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COAL PRODUCER'S ENERGY EFFICIENT POTENTIAL ASSESMENT

In modern conditions, the limited availability of Ukraine's own fuel and energy resources, increasing the dependence on imported natural gas and, as a result, increasing energy prices are of particular importance for improving energy efficiency of industrial enterprises. In addition, in the context of integration trends in the international arena, which results in lower customs barriers, the Ukrainian industry risks becoming unprotected to foreign competitors, which dictates the need to move to a qualitatively new level of energy use. Under current economic conditions, coal CHP stations represent the resource that can be counted on by Ukraine to ensure the stability of the Ukrainian power system. There are positive trends in the world in creating more efficient enterprises of coal mining and enrichment, modernization of existing mines and factories, closure of inefficient enterprises. At the same time, the coal industry in Ukraine is in a state of decline, and the experience of implementing energy-efficient measures is not widely used. In the next twenty-five years, three quarters of the new coal-producing plants will use high-performance low emission technologies (HELE), thereby reducing the share of low-performing industrial coal companies by 40%, according to the International Energy Association's report [16]. In modern conditions, the shortage of energy resources and the growth of their prices to coal mining enterprises is a task not only to provide other industries with fuel and energy resources but also their effective use in their own production activities and the introduction of innovative measures that increase the energy efficiency of production activities. In this regard, the development of a system of indicators for assessing the energy efficiency of coal mining enterprises, which will meet the needs and take into account the specific features of this industry, becomes particularly relevant.

The energy efficiency potential is an integral part of the enterprise's potential. Determining the energy efficiency potential is the first step towards effective energy use. The issue of determining the potential of the enterprise is devoted by the works of many authors, and they all agree that potential is a set of capabilities and capabilities of the company, aimed on achieving the strategic and tactical goals of enterprise development. Thus, the potential of energy efficiency is a set of available and possible energy resources and methods for their effective application, aimed at achieving the strategic and tactical goals of enterprise development.

In order to analyze the current state and potential prospects for increasing the energy efficiency of a coal-mining enterprise, the following types of it can be identified [2, 8, 9].

From the point of view of energy efficiency potential over a certain period of time:

– the existing energy efficiency potential (or current potential level), which is determined by the energy efficiency measures currently available at the enterprise. At the same time, depending on the time interval for which the estimation of the level of the existing potential of the enterprise can be distinguished, its annual potential, which characterizes the company's ability to achieve the most efficient use of energy resources during the planned year, and the potential of energy efficiency for a certain period of the existence of an enterprise that describes this ability during the entire period;

– promising energy efficiency potential (prospective potential level), which is defined as existing energy efficiency measures currently in the enterprise, and those that the company may implement in the future for a certain period of time. According to the company's development strategy, this period can be medium-term (up to 5 years) or long-term (10 years or more), and in case of detailed planning of development of the enterprise, there will be several scenarios of development.

Such differentiation allows us to assess the degree of utilization of a company's potential by comparing its promising level with actual values. The main stage of the evaluation is determining the potential of the enterprise.

From the point of view of the company's current energy efficiency measures implemented:

– The realized energy efficiency potential is determined by the actual energy efficiency measures currently used in the enterprise, reflects already implemented changes in production processes that allow maintaining the current level of energy use.
– The untapped potential of energy efficiency is determined by the energy efficiency of the enterprise not used for various reasons. Under certain management decisions, energy efficiency measures can be implemented, which will increase the efficiency of the operation of the enterprise and its realized potential, or vice versa, due to lack of financial resources, lack of management awareness, excellent priorities in enterprise development and external factors, these opportunities remain unused.
– The benchmark aggregate achievable energy efficiency potential is determined by the aggregate capacity of the enterprise in increasing efficiency of energy use is the sum of realized and unrealized potential. As a benchmark, it is possible to use the actual experience gained from the most successful energy efficiency companies in the

industry. If to analyze the activity of the enterprise for a certain historical time period is isolated, in order to assess the quality of management decisions in the field of energy efficiency, the most successful year can be a references in terms of energy use of the enterprise. Measures implemented experimentally / irregularly during that year may be improved and introduced into the production process in order to increase its energy efficiency.

