provides more than 98% of Poland's total output of hard coal. In the years 1950 – 1976 18 new collieries were opened in this coal-field, the share of which attained 25% of total coal extraction in the basin. Mechanization of work in the mines has made progress, increasing to 93% of the worked coal in 1975 as compared with 29% in 1950 – with reference to mechanical hewing- and respectively to 75% as opposed to 4.5% with reference to mechanical loading. This made it possible to increase more than 3 times work productivity of a miner employed at the face.

The Lower Silesian Coal Basin is situated in the Sudety Mts in the region of the cities of Wałbrzych and Nowa Ruda. This is, too, of Carboniferous age but is of limnic type. Its area, ten times less than that of the Upper Silesian Basin has 60 times lesser reserves (workable reserves of some 400 mln tons). The geological conditions of exploitation are difficult, the beds being thinner (0.9 m on an average) and disturbed, sometimes saturated with carbon dioxide. The spatial concentration of the resources is 6 times lesser and the costs of exploitation twice as high as in Upper Silesia. Hence, the exploitation maintains a constant level of 3 – 4 mln tons a year and will not alter in the future. Nevertheless, the output here is profitable because of the high calorific (6,000 – 8,200 cal) and technological value of

the coals. The diversity of coal classes varies greatly from gas coals to lean and smithy coals. 83% of the output is liable to coking and produces the best sorts of blast-furnace and casting coke. The four collieries of this basin produce less than 2% of Poland's coal output but make it possible to obtain 15% of coke.

The third basin of hard coal in Poland, now in the stage of initiating exploitation, is that of Lublin. The occurrence of coal in that area had been stated before the last war but a more precise recognition of the coal-field took place only in the past 20 years. This, too, is a Carboniferous basin, paralic in its lower part and limnic in the upper. It stretches from Radzyń in the north to Hrubieszów in the south, covering an area of 4,600 sq. km, in that some 1,100 sq. km in its most abundant part, east of Lublin. Resources of this coal-field are estimated preliminary at 30 – 40 thousand million tons. The construction of the first colliery at Bogdanka is in the full swing, with first coal expected to be extracted in 1980. The thickness of beds is 1.3 m on an average, calorific value being some 6.400 calories, and the share of coking coals 30 – 40% in the evidenced deposits.

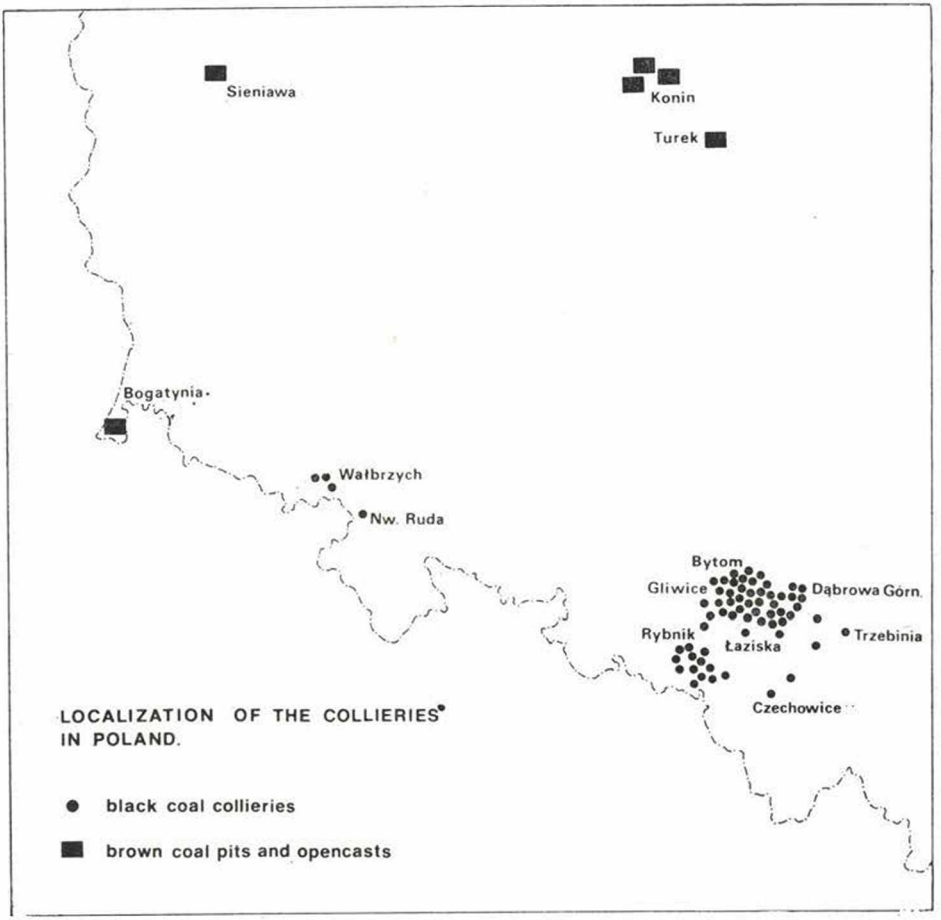
In respect of the possessed resources of hard coal Poland comes eighth in the world, surpassed by countries usually much larger (USSR, USA, Canada, China and the Republic of South Africa). Solely Great Britain and German Federal Republic display higher concentration of coal in respect to the area than does Poland. In the output of coal Poland was seventh or eighth before World War II but shortly after the war it came fifth, exceeding Japan and France. Since 1956 Poland's production of coal was behind that of China, then since 1967 it outdistanced German Federal Republic and since 1971 also Great Britain, emerging as the fourth largest producer of hard coal in the world. Besides, over the whole post-war period the output of coal in Poland has continued to grow and this trend is likely to be maintained.

