V. V. Prokhorova[1],
orcid.org/0000-0003-2552-2131,
O. Yu. Yemelyanov[*2],
orcid.org/0000-0002-1743-1646,
O. Ya. Koleshchuk[2],
orcid.org/0000-0001-8995-5206,
N. S. Antonenko[1],
orcid.org/0000-0001-8319-2826,
A. S. Zaitseva[3],
orcid.org/0000-0003-0818-7853

1 – Ukrainian Engineering and Pedagogy Academy, Kharkiv, Ukraine
2 – Lviv Polytechnic National University, Lviv, Ukraine
3 – V. N. Karazin Kharkiv National University, Kharkiv, Ukraine
* Corresponding author e-mail: Oleksandr.Y.Yemelianov@lpnu.ua

INFORMATION SUPPORT FOR MANAGEMENT OF ENERGY-SAVING ECONOMIC DEVELOPMENT OF ENTERPRISES

Purpose. Formation of theoretical and methodological approaches to structuring information provision and assessing its significance for achieving energy-saving economic development of enterprises.

Methodology. In the research process, the following methods were used: economic-mathematical modeling, grouping, generalization, system analysis, etc.

Findings. The conditions under which energy-saving economic development takes place at enterprises have been formalized. Methodological principles of quantitative and qualitative assessment of the level of such development are proposed. The array of information necessary for managing the energy-saving economic development of enterprises is structured. Based on a sample of 150 Ukrainian enterprises that consume natural gas, the level of energy-saving economic development is assessed. The importance of information management of this development is substantiated.

Originality. The methods for grouping the types of economic development of the enterprise by highlighting a new classification characteristic, namely: the nature of the relationship between the change in the value of a certain financial and economic result of the enterprise's activity and the change in its consumption of a certain type (types) of energy resources, have gained further development. Methodological principles for assessing the impact of the quality of information support on the performance of enterprises have been improved through the substantiation of the approach, which determines the impact of the completeness of information support for the management of energy-saving economic development of enterprises on its level. An approach to structuring an array of information for managing energy-saving economic development of enterprises is proposed, which, unlike the existing ones, involves taking into account the hierarchical nature of the array of data.

Practical value. The obtained results can be used by enterprises when evaluating the dynamics of their economic results in comparison with changes in the amount of consumption of energy resources and when forming information support for the management of energy-saving economic development.

Keywords: *enterprise, information, energy saving, economic development, management, natural gas*

Introduction. Currently, one of the main tasks facing the economies of many countries of the world is to reduce their consumption of non-renewable energy resources, primarily crude oil and natural gas. The need for such a reduction has been realized both by the governments of countries and by scientists and practitioners over the last few years. However, this problem has significantly worsened since 2022, when, against the background of a large-scale armed conflict in Ukraine, political relations between many states and the global level of economic stability have significantly deteriorated. Under such conditions, a number of countries, in particular the European Union, set the goal of significantly increasing the degree of their own energy independence on the basis of reducing the need for fossil energy imports.

It should be noted that the need to reduce the consumption of non-renewable energy resources, in addition to the desire of the governments of many countries to improve energy independence, is due to a number of other circumstances. These include, in particular, the significant level and significant volatility of prices for most energy sources, the harmful impact that the consumption of these energy sources has on the external environment, etc. Also, the high level of energy intensity of products often leads to their uncompetitiveness in many sales markets.

At the same time, along with the task of reducing the consumption of fossil energy resources, the governments of many countries face the need to achieve the appropriate growth rates of their economies. The need for such growth is caused, first of all, by the need to improve the welfare of the population and reduce unemployment.

However, ensuring permanent economic growth may require a corresponding increase in the consumption of non-renewable energy resources. Under such conditions, a contradiction arises between the need for sustainable economic development and the need to reduce the consumption of fossil energy carriers. The resolution of this contradiction requires the separation of the processes of economic growth and energy consumption. In turn, such separation should be based on the principles of energy-saving economic development, under which the growth of economies is accompanied by a decrease in the amount of non-renewable energy resources used by them. At the same time, the achievement of energy-saving development at the national level should be based on solving the task of such achievement at the level of individual enterprises. This is due to the fact that the activity of enterprises, on the one hand, is a source of development of the economies of countries, and, on the other hand, this activity is often associated with significant energy costs. As a result, enterprises, along with households, are the main consumers of non-renewable energy resources.