The energy efficiency potential is the share of specific actual annual energy consumption per tonne of extraction (E_{fakt}) and specific consumption per tonne of production at standard operating conditions (E_{norm}).

$$PE_{pot} = E_{fakt} / E_{norm} \quad (3.1)$$

Normative conditions of work for each concrete object are energy consumption in the implementation of a complex of energy saving measures, developed taking into account the technical feasibility and economic feasibility of application and organizational measures for energy saving. Possible methods for evaluating energy efficiency potential are:

- comparison of the actual indicator of energy consumption with the base value of the maximum efficiency benchmark, based on retrospective energy consumption of the rated enterprise;
- comparison of the actual indicator of energy consumption with the base value of the industry's maximum efficiency benchmark;
- comparison of the actual indicator of energy consumption with estimated energy consumption of the estimated enterprise provided implementation of concrete measures that will increase energy efficiency of production.

In order to calculate the energy efficiency potential, the first way as a benchmark is to determine the minimum energy consumption per tonne of ordinary coal for the last 5 years. Calculate the value of the potential of energy efficiency in retrospect (PE_{retr}) as the share of specific annual energy consumption per tonne of ordinary coal of the current year (E_{fakt}) and the minimum retrospective specific energy consumption per tonne of ordinary coal at comparable prices of the current year (E_{retr}):

$$PE_{retr} = E_{fakt} / E_{retr} \quad (3.2)$$

In order to assess the energy efficiency potential of the industry, we will define a mine with a minimum energy consumption per tonne of ordinary coal for the current year. We'll calculate the value of the energy efficiency potential of the industry (PE_{sect}) as a share of the specific annual energy consumption per tonne of extraction of ordinary coal of each mine (E_{fakt}) and the minimum energy consumption per tonne of ordinary coal (E_{sect}) by the sector:

$$PE_{sect} = E_{fact} / E_{sect} \quad (3.3)$$

In order to assess the potential of energy efficiency, provided that innovative measures are implemented that will increase the energy efficiency of production, we will determine scenarios for reducing the current energy consumption of each mine for a certain percentage. Calculate the value of the scenario potential of energy efficiency (PE_{scen}) as a share of the specific annual energy consumption per tonne of extraction of ordinary coal of each mine (E_{fakt}) and the scenario specific energy consumption per tonne of ordinary coal after the implementation of measures to improve energy efficiency (E_{scen}):

$$PE_{scen} = E_{fak}t / E_{scen} \quad (3.4)$$

To calculate the hypothetical scenario, let's take a percentage reduction in the energy consumption of the mine from 10% to 50%. The following values of the calculated potential for the following mines will be relevant for all mines (Table 3.2):

Table 3.2

Energy Efficiency Potential scenario

% Reduced power consumption	10%	15%	20%	25%	30%	35%	40%	45%	50%
Potential value (PEscen)	1,11	1,18	1,25	1,33	1,43	1,54	1,67	1,82	2,00

In calculating the scenario for implementing energy saving measures for each mine, it is necessary:

- take into account all the ways and principles of obtaining savings from the implementation of an energy saving measure;
- calculate the potential annual savings in physical and monetary terms;
- determine the composition of the required equipment, its approximate value, the cost of delivery, installation and other costs for bringing the equipment to working condition;

- consider all possibilities for reducing costs, for example, manufacturing and installation of equipment by the enterprise itself;
- identify potential side effects from implementing measures that affect real economic efficiency;
- assess the overall effect of the proposed measures, taking into account all of the above items.

There are three components of innovative measures necessary for implementation of the potential of energy efficiency: technological, structural and technical [1].

Technological component – increase of efficiency of production and, accordingly, reduction of energy intensity due to introduction of progressive energy-efficient technologies.

The structural component is the reduction of the share of energy-intensive equipment in the technological chain of the mine due to the introduction of equipment with low energy consumption.

The technical component is determined on the assumption that all outdated and inefficient equipment and technologies are replaced by the most effective ones used in the industry's flagships.

