Mining and Energy Supply

Mining

By international comparison, ore mining in Hungary was a significant industry during the Middle Ages.

The country was also a leader in gold mining in 13th century Europe (two fifths of world production), and ranked second in silver mining (one quarter).

The world's first mining school ('Bergschola') was founded in 1735 in the Kingdom of Hungary at Selmecbánya (Schemnitz, today Banská Štiavnica in Slovakia), which was bestowed the rank of a mining academy ('Bergakademie') by Empress Maria Theresia in 1770.

The once famous precious metals mining industry had fallen into decline by the early 19th century, but economic prosperity during the time of the Austro-Hungarian Monarchy lent a new impetus to iron ore production and the quarrying of construction materials.

Following World War I, almost all the ore and salt mines, hydrocarbon resources and one-third of coal deposits had been annexed by the Treaty of Trianon, as they were in territories awarded to neighbouring countries.

After World War II, as was the case in most Eastern Bloc countries, the share of mining rose within overall industrial output, as a result of hasty industrialisation and the considerable efforts required to meet the country's demand from domestic resources for fuel, as well as other raw materials.

Over the past thirty years or so, the specific problems experienced by some branches within the mining industry, and imperatives of efficiency, have led to a mining crisis and the drop in its share within industrial production from 11.2% (1950) down to 0.5% (2008).

Hungary is a country with limited natural resources.

At the same time, the solid and liquid resources that are available, represent a colossal value and there is an ample supply of certain energy-rich materials, ores, and minerals (coal, lignite, bauxite, limestone, etc.), which arises due to the specific geological structure and character of the Carpathian Basin.

Even though the domestic mining of most natural resources might be limited, and the country is strongly import-oriented, available resources play a fundamental role in the national economy, being an important factor in its sustainability and contributing to the gradual improvement in living standards.

At the end of 2007, the National Cadastre of Resources registered 23.8 billion tons of industrial (recoverable), and 37.7 billion tons of geological reserves at 3,600 locations.

Projections indicate 480 billion tons of industrial, and 644 billion tons of, as yet-to-find (prospective) natural resources nationwide.

About eighty different mineral products are known to be found in the country's terrain, 98.5% of which (by weight) are proven reserves of *solid minerals* (37.7 billion tons).

Of the nation's total mineral reserves, 67.4% are non-metallic mineral resources, 28% coals, 3.1% ores, and 1.5% are *hydrocarbons (Table 30)*.

Lignite, non-metallic mineral resources and certain construction materials represent the greatest quantities, and are of considerable financial value.

Hungary is ranked among the five leading producers of gallium and perlite in the world, whilst it occupies a rank of between tenth and twentieth largest producer of bauxite, lignite and manganese.

Table 30. ***Mineral resources (2008)***

Type of mineral	Production in 2007	Geological reserves 01.01.2008	Industrial reserves 01.01.2008	Undiscovered (hypothetical) industrial reserve	Average life-expectancy of reserves at 2007 production levels based on total extractable resources
	million tons				years
Crude oil	0.84	207.0	19.2	10-58	23
Natural gas*	2.65	5,307.0***	3,355.3***	29-93	25 (>50***)
Carbon dioxide gas**	0.11	46.14	32.4	..	> 100
Hard coal	..	1,596.7	1,986.2	336	no production
Brown coal	1.45	3,199.7	2,245.5	975	> 100
Lignite	8.35	5,782.2	4,376.8	1,236	> 100
Uranium ore	..	26.8	26.8	7	no production
Iron ore	..	43.1	43.6	37	no production
Bauxite	0.5	127.0	82.0	151	> 100
Lead-zinc ore	..	90.8	100.2	192	no production
Copper ore	..	781.2	726.5	276	no production
Precious metals	..	36.6	36.5	21	no production
Manganese ore	0.05	79.6	52.6	9	> 100
Non-metallic minerals	3.0	3,200.0	1,002.4	16,004	> 100
Raw materials for the cement and lime industry	5.5	2,872.3	1,301.0	17,307	> 100
Dimension and crushed stone	13.0	4,220.1	2,362.7	99,549	> 100
Construction sand, gravel	34.8	8,035.8	4,855.0	203,648	> 100
Clays for the ceramic industry	4.9	1,889.8	1,074.5	141,131	> 100
Peat, paludal lime mud	0.1	182.0	110.4	..	> 100
Total	**75.3**	**37,723.8**	**23,789.6**	..	..

Remarks: * 1000 m^3 natural gas = 1 t crude oil. ** 1000 m^3 gas = 1 t. *** including non-conventional Makó deposit.
Source: Hungarian Mining and Geological Institute (www.mbfh.hu)

Solid Mineral Resources

Explored geological reserves of ***non-metallic mineral resources*** represent 20.4 billion tons, 52.5% of which is economical to recover. Nearly 80% of the annual output of the more than 1,100 functioning quarries (61.4 million tons in 2007) is construction sand, gravel, dimension and crushed stone. This volume of production guarantees a long-term supply for the Hungarian processing industry and facilitates the export of some products, e.g. perlite, glass sand and construction gravel. One can conclude that Hungary has a medium level of non-metallic mineral resources, and the country is even rich in some of them (e.g. quartz sand, perlite, bentonite, gypsum and zeolite) to be found in the North Hungarian and Transdanubian Mountains (*Figure 118*). Due to Hungary's geological endowments (its basement position in the Carpathian Basin) there is an oversupply of building materials. High capacity limestone quarries, supplying *raw materials for the cement and lime industry*, operate at Vác, Miskolc, Beremend, Nagyharsány and Nyergesújfalu. The largest extraction centres for *dimension and crushed stones* are in the North Hungarian and Transdanubian Mountains: limestone (Tatabánya, Eger and Süttő); dolomite (Iszkaszentgyörgy, Gánt and Keszthely); basalt (Várvölgy-Uzsa); and andesite (Tállya, Kisnána, Márianosztra and Bercel). Additives used in the production of concrete (*construction gravel and sand* of fluvial origin) are mainly found in the alluvial fans of the Danube, Sajó, Lajta and Mura rivers (e.g. Bugyi, Kiskunlacháza, Hejőpapi, Nyékládháza, Hegyeshalom and Muraszemenye). The mining of *clays for the ceramic industry* (bricks and tiles) shows a relatively uniform spatial pattern. The largest clay pits are along the Danube (Bugyi and Dunavarsány), in the north (Görömböly and Tiszavasvári), and in Transdanubia (Várvölgy-Uzsa and Devecser). The main deposits of *peat* (as a fuel and raw material for the manufacture of fertilisers) can be found in South West Transdanubia (near Little Balaton).

