УДК 338

FERENC KOVÁCS, Prof. Em. Dr. h. c. mult. Dr. Ing. Member of Hungarian Academy of Sciences Research Group of Geoengineering, Hungarian Academy of Sciences

COAL RESOURCES AND SUPPLY CONDITIONS IN DIFFERENT COUNTRIES

The dynamics of change of norm of consumption of coal is considered for the production of electric energy. Possibilities of the use of coal are investigational on the production of electric energy on a perspective period. The estimation of coal beds of Hungary and possibility of their use is produced.

Keywords: fuel, norms of expense, economic efficiency, production of electric power, coal.

Nowadays (2008, 2010), the rate of coal in the world's electricity production of $20 \cdot 10^{12}$ kWh/year is a round 40%. It is similarly high in leading coal producer countries: 47% in both the US and Germany. For the future (2020, 2030, 2050), long-term forecasts/plans predict a similarly high rate: 38% in the U an, a round 50% in Germany. with the world average being predicted to be 43% in 2035 with a production of $35 \cdot 10^{12}$ kWh/year.

The present (2010) coal production of 6.3 billion t/year may increase to 11 billion t/year by the end of the 21st century with the century average amounting to 8 billion t/year.

On the basis of official reports and expert estimations, the forecast data for both geological and, in greater detail, explored industrial coal resources (that can be economically exploited) are analysed. The wide range of professional estimations give approximately identical figures: the world's industrial coal resources are 700 -1,000 (1,200) billion tons while estimated geological resources amount to 5,000 – 8,000 (15,000) billion tons.

On the basis of the production (demand) data forecast for the 21st century, the average period of supply in industrial resources is 200-300 years in the large coal producer countries (over 1,000 years in Russia) while the world average is 160 years due to China's figure of 40 years attributable to exceptionally intensive production there. The average of the 8 leading coal producer countries (China's 40 year figure included) is approximately identical with this while the average of 7 countries (China excluded) is a round **400 years.**

On the basis of the estimated geological resources (5,000 – 8,000 billion tons) and subject to further successful explorations, period of supply may even be 500-800 years.

With a 10 Mt/year production volume, Hungary has supplies for 330 years, and with an unjustifiably low 4 Mt/year production volume, for 800 years.

According to publication [1], the rate of coal in electricity production is quite considerable in the current period (2008-2010). In the world's electricity production of $20 \cdot 10^{12}$ kWh/year, the rate of coal is 41%, in the US, it is 47% for a $3.7 \cdot 10^{12}$ kWh/year production while in Germany, it is 43% for a $0.62 \cdot 10^{12}$ kWh/year production volume.

When planning for the future, countries prepare long-term forecasts. According to the global forecast for 2035, coal will be responsible for 43% of the $39 \cdot 10^{12}$ kWh/year production volume. The US forecast for 2050 takes into account a 38% coal rate for the $5.0 \cdot 10^{12}$ kWh/year production. For the period following 2020, the basic German forecast takes into account a 50% coal rate, which may even be higher due to the reduction of the production of nuclear power plants (close-downs) also depending on the amount of imported gas. [2, 3, 4]

There are different estimations concerning fossil fuel (coal, lignite, mineral oil, natural gas) resources. As regards mineral oil, conventional world supply is estimated to last for 30-40-50 years while the same figure for natural gas is 50-60-70 years. The exploration and exploitation of non-conventional resources (oil shale, oil sand, gas shale, gas hydrate) may significantly expand supply opportunities. In case of coal (hard coal, brown coal, lignite), every estimation indicates significantly larger resources and longer supply periods.

With regard to the above forecasts taking into account a 30-40-50% coal rate in electricity production, this paper gives an overview of what data the different experts and institutions have published about the world's coal resources. In most of the cases, the figures for industrial coal resources (that can be economically produced with the currently available technologies) are given but for some authors, the figures for geological resources and for other expert estimations, the period of supply (how long it will be enough) are presented for the production volume at the time of estimation. As regards the issue of saving/depletion of coal resources, it is investigated what supply volumes can be taken into account for coal, and for how many generations, they will be sufficient.