By the nature of the changes, there are three types of measures aimed at increasing energy efficiency:

- Organizational measures are fast payback initiatives that do not require significant investments and are reduced to the introduction of electricity accounting systems and the installation of meters on the main energy consumers' sites, improvement of the discipline of labor, and consequently the elimination of downtime of operating equipment due to staff, level of knowledge of workers in the issues of energy saving, stimulation and motivation of energy saving behavior of personnel, the creation of regulatory procedures in the field of procurement of equipment. The payback period of such initiatives does not exceed one year due to the low cost of their implementation. On average, quick payback initiatives allow up to 15% potential.
- Technological measures are generally more radical and involve separate technological processes and allow them to increase their energy efficiency. Such measures include the replacement of equipment on high-performance with similar or lower power consumption, change of the circuit of electric power supply, conditioning and type of heating of boiler-houses. Such measures allow to realize the potential of energy efficiency up to 50%. Since

the cost of technological measures is much higher than the organizational, an acceptable payback period for them is 1-3 years.

- Large investment measures can realize the remaining energy efficiency potential. High-cost, high-performance measures contribute to eliminating the main causes of low energy efficiency, in most cases guarantee substantial energy savings, but require higher initial costs. These are high-cost, highly effective measures, which involve replacing large stationary equipment, which affects the work of the entire mine (main air ventilation fans, lifting installations, etc.), making significant changes in the technological chain of the enterprise. Realization of such measures includes designing, manufacturing of specific equipment under the order, construction works and can last from 2 to 5 years. Therefore, the payback period of large investment measures is more than 5 years. Implementation of such measures is laid down in the strategic plans for the development of the mine, with the allocation of the corresponding budget over the years in accordance with the timetable for implementation.

In cases where simultaneously it is possible to apply different energy-saving technologies, it is advisable to divide them into the following two types:

- Alternative are technologies that cannot be applied together, and one must select one of the available list;
- Consecutive – technologies that do not have alternatives, and which can be used in conjunction with others.

The described ranking method can be used to identify the owner of priority enterprises for investing in energy efficiency, but not in the case of identifying industry leaders to stimulate energy efficiency at the state level. This is due to the fact that the efficiency of the coal-mining enterprise is influenced by various factors, not all of which the enterprise can manage [5, 10, 15]. The efficiency of coal mining activities depends on the structure of the mineral reserves and the strategy of their development, the level of used equipment and technology, the mining and geological conditions (rock strength, water availability, etc., slope and thickness of the reservoir, gas pollution, etc.), qualitative and quantitative composition of stocks, permanent change of the produced space, which is a working area, high degree of danger of accidents.

In addition, for the production activity of such enterprises characterized by variability of mining and geological conditions, especially dangerous conditions for the personnel, rapid deterioration of the technological equipment, the impossibility of extracting equipment from flooded and prematurely excavated work, the need for periodic consolidation of the production space due to corrosion of materials mounting, the need for a preemptive holding of capital mining to prepare the refining front of future periods. The volume and speed of coal mining at mines are limited by the capacities of the mine, the depth of coal deposits, the method of coal production, etc. Therefore, when investing the same investment in energy efficiency, the effect of different enterprises will be incompatible, therefore, an assessment to promote measures in the field of energy efficiency should take into account the impact these factors in the form of correction coefficients.

Determine the key factors affecting the operation of the coal mining enterprise. Calculate the median and the mean square deviation for each factor. With the help of a group of experts in the field of geology, energy, production and technical development of coal mining enterprises, we reran the factors affecting the energy efficiency of the mine from 1 to 5, where 1 – low impact, 5 – high impact.

Calculate the adjusted values for the ranking as follows.

If the difference between the factor a1 on the mine x_1 and its median is a positive value and greater than the root mean square deviation of factor a_1, then the adjusted value is equal to the particle value of the factor a_1 x_1 and the median amount and the mean square deviation of this factor.

If the difference between the factor a1 on the mine x_1 and its median is a negative value and the module is greater than the root mean square deviation of factor a_1, then the adjusted value is equal to the particle value of the factor a_1 x_1 and the median difference and the mean square deviation of this factor.

If the difference between the factor a1 on the mine x_1 and its median is zero, then the adjusted value is equal to the particle value of the factor a_1 x_1 and the median, that is, the unit.

After that, we multiply the corrected values of the factors for the corresponding ball scores, sum up the mines and divide by the amount of ball scores.