Ensuring energy-saving economic development of enterprises is a rather difficult task, the solution of which may require companies to incur significant investment costs. In addition, the implementation of measures to save energy resources while simultaneously ensuring the growth of the financial and economic results of enterprises will require significant organizational efforts from their owners and managers. Therefore, in

addition to financial resources, for the successful implementation of programs of energy-saving economic development of enterprises, management systems for the implementation of such programs must be properly built. At the same time, one of the key components of enterprise management systems is information support for the processes of such management. This also applies to the management of energy-saving economic development of companies.

Therefore, there is a need to structure information support for managing energy-saving economic development of enterprises and to assess the importance of such support for reducing the consumption of the main types of non-renewable energy resources, in particular natural gas.

Literature review. The study on the problem of ensuring energy-saving economic development is based on studies on the relationship between changes in indicators of the achieved economic results of economic activity and the amount of energy resources consumed. In modern scientific literature, such studies are carried out mainly at the macro level of the economy. However, it should be noted that real economic activity is carried out directly by enterprises that are producers of final products and, at the same time, consumers of resources. That is why it is important to focus attention on the micro-level of the national economy when studying energy-saving problems, bringing to the fore the problem of identifying factors and conditions for energy-saving economic development of enterprises that consume energy resources.

The analysis of the scientific literature devoted to the issue of finding the relationship between economic growth and energy consumption in different countries revealed a certain inconsistency of the obtained results. Thus, in the research by Smiesova V., Pylypenko A., Ivanova M. & Karpenko R. according to the data of 96 countries of the world at different levels of development, the relationship between the quality of the economic and institutional environment, characterized, in particular, by indicators of energy resource conservation, and opportunities for the realization of economic interests by economic entities [1] was demonstrated. M. Salahuddin & K. Alam, on a sample of member countries of the Organization for Economic Cooperation and Development, proved the existence of a relationship between economic growth and energy consumption both in the short-term and in the long-term [2]. However, according to the results obtained by G. Fadiran, A. Adebusuyi & D. Fadiran during the study on twelve European countries regarding the impact of natural gas consumption on economic development, such a relationship was found only in the long term [3]. At the same time, F. Furuoka's analysis of natural gas consumption and economic development of China and Japan demonstrated the ambiguity of such dependence [4]. Moreover, for some countries of the Persian Gulf, A. Rafindadi & I. Ozturk even found an inverse relationship between natural gas consumption and the dynamics of the gross domestic product [5].

As you know, one of the main ways to reduce the use of fossil fuels is to replace them with renewable energy sources. As established by F. Cucchiella, I. D'Adamo & M. Gastaldi, predicting the future consumption of renewable energy resources is quite a difficult task [6]. At the same time, the nature and scope of the impact of replacing non-renewable energy sources with renewable ones on economic growth have not yet been definitively investigated. The impact of renewable energy on economic growth was established only for some countries. In particular, M. Bhattacharya, at al. found the presence of such an influence only for 57 % of the 38 countries considered [7]. Similar results were obtained, in particular, by E. Kocak & A. Şarkgüneşi. They established the presence of the influence of renewable energy on economic growth only for some of the studied countries of the Black Sea and Balkan regions, including Ukraine [8].

More difficult is the question of determining the conditions under which sustainable energy-saving economic development can take place. O. Yemelyanov, at al. formalized these conditions at the enterprise level [9]. However, currently there are practically no studies on the influence of individual factors on the possibility of ensuring long-term energy-saving economic development at the level of enterprises. This concerns both the drivers of such development and the obstacles that stand in its way.

In general, as noted by G. Kostka, U. Moslener & J. Andreas, when implementing energy-saving programs and projects at enterprises, various obstacles quite often appear [10]. The researchers identified the most significant of such obstacles. In particular, according to A. Trianni, at al., such obstacles include, among other things, the insufficient level of economic efficiency of energy-saving measures [11]. Z. Zhang, at al. indicate the lack of financial incentives for the implementation of these measures as one of the key barriers on the way to such implementation [12]. F. Backman refers to these barriers as the lack of rationality when making investment decisions regarding energy saving [13]. At the same time, V. Lesinskyi, at al. single out such obstacles on the way to energy saving as the excessive level of riskiness of energy saving projects [14] and the presence of organizational and technological inertia of energy consumption processes at enterprises [15]. A number of scientists, in particular F. Al Sharari, at al. [16], consider the lack of adequate amounts of own funds at enterprises as a factor that can slow down the process of implementation of energy-saving measures by business entities.