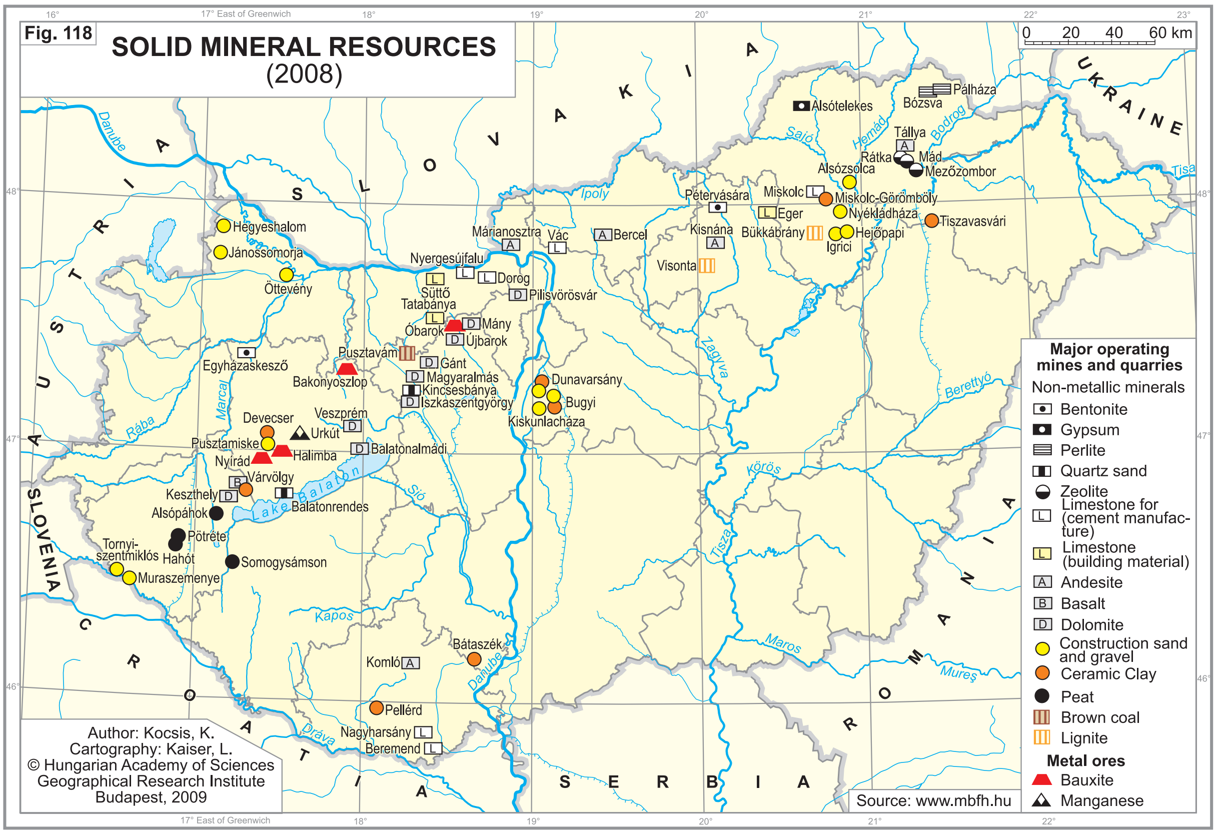


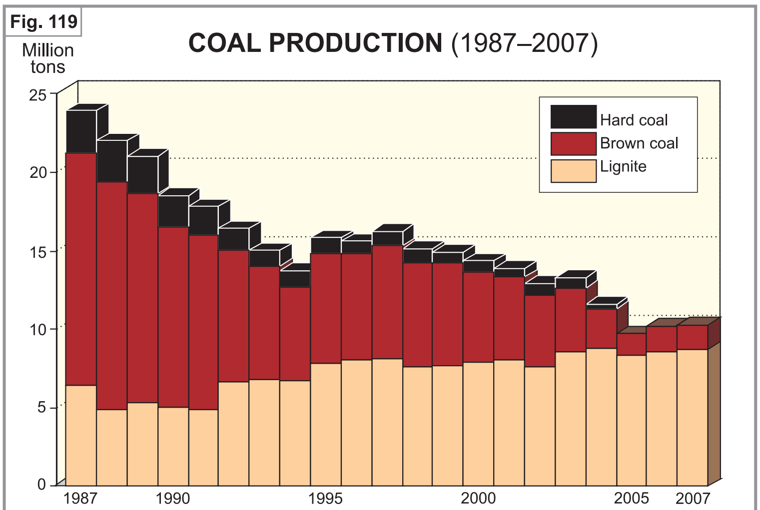
Fig. 118 SOLID MINERAL RESOURCES (2008)

Coals. Although coal mining in Hungary started at Brennbergbánya-Sopron as early as 1753, industrial-scale production gained momentum with the expansion of steamship navigation on the Danube, and the spread of steam powered flour mills over the country, from the 1830s onwards.

During the era of the Austro-Hungarian Monarchy, it was dynamic industrialisation and the rapid expansion of the railway network that was the main consumer. Subsequently electricity generation has become the primary consumer, and coal production has increased from 2 million tons up to 8 million tons.

Following World War II, the coal mining branch (nationalised by then) was expected to rise to the challenges presented by enforced socialist industrialisation, with its highly power-intensive activities, and output had grown to 31.5 million tons by 1964. The oil crisis in 1973 led to the stabilisation of production at around an annual 25 million tons until the mid-1980s. Since then, due to the increasing efficiency of fuels, economic crises and the inefficiency of domestic mining, most deep shaft mines have been closed (*Figure 119*). The bulk of the output of 10 million tons per year is lignite with a low calorific value, mined opencast.

Fig. 119



Source: www.mbfh.hu, www.ksh.hu

Mining of highly calorific (Liassic) *hard coal* in the Mecsek Mountains was terminated in 2004. Mines producing (Eocene and Miocene) *brown coal* in the Transdanubian and North Hungarian Mountains were closed at roughly the same time. The only exception is Márkushegy at Pusztavám (North Transdanubia) with a sizeable output. Pannonian *lignite* with its low heating quality is economically recoverable by strip mining and used for energy generation. There are 4.4 billion tons of workable reserves in deposits along the southern foothills of the Mátra and Bükk mountains (Visonta and Bükkábrány) and along the border with Austria (Torony). They may prove to be instrumental in diversifying the power supply, rendering it less dependent on imports.

Ores. Prior to World War II the centres of ore mining (on the present territory of the country) were Gánt (bauxite), Úrkút and Eplény (manganese), Rudabánya (iron) and Recsk (copper). During the socialist era, due to the dynamic development of the aluminium industry, production of bauxite steadily increased, reaching nearly 3 million tons in 1980, only to decline considerably after 1990. Owing to the deteriorating geological conditions and high costs of production, bauxite mining as become uncompetitive on the world market and output has recently dropped down to 0.5 million tons. Bauxite is currently mined at Halimba, Bakonyoszlop, Nyirád and Óbarok.

Geological reserves worthy of mention but not presently economical to recover, are *non-ferrous metal ores* (copper, zinc, lead, etc.) in the Mátra Mountains (key deposits at Recsk), and precious metal reefs at Nagybörzsöny, Recsk, Telkibánya and Füzérradvány, locations where gold and silver have been mined for centuries. *Uranium ores* are known and explored to the west of the Mecsek Mountains (Kővágószőlős), in green sandstone of Upper Perm, though these are unfavourably located for mining. Between 1954 and 1997, 16.4 million tons of ore was extracted and residual reserves are estimated at 27 million tons. Mining activities were closed in 1997 because of the high costs of production, relative to the price of uranium on the world markets, and due to the generally low competitiveness of the branch.