Advantageous part will be played in the near future by the launching of coal exploitation in the Lublin Basin. This will create a stimulus for the quicker economic development of the less industrialized eastern part of this country, and will foster rational reconstruction of the Upper Silesian Industrial Region where the necessity to continually increase coal output made it difficult to solve the ever-growing problems of transport, building and environmental protection.

Of the total quantity of 186.1 mln tons of coal extracted in 1977 78.9% were used at home. Conversion into coke involved 13.4% of output, other industrial and power uses engulfed 49.5%, market sale 12.1%, allowances 2.4%, patent fuel 0,8%. Exportation involved 21.1% of the whole output i.e. 39.3 mln tons.

Throughout the entire post-war period Poland has been the largest, after the USA, coal exporter in the world outstripping Australia and the USSR. Some 35 – 40% of Polish coal is imported by the socialist countries and 60 – 65% by capitalist countries. The most important coal recipients in the first group are USSR, Czechoslovakia, GDR and Hungary while in the

second France, Finland, Denmark, Italy, Austria, German Federal Republic and Spain, and Japan among the extra-European countries.



The production of coke in Poland has been continually increasing and achieved 10.9 mln tons in 1960 and 19.1 mln tons in 1977. There are 18 cokeries including 75 batteries, their location confined chiefly to the collieries of coking coal in the western part of the Upper Silesian Basin as well as to the Wałbrzych Basin. Three coking plants are to be found within the biggest iron works in Cracow, Dabrowa Górnicza and Częstochowa, one within chemical works on the Upper Oder at Zdzieszowice. In recent years Polan has been exporting 2—3 mln tons of coke, chiefly to GDR, Hungary, Romania, Yugoslavia and Bulgaria as well as to Austria.

Apart from hard coal Poland possesses considerable reserves of brown coal, the geological resources of which are put at 40 thousand million tons and the workable resources at 4–6 thousand million tons. They are as a rule of Miocene origin and are characterized by their low calorific value (1,800–2,100 cal) but in some places they occur in thick deposits which makes it possible to exploit them cheaply and with profit. Apart from the Miocene deposits there is also one small deposit of Lower Jurassic (Liassic) in the region of Zawiercie, once exploited in the first two decades of the 20-th century and now nearly completely worked out. The largest deposits are grouped in the provinces of Jelenia Góra, Legnica, Konin, Piotrków and Zielona Góra. Exploitation in the territory of the provinces of Jelenia Góra and Zielona Góra was started at the close of the 19-th century. In the interwar Poland there were no favourable conditions to extract brown coal since the consumption of electricity was low, the country did not produce mining equipment and the methods of opencast mining were still poorely developed. There also lacked capital for great investments and foreign capital was unwilling to invest in enterprises like that. Hence, during the major part of the interwar period Poland did not yield brown coal at all within her boundaries of those days. The change of this situation took place in People's Poland. Heavily extended was the management of the Turoszów coal-field, province of Jelenia Góra, very favourable for exploitation, with a maximum thickness of coal beds up to 60 m. In the region of Zielona Góra a few underground mines were kept in operation. In the 1950s and 1960s a few large opencasts were launched near the towns of Konin and Turek, province of Konin, and at present a new coal-field of Bełchatów, province of Piotrków, is being opened, its resources over 2 thousand million tons. The output of coal from this field is to be started in 1982.

The total extraction of brown coal in Poland rose from 4.8 mln tons in 1950 to 9 3 mln tons in 1960, 32.8 mln tons in 1970, and achieved as much as 40.8 mln tons in 1977.

As much as 99.5% of coal is extracted mechanically using the method of opencast mining, with the remaining 0.5% of output performed by the last underground mine in the region of Zielona Góra. Polish brown coal is nearly fully consumed at home for the production of electric energy. In 1977 24% of total output of energy was due to this coal.

In the region of Konin a small quantity of brown coal is turned into patent fuel (158 thousand tons in 1977) and about 15% of output from the Turoszów coal-field (3.4 mln tons in 1977), is transferred to the power plant of Hirschfelde, GDR, across the frontier river Lusatian Neisse.

Polish fields of brown coal tend to be comparatively quickly exhausted. The deposits now in exploitation will suffice for 20–30 years. This spell of time will be quite enough to fully allow for the depreciation of the erected power stations the installed capacity of which now totalling 4,800 MW will increase by a further 4,300 MW at Bełchatów. On the other hand, it is unprofitable to develop processing industries in these regions as well as to concentrate population and expand towns. As opposed to hard coal which, for example, has involved the creation of the largest Polish agglo-

meration of Upper Silesia, the deposits of brown coal are not but of temporary importance and will not play major part in creating urban regions.

