https://doi.org/10.33271/nvngu/2022-1/163

S. Smerichevskyi[1],
orcid.org/0000-0003-2102-1524,
T. Kosova[1],
orcid.org/0000-0002-1859-0542,
O. Tryfonova[2],
orcid.org/0000-0003-2283-6258,
O. Bezgina[3],
orcid.org/0000-0002-0568-4806,
G. Solomina[4],
orcid.org/0000-0003-0917-7999

1 – National Aviation University, Kyiv, Ukraine, e-mail: kosovatd@meta.ua
2 – Dnipro University of Technology, Dnipro, Ukraine
3 – DTEK Energy LLC, Kyiv, Ukraine
4 – Interregional Academy of Personnel Management, Kyiv, Ukraine

FINANCIAL AND ACCOUNTING SUPPORT OF MARKETING STRATEGIES FOR ENERGY EFFICIENCY OF COAL MINES

Purpose. Identification of the approaches to improve financial and accounting support of marketing strategies as a subsystem of energy management of coal mines.

Methodology. Methods are to formalize theoretically energy management of coal mines based upon GOST and ISO requirements; generalize empirically electricity costs relying upon decade management reporting of fifteen mines in Donetsk coal field; formulate them consistently on the basis of price indices of industrial product manufacturers in the field of electric supply; and evaluate efficiency of energy management of coal mines while calculating their individual and sectoral potential, ranking of specific expenditures for electrical power as well as relative potential of energy efficiency.

Findings. External and internal factors, influencing energy efficiency of coal mines, have been systemized. Requirements for such tools improving energy efficiency as energy management, energy marketing, energy accounting, energy analysis, energy audit, and energy-and financial planning have been generalized. Methodological approaches to identify individual and sectoral potential of energy efficiency of coal mines have been developed and implemented; their level and variability have been evaluated quantitatively.

Originality. System approach is applied to classify energy audit of coal mines in terms of the following criteria: functioning phases of the audited entities; nature; scope of the audited entities; auditing methods; class of the involved problems; and auditing entities. Casual connections between individual ranking of energy efficiency and individual potential energy efficiency of coal mines have been determined; and dependence function of overall rankings of coal mines and sectoral potentials of their energy efficiency potentials has been formalized. Dynamic approach to identify subjects of financial and accounting support of marketing strategies of coal mines is applied in the form of energy efficiency potential progress.

Practical value. Recommendations concerning the development of the basic program document on the energy management of coal mines have been substantiated in the form of "Order for energy policy" to identify the key energy efficiency indices as well as responsibility for their achievement. Details for such its sections as "Energy accounting, analysis, and audit", "Marketing support of energy policy", and "Financial and investment support of energy policy" have been proposed.

Keywords: *financial and accounting support, marketing strategies, energy efficiency, coal mines*

Introduction. Use of energy resources by industrial enterprises involves several aspects, among which economic, social and environmental ones are the most important. Use of new energy and environmental standards along with the expansion of renewable energy sources are the *21st* century trends. Despite the strategic intentions of European countries to reach a result of 20 % in terms of their energy balance share by the year of 2020, extraction of coal as the energy source is still topical.

Mining is an energy-consuming type of economic activity; in terms of Ukraine, it is characterized by a high level of costs due to complicated mining and geological mode of occurrence, minor thickness of coal seams, considerable methane content and so on. Solution of the problems of national coal mines and maintenance of their competitiveness require close connection of the principles of financial, marketing, energy, and environmental strategy-based management. Development of the strategy of mining enterprise functioning should rely on the analysis of tendencies in the market environment changes as well as on the general trends in its social-economic and environmental development in the context of solution of topical national-level problems. Contribution of coal mines in the formation and implementation of Ukrainian energy strategy is related not only to their operations represented by the extraction of energy carriers but to the rational use of energy resources. Solution of the problem of national safety strengthening requires elimination of the disbalance between a general strategy of enterprise development and its investment, production, and functioning strategies, causing deteriorated results of the business management and efficiency. We agree with D. Somov that a system-based approach to the interrelated consideration of specific functions of the management (audit, control, planning, and prognosis) will make it possible to improve the efficiency of functional strategies of a company [1]. Thus, strategies of energy marketing and management require corresponding financial and audit support.

Literature review. The problem of the energy-efficiency increase in coal mines is the research object in terms of various aspects of strategic management worldwide. Having performed simultaneous assessment of mining activities and environmental management, Chinese scientists have divided their national coal enterprises into three categories according to the rating of efficiency and synergetic development [2]. The first (highest) category includes green mining enterprises, which have undertaken serious responsibility for implementing energy efficient and environmental development. The adjective "green" highlights environmental features of the activity of those mines and the necessity to consider interests of the future and responsibilities for it.