In a study by L. G. Giraudet, the significance of informational obstacles arising during the implementation of energy-saving projects by enterprises was revealed [17]. As established by J. Palm & F. Backman, these obstacles may be related to both the lack of input information and the insufficient competence of enterprise managers in processing this information [18].

Given the existence of informational obstacles at many enterprises on the way to their implementation of energy-saving measures, scientists have proposed a number of ways to overcome these obstacles. In particular, H. L. Kangas, at al. classify increasing the level of relevance of input information as such methods [19]. D. Chiaroni, at al. draw attention to the importance of improving energy audit mechanisms [20], while L. G. Giraudet suggests improving the competence of managers and company specialists in matters of processing input information [17].

Prajogo D., at al., as well as many other researchers in the field of information management, prove the exceptional importance of information support for managing the activities of enterprises [21]. Also, as it follows from the performed review of the literature, scientists are fully aware of the importance of information for energy saving management at enterprises. However, the role played by information provision in the management of energy-saving economic development of enterprises has not yet been established. There is also no structuring of the information necessary for such management. These issues are relevant for ensuring the long-term economic development of enterprises under the conditions of reducing their consumption of non-renewable energy resources. Therefore, there is a need for structuring and evaluating the significance of information necessary for managing energy-saving economic development of enterprises.

Purpose of this article is the formation of theoretical and methodological approaches to structuring information support and assessing its significance for achieving energy-saving economic development of enterprises. Achieving the set goal presupposes the need to solve a number of tasks, the main of which are the following:

- to formalize the conditions under which energy-saving economic development takes place at enterprises, and develop methodological principles for assessing its level;

- to build a typology of relationships between the change in the value of a certain financial and economic result of the business entity's activity and the change in its consumption of a certain type (types) of energy resources;

- to structure the array of information required to manage the energy-saving economic development of the enterprise;

- to assess the level of energy-saving economic development based on a sample of enterprises − consumers of natural gas and to analyze the information management of this development.

Methods. Various methods of scientific knowledge were used in the research process. In particular, when formalizing the conditions under which energy-saving economic development takes place at enterprises, economic-mathematical modeling was applied. When determining the types of relationship between the change in the value of a certain financial and economic result of the enterprise's activity and the change in the volume of its consumption of a certain type (types) of energy resources, grouping and generalization methods are used. In order to structure the information provision of the management process of energy-saving economic development of enterprises, the method of system analysis was used. When conducting empirical studies on the impact of the quality of information support on the level of energy-saving economic development of enterprises, the methods of economic analysis and technical and economic calculations were applied. A questionnaire survey method was used to conduct a survey of the owners and managers of the investigated enterprises regarding the level of information provision of their activities. The apparatus of mathematical statistics was used to process the obtained results.

Results. Energy-saving economic development of enterprises according to a certain type (types) of energy resources used by them is characterized by two main parameters, namely: the rate of growth of the value of a certain financial and economic result of activity and the rate of decrease in the consumption of the corresponding type (types) of energy resources. At the same time, the first of these parameters must exceed unity, and the second must be less than it, that is, the following inequalities must be fulfilled

$$T_1 = \frac{P_1}{P_0} > 1; \qquad (1)$$

$$T_2 = \frac{E_1}{E_0} < 1, \qquad (2)$$

where T_1 is the growth rate of a certain financial and economic result of the enterprise's activity; P_1, P_0 are the values of this result, respectively, in the reporting and base time intervals; T_2 − rate of decrease in consumption of the corresponding type (types) of energy resources; E_1, E_0 − respectively, the reported and basic natural volumes of consumption by the enterprise of the corresponding type (types) of energy resources.

Inequality (2) can be transformed as follows

$$\frac{E_1/P_1}{E/P_0} < \frac{P_0}{P_1}$$

or

$$T_1 = \frac{P_1}{P_0} < \frac{E_0/P_0}{E/P_1} = \frac{1}{T_3}, \qquad (3)$$

where T_3 is the growth rate of the energy efficiency of the business entity's functioning according to a certain financial and economic result of its economic activity

$$T_3 = \frac{P_1/E_1}{P_0/E_0}.$$

Taking into account inequalities (1 and 3), we obtain the following formalized condition of presence at the enterprise in the reporting period compared to the basic energy-saving economic development for a certain financial and economic result of activity

$$1 < T_1 < \frac{1}{T_3}. \qquad (4)$$

Since any set of three elements is subject to six different ways of their permutations, in general, six chains of inequalities similar to (4) can be constructed. Each of them will correspond to a certain type of relationship between the change in the amount of the financial and economic result of the enterprise's activity and the change in the amount of energy resources consumed by it (Table 1).