Iron ore deposits are mainly concentrated at Rudabánya, where mining stopped in 1985. Manganese is to be found at Úrkút (Transdanubia) with an annual output of merely 0.05 million tons.

By the end of the 20th century and over the recent past decade, the main issues at the core of Hungary's energy production policy were energy security, economic growth and environmental protection. The most important parts of government activity have been the exploration, production, transportation, refinery, and allocation of hydrocarbons among the different sectors of the national economy, including the use of raw and refined materials for energy generation, industrial, and residential uses. Hydrocarbons – as fundamental natural resources – are relatively new actors in the national economy of Hungary. Although earlier governments encouraged exploration already at the end of the 19th century, the first indications of the existence of gas and oil resources were reported between 1914 and 1919. After the pioneering age, exploration accelerated the discovery of substantial hydrocarbon resources in numerous locations in the country, and as a result, the industrial production of oil and gas started in the mid-1930s. In recent years, the active area of exploration totaled roughly 75,000 km^{2,} at 68 locations and nearly 50% of them were under the control of MOL (Hungarian Oil and Gas Company).

In terms of the sheer quantity of hydrocarbon resources, they are much less than coal, but the number of occurrences is not in least. The most important (and currently still active) oil and gas fields can be found in the southern and southwestern part of Hungary (*Figure 120*).

Industrial scale ***oil*** production began in 1937, when the Eurogasco drilled a well into the Budafa formation. During the same period, the Hungarian-American Oil Co. (MAORT) also found recoverable quantities of oil in the nearby regions of Lovászi, Hahót and Újfalu. Afterwards, the production rate steeply increased, and output reached 420 Kts in 1940; Hungary became a net oil exporter in Europe. During, and immediately after the disruption caused by World War II, oil production soon dropped, despite the fact that new oil and gas fields were discovered not only in Transdanubia, but also in the Alföld (Great Hungarian Plain).

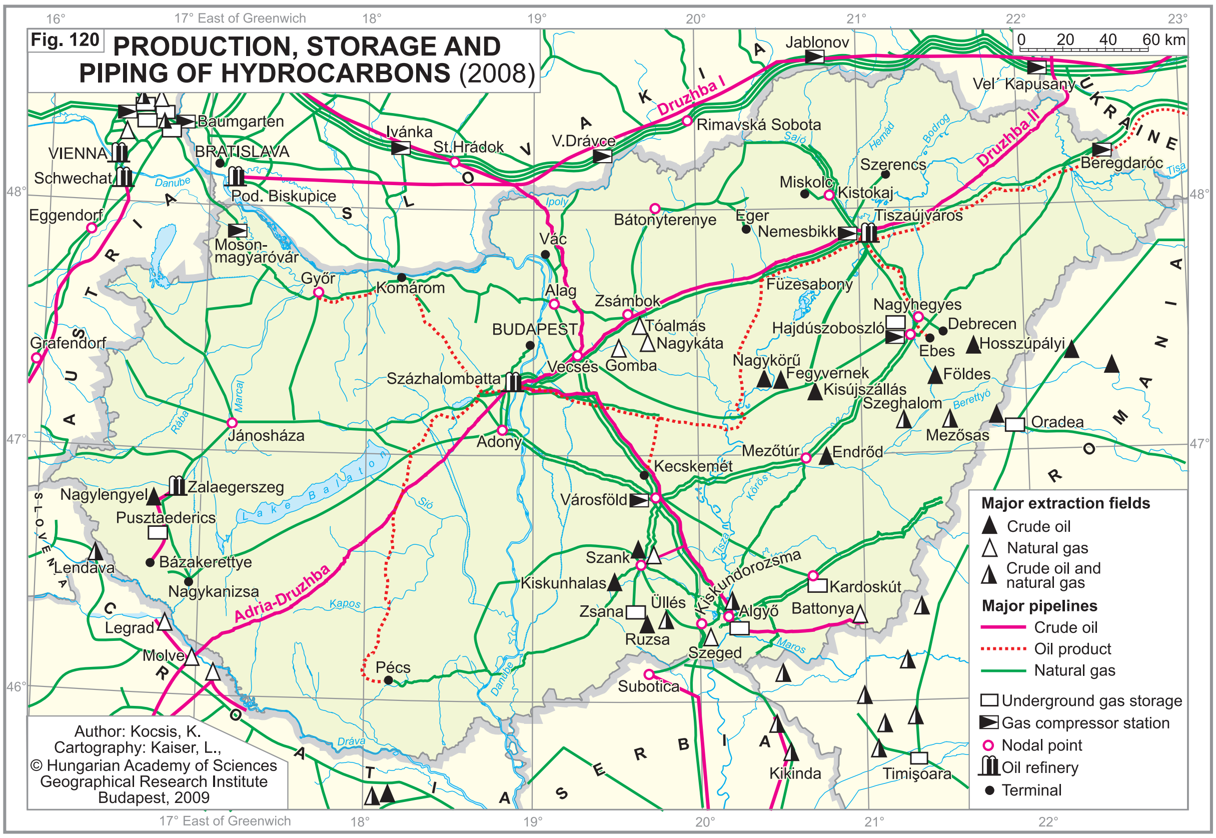


Fig. 120 PRODUCTION, STORAGE AND PIPING OF HYDROCARBONS (2008)

By the mid-1950s, a reservoir bearing heavy oil was discovered close to Nagylengyel. The spike between 1953 and 1957 in the cumulative production diagram indicates its significant contribution to domestic production. The golden age of Hungarian oil production started when the stacked oil and gas field was discovered at Algyő. Soon the production rate increased to 1,500 Kts annually and leveled out at 2,000 Kts per annum for nearly ten years (1976–1986). Since new fields with similar reserves were not discovered, production gradually declined from 1990 onwards, and cumulative domestic oil production continued to remain on the same downward trajectory. These days, 207 million tons of geological reserves exist in Hungarian oil fields, although the recoverable reserve is a mere 19.2 million tons. Hence, current resources at the present annual production rate will be exhausted in roughly 23 years.

Due to rapid industrial development, a dynamic growth in transport and consumption of the population, domestic hydrocarbon production has been unable to meet demand since the 1960s. In 1965, imported crude oil already accounted for 50% within total consumption (*Figure 121*). Since then, the import dependency of the country has gradually increased and reached 86% (total consumption was 8,357 million tons and domestic production 1,193 million tons in 2007). The share of oil in the Total Final energy Consumption (TFC) figure stood at 31.9% in 2004. The responsible organisation forecast a greater than 2% annual growth in oil demand, although domestic production is expected to have by 2030 (output of slightly above 0.5 million tons per annum is predicted).