As early as at the beginning of the 20th century, this was written [5]: 'There is hardly any other issue in natural sciences that scholars would deal with so much as the question of fuels: what will happen if there is no longer any hard coal in the layers of the Earth..... and hard coal **is** running out.' The authors then made the following forecasts:

- The hard coal resources of Great Britain (one hundred million tons) will run out in 435 years…
- Belgium, Prussian Silesia and Russia possess the largest hard coal resources but even these will not be able to satisfy rising demand for longer than 500 years,
- According to Hall, North America may meet current world demand for ten thousand years.

Fifty years later (in 1944), Kálmán Sztrókay [6] wrote the following on the basis of 1929 data: the brown coal resources of the Earth amount to 3,000 billion tons, of which industrial resources are 400 billion tons, and black coal resources give 4,400 billion tons, of which industrial resources amount to 300 billion tons. The figure for the resources of the five continents is 5,662 billion tons in black coal equivalent of 7,000 calories. With the 1929 production volume of 1.25 billion tons, the industrial resources of 700 billion tons (present-day estimates indicate an identical figure for the minimum amount of current industrial resources) meant supply for 570 years (early 2000s).

Now, let us investigate current 'official' and scientific figures and estimations.

According to data from the Hungarian Geological Service [7], the world's industrial black coal resources are 519 billion tons while brown coal resources are 465 billion tons so with a 4.3 billion ton production volume, the 984 billion tons of resources provide supply for 228 years.

According to data from György Vajda [8,9], the world's industrial black coal resources amount to 510 billion tons and brown coal resources are 475 billion tons, altogether 985 billion tons, which ensures supply for 219 years, taking a production volume of 3.6 + 0.9 = 4.5 billion tons/year into account. The coal resources of eight prominent countries (Russia, USA, China, Germany, India, Poland, South Africa) amount to 817 billion tons. He indicates the world's geological resources to be 5,000 billion tons.

Estimating the world's geological resources to be 4,773 billion tons, the author of publication [10] gives a 136-year period of supply for industrial hard coal resources and a 293-year period of supply for lignite resources.

Investigating the expected prospects of coal production, Klaus Brendow [11] gives the figure 510 billion tce (7,000 calories) for the world's black coal resources and 200 billion tce for brown coal resources, which are 710 billion tce altogether, equivalent to 160- and 460-year periods of supply and an average 196-year period of supply. His figures for geological resources are the following:

6,000 billion tce black coal and 2,700 billion tce brown coal, altogether 8,700 billion tce. Adding up the production forecasts of the different countries, Klaus Brendow expects a 7 billion ton coal production volume for the year 2030 while the World Energy Council (London) gives the coal production forecast of 11 billion tce for the year 2100.

In his study, István Lakatos [12] gives the figure of 1,083 billion tons for industrial coal resources with a 40% rate of black coal.

According to Shashi Kumar's data [13], the world's industrial coal resources (2002) amount to 951 billion tons black coal and 465 billion tons brown coal. He gives the supply data of 204 and 209 years.

The author of publication [2] estimates the world's industrial coal resources to be at least 900 billion tons (Mehr als 900 Mrd Kohlevorräte, 2004), of which the US accounts for 250, Russia for 157, China for 120, India for 80, Australia for 75, Germany for 65, South Africa for 50 and the Ukraine for 30 billion tons, 827 billion tons altogether, other prominent contributors being Brasil, Poland, Indonesia and Colombia.

According to V. S. Kovalenko's data based on former explorations [14], in the world, Russia possesses the second largest coal resources after the US. Russian geological resources amount to 5,335 billion tons, which is 36% of the world's geological resources accoding to him. This indicates the world's geological resources to be a round 15,000 billion tons.

With the above 800-1,000 (1,200) billion ton data of the world's industrial coal resources/reserves (economically exploitable with current technologies) taken from official publications and expert estimates, a supply period of 150-230 years is estimated by experts. Even with the current production volume of 6.3 billion tons and the production volumes of 7 billion tons estimated for 2030 and 11 billion tons for 2100, taking into account an average production volume of 8 billion tons/year for the 21st century, the currently registered industrial resources will safely meet the demands forecast for this century.