Distribute the estimated mines into three categories in terms of complexity.

Category 1 – Uncomplicated conditions. The mine where the cumulative coefficient is less than the difference between the unit and the mean square deviation calculated on the cumulative coefficient of this mine selection.

Category 2 – conditions of moderate complexity. We will referred the mine to this category if the cumulative coefficient is in the range of the unit plus minus the mean-square deviation.

Category 3 – difficult conditions. It's about the mine where the cumulative coefficient is greater than the unit amount and the mean square deviation.

The resulting cumulative values are corrective factors that should be used in comparing mines to stimulate energy efficiency at the state level. These coefficients take into account the complexity of production conditions and allow the indices of energy consumption of mines to be taken into a single evaluation vector.

For a more detailed analysis of the energy efficiency potential of coal-mining enterprises, we adapt the methodology of the International Energy Association, according to which macroeconomic indicators of energy efficiency can be schematically represented as a pyramid with a declining level of detail of the analyzed data and a growing level of aggregation of indicators (from the bottom up) [7].

Indicators of energy efficiency of an industrial enterprise can be expressed in units of energy (energy consumption of the enterprise as a whole or of some kind of final consumption), as well as by the ratio of energy consumption (in units of energy or in monetary units) to the data on enterprise activity (in physical units). They can also be expressed as a percentage as a share of electricity consumption for the production needs of the total energy consumption. For further application of energy efficiency indicators in the analysis of the impact of energy efficiency on the cash flow of the enterprise it is expedient to calculate them in monetary terms in comparable prices. Indicators of energy efficiency are calculated at the level of final consumption or at a more disaggregated level - the level of energy consumption of the unit of equipment.

Indicators of energy consumption can be developed at different levels of aggregation, depending on the purpose of the use and the amount of available information. The level of aggregation is very important, since it determines the degree of influence of structural differences on the observed results. Structural differences may include:

- Availability and quality of input resources. Energy requirements for some industrial processes depend on the quality of natural or other resources. Indicators should take into account the quality of the resource variation in the comparison of different enterprises.

– Definition of products. Product definition requires caution. For example, in the coal mining industry, the choice as a final product of ordinary or enriched coal can significantly affect the result of the analysis by excluding or incorporating the effects of enrichment processes.
– Variety of products. Manufactured goods are not monotonous. The indicator should be designed in such a way that the categorization product makes sense. So for coal mining enterprises, it is expedient to consider the product at a given quality of 5200 kcal for comparability of the results of the analysis.
– Definition of process technology. At industrial enterprises various technological processes with essentially different needs in energy are used. Indicators at this level should take into account different proportions technological processes in the total volume of production when compared. These problems can be solved by developing indicators at different levels of aggregation.

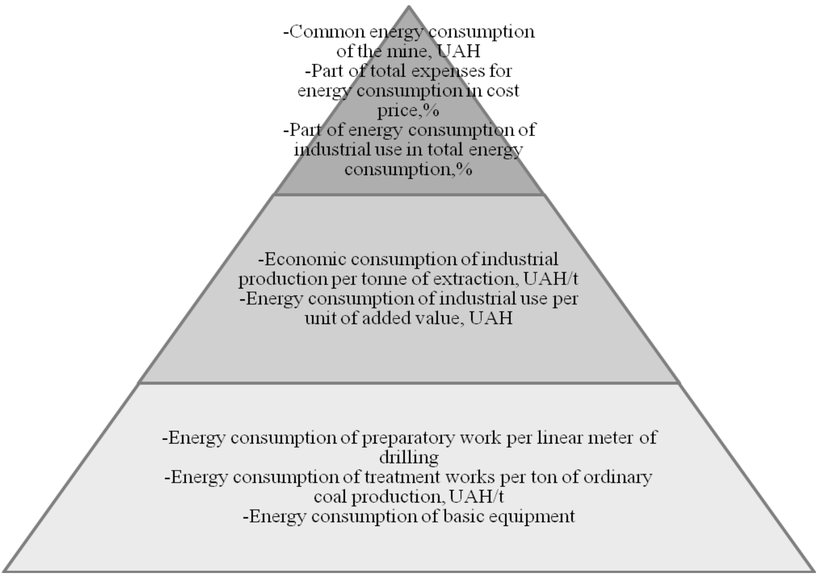

Figure 3.3 The system of indicators of energy efficiency of coal mining enterprises

The most aggregated level refers to the total energy consumption of coal mining enterprises in the monetary equivalent, as well as to the share of energy consumption costs in cost and share of energy consumption of production in the overall structure of the energy consumption of the mine. These indicators give a generalized picture of the consumption of the enterprise and allow the first comparison of different mines, as well as a preliminary assessment of energy efficiency.