The most important producer of hard coal among the socialist countries of Europe, apart from Poland, is CZECHOSLOVAKIA. This country is in possession of one medium-size coal-field and of four small ones. All of them are within the Czech Republic. Of greatest importance is the coal-field of Ostrava which is part of the large Upper Silesian Basin, situated mainly in Poland. The area of exploitation covering till recently as little as 200 sq. km near the towns of Ostrava and Karvina has now expanded a little to the south, towards the Carpathians. Its coal contains some 100 workable beds and is similar in character to Polish beds in the region of Rybnik i.e. represents good coking classes. Its resources are estimated at more than 10 thousand million tons. Exploitation there was started at the close of the 18-th century, exceeding 1 mln tons in 1872, and amounting to 9.3 mln tons just before World War I. In the prewar period 10 – 14 million tons were extracted and since 1960 the output has established at the level of 20 – 24 million tons a year. In the area of the basin already in the 19-th century the most important region of heavy industry of the then Austro – Hungary and later of Czechoslovakia came into being, its function maintained up to now. The Ostrava Coal-Field provides at present 85% of the whole Czechoslovak output of hard coal.

The second most important coal-field in Czechoslovakia is that of Kladno-Rakovnik, west of Prague, where according to the first records coal was extracted already in the 18-th century. Coal reserves of this basin are put at 180 mln tons, and the output since many tens of years has maintained roughly at the level of 1.8 mln tons to 2.6 mln tons a year. The maxi-

mum output of 3 mln tons was recorded over a few years around 1960. The basin now provides nearly 10% of total yield of that country. There came into being a medium-size centre of heavy industry, with two iron works and a few processing plants.

The remaining three coal-fields are very small. First of them near the town of Trutnov is the extension of the Polish basin of Wałbrzych and lies in the Central Sudety Mts, district of Trutnov. Its reserves of the order of 60 mln tons are exploited in 3 collieries yielding some 500 – 700 thousand tons a year which constitutes about 2.5% of total output of Czechoslovakia. The second coal-field of Rosice – Oslavany lies in Moravia, west of Brno, its annual production some 400 thousand tons of good quality coal derived from a small deposit with resources of some 40 mln tons. The smallest of the coal-basins lies west of Plzen and is characterized by a regression of output. The output in this field had been diminishing from 1.3 mln tons before World War I to 0.3 mln tons at present. The exploitation of this field is expected to be completed in 1980 on account of depletion of its resources.

Because 76% of the reserves of the Ostrava Basin constitutes high quality coking coal, Czechoslovakia belongs to more important world producers of this fuel in providing some 11 mln tons a year, part of which is exported. Over the last 20 years the amount of coke exported was rising from 1.2 mln tons in 1955 to 2.1 mln tons in 1976. The recipients of the greatest quantities of coke are GDR, Romania and Hungary which received 72% of the whole Czechoslovak export of coke in 1976.

Apart from the Ostrava Basin it is only the region of Kladno which provides small quantities of coke; the remaining coal-fields supplying steam coal only. Its output being insufficient, Czechoslovakia is compelled to import some 5.5 mln tons of coal a year, roughly fifty-fifty percent from the USSR and Poland. At the same time Czechoslovakia exports a little smaller amounts of coking coal, namely nearly 3.8 mln tons in 1976 chiefly to Romania (21%), Austria (17%), GDR (15%) and Hungary (6%).

The evolution of exploitation in Czechoslovakia's individual coal-fields is shown in table.

Coal-fields	Years			In thousand tons	
	1937	1950	1960	1970	1976
Ostrava	12 900	14 677	20 682	23 725	24 401
Kladno	1 800	1 922	3 142	2 451	2 304
Trutnov	480	558	834	737	707
Rosice	500	524	680	608	386
Plzeň	900	775	876	543	341
Total	16 580	18 456	26 214	28 239	28 139

For some time past a shortage of manpower is visible in Czechoslovakia's coal-mining. Therefore, efforts have been made to raise work productivity and at the same time to decrease employment. Hence, mechanical

mining covering as little as 21.8% of coal output in 1960 increased up to 90% in 1976, and mechanical loading rose simultaneously from 14% to 92%.

More important for the power engineering of Czechoslovakia as compared with hard coal are the deposits of brown coal the proved resources of which exceed 10 thousand million tons, and geological reserves are estimated at up to 200 thousand million tons. The most important deposits of brown coal are derived from the Oligocene and Miocene sediments at the southern foot of the Czech Ore Mountains where two main coal-fields occur, one of Most, the other of Sokolov. Coals of these fields display considerable calorific value (3,500 – 5,600 cal) and their varied physico-chemical properties make them suitable for various uses. At one time exploitation was chiefly underground while in the postwar period opencast mining strongly increased from 45% in 1946 to 86% in 1976. Of greatest importance is the Most coal-field which stretches over a distance of some 50 km from Chomutov in the west to Usti nad Labem in the east. The basic Miocene deposit is up to 30 m thick. Since the 16-th century till the mid-19-th century exploitation here was low; in 1860 604 thousand tons were extracted. Output rose quickly in the years 1870 – 1913 to attain 18 mln tons. There was a deadlock during the interwar period with a renewed growth started after World War II. The output then rose from 16 mln tons in 1948 to 63 mln tons in 1976 providing 72.5% of Czechoslovakia's total production. The Most coal was widely used in railway transport, as house-coal, and steam coal in power plants, and during World War II the Nazis used it to produce considerable quantities of synthetic petrol. At present brown coal is more and more widely used in power stations, the other forms of its use decreasing. Power plants fired with coal of Most have total capacity of some 4,000 MW. Coal reserves of the Sokolov Basin are smaller and their calorific value is a little lower (3,500 – 4,600 cal). Exploitation here was of the order of 4 mln tons in the interwar period while its present level is between 18 and 20 mln tons which constitutes 22.5% of Czechoslovakia's domestic production. The basin provides with fuel the south-western part of Bohemia in feeding power plants of some 1,000 MW. The remaining inconsiderable quantities of brown coal are worked out in the Slovak Republic, being derived from two small coalfields at Handlova (region of the Nitra water-heads) and at Modrý Kameň, south-west of town Lučenec, near the Hungarian frontier. The calorific value of coal of these two fields is fairly high (4.5 – 7 thousand cal) but their resources are small. In spite of this, in the fueldeficient Slovakia, the exploitation in both these coal-fields slowly rises and constitutes 4% in the region of Handlova and 1% in that of Modrý Kameň.