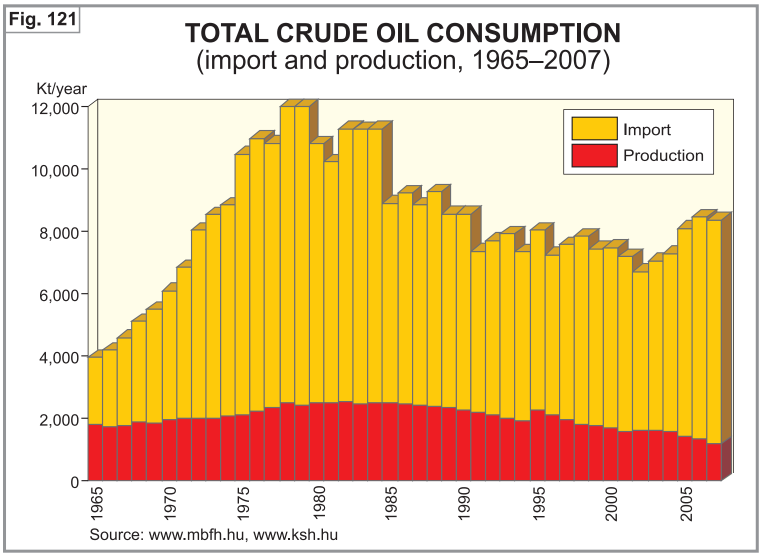


Fig. 121 **TOTAL CRUDE OIL CONSUMPTION** (import and production, 1965–2007)

Russian crude oil imports arrive exclusively via the 'Druzhba (Friendship) II' pipeline (*figures 121 and 122*). In 2005, the amount of oil import transported through this pipeline totaled 6.1 million tons. Another international pipeline ('Adria') connects the largest Hungarian refinery to the oil terminal in Omišalj on the Adriatic Sea (Croatia). In addition, the 4 Hungarian oil refineries benefit from pipeline connections, both amongst one another and externally with the Slovnaft Refinery (Bratislava) in Slovakia. These refineries and ongoing new installations serve the primary goal of ensuring compliance with the requirements of new EU fuel regulations.

Hungary's energy security situation is strained. Domestic production and reliable imports are the highest priorities, as the share of ***natural gas*** in the energy mix is 45% which is the highest among all European countries. Thus, the joint share of crude oil and natural gas represents more than two-thirds of the Total Primary Energy Supply (TPES). Until 2020, the share of natural gas will probably increase by an additional 24.5% (up to 15.6 Mtoe), and hence, crude oil and natural gas will remain indispensable and a determining factor in ensuring ongoing energy supplies.

The exploration of natural gas coincided with the search for crude oil, and its industrial scale production began in 1937, but the production rate remained very low until 1960. In the mid-1960s, however, gas production rapidly increased and it reached its maximum less than ten years later, with an annual production rate of almost 7 Mtoe (7 Gm^3). The majority came from large gas reservoirs in the southern part of the Alföld (Hajdúszoboszló and Algyő), whilst smaller extraction enterprises operated in Transdanubia. As shown in *Figure 123*, this period of abundance ended in 1990 and production began to considerably decline. Recently total gas production output is fluctuating around 2.6 Mtoe (2.6 Gm^3), but a further drop in production is anticipated. Total natural gas resources amount to 5,307 Mtoe, of which 3,355 Mtoe is recoverable; remaining reserves are expected to last more than 50 years (including the unconventional Makó deposit).

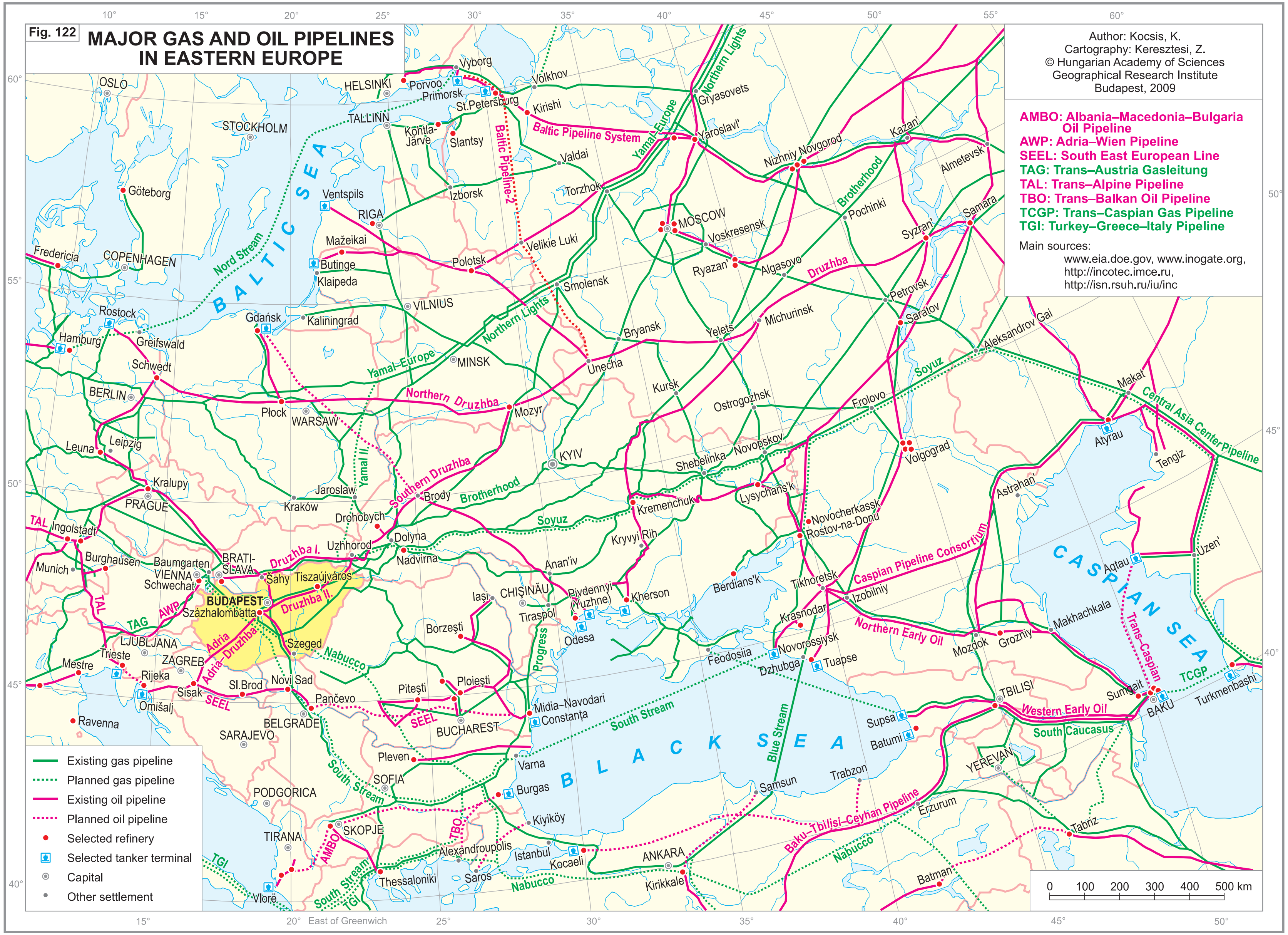
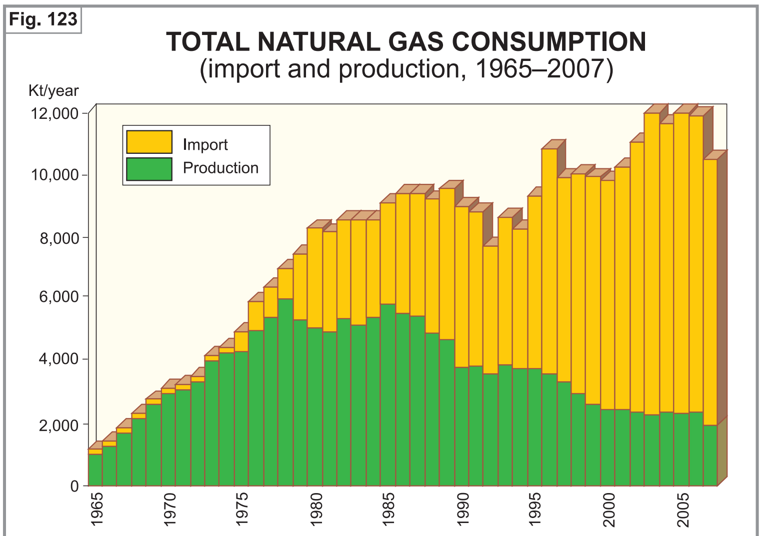