With regard to the currently known (estimated) geological resources of 5,000 – 15,000 billion tons and taking into account the expected development of production technologies, further industrial resources of 2,000 – 5,000 billion tons may be forecast for the period after the 21st century, providing supply opportunities for future generations. In view of all this, it is hardly justified to speak broadly about 'ever decreasing fuel resources' – at least with respect to coal types.

In addition to world data and forecasts, here are some data concerning coal in Hungary. [7]

Coal type	Geological resources M (10^6) tons	Industrial resources M (10^6) tons	Reserves M (10^6) tons
Black coal	1,950	200	450
Brown coal	2,170	195	180
Lignite	4,400	2,930	730
Total	8,520	3,325	1,360

Present annual coal production (2010, 2011) is 8.0 – 8.5 M tons of lignite and 1.5 – 2.0 M tons of brown coal. Although emphasizing 'a commitment to coal in principle', the National Energy Strategy [14] takes into account a decreasing future coal rate of 4-5% in electricity production in spite of the present rate of 14%. This decrease cannot be supported with rational arguments and is totally unjustified.

The level of supply of a country or the world with utilisable raw minerals, namely with coal, with a given production volume, also depends on the number of the population. Next to the data of industrial coal resources, the following table provides the figures of annual production and the number of population, and calculates the per head amount of industrial resources and the expected supply period subject to current production volume.

Country	Total industrial coal resources M (10^6) tons	Production volume M (10^6) tons/year	Population M (10^6)	Industrial coal resources per head t/person	Period of supply years
Hungary	3,325	10	10	330	330
		4			830
US	250,000	932	310	800	270
Russia	157,000	140	142	1,100	1,120
China	120,000	3,162	1,321	90	40
India	80,000	400	1,210	70	200
Australia	75,000	353	21	3,570	210
Germany	65,000	190	82	790	340
South Africa	50,000	225	44	1,140	220
Ukraine	30,000	80	46	650	375
Total and average for 8 countries	827,000	5,482	3,176	260	150
World	1,000,000	6,300	7,000	140	160

Conclusions. On the basis of the data per head (t/person) (specific values) and the period of supply figures (years), the following conclusions can be made:

- In the world's 8 leading coal producer countries, the amount of coal resources per head is practically twice as much as the 'world average' (260/140,) calculated from currently known (estimated) data. (Obviously, in Asia, Indonesia, Africa or South America, considerable resources may still be discovered.)
- The period of supply calculated for the world's 8 coal producer countries is practically identical with the world average (150/160) although figures reveal quite significant differences between the individual countries (see for example, Russia or China), similarly to the data of industrial coal resources per head (t/person). (Due to export/import data and rates, use parameters may differ for the individual countries.)
- In Hungary, the amount of industrial coal resources per head as well as the supply parameter calculated on the basis of production volumes 10 M t/year, and especially 4 M t/year, well exceed the world average. In view of this, it is unjustified that the National Energy Strategy only takes into account a 5% coal rate in electricity production forecasts.

