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Main trends of development of clean coal technologies in Ukraine

Key words

Energy policy, coal

Abstract

Taking into consideration the level of world economic development the analysis of contemporary world tendencies of fuel and power resources production and consumption is presented. The role of coal in electric power industry of Europe and Ukraine is shown.

The results of establishment of innovative mining machines and mechanisms in Ukraine (mining mechanized complexes, winning and heading combines, transport equipment etc.) are laid down.

The issues of the most effective using coal energetic capacity and complex exploitation of coal deposits for chemical industry including motor oil production are considered.

Taking into account contemporary world tendencies and environmental aspects the substantiation of ways and technical decisions that allow the Ukraine avoid ineffective using natural gas in power industry is presented.

Wprowadzenie

The current world trends of production of fuel and power resources are determined taking into consideration the level and prospects of the world economy development today (Fig. 1). For a period of thirty years definite changes took part in the structure of electric power generating as for the types of fuel. First of all, they are connected with nuclear power progress.

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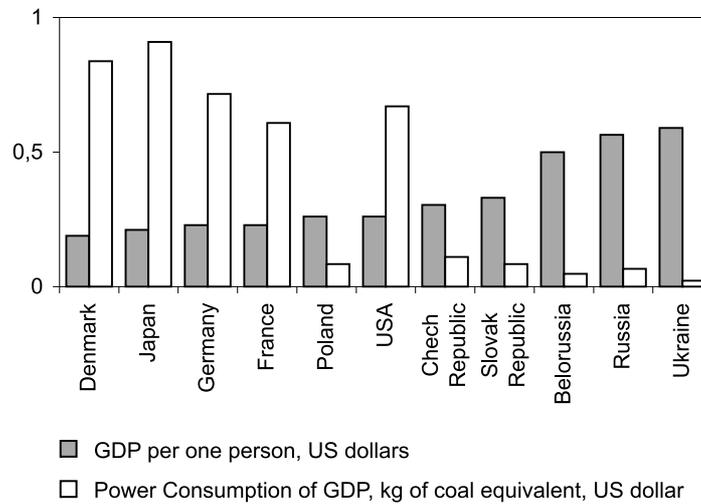


Fig. 1. Economic figures of the world countries

Rys. 1. Dane ekonomiczne niektórych krajów świata

General world share of coal decreased but in such countries as Japan, Canada and Australia it increased. The share of coal in the structure of the world power industry is 23 per cent. Coal electric power stations generate 38 per cent of electric power. Almost 70 per cent of the world steel works rely on coal. Experts from the International Energy Agency suggest that by 2020 coal consumption will grow by 43 per cent to compare with 2000. According to the World Coal Institute prognosis coal world mining will come to 5 thousand million tons in 2010. If production rates stay to be at a current level the coal reserves will be sufficient for 200 years: as for oil — for 45 years, and gas — for 65 years. General trend to pay special interest to efficient production processes of coal use is connected with terrorism threat, unmanageable price rise for oil and gas, and concentration of these resources in critical regions of the world.

Many experts believe that opportunity for coal share increase in power industry of Europe that has been observed lately can minimize the acuteness of power problems. Modernization of existing coal power units and implementation of the new, extensively approved processes of pure use of coal are rather economical way to provide future power safety. The new technologies are not only ecologically clean but they are more efficient as well. Within 10—15 years the efficiency of coal power units was increased from 35 per cent up to 45 per cent. It is suggested that future improvement of methods will help to increase the efficiency of potent coal power units up to 55 per cent (Fig. 2).

The state economy provision with power is one of the most important aspects. In 2005 power provision in Ukraine is more than 4 tce per person. It is much less to compare with developed world countries. Power dependence of Ukraine on the delivery of organic fuel in 2000—2004 went above 60 per cent. That's why the state of affairs in power energy in Ukraine needs to be changed radically.