Apart from these brown coals, characterized by a fairly high caloric value, there are exploited in Czechoslovakia some 3.5 mln tons of low caloric Young Tertiary lignites, poorely carbonized. Their exploitation takes place in the region of the town Hodonin, South Moravia (some 2 mln tons), and at Novaky on the upper Nitra, Slovakia (some 1 mln tons).

In all, Czechoslovakia supplies more than 80 mln tons of brown coal, being the fourth largest producer of this raw mineral in the world. At

the same time it is second in respect of the importance of brown coal for the whole power engineering of a country. Nearly the whole output is consumed at home, with only 1.6 mln tons exported mainly to the GFR, Selb Industrial District NE Bavaria in 1976. In the consumption of brown coal there dominates the generation of electric power although some 1.3 mln tons were turned into patent fuel, used in domestic heating.

GERMAN DEMOCRATIC REPUBLIC holds only two very small fields of hard coal in the northern foreland of the Erzgebirge. The larger of them occurs near the town Zwickau, the smaller one at Freital near Dresden. The output of coal in the region of Zwickau had been initiated in 1838, being increased after railway line Plauen – Chemnitz – Dresden had been built in 1858 which opened new markets for the coal. The exploitation there never exceeded 3 mln tons a year and was of regional importance. The still smaller coal-field of Freital was of only local importance for the agglomeration of Dresden. In recent years output in the latter field has stopped completely and is continued on a very limited scale in the region of Zwickau. The country's hard coal demand is covered by imports which in recent years have oscillated between 6 and 9 mln tons. The two main exporters into GDR are the USSR and Poland, far lesser are Czechoslovakia and German Federal Republic. Apart from coal GDR imports from the same countries considerable quantities of blast-furnace and casting coke to satisfy the needs of its growing iron metallurgy. The evolution of the total output and imports of hard coal and coke in the GDR is illustrated in table.

Year	Output of hard coal	Imports of hard coal in thousands of tons	Imports of coke
1950	2 805	no data	no data
1960	2 721	8 028	2 527
1970	1 020	8 192	3 123
1977	300	6 058	3 065

In 1977 GDR imported from the USSR 4,310 thousand tons of coal and 1,088 thousand tons of coke while from Poland 1,076 thousand tons of coal as well as 857 thousand tons of coke and from Czechoslovakia respectively 556 thousand and 809 thousand tons.

GDR is an example of a country in which the dominant part in power engineering is played by brown coal. Reserves of this mineral cover nearly 10% of the whole territory of that country, being concentrated chiefly in two complexes. The largest one stretches along the central and southern part of GDR's frontier with Poland in the districts of Frankfurt, Cottbus and Dresden with the highest concentration of deposits in the district of Cottbus. This is the so-called Lower Lusatian Coal-Field. The other complex concentrates between the rivers Elbe and the Lower Saal in the regions of the towns Leipzig, Halle and Bitterfeld and crosses in some places to the western bank of the Saale. Besides, there occur a number of tiny and

isolated deposits. All of them lie close to the surface and at present-day technological conditions can be worked opencast although the costs of removing caprock constitute sometimes up to 50% of overall costs of production. All the deposits are derived from the Tertiary. The entire eastern complex and part of the dispersed deposits are of Miocene age, while the western complex in its north-eastern part contains deposits of the Upper Oligocene (near Bitterfeld) and in the remaining part of Eocene (see map enclosed).

Caloric value of the coals rises to the west from approximately 2 thousand calories near the Polish frontier to over 3 thousand calories at the Saale. Changeable, too, are in various places other properties of the coal, these due to its chemical composition. For instance, coals of the eastern complex (Lower Lusatia) are better for the production of patent fuel, partly to be turned into coke, which in the first place relates to the deposits in the region of the towns Senftenberg and Spremberg. Coals of the western complex contain more bituminous components, being thus more suitable for chemical processing. During World War II they were the basic raw material for the production of synthetic petrol. Unfortunately, the western part of the complex is sometimes affected by heavy salinization (this due to copious salt-beds in the vicinity) of coal deposits which makes them unserviceable.

Total workable resources of brown coal in GDR are estimated at about 25 thousand millions tons which, taking the presentday rate of output, should suffice for 100 years. About 60% of these resources are grouped in the eastern complex where occur 100% of coking-coal, and 60% of coal suitable for the production of patent fuel or to be used as steam coal. The remaining 40% of coal concentrates in the western complex and in the dispersed deposits.