The majority of scientists and experts relate solution of a problem of increasing energy efficiency of mines to the implementation of innovative technologies of coal mining and evaluation of energy consumption; the energy includes diesel, petroleum, electricity, and explosives [3]. A team of authors [4] puts emphasis on the use of modern IT integrated into the automatic system of industrial process control at coal mines, which records exact electric energy consumption by each unit of machinery, equipment, power plants and so on. Russian

scientists consider monitoring of electric energy use and prognosis of its consumption on the basis of artificial neural networks, performing information and computational tasks, to be an important trend in the increase in energy-efficient coal mining [5].

Kambur O.L. and Petryshchenko N.A. believe that the use of raw materials and production methods, favouring the company's energy efficiency, is the basic task of the energy-saving marketing [6]. The following are the important trends in energy-saving marketing: implementation of innovative developments providing energy efficiency [7], strengthening of the competitiveness of an enterprise as a buyer of electric energy in the wholesale market as well as of other energy carriers (especially, gas) [8], and marketing promotion of energy-saving technologies [9].

Thus, based on the methodology by Pogodaiev, S.E., the mentioned concept of energy-saving marketing can be considered as the hybrid one [10].

We agree with Giliorme T.V., Smyrnov S.O., Levkovych O.V., and Tsynovnik A.Ye. that energy and economic safety of the functioning of economic objects and large sectoral associations is provided exactly by using the results of progressive innovative technologies in the electric-power industry [11] that determine economic and marketing efficiency of the implementation of energy-saving technologies [12].

Unsolved aspects of the problem. The scientific findings of the mentioned authors are quite significant; however, we should point out the necessity of comprehensive approach to the management of energy-efficient coal mines on the strategic basis. A system of energy management of coal enterprises, emphasis on its subsystems, and identification of complex cause-and-effect relations between them require certain formalization.

Purpose. The objective is to identify approaches to the improvement of financial and accounting support of marketing strategies as a subsystem of energy management of coal mines.

Methods. The research is based on the key concepts of energy saving, energy conservation, and energy efficiency; the concepts demonstrate complex dialectic interconnection. The Law of Ukraine "On energy saving" of 01.07.1994 No. 74/94-BP defines "energy saving" in the national economy as an organizational, scientific, practical, and information activity, which is implemented by means of technical, economic, and legal methods; it is aimed at rational and expedient use of primary and transformed energy as well as natural energy resources. Similar definition of "energy conservation" is given in DSTU 2420-94, which makes it identical to the definition of "energy saving" (DSTU 2420-94). The categories of Regulations (EU) 2017/1369 of the European Parliament and of the Council of 4 June 2017 define "energy efficiency" as a ratio between the output amounts of the obtained results of activity (productivity), services, products, or energy and the input consumed energy [13], which corresponds to general approaches to the definition of the concept of efficiency. The information basis of the research is represented by the recommendations of energy efficiency assessment of the International Organization for Standardization, ISO, data of managerial reports of 15 mines of Donetsk coal basin in terms of extraction output, costs for electric power within the period of 2011–2020, and producer price index of industrial products (electric energy supply). The research methodology involves calculation of individual and sectoral energy efficiency potential of coal mines, rankings of their specific costs for electric energy, and relative potential of energy efficiency.

Results. Energy strategy of Ukraine "Safety, energy efficiency, competitiveness" for the period up to the year of 2035 approved by the Ordinance of the Cabinet of Ministers of Ukraine of 18.08.2017 No. 605-p. provides for the formation of competitive energy markets, rejection of costly pricing for coal, and regulation of prices at the intermediate stage of transition from free market pricing. Increasing energy efficiency of coal mines helps obtain the following strategic effects: reduction of the absolute cost of consumed energy and specific energy consumptions; proper operation of machines and equipment, which, in turn, influences their productivity, maintenance, safety, and ecological indices; reduced prime cost, increased competitiveness of production and stimulation of demand for products. The main tendencies in the growth of energy efficiency in coal industry are as follows: completeness and transparency of the accounting of all forms of energy and energy resources; optimization of the use of production facilities, their technical and technological modernization; setting the requirements for equipment and technologies as for the level of energy consumption and ecological parameters; creation of tools for state financial and technical support (including the involvement of foreign partners), and implementation of energy-efficient processes and technologies.

Numerous factors of internal and external environment affect the state of energy efficiency of coal mines. Macroeconomic factors include: price for energy resources, their current deficit and surplus in the market. State of internal subsystems of company management belongs to the microeconomic factors. These subsystems are as follows: marketing (supply of energy efficient technologies, competitiveness of prices for energy resources), production (complexity of mining and geological conditions, depth of a mine working, seam thickness, production capacity, technological conditions of main facilities, features of coal mining processes and technologies, technical and technological losses of electric energy), financial (possibility to finance current and permanent measures for energy efficiency), personnel (sufficient level of personnel knowledge and motivation in the sphere of energy conservation), and accounting and control (development of cost accounting in terms of centres of energy resources consumption, available meters and other control devices). There are following factors of energy efficiency reduction: operation of electromechanical systems with underloading, poor power supply networks, insufficient maintenance, inexpedient management of technological process, influence of random factors [14]. Energy management, energy marketing, energy accounting, energy analysis, energy audit, energy and financial planning are the tools for energy efficiency increase. Energy management system is aimed at increasing energy efficiency and support of expedient energy consumption (Fig. 1).