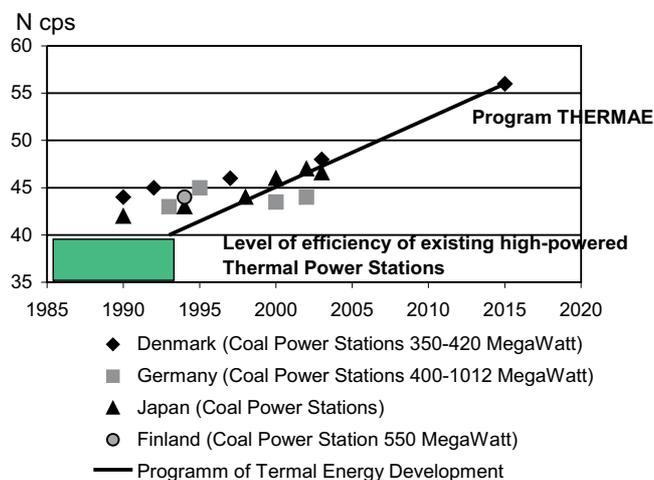


Fig. 2. Increase of efficiency of Coal Power Station

Rys. 2. Wzrost efektywności elektrowni węglowych

Today power industry of Ukraine (Fig. 3) has such key problems:

- high power intensity of GDP which is 0.89 kg of coal equivalent per USA dollar (Fig. 4). One can see it is two or three times more than average level of power intensity in the world countries taking into consideration the point of real purchasing parity. As a result, excessive consumption of power products, and constant import of hydrocarbon into Ukraine take place;

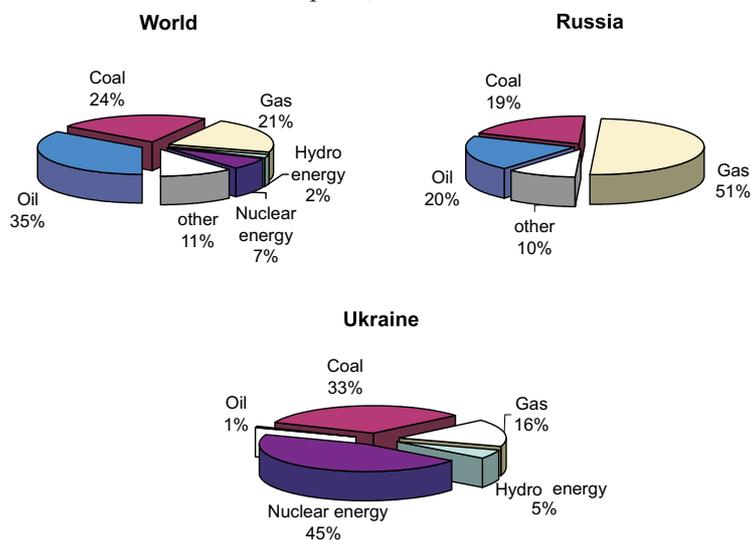


Fig. 3. The structure of prime power resources consumption; actual (World, Russia), provisions for 2030 (Ukraine)

Rys. 3. Struktura zużycia energii pierwotnej aktualna (świat, Rosja) oraz przewidywalna na 2030 r. (Ukraina)

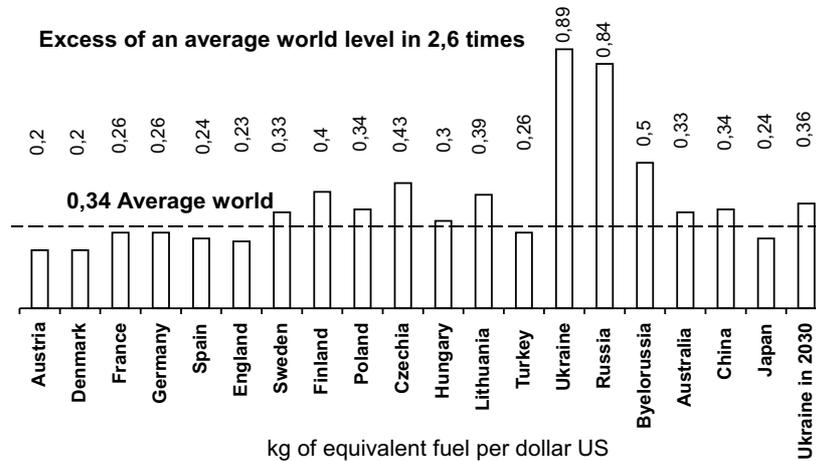


Fig. 4. Power intensity of GDP of the countries of the world

Rys. 4. Energochłonność Produktu Krajowego Brutto w niektórych krajach świata

- disappointing situation at power plants due to critical wear of capital assets (60 to 70 per cent), drop in reliability of power plants activities, rise in specific fuel consumption to generate electric power, losses in networks while power products are being transported (as for power industry the electric power costs for transportation in networks were 9 per cent in 1991. Now they are more than 14 per cent);
- the lack of effective management system for power engineering;
- the lack of diversification of sources of supply with original power products, natural gas, oil, and nuclear fuel. Such a situation imperils to power safety of the state.