At the second level of the pyramid is the energy intensity of the mine as a whole, calculated as the ratio of energy consumption to value added. It is important to use value added at constant prices in order to avoid deviations caused by fluctuations in the money market. Since the overall energy consumption of an enterprise is not in a certain correlation with value added, in the calculation of the indicator include energy consumption for production needs. This indicator can give a first estimate of the total energy intensity of the sector and its trends. Due to the heterogeneity of the qualitative characteristics of ordinary coal extracted by different mines, and hence the impact of a ton of extraction on the cash flow of the company, the energy per unit of output in kind is calculated as the ratio of energy consumption to industrial needs to the volume of production.

At the third level of the pyramid there are indicators of energy efficiency of individual production processes. Proceeding from the specifics of coal mining enterprises, they can be divided into preparatory and sewage works. The result of the first process is the running meters of revealing and preparatory workings, the result of the second - directly extraction of coal. Accordingly, indicators of energy efficiency at the third level of the pyramid are the energy consumption of preparatory work per meter of penetration and energy consumption of treatment works per ton of coal. The processes of transportation of mountain mass and ventilation are, of course, also energy-intensive, but it is problematic to correlate their energy consumption with the final result, because in essence they are serving character and indirectly affect the total amount of coal mine production. Therefore, for the analysis of energy efficiency of certain units of equipment and the comparison of the impact of possible alternatives to their use on the cash flow, it is possible to calculate the energy consumption of the main equipment (clearing and traction combines, ventilators of the main airing, etc.) in the monetary equivalent in comparable conditions.

Thus, the considered system of indicators can be used to analyze the energy efficiency of coal mining enterprises at different levels from specific units of equipment and production processes to the enterprise as a whole.

As the result, the following conclusions can be drawn from the research:

- Scientific views on the determination of the energy efficiency potential of the enterprise are systematized and summarized.
- Adapted to coal mining enterprises a methodology for calculating energy efficiency indicators based on the hierarchical methodology of the International Energy Association, where energy efficiency indicators can be schematically presented in the form of a pyramid with a declining level of detail of the analyzed data and a growing level of aggregation of indicators. The proposed indicators are determined on the basis of the following criteria: availability and quality of input resources, product definition, product diversity, process technology definition.
- The methodology for evaluating the energy efficiency potential for coal mining companies is proposed for further ranking in order to determine the priorities of investing in energy efficiency based on three parameters: retrospective, sectoral and expected.

A methodology for calculating correction coefficients for a fair comparison of coal mining enterprises to promote energy efficiency at the state level is developed. These coefficients take into account the level of complexity of the conditions of conducting the main industrial activity of the enterprise on the basis of expert evaluation of mining and geological and production-operational criteria and allow to bring energy consumption indexes of mines to a single evaluation vector.

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APPLICATION OF INFORMATION TECHNOLOGIES IN LOGISTIC ACTIVITIES OF ENTERPRISES

In today's conditions of dynamic development the digital economy is actualized the problem use of information technologies as an instrument of management logistics activities of enterprises. At present time the enterprises have to move on to qualitatively new technologies that can provide a level of service that meets the high demand and needs of consumers while at the same time maximizing possible costs. Therefore, the key task of enterprises is to create an effective logistics information system capable of flexibly responding to changing market conditions.

According to the Goals of sustainable development for 2016-2030 the priority measures to create sustainable infrastructure, promotion of neo-industrialization and innovation were recognized by strengthening the integration of industrial enterprises into logistics chains and markets, reducing losses of food products in the process of promotion and storage, moving to more rational models of production and consumption [1].