References. 1. *Kovács, Ferenc:* Szén arányok a villamosenergia termelésben, a klímaokok valódisága ('Coal rates in electricity production. The reality of climate causes') (manuscript). **2.** *Fabian, Jan* (2011): Steinkohle – lokale Auswirkungen eines globalen Aufschwungs. 12 November, 2011. Clausthal – Zellerfeld. **3.** *Karmis, Michael* (2010): Carbon Capture and Storage (CCS): The Road to Deployment. Annual General Meeting. Society of Mining Professors. Tallinn, Estonia, June 2010. **4.** *Karcher, Christian* (2012): RWE The Energy to Lead. Bergheim 18.04.2012. **5.** *Cholnoky, Jenő – Litke, Aurél – Papp, Károly – Treitz, Péter*: A Föld. A Föld múltja, jelene és felfedezésének története. ('The Earth. Past, present and history of exploration') Athenaeum Irodalmi és Nyomdai Részvénytársaság, Budapest, 1906. **6.** *Sztrókay, Kálmán: Föld,* víz, tűz, levegő. ('Earth, water, fire, air') Királyi Magyar Egyetemi Nyomda, Budapest, 1944. **7.** *Magyar Geológiai Szolgálat* ('Hungarian Geological Service'): Magyarország ásványi nyersanyagvagyona. ('Hungary's mineral resources') Budapest, 2004. **8.** *Vajda, György:* Energiapolitika. ('Energy policy') 2001. Magyar Tudományos Akadémia. **9.** *Vajda, György:* Energiaellátás ma és holnap. ('Energy supply today and tomorrow') Stratégiai kutatások a Magyar Tudományos Akadémián, Budapest, 2004. **10.** *Klank, Maksymilian:* Europe and the Coal Industry. EURACOAL European Association for Coal and Lignite. Coal Industry across Europe. 2008. **11.** *Brendow, Klaus:* Sustainable World Coal Mining. Perspectives to 2030. 20th World Mining Congress 2005. 7-11 November, 2005. Tehran, Iran. 'Mining and Sustainable Development', pp. 51-59. **12.** *Lakatos, István:* Perspectives of Oil and Gas Production/Consumption in the 21st Century. (manuscript). **13.** *Kumar, Shashi:* Global Coal Vision – 2030. 19th World Mining Congress. 1-5 November, 2003. New Delhi, India. Mining in the 21st Century – Quo Vadis? pp. 137-148. **14.** Nemzeti Energiastratégia 2030 ('National Energy Strategy 2030') 77/2011 (X. 14.) Parliamentary decision.

Надійшла до редколегії 18.01.2013

УДК 338

Coal resources and supply conditions in different countries /Ferenc Kovács// Вісник НТУ „ХПІ". Серія: Технічний прогрес і ефективність виробництва. – Х.: НТУ „ХПІ". - 2013. - № 20 (993) - С. 106-112. Бібліогр.: 14 назв.

Розглянута динаміка зміни норми споживання вугілля для виробництва електричної енергії. Досліджені можливості використання вугілля на виробництво електричної енергії на перспективний період. Зроблена оцінка вугільних покладів Угорщини і можливості їх використання.

Ключові слова: паливо, норми витрати, економічна ефективність, виробництво електроенергії, вугілля.

Рассмотрена динамика изменения нормы потребления угля для производства электрической энергии. Исследованы возможности использования угля на производство электрической энергии на перспективный период. Произведена оценка угольных залежей Венгрии и возможности их использования.

Ключевые слова: топливо, нормы расхода, экономическая эффективность, производство электроэнергии, уголь.

УДК 338.45:658.27

Д.В. БЕЗУГЛА, магістр, НТУ «ХПІ», Харків

ОРГАНІЗАЦІЙНО-ЕКОНОМІЧНІ АСПЕКТИ ІННОВАЦІЙНОЇ ДІЯЛЬНОСТІ ПІДПРИЄМСТВ ХАРКІВСЬКОЇ ОБЛАСТІ

Досліджено статистичні показники інноваційної діяльності промислових підприємств Харківської області у період 2000-2011років. Виявлені певні тенденції зміни чисельності інноваційно-активних підприємств, впровадження ними нових технологій та забезпечення фінансування інновацій. Запропоноване створення Державного інформаційного банку інноваційних бізнес-проектів як механізму підвищення ефективності інноваційної діяльності на загальнодержавному рівні.

Ключові слова: промисловість, інновації, технології, впровадження, ефективність, управління, інвестиції.

Вступ. Визначальною тенденцією розвитку світової економіки є невпинний розвиток інноваційних процесів і забезпечення, на цій основі, конкурентоздатності товарів, робіт та послуг. Це стосується як окремих підприємств і країн, так і міждержавних інтеграційних утворень на світових ринках виробництва і збуту. Підвищення ефективності інноваційної діяльності, впровадження ресурсозберігаючих технологій, виробництво нових видів продукції є актуальною проблемою сучасного розвитку економіки України, особливо з урахування кризових явищ у фінансово-інвестиційній сфері і рецесії у економіках провідних держав.