Fuel and energy complex (FEC) of Ukraine was created as a component of FEC of USSR. That's why it can't meet the demands of independent state. Power industry of the country needs to be restructured fundamentally to be in accordance with current geopolitical economic and ecological situation of the country development as a part of the world economy.

For ten years past the share of nuclear fuel to generate power increased in Ukraine. Since 1997 specific share of coal as mineral resource used as source of power has enlarged.

Having huge reserves of competitive in domestic market coal Ukraine occupies one of the last positions among coal mining countries as for its use. That's why the key problem for power industry in Ukraine is to change power consumption structure by means of natural gas share decrease, and coal share increase. Studies confirm that it is possible to reduce the share of natural gas consumption from current 41 per cent to 18 per cent till 2030. At the same time the share of coal consumption may be increased up to 32—33 per cent.

Proceeding from the world trends of power industry development and power safety the policy of coal industry progress in Ukraine to 2030 is aimed at significant growth of coal mining volumes.

According to the information by scientists the technical re-equipment of coal Thermal Power Station in Ukraine will help to reduce specific expenses of conditional fuel to generate power from 372 g in 2005 to 330 g in 2005, and coal economy will come to 49.6 mln tce (72.3 mln. tons of coal). That's why the competitiveness of Ukrainian coal in domestic market will help to provide own needs not only in power generating but the economy on the whole within the next decades. Only successive power policy will help to represent coal as the part of this policy, and consider it as equal component in power market.

Supply the needs in power products is planned under the following conditions: decrease the power intensity of GDP and increase the level of provision of country with power; increase in own output of coal, uranium, oil and gas; electric power generating by nuclear power plants with the help of own nuclear fuel; increase in volumes and intensity of oil processing.

Today general electric generating power is more than 53 million kW·h including Thermal Power Station and Thermoelectric Plant power (about 58 per cent), and APP (26 per cent), and HES and HEPSPP (about 10 per cent), and unit-stations and other sources (6 per cent). By 2030 generating power will have increased up to 73 million kW·h. Thermal power stations stay to be the basis of power system in Ukraine. They will persistently increase power generating to double it in 2030.

The progress of thermal power is based upon the prevalent use of coal, which share in fuel balances of Thermal Power Station will be about 80 per cent in 2030. It will help to develop domestic coal mining industry and influence optimistically power safety of the state.

Balance reserves of A + B + C₁ coal categories in Ukraine are 45 thousand million tons including over 13 thousand million tons of coking coal. Prospected reserves of lignite are over 8 thousand million tons. More than 2 thousand million tons of lignite can be produced by means of open-cast mining. The main reserves of coal are in Donetsk basin (up to 90 per cent).

About 23 thousand million tons of balance resources (categories A + B + C₁) have been prepared for mastering industrial production. About 9.5 thousand million tons of them are operated being kept in an account of running enterprises including 5.5 thousand million tons (58 per cent) of power-generating coal.

But coalfields in Ukraine (first of all, in Donbass) are characterized by difficult mining and geological conditions: small seam thickness, deep bedding, limited stability of enclosing rocks, high gas content, and tendency of many seams to gas dynamic symptoms — sudden outbursts of coal and gas, rock bumps. About 77 per cent of coal mines are considered as gas-bearing. Seams which thickness is more than 1.2 m make up only 20.4 per cent, and thin ones (from 0.8 up to 1.2 m) — 46.3 per cent, and rather thin seams (less than 0.8 m) — 33.3 per cent.

Coalfields in Ukraine contain huge methane reserves. According to different assessments there are about 2.5 to 25 thousand million cubic meters of methane in Donbass. Thus coalfields in Ukraine should be considered as coal and gas ones.