ISO/CD 50006.3 [15] contains approaches to the evaluation of energy indices with the help of output energy indices and energy efficiency indices. In 2018, a revised edition of the international standard for energy management system ISO 50001:2018 was updated, where great attention was paid to the implementation of smart technologies [16]. This standard can be used independently or it can be agreed or integrated with other management systems: product quality and safety, environmental safety, and company staff. This standard determines the following: algorithm of diagnostic energy efficiency audit, procedure of energy analysis, energy planning, and formation of technological report according to the results of energy efficiency audit. Implementation of the standard in the practice of coal mine management stipulates elaboration of energy efficiency policy and plan, monitoring of energy indices, substantiation of marketing energy efficiency strategies and their financial-accounting support, energy auditing and identification of the reserves of growth of energy efficiency potential.

The energy management plan outlines the structure and structured set of measures to be realized within the specified period of time to improve energy indices. It should be developed taking into consideration annual budget and plan of marketing activities. Inclusion of energy marketing in the system of coal mine management will provide effective use of possibilities to improve systems of material and equipment purchase.

Energy audit plays a key role in the growth of energy efficiency of coal mines. Energy audit means "technical and eco-

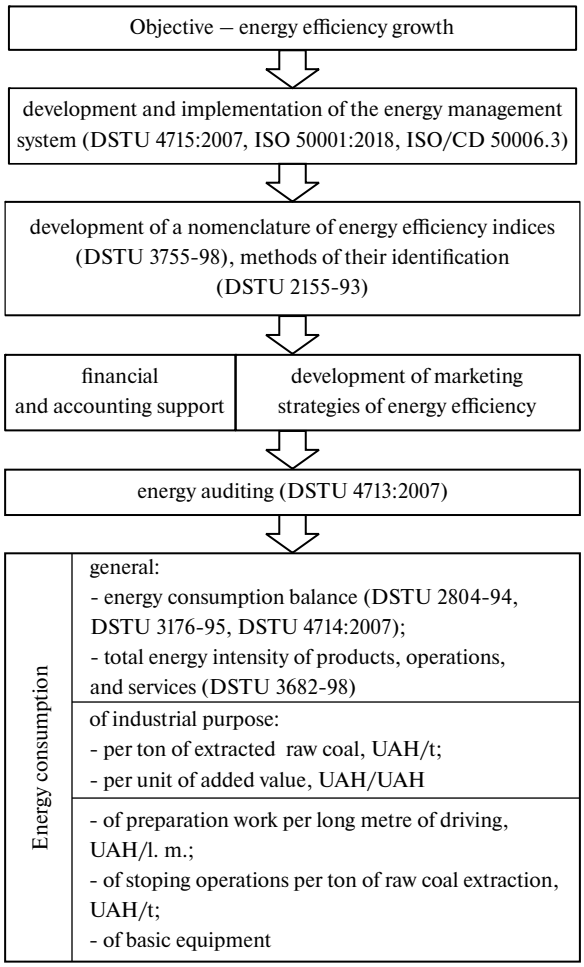

Fig. 1. Formalization of the system of energy management of coal mines

nomic inspection of the systems of generation, transportation, and consumption of energy resources and water aimed at identification and economic substantiation of technical, organizational, economic, and production ways to reduce consumption of energy resources and switch to alternative energy sources; that will help an enterprise reach real and considerable cost saving along with the decreased ecological load on the environment" [17]. Energy audit makes it possible to reveal positive and negative sides of the company's energy efficiency. It includes the following stages: collection of technical and technological, economic, and financial information; balancing of sources of energy supply and areas of its use, identification of nonproductive losses; comparison of normative and actual energy capacity; determination of the reserves of energy efficiency growth; development of measures for energy efficiency growth; elaboration of measures for their implementation; and formation of technical report with the calculation of payback for energy efficiency measures [18]. Energy and economic assessment is performed on the basis of indices of absolute and relative saving of the consumed energy resources in terms of cost and specific estimate (per 1 ton of the extracted coal, per 1 length metre of the underground mine workings). Financial and economic estimation in terms of current energy efficiency measures is performed basing on the index of additional income obtained by an enterprise. In terms of permanent measures, there are following criteria: payback period of capital investment for energy efficiency (simple and discounted), internal profitability rate, and net present value. A report with the anticipated costs and advantages of potential energy efficiency projects is the main result of energy auditing. It is the basis for the development of marketing and financial strategies of coal mines.