Exploitation of coal in the western complex was started already in the 18-th century although on a small scale and to satisfy local needs only. A century later after the railway lines had been constructed in the vicinity the exploitation began to expand but it was only at the decline of the 19-th century that brown coal came to be used as a fuel in power plants. The world wars were a stimulus for a considerable extension of chemical processing. As early as in 1917 the first carbo-chemical works was operating here with further big chemical plants aimed at processing brown coal constructed in the years 1925 – 1945 near Merseburg (works "Leuna" and "Buna") and south of Leipzig at Böhlen and Espenhain, all linked with big power stations. After World War II a few further power stations came into being (Thierbach 840 MW, Lippendorf 600 MW, Boxberg 2,520 MW).

Until recently the western complex of coal deposits has concentrated the major part of output. However recently exhaustion has been marked of the most abundant deposits as well as difficulties have appeared to open new deposits, this resulting from the high population density, heavy urbanization and dense transport network. The share of this complex in the total output decreases and the centre of gravity moves towards the Lower Lusatian Basin which for the last few years has yielded over 59% of total

output. The future of the GDR's power engineering is linked with this coalfield the exploitation in which dates from the 1880s, its systematic development proceeding in this century as is confirmed by figures illustrating the progress of output.

Years	1880	1896	1913	1936	1958	1970
Brown coal output in the Lower Lusatian Basin in mln tons	0.8	4.6	19.5	34.9	69.7	130,0

Coal extracted in the Lower Lusatian Basin is in most part devoted to fire power stations. Part of it is used for the production of patent fuel (some 39 mln tons a year), part for its conversion into brown coal coke (more than 5 mln tons). Mention may also be made here of a new opencast at Berzdorf near the Polish frontier, south of Zgorzelec, which feeds big power station at Hagenwerder (3,000 MW).

It may be stated in examining the evolution of brown coal production and its processing on a scale of the whole GDR that the output was growing systematically from 101 mln tons in 1937 to 127 mln tons in 1949, and 200 mln tons in 1955 to achieve the highest recorded level of 262.8 mln tons in 1971, which constituted in this year 32% of world output of brown coal. In recent years, with inconsiderable downward oscillations, its output reached nearly 254 mln tons in 1977. Coke production from brown coal was highest in 1960 and goes very gently down since that time. The production of patent fuel achieved its maximum in 1965 and also gradually decreases. The most important use of brown coal is to produce electric power. On its basis some 85% of total electricity was yielded in 1970, although in recent years this share slightly decreases, as a result of launching successive reactors in nuclear power plants. These produced some 5 thousand million kWh of electricity out of total production of 92 thousand million kWh supplied in 1977. The production of patent fuel from brown coal amounted to 48.7 mln tons in this year, and of brown coal coke to 5.2 mln tons.

ROMANIA holds small reserves of coal of various classes and varying caloric value on both sides of the Carpathians. Coals to be encountered on the outer side are usually younger and of low thermal value as compared with those in the inner Carpathian basins which are older and better in quality, inclusive of anthracite. It would not be purposeful to examine hard coal and brown coal separately as no clear difference between these sorts occurs in that country. For instance, reserves in the region of Petroşeni were once included in brown coal and for some time past are considered – in accordance with the accepted international classification – to be hard coals. Exploitation of good coal was first initiated already at the end of the 18-th century in the district of Banat near Anina and Secul. The scale of this output has risen since the end of the 19-th century after a railway line had been completed to Anina.

In the first half of the 19-th century exploitation was initiated of brown coal at Comanești, Moldavia. A little later output was launched in the largest coal-field of Petroșeni – Lupeni in the upper Jiu valley which was soon provided with a railway line from the Mureș valley, this due to the fact that railway was in those days the main recipient of coal. At the decline of the 19-th century a number of small fields were opened near Mehadia, Brașov, as well as in the Someș valley in Transsilvania. In 1938 2,826,000 tons of coal were extracted in Romania, including 2,264,000 tons of hard coal together with anthracite and some two hundred thousand and a few tens of tons of brown coal and lignite each. Anthracite is to be encountered at Schela, Oltenia, north of the pass Vulcan.

The chief consumers of coal was railway, lesser one being industry and the least one house heating. Progress of geological surveys after World War II led to the discovery of vast deposits of Young Tertiary lignites at the edge of the Pannonian Lowland, between Oradea and Satu Mare, and of the largest one in Oltenia, with centres at Motru and Rovinari. Their exploitation on a large scale has developed in the last decade causing lignite constitute more than 60% of total output of coal in Romania. It is used chiefly to fire big power stations at Craiova and Rovinari. Hard coal is derived principally from the upper Jiu and the environs of Anina where more than 8 mln tons are now exploited, including 1,924,000 tons of coking coal. It may be said that coal is a secondary fuel for Romania, its share in power balance amounting to only 15% in 1950 and 17.4% in 1970. Following the development of iron metallurgy in recent years also the country's output of coke has been rising, amounting to 2,472,000 tons in 1976. The remaining part of coke demand by metallurgy is covered by imports of 2,816,000 tons in 1976, mainly from the Soviet Union and Poland. The evolution of production of individual types of coal and of employment in coal-mining is shown in table.