45 vacant sites can be recommended to build 48 new mines in Donetsk basin, but depth of 10 of them will be over 1400 m. Almost all mines to be built are considered as deep ones, or have rather difficult situation concerning bedding of seams. There are more than 40 fields to build rather shallow high-profitable mines which total capacity is 4 to 5 million tons a year.

According to different scenarios the *general needs of Ukraine for marketable coal* will be 75,9...89,3 million tons in 2005; 78...94 million tons in 2010; 80...100 million tons in 2015; 82,2...110,5 million tons in 2020; 90,1...120 million tons in 2025; 120...123,4 million tons in 2030.

Taking into consideration the weight of coal for electric power generation and for ferrous metallurgy, the *strategy of coal industry development* is a very important component of the Energy Strategy of Ukraine. It stipulates the rise of volumes and effective use of own coal as the means to provide the power safety of Ukraine.

Systematization of production and technical tasks taking place in the period of development of coal deposits in Ukraine gives ability to formulate *scientific-and-technological problems* which solutions will help to accomplish the main goal of coal industry growth strategy, that is to increase output being competitive in domestic market.

Mining and geological conditions of coalfields in Ukraine predetermined the *actuality of scientific and technological problems of mining knowledge, among which the following are the key ones:*

- study of manifestations of high mining pressure, gas dynamic effects, and temperature conditions;
- study of nature of stressed and deformed condition of rock massif around very deep workings;
- backing underground workings with resource-saving methods based upon the management of rock massif power;
- creation of effective and safe and sound mining methods with the use of the new reliable and highly productive equipment;
- creation of mining safety system being equal to modern conditions of development of coal deposits.

The progress of current mining methods is a vital problem. Today coal industry has credible experience how to increase the efficiency of mining at the expense of concentration of mining operations using mining and drifting/sinking equipment of a new generation produced in Ukraine.

The new economic and legal models concerning the investment of coal enterprises have been created and work. Coal company “Krasnoarmeyskaya — Zapadnaya No 1” is an example. In it mining capacities and labour productivity are at the level of the best European companies. Coal Company “Pavlogradugol” makes obvious positive dynamics of coal mining intensification.

Machines and mechanisms of the new technical level (mining mechanized complexes, cutter-loaders and heading machines, transport equipment etc) have been made in Ukraine.

They better the best world prototypes, which give ability to increase mining in one wall up to 2000...6000 tons a day. Their application needs to be agreed with mining methods.

If mining is limited because of gas factor preliminary degassing of coal seams and enclosing rocks is performed. To do that it is necessary to build “gas” levels, drill wells from openings as well as from surface having ability to mine methane too.

Lately a positive process of load intensification as for complex-mechanized stopes has been emerged. Exploitation of five MKD90 complexes with proper driving and sinking machines, and transport means gives annual coal mining growth within 1.3 million tons. It is equal to putting into operation a new mine which cost of production is 40 mln. US dollars.

The resource of new equipment is 15 to 20 thousand hours, and it is equivalent to 5 to 6 years of operation before overhaul is necessary. Cutting combines (KPD and KPU) have been designed to provide the front of preparatory activities. To provide the activities of transport chains from high-loaded faces the L800D, L100D, L1200D conveyers having gradually more per capita power consumption and transportation remoteness range have been designed.

Double or treble performance measures of new getting and delivery machinery on productivity, per capita power consumption, and reliability let work in walls extended up to 250—450 m, work in thin seams, and decrease sharply consumption of human labour for finishing operations in stopes which will result in average load growth for such complexes up to 1700—1800 tons a day (Fig. 5).

Production of end product, that is power energy having minimum cost price, natural properties of mineral resources used as sources of power and technical level of the power industry is the task of industrial cycle of coal output and use.