Unfortunately, current Standard Methods "General requirements for the organization and conduct of energy audit" approved by the Order of the National Agency of Ukraine on Ensuring of Efficient Use on Energy Resources of 20.05.2010 No. 56 contains a limited list of energy audit types. Basing on the system-based approach, it is proposed to be classified according to the following features: in terms of functioning of the audit object (primary – prestart and preoperational; secondary – operational; and tertiary – post-operational); in terms of mode (periodical – in certain time intervals; unscheduled – occurs between the scheduled audits; summarizing – after the period completion); in terms of coverage of the objects (local – audit of certain types of fuel and energy resources, technological processes of main and auxiliary productions, enterprise sites; systematic – audit of the whole enterprise); in terms of auditing methods (express-audit – according to the most generalized indices at a pre-contract stage; detailed audit – according to the programme specified in the contract); in terms of the problems to be covered (traditional – within the framework of standard operational activities; specific – while solving special problems, including the ones related to the energy system resistance to accidents); in terms of objects (objective-subjective – certain objects consuming fuel and energy resources, and subjects controlling that consumption; and system-based – energy supply, accounting and control of the use of fuel and energy resources, energy management).

Accounting system of an enterprise plays an important role in the information support of the development of energy efficiency strategies as it provides: obtaining and paying of accounts for the consumed energy resources, keeping commercial and technical accounting of the consumption of fuel and energy resources, their representation on the accounting records and in the statistical reporting forms of an enterprise. The system of accounting records also accumulates important information concerning equipment and machinery repair, adjustment and testing operations, implementation of reconstruction programmes and projects, and modernization of main facilities connected with the energy efficiency increase.

The following documentation is the source for comparison of standard and actual costs in the process of energy analysis: energy performance certificate of an object; schedule of the consumption of fuel and energy resources; technical documents for machines and equipment; norms of specific consumption of fuel as well as heat and electric energy for mining and preparatory operations. Energy planning is based on the systems of consumption of fuel and energy resources, recommendations of energy audit, developed energy-saving measures, and investment programmes on energy efficiency increase.

Exclusive role of the evaluation of electric energy consumption, accounting, and control of consumption of fuel and energy resources for energy analysis and audit makes it possible to talk about the appearance of such an element of energy management system as energy accounting conducted with the help of stationary and portable means of control and measuring equipment. The measuring may be of different purposes: one-time, balance, and registration ones. Energy information system allows both detecting the coal mine personnel's being stick to the key indices of energy efficiency and ensuring the staff responsibility.

Substantiation of marketing strategies and their financial and accounting support require calculation of the energy efficiency potential, which is classified in terms of two basic features: belonging to a certain period of time (current, perspective) and currently available implemented measured for energy efficiency increase (implemented, non-implemented, reference (total achievable)).

Contrary to the available one, prospective energy efficiency potential is defined not only by the available energy consumption measures the enterprise is practicing now but also by the ones that the enterprise may implement additionally in the

future within a certain period of time – medium-term (up to 5 years) or long-term (10 and more years); moreover, in terms of detailed financial planning of the development, an enterprise will have several alternative marketing strategies. The implemented energy efficiency potential is determined by the energy efficiency measures applied actually by an enterprise; while the non-implemented one is defined by the measures, being non-applied due to different reasons including shortage of financial resources, poor marketing strategies and organization of energy consumption auditing, inefficient economic control, insufficiently informed authorities and so on. The reference energy efficiency potential is determined by the total company capacities as for the increase in efficiency of energy resources consumption being the total of implemented and non-implemented potential [19].

In the context of the performed research, the following methodological approach to the determination of individual and sectoral energy efficiency potential of coal mines is proposed:

- output data concerning annual costs for electric energy per ton of extracted material are reduced to the comparative form (price as of 2020) basing on the cumulative index of producer price of industrial products (electric energy supply);

- individual ranking of energy efficiency of the i^{th} coal mine (R_{ind_i}) is calculated by ranging the costs for electric energy per ton of output in 2020 along with their growth; individual reference value is determined for the i^{th} coal mine (E_{ind_i}) as a minimal value of annual specific costs for electric energy in comparative prices (CE_{ij}) in the j^{th} year $j = \overline{2011,2020}$;

- sectoral reference value (E_{branch}) is equal to the individual reference value of the annual specific costs for electric energy of a coal mine with "1" ranking;

- individual (P_{ind_i}) and sectoral (P_{branch_i}) energy efficiency potential of the i^{th} coal mine is calculated according to formulas

$$P_{ind_i} = CE_{i2020} \Big/ P_{ind_i};$$
$$P_{branch_i} = CE_{i2020} \Big/ P_{branch_i};$$

- sectoral competitiveness of the *ith* coal mine is determined by the difference between sectoral and individual potentials

$$\Delta P_i = P_{branch_i} - P_{ind_i}; \quad (1)$$

- index, calculated according to (1), is the basis to calculate general ranking of energy efficiency potential of the i^{th} coal mine ($R_{general_i}$) by its ranging along with its growth.

The calculation results of energy efficiency potential are represented in Table.