Fig. 122 MAJOR GAS AND OIL PIPELINES IN EASTERN EUROPE

Fig. 123



Source: www.mbfh.hu, www.ksh.hu

Since 1973, Hungary has no longer been self-sufficient in its gas supply. The country currently relies on substantial imports, exclusively from Russia. Total imports reached 8.54 Mtoe (8.54 Gm^3) in 2007. Roughly 20% of that volume was supplied by new companies (Gaz de France, Ruhrgas and EMFESZ), but the gas itself is entirely Russian in origin. Import dependency already exceeds 80% and this is set to increase to 85% by 2020, parallel with declining domestic gas production. At present more than 3.5 million Hungarian households are connected to the low-pressure gas network, domestic household consumption occupying a share of over 80%, which contributes to the very high seasonal variation in demand. Industry consumes relatively little natural gas and the chemical (and other) industries account for only 10% of total gas consumption, whilst power plants used an additional 15%. Only the latter consumer could act as a buffer in the event of a supply interruption.

Based on an analysis of production, import, and consumption statistics, one can conclude that it is indispensable to increase the buffer (*underground gas storage*) capacity and to diversify import sources by extending the high-pressure, international pipeline network. Underground storage plays a very important role in Hungary, overcoming seasonal consumption fluctuation and allowing the country to cope with any crises in the transport network. Currently, five underground storage facilities operate in the country with 3.38 Gm^3 mobile and 4.64 Gm^3 cushion gas capacity (*Figure 120*). Although their maximum release in winter is potentially 47.5 Mm^3/d, additional capacity is needed to meet future demand.

Another element of a reliable and safe gas supply network is a high quality and well connected international and domestic *pipeline network*. The prime pipeline connects Hungary with Ukraine, Austria, and Serbia (*figures 120 and 122*). The Ukrainian pipeline is the main import route with a capacity of 10 Gm^3 per annum, while the Austrian branch (with capacity of 4.4 Gm^3 per annum) is essentially only used to balance the system during times of high demand. Since the government has an ambitious goal to diversify imports, further international connections are currently under discussion, including the Blue/South Stream and Nabucco pipelines (each with 30 Gm^3 per annum capacity) and the construction of an LNG terminal on the Croatian island of Krk. The domestic medium- and low-pressure pipeline network provides reliable access for industry and all residential areas. Network construction began in 1963 and has been gradually improved ever since, reaching a length of 5,194 km in 2005 and includes five high capacity gas-turbine compressor stations. Unfortunately the average age of the system is over 25 years, a result of which continuous inspection, maintenance, and replacement are everyday tasks of network operators.

In three locations (Répcelak, Hahót and Budafa), Hungary has relatively large geological reserves of good quality ***carbon dioxide***. In 2007, the reserves were estimated to be 46.3 million tons, and its recoverable amount was 30.7 million tons. Annual production is currently about 150 Mm^3 per annum; the food industry and health-care sector use the majority of this. Previously, the abundant natural supplies provided an easy option of using CO_2 for enhancing oil recovery, increasing displacement efficiency and improving gravity drainage in the Kiscsehi and Nagylengyel oil reservoirs.

Extensive use of crude oil and natural gas in Hungary and the high import dependency of the country have turned the energy sector's attention to ***unconventional hydrocarbons***. The Hungarian potential of *methane* captured by coal seams is promising. In the Mecsek Mountains, the coal seams may contain great quantities of methane. The joint project of the Hungarian and American geological surveys discovered that at a minimum 140–170 Gm^3 (and by optimistic assessments 240–280 Gm^3) of methane may exist in the coal left behind in disused mines. There is a good chance in the future of recovering 30–50 Gm^3 of methane and a similar proportion of CO_2 from the flue gases of power stations.

Recently a foreign company reported that whilst exploring deep geological formations in the *Makó* trough, huge *unconventional gas resources* were discovered between 4,000 and 6,500 m. The Basin Concentrated Gas Accumulation (BCGA) was first estimated to be around 400–600 Gm^3, but a later report put the figure at 1,200 Gm^3. The official announcement aroused unprecedented attention, since discoveries of this magnitude would make Hungary not only self-sufficient in natural gas, but turn it into a net exporter in Europe. One can conclude that such reserves have enormous energy and economic potentials as their total resource could exceed several times over, the amount of conventional natural gas in Hungarian reservoirs. The expression, "what is unconventional today, will be conventional tomorrow" leads us to predict that unconventional hydrocarbons will be available to all sectors of the country at a reasonable price in the decades to come.