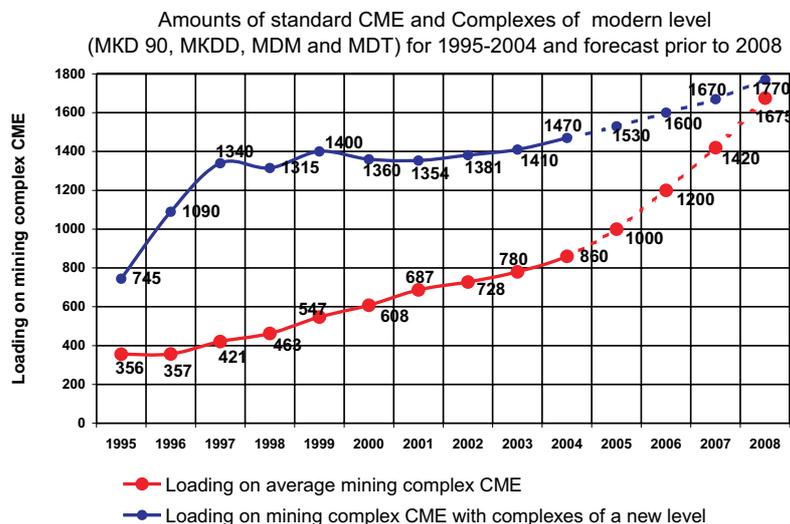


Fig. 5. Diagram of change of loadings on Complexes of the Mechanized Extraction (CME) in Ukraine

Rys. 5. Zmiany nośności zmechanizowanych kompleksów eksploatacyjnych na Ukrainie

The problem of coal quality grounding should be considered from the point of view of its power potential total use, technological possibilities to achieve it, and economic expediency. If we proceed from consumer properties of fuel it is possible to obtain maximum quality of functional heat if its quality is optimal.

Much is being done in Ukraine to develop and implement the new generation of harmless methods of coal burning (processes of circulating fluidized bed under pressure) which object is to increase the efficiency greatly while generating power by means of coal electric power stations and to decrease seriously the discharge of harmful substances (to admissible level). Steam and gas plant with coal gasification is developed.

Such an approach will help to realize more entirely power potential of combustible coal mass, and economize fuel reserves of the country, and reduce the price of electric power generation on the basis of solid fuel, and solve ecological problems of the country.

Investment problems of coal industry are stipulated by investment attractiveness of mines but not the value of their assets. High cost of fixed assets of a mine can not confirm its profitability. Profitability of mining as business depends on the prospects of mining. Investment attractiveness is another most important aspect to support mine capacities.

The availability of more than 3.5 thousand million tons of bituminous coal reserves in South Donbass (Bogdanovskoye Deposit) gives ability to consider the new district as promising one from the point of view of power-generating coal mining. Favourable mining and geological environment determines its mining expediency: thickness of strata is 1.2 to 3 m, depth is 550 to 770 m, pitch angle is up to 4 degrees, and gas-bearing is 5 to 8 cubic metres per ton. Simultaneously with construction of new mining enterprises the construction of plant to produce synthetic motor fuel with capacity up to 3 million tons a year has been started. The persons responsible believe that *it will absolutely help to provide the transport industry of Ukraine with synthetic petroleum* for decades liquidating vital dependence of economy of Ukraine on deliveries of oil and oil products from other states.

Conclusion

Strategy of coal industry progress in Ukraine is oriented to the increase of volumes of effective and harmless use of coal by power industry taking into consideration investment attractiveness of projects.

Realization of the strategy will need to increase production capacities to develop new deposits at the expense of construction of new mines and reconstruction of running ones.

Significant investment of mining science is needed to solve those scientific and research problems to be determined by mining and geological conditions of underground mining and up to date economy.

The experience of Ukraine begins to show the progress of the new potential methods to develop coal seams and complex processing of rock mass, and application of harmless processes of coal burning.

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GIÓWNE TRENDY BADAŃ CZYSTYCH TECHNOLOGII WĘGLA NA UKRAINIE

Słowa kluczowe

Polityka energetyczna, węgiel

Streszczenie

W artykule przedstawiono analizę globalnych pierwotnych nośników energii, ich zasoby, produkcję i zużycie. Na tym tle omówiono rolę węgla do produkcji energii elektrycznej w Europie, jak również na Ukrainie. Szczególną uwagę zwrócono na sytuację w górnictwie węglowym Ukrainy. Wskazano na możliwości zastosowania węgla do produkcji paliw płynnych, mając na uwadze ochronę środowiska przyrodniczego w energetyce, przedstawiono możliwości zamiany węgla na gaz ziemny przy wytwarzaniu energii elektrycznej.