Costs for electric energy vary considerably in terms of the coal mines; absolute variation range is from 168.5 UAH/t in 2012 up to 923.6 UAH/t in 2013; the relative one is from 199.1 % up to 656.9 % to the average range respectively. In 2020, variation range is 369.8 UAH/t (442.5 %). In case of coal enterprises with the individual energy efficiency ranking from "1" to "6", costs for electric energy are not more than 50 UAH/t (such mines as *Pavlohradska, Heroiiv Kosmosu, Blahodatna, Ternivska*, and *Dniprovska*). Individual ranking from "7" to "10" is given for the coal enterprises where electric energy costs are within the range of 50–80 UAH/t (*Zakhidno-Donbaska, Samarska, Yuvileina,* and *Stashkova* mines). The mines with the estimates from "11" to "14" (*Dobropilska, Almazna, Novodonetska*, and *Bilozerska*) demonstrate higher level (up to 100 UAH/t). The *Pioner* mine has much higher level of costs (more than 400 UAH/t) due to complex mining and geological conditions. Individual energy efficiency potential of the coal mines is within the range from 1.07 up to 2.02 in terms of average value of 1.29. The variation range is 0.95 or 73.9 of the average value.

It has been identified that there is no cause-and-effect relations between the individual energy efficiency ranking and individual energy efficiency potential; that is confirmed by a low value of correlation coefficient between the indices (r = = 0.223) and graphic visualization represented in Fig. 2, *a*. Eight mines with wide range of ranking (1, 5–7, 11–14) have the potential values up to 1.2. Four mines with 2–4, and 9 rankings are within the interval from 1.2 up to 1.4; the interval from 1.4 up to 1.6 includes two mines with 8 and 10 rankings. The *Pioner* mine stands apart with its 15 ranking and individual energy efficiency potential exceeding 2.0.

Sectoral potential of energy efficiency has much greater variability comparing to the individual one; its minimum and maximum values are 1.11 and 14.04 respectively in terms of average 2.92. The variation range reaches 12.93 or 442.5 %. Due to great contrast with others, the *Pioner* value is considered as the runout, being excluded while formalizing a dependence of general rankings of the coal mines and sectoral potentials of their energy efficiency; it is described by the second order polynomial with a high value of multiple coefficient of determination (R^2 = 0.9456) (Fig. 2, *b*). The developed trend shows almost functional simultaneous deterioration of a general ranking and sectoral potential of energy efficiency. It means that the problems of energy efficiency management are of the system-based nature; they require complex solution.

Thus, there arises a need in creating an integrated system to increase energy efficiency of coal mines basing on the requirements of ISO 50001:2018, ISO/CD 50006.3 standards when we implement not some concrete programme of measures but a system of management with the mechanisms of planning, accounting, monitoring, analysis, and correction for different actions. The "Order for energy policy" (further – Order), determining the objective and tasks in the sphere of energy management, key indicators of energy efficiency, and responsibility for their reaching, should become the main programme document at the coal enterprise level. Such sections as "Energy accounting, analysis, and audit", "Marketing support of the energy policy", "Financial and investment support of the energy policy" should be the integral parts of the Order.

The following content of the "Energy accounting, analysis, and audit" section is proposed: estimation and documentation in terms of energy management, collection of energy data in terms of production mine sites, determination of the energy efficiency parameters according to certain technological processes (stoping, driving operations) and equipment units (ventilation and hoisting facilities, equipment of the conveyor transport sites and so on), indicators of energy efficiency monitoring from the authorities, procedures of operational control and measures of reacting to deviations from the energy consumption norms, periodicity and methods of energy analysis and energy audit.

The "Marketing support of energy policy" section should highlight the following: provision of coal enterprises with the progressive energy-efficient equipment, technologies, and inventory at competitive prices; growth of energy efficiency in the technological chain of the mine by implementing the equipment with low energy capacity; optimization of the price of supply, installation and other costs for the equipment bringing to the operating condition; inclusion of energy requirements into the procedures of mining equipment purchase and designing of new objects of underground and surface infrastructure; use of benchmarking to compare actually consumed energy with the theoretical (calculated or modelled) amounts.

In terms of the "Financial and investment support of energy policy" section, it is expedient to stipulate certain measures for financing replacement of obsolete equipment and technologies with much more efficient ones, to optimize the effect of energy consumption management and use of financial resources, to assess risks of the implementation of investment projects, especially the costly ones (replacement of large stationary equipment that influences the operation of the whole

Table

Calculation results of energy efficiency potential [20]