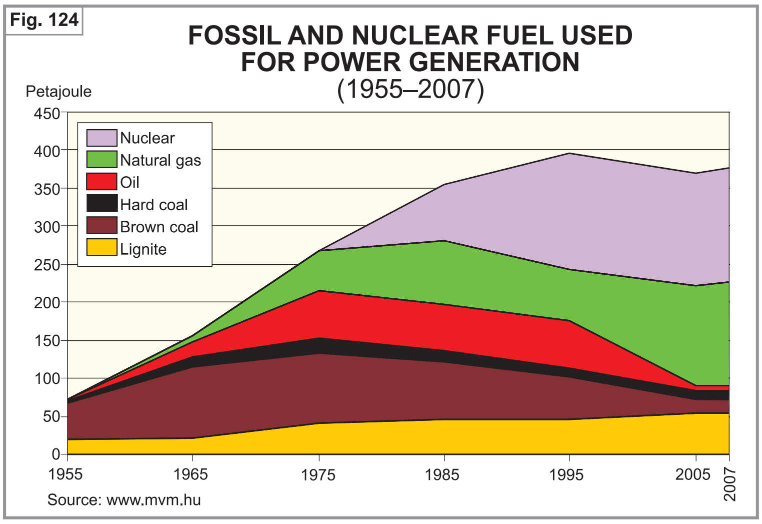
Energy Supply

Development Trends

Coalfields served as the energy source for the socialist industrialisation that was gathering momentum in the *early 1950s (Figure 124)*. Most of the factories involved in the processing of raw materials and manufacturing (e.g. iron and steel, chemicals, construction materials, machinery industries, etc.) were spatially confined to the coal mining regions. Following the arrival of cheap crude oil imported from the USSR, the share of hydrocarbons in the energy sector was growing rapidly *in the 1960s*, but due to the oil price explosions of 1973 and 1979, efforts were also made to utilise domestic coal reserves (the so called Eocene and Liassic programmes) in the *1970s and 80s*. Efforts were also made to find greater uses for natural gas, to increase the import of electricity, and to create an option for the use of nuclear power (Paks Nuclear Power Plant). A drop in energy consumption occurred after the regime change, due to the economic collapse experienced by all Eastern Bloc countries and the closure of a mass of uncompetitive and energy-intensive industrial sites. Declines eventually stabilised total consumption at an annual level of approximately 1,100 PJ. A reduction in the use of domestic resources resulted in a parallel rise in the ratio of imported power, from 50.7% to 67% of energy consumption, between 1990 and 2007. Simultaneously, industry's share of consumption diminished, with a concurrent growth in residential and local public use.

Faced with such circumstances, the current *priorities of govern-*

Fig. 124



ment energy policy when addressing issues of reliability and sustainability of the energy supply are: energy saving and efficiency improvements, reducing dependency on imports and natural gas, diversification of import sources, a higher use of lignite reserves in the energy balance, a further emphasis on the long-term use of nuclear power, increasing participation of renewable energy sources and, finally, closer attention paid to environmental issues.

Electricity

The first thermal power station for the generation of public electricity began working in Temesvár (Timişoara, today Romania) in 1884. Later several plants were built separately from one another, which supplied electricity to two fifths of settlements by 1945. The first high voltage (100 kV) transmission line was opened between Budapest and the Bánhida Power Plant (Tatabánya) in 1932. Following World War II, the capacities of these thermal power stations rapidly increased and the network was extended to meet the considerable growth in demand for electricity. All settlements had been connected to the electricity grid by 1960. Important changes in the fuel supply of the hitherto coal-fired thermal power plants were brought about by the introduction of the hydrocarbon-fuelled Dunamenti (Százhalombatta) and Tisza II (Leninváros/Tiszaújváros) power stations in the 1970s, by Paks Nuclear Power Plant (NPP, commencing operation in the 1980s), later by the widespread exploitation of gas turbines, biofuels (biomass) and the harnessing of wind power over the past two decades. Such changes are also visible in the proportions of energy sources used for electricity generation between 1990 and 2007. The share of brown and hard coal decreased from 22.2% to 3.3%, parallel with an increase of lignite (from 9.5% to 15.2%) and natural gas (from 16.3% to 37.9%). The contribution of nuclear energy (36.8%) has remained – similar to that of natural gas – extremely important.

The total generating capacity of ***domestic power plants*** is 9,139.8 MW, out of which 85.5% is produced by the major power installations (over 50 MW). Besides Paks NPP the largest power stations operate in Central and North Hungary and North Transdanubia (e.g. Százhalombatta, Visonta, Tiszaújváros, Budapest, Oroszlány, Tiszapalkonya and Berente) (*Table 31, Figure 125*). The power stations using ***lignite and brown coal*** are located near their fuel deposits (e.g. Visonta, Oroszlány and Berente), the others *using* ***hydrocarbons*** can be found adjacent to gas and oil pipelines and near their largest consumers (e.g. Százhalombatta, Tiszaújváros and Budapest). Additionally, 210 smaller electricity producers and many autoproducers are operating, which are not part of the Hungarian national grid (e.g. BorsodChem in Kazincbarcika and Dunapack in Budapest). The installed capacity of the biggest ***hydroelectric*** *power plants* is below 30 MW (Kisköre and Tiszalök). The largest power stations using ***biomass*** as their fuel are in Pécs (Pannon Green Ltd) and in Ajka (Bakony Bioenergy Ltd). The 'FKFV–HUHA' power station located in Budapest, is fuelled with ***municipal waste*** and can generate 24 MW. ***Wind farms*** (10–24 MW) were recently established in North-West Transdanubia, owing to favourable climatic conditions (e.g. Levél, Sopronkövesd, Nagylózs and Mosonmagyaróvár).

The ***Paks nuclear power plant*** makes an important contribution to the safe, cheap and clean energy supply of Hungary. Paks NPP is located in the central part of Hungary about three kilometres south of the town of Paks on the west bank of the River Danube. There are four WWER-440/V213 type reactor units at the site. Construction of the plant commenced in 1974 and was completed in 1987, representing the largest industrial project of 20th century Hungary. The power station is owned by the MVM (Hungarian Power Company), together with its parent company State Asset Management Ltd. *(Table 32).*

At Paks NPP a comprehensive programme of safety upgrades have been implemented, which resulted in a decrease to the annual occurrence of core damage; since reduced to a level

Table 31. ***Major power plants (2008)***

Name	Settlement	Installed capacity (MW)	Fuel
Paks NPP	Paks	1,940.0	nuclear
Dunamenti II.F, G1, G2	Százhalombatta	1,736.0	hydrocarbon
Mátrai	Visonta	950.0	coal, biomass
AES Tisza	Tiszaújváros	900.0	hydrocarbon
Csepel GT	Budapest	396.0	hydrocarbon
Oroszlányi	Oroszlány	240.0	coal
Tiszapalkonyai	Tiszapalkonya	200.0	coal, biomass
Kelenföldi	Budapest	185.9	hydrocarbon
Lőrinci GT	Lőrinci	170.0	fuel oil
Borsodi	Berente	136.9	coal, biomass
Pannon	Pécs	132.5	hydrocarbon
Sajószöged GT	Sajószöged	120.0	fuel oil
Litéri GT	Litér	120.0	fuel oil
Újpesti	Budapest	110.0	hydrocarbon
Kispesti	Budapest	110.0	hydrocarbon
Ajkai	Ajka	101.6	coal
Bánhidai	Tatabánya	100.0	hydrocarbon
Debrecen GT	Debrecen	95.0	hydrocarbon
ISD Power	Dunaújváros	69.0	hydrocarbon