Types of coal	Output in tousand tons in years				
	1938	1950	1960	1970	1976
Hard coal with anthracite	2 264	2 733	4 481	8 087	8 696
Brown coal	289	349	537	704	600
Lignite	273	811	3 145	14 044	18 819
Total coal output	2 826	3 893	8 163	22 835	28 115
Employment in thousand persons		25.5	41.1	49.9	57.9

YUGOSLAVIA. Its situation in respect of coal is much similar to that of Romania, hence all sorts of coal will be examined together. Coal deposits there vary considerably and are still more dispersed than those in Romania. All are small in size and the majority of them are very small. Coal output prior to World War II totalled 7 mln tons, rose to 15 mln tons in 1955 and achieved 30 mln tons in 1965, continuing to rise slowly up to 37 mln tons in 1976. However for some time past it is only the output of lig-

nite which has been increasing while that of hard coal is systematically decreasing and of brown coal stagnating. Coal needs of the Yugoslav metallurgy, its development poorer than that of Romania, are satisfied by coke produced from the coking coal, chiefly imported from the USSR. Inconsiderable imports of coke, mainly from Poland and Italy, attained 170 thousand tons in 1976 as compared with its domestic production of 1,786,000 tons.

More detailed review in a few time sections is given in table.

Year	Output in thousand tons			Coal imports	Coke imports
	hard coal	brown coal	lignite	thousand tons	
1939	1 419	4 312	1 301		
1955	1 134	7 682	6 388	909	118
1965	1 169	10 509	18 279	2 186	111
1970	643	8 989	18 790		
1976	587	9 110	27 148	2 755	170

Yugoslavia's resources of hard coal are chiefly of Jurassic and Cretaceous origin. They are small in quantity being estimated at 200 mln tons. They occur near Rasa in the eastern part of the Istra peninsula where their output is concentrated, besides in Serbia at the upper and middle Timok river at the borderland between Yugoslavia and Bulgaria as well as in the valley of the Ibar, south of Kraljevo. More dispersed are the resources of brown coal derived from the Oligocene and Miocene, predominantly composed of a few thin layers interbedded with barren layers. Deposits of greater importance occur at the borderland between Slovenia and Kroatia between the Sava and the Drava rivers (main centre at Trbovlje), in central Bosnia (Banovići, Kakani, Zenica and others), in Dalmatia near Drniś and in the eastern Serbia in the environs of Petrovac, Paračin, Aleksinac, and Niś. The reserves of Yougoslavia's brown coal are put at 2 thousand million tons and their heating value is considerable (4 – 5 thousand cal). Lignites of Pliocene age are most copious in the whole of coal reserves of that country, their resources being estimated at 20 thousand million tons and with output rapidly growing. Their use is nearly fully confined to the feeding of power stations. The most important exploitation areas are concentrated in the valley of the Kolubara, south-east of Beograd, in Kosovo Polje near Priština, in North Bosnia near the town Tuzla, and in northern Slovenia near Velenje.

BULGARIA. In respect of the size and the structure of coal resources its character is very much like that of Yugoslavia and Romania. The dominant part of its resources, some 85%, are low calorific Pliocene lignites; much smaller is the share of Old Tertiary brown coals, some 23%, while hard coals constitute as little as 2%, being of subordinate and continually decreasing importance. Exploitation of brown coals was first started in 1878 in the coal-field of Pernik, west of Sofia, in 1878 immediately after Bulgaria

regained her independence from the Turkish thraldom. The extension of railway lines was in ever-growing need of coal, therefore output was started in the region of Bobov Dol, south of Pernik. Nevertheless, exploitation in 1900 did not exceed 100,000 tons, approaching to only 400,000 tons before World War I. In the interwar period Bulgaria's needs were more serious, hence output was extended in both the mentioned coal-fields, in addition to the launched extraction of hard coal in the so-called Balkan Basin between the towns of Gabrovo, Kazanlyk and Sliven. There are also some though inconsiderable reserves of coking coal. Total production before World War II had exceeded a little 2 mln tons. Further considerable growth of the output took place following the war. Exploitation was started of the two small deposits of anthracite in the region of Belogradchik, and in the gorge of the Iskyr, north of Sofia, in addition to an intensification of output in all the known coal-fields. Above all, investigations were carried out of the deposits of lignites and their opencast exploitation was begun, which was possible only now owing to progress in removing the caprock of large earth masses. The largest reserves of lignites are to be found in the plain of the Marica near the town of Dimitrovgrad, smaller ones in the Sofia Basin, and inconsiderable in the region of Kjustendil and near Goce Delchev on the river Mesta. The lignites have become the principal, apart from water power, base for the production of electric power while hard coals and brown coals supply other branches on industry, house heating and transport. Evolution of exploitation of the main types of coal is illustrated by the table.

Types of coal	Output in thousands of tons in years			
	1960	1965	1970	1976
anthracite	161	190	161	99
hard coal	409	362	236	196
brown coal	10 060	9 564	6 883	5 850
lignite	5 355	14 925	21 970	19 334
Total	15 986	25 042	29 250	25 479

Among the administration units of Bulgaria it is nowadays the region of Stara Zagora which is the main producer of coal, supplying more then half country's output. The second largest is the region of Pernik with more than 20% followed by the region of Kjustendil, Chaskovo, and Sliven. The shortage of coal at home is supplemented with imports of hard coal and anthracite from the Soviet Union, which in 1976 amounted to 6,190,000 tons, including to 3,528,000 tons of anthracite. In the same year Bulgaria imported, too, 328,000 tons of coke, chiefly from the USSR, and small quantities from Poland and Czechoslovakia.