No	Mine	Costs for electric energy (CE_{ij}) per ton of output in the prices of 2020, UAH/t										R_{ind_i}	E_{ind_i}	E_{branch}	Potential		ΔP_i	$R_{general_i}$
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020				P_{ind_i}	P_{branch_i}		
1	Pavlohradska	42.5	32.5	29.8	32.9	37.1	33.7	28.6	29.5	30.9	31.8	1	28.6	28.6	1.11	1.11	0.00	1
2	Heroiiv Kosmosu	33.7	36.5	36.9	36.0	36.8	32.3	29.2	29.6	39.1	40.2	3	29.2	28.6	1.38	1.41	0.03	2
3	Blahodatna	38.8	46.4	38.3	30.9	30.9	29.8	29.8	35.3	35.9	39.2	2	29.8	28.6	1.32	1.37	0.05	3
4	Ternivska	56.5	64.9	45.9	42.3	37.0	40.2	31.9	33.6	37.6	41.6	4	31.9	28.6	1.30	1.45	0.15	4
5	Stashkova	62.6	56.5	62.5	49.1	77.3	86.2	66.1	54.1	88.5	77.3	10	49.1	28.6	1.57	2.70	1.13	10
6	Stepova	71.7	60.8	53.3	57.5	52.4	50.8	40.6	44.5	51.2	48.2	6	40.6	28.6	1.19	1.69	0.50	5
7	Zakhidno-Donbaska	65.5	63.3	56.8	59.8	64.8	59.7	56.8	51.6	60.3	55.3	7	51.6	28.6	1.07	1.93	0.86	9
8	Samarska	43.6	40.8	41.3	42.6	49.4	50.1	46.1	55.8	58.1	62.4	8	40.8	28.6	1.53	2.18	0.65	7
9	Dniprovska	54.5	53.2	48.4	81.1	48.8	51.8	46.8	50.2	42.7	47.9	5	42.7	28.6	1.12	1.67	0.55	6
10	Yuvileina	46.0	48.7	46.7	60.5	48.9	55.9	51.7	54.0	57.6	63.8	9	46.0	28.6	1.39	2.23	0.85	8
11	Dobropilska	77.6	108.9	100.0	133.3	185.5	242.9	88.9	99.5	86.2	83.1	11	77.6	28.6	1.07	2.91	1.84	11
12	Almazna	111.2	145.3	953.4	131.7	83.4	87.1	154.9	95.0	78.4	84.2	12	78.4	28.6	1.07	2.94	1.87	12
13	Bilozerska	-	200.6	104.9	148.0	115.1	204.8	136.7	80.8	108.3	91.2	14	80.8	28.6	1.13	3.19	2.06	14
14	Novodonetska	80.5	109.8	97.6	144.8	210.8	176.8	233.5	81.9	92.9	85.9	13	80.5	28.6	1.07	3.00	1.94	13
15	Pioner	217.8	201.0	393.3	243.4	228.8	226.1	281.8	198.9	724.6	401.6	15	198.9	28.6	2.02	14.04	12.0	15
	average	71.6	84.6	140.6	86.3	87.1	95.2	88.2	66.3	106.2	83.6	–	60.4	–	1.29	2.92	1.63	–
	minimum	33.7	32.5	29.8	30.9	30.9	29.8	28.6	29.5	30.9	31.8	–	28.6	–	1.07	1.11	0.00	–
	maximum	217.8	201.0	953.4	243.4	228.8	242.9	281.8	198.9	724.6	401.6	–	198.9	–	2.02	14.04	12.0	–
	variation range	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	- absolute	184.1	168.5	923.6	212.5	197.9	213.1	253.2	169.4	693.7	369.8	–	170.3	–	0.95	12.93	12.0	–
	- in % to average	257.1	199.1	656.9	246.3	227.2	223.8	286.9	255.6	653.5	442.5	–	281.7	–	73.9	442.5	736	–

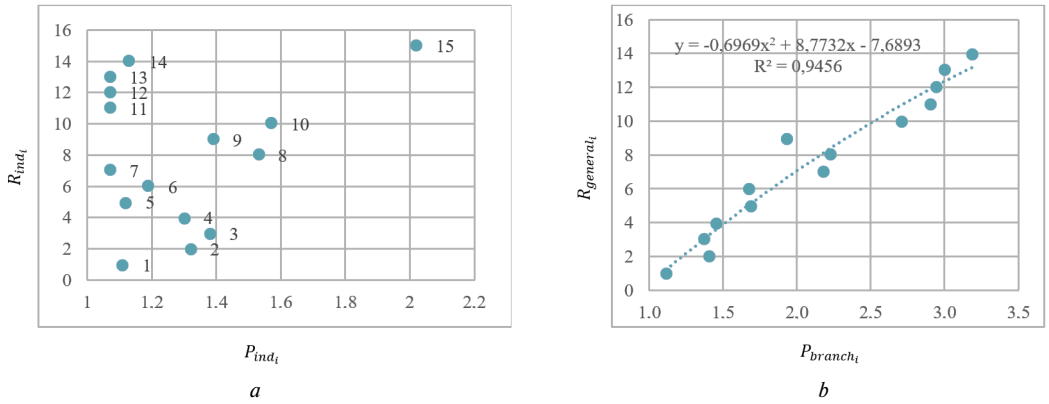

Fig. 2. Formalization of the dependence of rankings of the coal mines and their energy efficiency potential: a – individual estimates; b – general estimates

mine – main fans, hoisting plants and so on), to take into consideration the savings owing to the implementation of energy-saving measures expressed in physical and monetary terms; to identify the ways of searching for the external sources of financing if there is lack of proper finances; and to develop mechanisms of fiscal energy efficiency optimization.