Source: www.mavir.hu

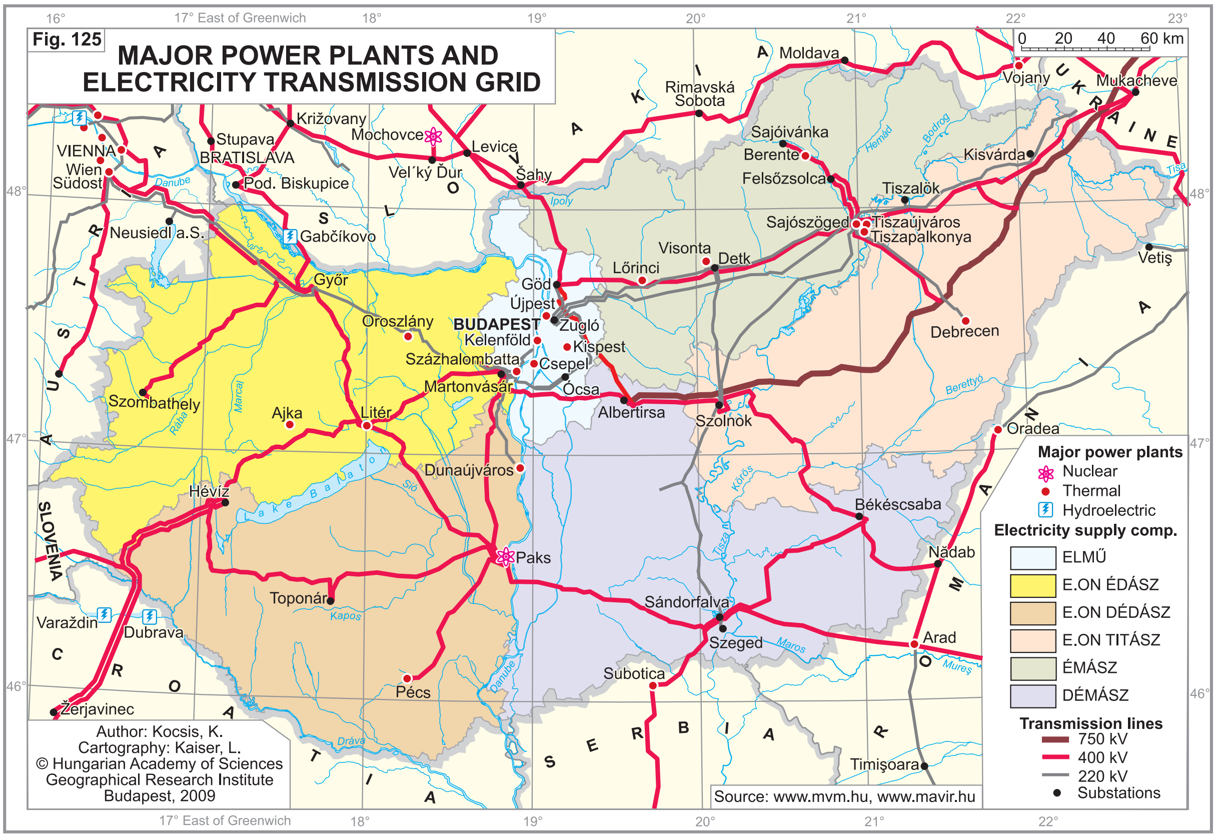


Fig. 125 MAJOR POWER PLANTS AND ELECTRICITY TRANSMISSION GRID

of 10^{-5}/a. Operation of the plant is very smooth and there were no reactor scrams in 2008. An incident occurred in 2003 at Unit 2, which resulted in damage to the fuel assemblies inside a cleaning tank. The incident was unrelated to the safety of the basic technology of Unit 2 and there was no environmental harm.

The capacity of the plant has been expanded, first through an increase in thermal efficiency, and more recently by an 8% increase in the thermal power of the reactor, implemented via the employment of modernised fuel assemblies and some minor modifications, all the while safety margins being maintained.

Table 32. ***Basic technical data of the Paks Nuclear Power Plant***

Unit	Connected to the grid	Net capacity at start of operation, MW	Net capacity before recent power up-rate MW	Capacity in 2008, MW	
				Net	Gross
1	28.12.1982	410	437	470	500
2	06.09.1984	425	441	473	500
3	28.09.1986	427	433	443	470
4	16.08.1987	425	444	473	500

Source: www.atomeromu.hu

In 2008, the NPP produced 14,814 GWh, contributing a 37.2% share to the national electricity output. The cumulative load factor of the plant is 84.39%. The cheapest electricity in Hungary is generated at Paks NPP, and since a doubling in fuel prices will cause less than a 20% increase in production costs, the cost base is very stable. Two years worth of nuclear fuel is stockpiled, to ensure the plant's ongoing operation in the event of short-term disturbances in the fuel markets. Alternative fuel supply might be ensured.

Paks NPP has practically no greenhouse gas emissions. Any replacement technology would result in greater 'whole-life' emissions, e.g. an equivalent power plant to Paks NPP, running on natural gas, will emit more than 5 million tons of CO_2 annually. The ongoing operation of Paks NPP causes a negligible environmental effect with respect to radioactive releases. In 2008 the plant used 0.25% of its release limits. The extra dose relevant to a critical group of the public due to plant emission was 58 nSv in 2008, equivalent to only 10 minutes worth of exposure to natural background radiation. The sole environmental burden results from the release of cooling water into the Danube. Results from the environmental monitoring programme that analysed the environmental impact of the prolonged operation of Paks NPP, showed no adverse effects on the environment after 20 years of operation.

Nuclear waste generated by the plant, including radioactive waste, is collected, classified and contained. The facilities necessary for the processing and storage of solid and liquid radioactive waste are available at the plant. Spent fuel, after five years of cooling at the plant, is stored for 50 years in the intermediate on-site storage facility.

One of the options for ensuring the mid-term ongoing reliable supply of clean and cheap energy, is an extension to the operational life of Paks NPP. The life expectancy of the units at Paks is 30 years, expiring between 2012 and 2017. Starting with a feasibility study in 2000, systematic engineering work has started on secure an extension to their operation life, by an additional 20 years. Environmental authorisation was received back in 2006. In 2008, plans for its extension were submitted to regulatory scrutiny and the formal licensing for the extension for Unit 1 is anticipated to be received by the end of 2011, and later for other units.

An option for the development of Hungary's power industry with a view to the longer perspective, is the construction of a new plant at the Paks site, with capacity twice 1,000 to 1,600 MW between 2020 and 2025. The new plant would secure the power supply and make an essential contribution to electricity generation for a minimum of 60 years, at competitive prices, with practically zero emissions and negligible environmental impact. The new project would stimulate the development of the scientific, engineering and construction industries in Hungary, creating thousands of jobs for more than a decade. The experience and skills for its safe operation are already present in the country; the legal framework is naturally pre-existing for the regulatory oversight of the new plant. The Paks proposals have been thoroughly investigated, the site already possesses the necessary infrastructure and offers opportunities to synergise with that already established.

For many years, the public acceptance level of Paks NPP has been over 70%. In November 2005, the Hungarian Parliament endorsed plans to extend the life expectancy of units 1–4 at Paks by 20 years. Construction of a new plant on the Paks site is also supported by the public and in March 2009, the Hungarian Parliament gave its approval in principle for the preparation of the new project.

Foreign investors own 38.9% of ***companies operating power plants*** (licence holders in electricity generation) of 50 MW and higher. Out of them the Dunamenti, Mátrai and AES Tisza

Power Plant Ltd are the most important. MVM Power Trade Zrt. (Hungarian Power Company) and MAVIR Zrt. (Hungarian Transmission System Operating Company) are exclusively in the hands of Hungarian investors.