HUNGARY has an average supply of domestic sources of energy. Although it possesses several types of energy sources (black and brown coal, lignite, petroleum, natural gas, uranium ore), disadvantages in the distribution of the reserves, the economy of the mining poses a number of prob-

lems the power economy is to cope with. Until 1960 over three quarters of the Hungarian power economy rested on domestic sources of energy, first of all on internal coal production. Making the most of the favourable import possibilities of the 1960s Hungary has been increasingly relying on energy sources obtained from the Soviet Union within the framework of the COMECON integration. By the mid-1970s the share of domestic production in the consumption of energy fell to around 50%. At the same time the structure of consumption has been swiftly transformed. Between 1960 – 1975 share of hydrocarbons in the structure of consumption rose from 21% to 57%, while that of coal and coke fell from 72% to 34%. This turnabout has been made possible to a lesser extent by increased domestic production of hydrocarbons (especially natural gas) but mostly by the dynamic growth of imported petroleum and natural gas from the Sovietunion. It has to be noted that imported primary energy is supplemented by considerable amounts of imported Soviet electricity (6 thousand million kw-hours in 1979).

Shortage of goods on the world marked of energy surces in the 1970s and the subsequent price explosion have led to a revaluation of the role of Hungarian energy sources. Compared to the elevated international price levels marketability of energy sources extracted in Hungary has greatly improved. Hungary's reserves make it possible that half of the demands will be met – over a long period – by domestic sources of energy, provided that appropriate investments and technological improvements are carried out. Based on reserve estimates production of oil and natural gas can be held at present levels, with even a possible slight increase. Coal however, comprises over 80% of the energy source reserves of this country. With a view to domestic energy production development of coal mining is thus of primary importance.

Hungary's coal reserves are put at nearly 7 thousand million tons; of this the proportion of industrial reserves stands at some 40 per cent. Coal deposits differ greatly in age, facies and quality. All deposits have complicated and varying beds, broken by faults. Secondary rocks are of low solidity. Aquosity in the majority of deposits is high, and so is the hazard of firedamp.

According to geologic age and quality Hungarian coal deposits may be divided into four main groups.

1. The only black coal deposit of the country is situated in the Mecsek Hills, with the town of Komló as the centre of mining. Thickness of the liassic-age coal measures is 250 – 500 metres. The seams are 0.8 – 10 metres thick and dip between 20° and 70°. The coal seams are cut by faults, and extraction is made difficult by the danger of firedamp and gas as well as by the possible self-ignition of seams. Working depth may reach 500 metres. Industrial reserves are proved to be over 350 million tons, of this amount 60 per cent is coking coal. Heating value averages around 4400 kcal/kg.

2. Brown coal occurrences of the Transdanubian Hills are concentrated in three regions.

The Dorog coal basin holds the best quality brown coal. (Industrial reserves: 55 million tons, average heating value: 4200 kcal/kg). Exploitation is made difficult by the danger of karst water.

The biggest good-quality brown coal occurrence of Transdanubia is found in the Tatabánya – Oroszlány basin. (Industrial reserves: 355 million tons, average heating value 4000 kcal/kg). The eocene-age coal seams are strongly broken. Of Hungarian coal mines still working Tatabánya has the longest operation history (since 1780).

Among coal deposits of Central Transdanubia Ajka is the most important. Upper cretaceous brown coal is mined here. (Total industrial reserves of the region stand at 75 million tons, average heating value is 3200 kcal/kg.)

3. The predominantly miocene brown coals of the North Hungarian Hills have two fields.

The Nógrád basin, with its industrial reserves of 20 million tons is of less importance. Heating value of this coal is 3200 kcal/kg. It is being mined south of the town of Salgótarján.

The 215-million-ton industrial reserves of the Ózd – Borsod basin has a heating value of only 2950 kcal/kg on the average. Depth of the seams is 100 – 110 metres.

4. There are three lignite deposits in Hungary. The best quality deposits – though relatively small in volume – lie around the town of Várpalota in the southeastern foothills of the Bakony Forest. These miocene seams are 4.5 – 8.7 metres thick. (Industrial reserves: 100million tons, average heating value: 2350 kcal/kg.)

The 10 – 16 m thick pliocene lignite deposits that lie in the southern fringes of the Mátra and Bükk Hills contain many spoil interlays. These seams that are suitable for open mining hold some 40 per cent of this country's coal reserves (calculated in heating value). Industrial reserves amount to 1.3 thousand million tons, with an average heating value of 1780 kcal/kg.

Lignite deposits between the town of Szombathely and the Austrian border are being explored. Estimates of the deposits run to above 300 million tons.

At present mining is being done only at Várpalota and at the foothills of the Mátra – both for energetic purposes. The open-pit mine "Maurice Thorez", being worked at the Mátra foothills near the village of Visonta is the biggest mine in the country with its yearly output of 7 million tons. The 800 MW Gagarin Thermal Power Plant was built immediately next to the mine.

As can be seen from the table above coal production had its overall yearly peak volume in 1965. Competition from hydrocarbons has decreased production by 20% during the following 8 – 10 years – first of all in the technically unfavourable mining regions (Nógrád, Borsod). Present tensions on the energy market have again encouraged the increase of coal output. The drop in production has stopped, and there is even a slight growth.