Positive effects of the implementation of financial and accounting support of marketing strategies of coal mines' energy efficiency are as follows: decreasing prime cost of coal extraction; increasing competitiveness of the products and services; and growing income or reducing costs. Being stick to the following set of principles is the condition for reaching those effects: continuity of actions in time, support of the programmes by the top management, training of personnel along with the increase in their awareness, rational balance between different financing sources (income from operational activity, attraction of loans, finances of external investors, state support), effective communication with stakeholders.

Conclusions.

1. Factors of external and internal environment influencing the energy efficiency of coal mines have been systematized. Requirements for the following tools of energy efficiency increase have been generalized: energy management, energy marketing, energy accounting, energy analysis, energy audit, energy and financial planning. Methodological approaches to the determination of individual and sectoral potential of energy efficiency of coal mines have been developed and implemented; qualitative estimates of their level and variability have been obtained.

2. Financial and accounting support of marketing strategies as a subsystem of energy management of coal mines has been studied. "Energy saving" and "energy efficiency" have been identified as its objects; the latter is interpreted as a wider concept as it means not only saving but also efficient energy consumption, expedient and well-thought use of energy resources in terms of real level of processes and technologies development and being stick to the environmental requirements. Development of the energy efficiency potential as the reserve to open up unused capacities and resources in the sphere of energy efficiency is the objective of the financial and accounting support of marketing strategies of coal mines.

3. Recommendations as for the elaboration of the main programme document on energy management of coal mines in the form of the "Order for energy policy", determining key indicators of energy efficiency and responsibility for their reaching, have been substantiated. Content of its sections has been proposed: "Energy accounting, analysis, and audit", "Marketing support of energy policy", "Financial and investment support of energy policy".

Financial and auditing as well as marketing aspects of the sustainable development of coal enterprises are the prospects for further studies.

References.

1. Somov, D. (2018). The functional approach to strategic management. *Economic Annals-XXI, 171*(5-6), 19-22. https://doi.org/10.21003/ea.V171-03.

2. Wang, Y., Lei, Y., & Wang, S. (2020). Green Mining Efficiency and Improvement Countermeasures for China's Coal Mining Industry. *Frontiers in Energy Research, 3.* https://doi.org/10.3389/fenrg.2020.00018.

3. Kecojevic, V., Vukotic, I., & Komljenovic, D. (2014). Production, Consumption and Cost of Energy for Surface Mining of Bituminous Coal. *Mining Engineering*, *66*(1), 51-57.

4. Bogunovic, D., Kecojevic, V., Lund, V., Heger, M., & Mongeon, P. (2009). Analysis of energy consumption in surface coal mining. *Society for mining, metallurgy and exploration*, *326*, 79-87.

5. Efremenko, V., Belyaevsky, R., & Skrebneva, E. (2017). The Increase of Power Efficiency of Underground Coal Mining by the Forecasting of Electric Power Consumption. *E3S Web of Conferences. The Second International Innovative Mining Symposium*, *21*, 02002. https://doi.org/10.1051/e3sconf/20172102002.

6. Kambur, O. L., & Petrishchenko, N. A. (2018). Marketing of energy saving in enterprises. *Efektyvna ekonomika*, *9*. Retrieved from http://nbuv.gov.ua/UJRN/efek_2018_9_28.

7. Kubyshyna, N. S., & Tsapuk, O. Y. (2013). Formation of the marketing mechanism of innovative developments in the energy saving market. *Ekonomichnyi visnyk Natsionalnoho tekhnichnoho universytetu Ukrainy «Kyivskyi politekhnichnyi instytut», 10*, 369-373.

8. Katsedan, A. V. (2013). Formation of marketing strategy of an energy company in a competitive relationship. *Modeliuvannia rehionalnoi ekonomiky*, *1*, 71-83. Retrieved from http://nbuv.gov.ua/UJRN/Modre_2013_1_10.

9. Smirnov, S. O., & Guillermo, T. V. (2015). Methodological platform for the formation of organizational and information mechanism of marketing promotion of energy-saving technologies. *Biznes Inform*, *7*, 311-315.

10. Pogodayev, S. E. (2013). Marketing of works as a source of the new hybrid offerings in widened marketing of goods, works and services. *Journal of Business and Industrial Marketing, 28*(8), 638-648. https://doi.org/10.1108/JBIM-04-2012-0069.

11. Guillermo, T. V. (2016). Formation of a system of integrated marketing communications, promotion of energy saving measures. *Ekonomika. Finansy. Pravo*, *5*, 7-11.