Electricity production in the country increased from 1.4 TWh in 1938 to 28.4 TWh in 1990 and further to 39.9 TWh in 2007. However, this amount is not sufficient for the total ***electricity consumption*** of the country (54.3 TWh in 2007), which includes domestic consumption, private power plants, network and transformer losses, as well as electricity exports. The Hungarian power network has been a net ***importer*** of power since 1940, the share of which in the total sources of electricity reached 26.3% in 2007. Since 2005, electricity transit towards the Balkans has played a significant role in the increase of imports, and even more of export. The electricity import of 14,278 GWh (2007) arrives mainly from Slovakia (9,058 GWh), Ukraine (3,915 GWh) and Austria (1,455 GWh), whilst export deliveries (10,291 GWh, 2007) are mostly directed to Croatia (6,536 GWh) and Serbia (3,430 GWh).

Hungary (together with Poland, Slovakia, Romania and Cyprus) became a full member of the ***ETSO (European Transmission System Operators)*** alliance in 2004, which supplies more than 490 million people with electricity through high voltage transmission lines totaling 290,000 km in length. ETSO, as an international association, incorporates four regional organisations (NORDEL, TSOI, UCTE and UKTSOA) which are the result of European efforts to maximise the reliability of the electricity system and the quality of supply, in order to optimise the use of primary energy and capacity resources (*Figure 126*). The Hungarian power generation industry joined the largest organisation – ***UCTE (Union for the Co-ordination of Transmission of Electricity)*** – in 1995, which subsequently also accepted MVM Zrt (in 1999) and MAVIR Zrt (in 2001). In UCTE, Hungary became part of North control block (RWE, with the accounting centre in Brauweiler, Germany). From 1 July

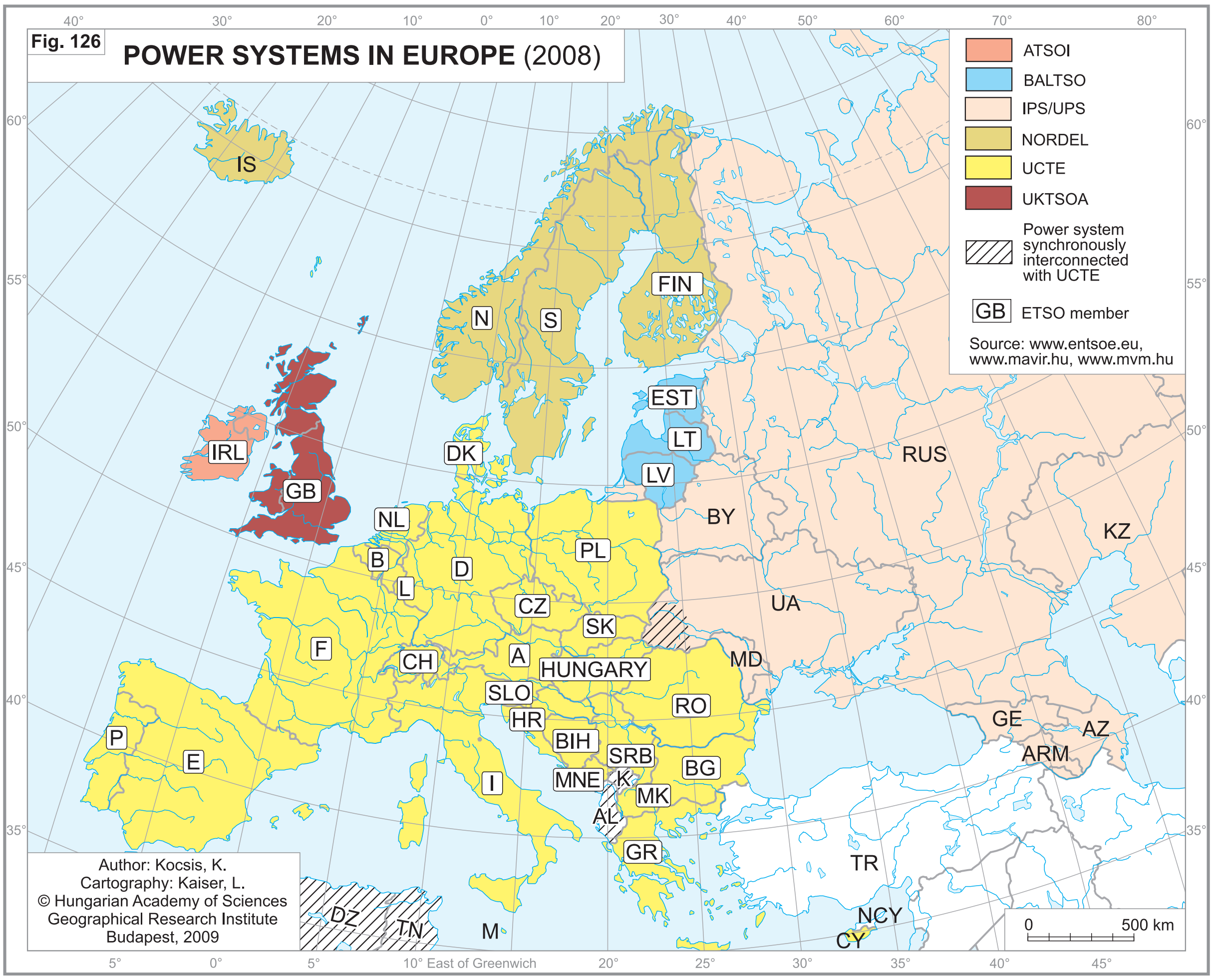


Fig. 126 POWER SYSTEMS IN EUROPE (2008)

2009 on the ATSOI, BALTSO, ETSO, NORDEL, UCTE and UKTSOA has been fully integrated into the new established ***ENTSO-E*** (European Network of Transmission System Operators for Electricity).

The link between producers and consumers is established through the ***transmission and distribution network***, the length of which is 161,629 km (2007). More than two thirds of the system was constructed after 1955. The first 220 kV transmission line started operating in 1960, whilst the first 400 kV line was launched in 1970; a single 750 kV line started operating between the Ukrainian Vinnitsia and the Hungarian Albertirsa in 1978. The length of high voltage transmission lines is 3,455 km, of which 8% are in the 750 kV category and 58% in the 400 kV category.

In 2007, nearly 28 TWh of electricity was generated for domestic consumers by the ***electricity supply companies***. Since privatisation in 1995 and 1996, 95.1% of electricity distributors and public utility suppliers are in the hands of foreign (mostly German) investors. *E.ON Hungária Zrt*. is a subsidiary of the multinational E.ON Energie (Europe's largest private supplier of electricity), and is a leader in the country's power supply, with responsibility for the provision of electricity to Transdanubia and the North Alföld. 53% of electricity sold was consumed in the highly developed regions of the country, supplied by ELMÜ Nyrt. (Budapest area) and E.ON ÉDÁSZ Zrt. (North Transdanubia) *(Figure 125)*.

An overwhelming proportion of the Hungarian electricity infrastructure is obsolete being more than 30–50 years old. The average age of large power plants is 24 years. According to the opinion of reliable sector-based professionals, an enlargement of 4,500–6,000 MW would be necessary in the forthcoming 10–15 years. With respect to technological and environmental considerations, and in order to ensure reliability in the power supply, such development should be primarily reliant on nuclear fuel or lignites. There are also opportunities for an increasing contribution of hydroelectricity and other renewable sources.