Development of coal mining
(in Million tons)

	1938	1949	1955	1960	1965	1970	1975	1977
Black coal								
Mecsek coal basin	1.0	1.3	2.6	2.8	4.4	4.1	3.0	2.9
Brown coal								
Dorog coal basin	1.6	1.6	2.0	2.0	2.2	1.4	0.8	0.6
Tatabánya – Oroszlány ..	1.9	2.7	4.4	5.2	6.9	6.3	5.3	4.9
Central Transdanubian ..	0.6	0.9	2.5	3.3	3.0	3.1	2.7	2.6
Nógrád coal basin	1.2	1.6	3.1	3.3	3.8	2.0	1.0	1.0
Ózd – Borsod coal basin .	2.0	2.6	4.0	5.4	6.2	6.2	5.2	5.3
Lignite								
Várpalota coal basin	0.3	0.5	1.8	2.2	2.6	1.9	1.5	1.3
Mátra coal basin	0.1	0.1	1.5	1.9	2.3	2.8	5.4	6.8
Total	9.3	11.8	22.3	26.5	31.4	27.8	24.9	25.5
Average heating value of excavated coal kcal/kg ..	4476	3953	3425	3335	3193	3271	2923	2782

Deterioration in the mean quality of coals mined is striking. This can chiefly be explained by the proportionate increase in the output of lignites, and also, to a lesser extent by the mining of lower quality black and brown coal deposits. The most economical collieries are the highly mechanized open-pit mines; their proportion in the yearly overall production has reached 29 per cent in 1977.

	Number of employed	Heating value output in Tcal (10^{12}cal)	Heating value (Tcal) per capita employed
Black coal			
Mecsek coal basin	15 005	12 580	0.80
Brown coal			
Dorog coal basin	6 000	3 339	0.56
Tatabánya – Oroszlány coal basin	19 948	19 267	0.97
Central Transdanubian	7 134	8 135	1.14
Nógrád coal basin	6 278	2 975	0.47
Ózd – Borsod coal basin	19 266	15 435	0.80
Brown coal basins	58 626	49 151	0.84
Lignite			
Várpalota coal basin	3 773	3 577	0.95
Mátra coal basin	6 274	7 981	1.27
Hungarian coal mining	83 678	72 765	0.87

In 1975 72 765 Tcal of heating material was produced by the 83 700 persons employed in Hungarian coal mining. This can be broken down to the individual coal basins as follows:

The table indicates that caloric output per capita employed is highest in lignite mining, with exceptionally high productivity in the Mátra open-pit mines. Productivity has markedly improved here, over 1.6 Tcal per worker is produced yearly at present. Productivity in the Nógrád and Dorog basins is especially low, due to the difficulties of working those mines. This explains the strong reduction of output in these two basins.

At present a large-scale energetics program of coal mining is under way, the "eocene program". Within its framework four eocene brown coal mines are to be opened south-east of the town of Tatabánya with a total yearly output of 7.8 million tons. The coal will fuel the Transdanubian Collecting Power Plant (as it collects its fuel from several mines). Construction of one, perhaps two additional large, open lignite mines and power plants can be expected until the end of the century. The choice will most probably fall on the utilization of the over 500-million-ton lignite deposit at the village of Bükkábrány (at the Bükk foothills), and that of the Austrian border area. With deep working mines priority is given to mine concentration and technological development. The number of pits working will be reduced from the present 49 to 27 – 31 by the year 2000 (in 1955 there were 155 of them). Yearly output of pits will be raised from today's 340 thousand to 7 – 800 thousand. All this infers the eventual closure of over one half of the number of present pits, and the opening of new pits with larger capacities. According to plans production will continue to supply the bulk of domestic consumption. Apart from these Hungary will be a constant importer of high quality coal. The chief suppliers of imported black coal and blast furnace coke are the Soviet Union and Poland.

Amount of imported coal into Hungary:

1960:	1.43 million ton
1965:	2.79 million ton
1970:	2.21 million ton
1975:	1.71 million ton

РЕЗЮМЕ

РОЛЬ УГОЛЬНОЙ ПРОМЫШЛЕННОСТИ ЕВРОПЕЙСКИХ СОЦИАЛИСТИЧЕСКИХ СТРАН В ПРОИЗВОДСТВЕ ЭЛЕКТРОЭНЕРГИИ

В статье рассматривается роль угольной промышленности социалистических стран Центрально-Восточной Европы в производстве электроэнергии. С помощью многочисленных данных авторы покаУют состояние добычи угля в отдельных странах. Среди стран региона особо выделяется Польша, которая на базе огромных запасов каменного и бурого угля из года в год укрепляет свои позиции как крупный производитель угля и как второй в мире экспортёр каменного угля. Богатство в угле, несмотря на бедность других энергоносителей, делает Польшу нетто экспортёром электроэнергии. Остальные страны стараются укрепить свою энергетическую

базу за счот увеличения добычи бурого угля и лигнита. Однако это не ликвидирует их зависимость от импорта энергии, и требует использования новых источников энергии (атомной). Основу изложенного материала составляет обзор запасов угля, их географического размещения, геологического возраста и горно-технических условий их добычи. Уделяется внимание также рассмотрению исторических изменений в территориальном размещении угольной промышленности, в связи с чем приводятся соответсвующие статистические данные. Показана и внешняя торговля углём.

Большую часть новой информации читатель получит при знакомстве со строящимися новыми объектами угольной промышленности и электроэнергетики.