12. Smirnov, S. O., Levkovich, O. V., & Tsinovnik, A. E. (2016). Economic and marketing efficiency of energy saving technologies. *Ekonomichnyi prostir*, *115*, 236-244.

13. *Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU* (2017). Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32017R1369.

14. Zakladny, O. O., & Zakladny, O. M. (2013). Means of diagnostic audit of energy efficiency as an element of building an energy management system. *Enerhetyka*, *2*, 44-50.

15. I*SO/CD 50006.3 Energy management systems – Evaluating Energy Performance using Energy Baselines and Energy Performance Indicators* (n.d.). Retrieved from https://www.iso.org/standard/79367.html.

16. *ISO 50001:2018. Energy management systems – Requirements with guidance for use* (n.d.). Retrieved from https://www.iso.org/standard/69426.html.

17. Dzhedzhula, V. V. (2013). Energy audit as a means of ensuring energy efficiency of industrial enterprises. *Visnyk Odeskoho Natsionalnoho Universytetu. Ekonomika*, *18*(3(1)), 123-125.
18. Yakobchuk, V. P., Tishchenko, S. V., & Yarosh, S. V. (2016). Theoretical and methodological foundations of energy audit. *Ahrosvit*, *7*, 51-56.
19. Smerichevskyi, S. F., & Biezghina, O. S. (2015). Approaches to improving the energy efficiency of a coal mining enterprise. *Modern Ukraine in a global environment: strategic guidelines for economic development*: *monograph*. Dnipro.
20. DTEK (n.d.). Retrieved from https://dtek.com/investors_and_partners/reports.

Фінансово-облікове забезпечення маркетингових стратегій енергоефективності вугільних шахт

С. Ф. Смерічевський[1], *Т. Д. Косова*[1], *О. В. Трифонова*[2], *О. С. Безгіна*[3], *Г. В. Соломіна*[4]

1 – Національний авіаційний університет, м. Київ, Україна, e-mail: kosovatd@meta.ua
2 – Національний технічний університет «Дніпровська політехніка», м. Дніпро, Україна
3 – ТОВ «ДТЕК Енерго», м. Київ, Україна
4 – Міжрегіональна академія управління персоналом, м. Київ, Україна

Мета. Визначення підходів до вдосконалення фінансово-облікового забезпечення маркетингових стратегій як підсистеми енергетичного менеджменту вугільних шахт.

Методика. Теоретична формалізація системи енергетичного менеджменту вугільних шахт на основі вимог ДСТУ та ISO. Емпіричне узагальнення витрат на електроенергію за даними управлінської звітності п'ятнадцяти шахт Донецького вугільного басейну протягом десятиріччного періоду, приведення їх у зіставний вигляд на основі індексів цін виробників промислової продукції у сфері постачання електроенергії. Оцінка результативності функціонування енергетичного менеджменту вугільних шахт шляхом розрахунку їх індивідуального й галузевого потенціалу, ренкінгів питомих витрат на електроенергію та відносного потенціалу енергоефективності.

Результати. Систематизовані фактори зовнішнього та внутрішнього середовища, що впливають на енергоефективність вугільних шахт. Узагальнені вимоги до інструментів збільшення енергоефективності: енергоменеджменту, енергомаркетингу, енергообліку, енергоаналізу, енергоаудиту, енерго- та фінансового планування. Розроблено й реалізовано на практиці методичний підхід до визначення індивідуального та галузевого потенціалу енергоефективності вугільних шахт, отримані кількісні оцінки їх рівня та варіабельності.

Наукова новизна. Застосовано системний підхід до класифікації видів енергетичного аудиту вугільних шахт за такими ознаками: за фазами функціонування об'єктів аудиту, за характером, за охватом об'єктів аудиту, за методами проведення, за колом охоплюваних питань, за предметами. Виявлені причинно-наслідкові зв'язки між індивідуальним ренкінгом енергоефективності та індивідуальним потенціалом енергоефективності вугільних шахт, формалізована функція залежності загальних ренкінгів вугільних шахт і галузевих потенціалів їх енергоефективності. Застосовано динамічний підхід до визначення об'єктів фінансово-облікового забезпечення маркетингових стратегій вугільних шахт у формі розвитку потенціалу енергоефективності.

Практична значимість. Обґрунтовані рекомендації з розробки основного програмного документу з енергетичного менеджменту вугільних шахт у формі «Наказу про енергетичну політику», що визначатиме ключові індикатори енергоефективності, відповідальність за їх досягнення. Запропоноване змістовне наповнення його розділів: «Енергетичний облік, аналіз і аудит», «Маркетингове забезпечення енергетичної політики», «Фінансово-інвестиційне забезпечення енергетичної політики».

Ключові слова: *фінансове та облікове забезпечення, маркетингові стратегії, енергоефективність, вугільні шахти*

The manuscript was submitted 23.04.21.