It should be noted that Table 1 presents only realistically possible types of relationships between a change in the value of a certain financial and economic result of the enterprise's activity and a change in its consumption of a certain type (types) of energy resources. For example, the type of ratios, according to which the value of financial and economic results decreases, consumption volumes increase, and the level of energy efficiency increases, is in principle impossible.

Thus, as follows from expression (4), in order for energy-saving economic development to occur at the enterprise, it is necessary that the rate of growth of the value of a certain financial and economic result of activity exceeds one, but is less than the value inverse of the rate of growth of energy efficiency.

In the process of formalizing the conditions under which energy-saving economic development will take place at the enterprise, these conditions can be specified. Such specification should take place, in particular, in terms of types of financial and economic results. Another direction of concretization of the specified conditions is the transition to consideration of individual types of products manufactured by the enterprise.

In particular, it is possible to evaluate the economic development of an enterprise based on the indicator of its profit obtained from operational activities. Then the condition for the growth of this profit in the reporting period in comparison with the base period can be formalized in the form of the following inequality

$$(p_0 \cdot I_p - c_{e0} \cdot I_e - c_{o0} \cdot I_o) \cdot B_0 \cdot I_B > (p_0 - c_{e0} - c_{o0}) \cdot B_0, \quad (5)$$

where p_0 is the price of a unit of production in the base period minus indirect taxes; I_p − the index of change in the price of a product unit in the reporting period compared to the base one; c_{e0} − specific costs for consumption of a certain type (types) of energy resources in the base period; I_e − the index of changes in specific costs for the consumption of a certain type (types) of energy resources in the reporting period compared to the base one; c_{o0} − specific value of all other costs in the base period; I_o − the index of change in all other specific costs in the reporting period compared to the base one; B_0 − the natural volume of sales of this product by the enterprise in the base period; I_B is the index of changes in natural volumes of product sales in the reporting period compared to the base period.

Inequality (5) is equivalent to this inequality

Table 1

Types of the relationship between the change in the value of a certain financial and economic result of the enterprise's activity and the change in its consumption of a certain type (types) of energy resources

Labels of relationship types	The nature of changes in financial and economic results	The nature of changes in energy consumption	The nature of changes in the level of energy efficiency of production	Formalized conditions of the corresponding types of relations
A	Growth	Growth	Growth	$1 < 1/T_3 < T_1$
B	Growth	Growth	Decrease	$1/T_3 < 1 < T_1$
C	Growth	Decrease	Growth	$1 < T_1 < 1/T_3$
D	Decrease	Growth	Decrease	$1/T_3 < T_1 < 1$
E	Decrease	Decrease	Growth	$T_1 < 1/T_3 < 1$
F	Decrease	Decrease	Decrease	$T_1 < 1 < 1/T_3$

$$I_e < \frac{1}{I_B} \cdot \left(\frac{p_0 \cdot (I_p \cdot I_B - 1) - c_{o0} \cdot (I_o \cdot I_B - 1)}{c_{e0}} + 1 \right). \quad (6)$$

It is also obvious that, in addition to the fulfillment of inequality (6), a necessary condition for the presence of energy-saving economic development at the enterprise is the value of the product of I_e by I_B, which is less than unity. Taking this into account, it is possible to present the final form of the formalized condition of the presence of energy-saving economic development at the enterprise based on the indicator of operating profit obtained from the enterprise's sale of a certain variety of its products. This condition will look like this

$$I_e = \min \left\{ 1, \frac{1}{I_B} \cdot \left(\frac{p_0 \cdot (I_p \cdot I_B - 1) - c_{o0} \cdot (I_o \cdot I_B - 1)}{c_{e0}} + 1 \right) \right\}. \quad (7)$$

Assessing the impact of certain factors on the energy-saving economic development of enterprises, in particular the quality of information support for their activities, requires a preliminary determination of the level of this development. The task of such a definition is not easy, since it is necessary to take into account the simultaneous change in two indicators (the value of a certain financial and economic result of economic activity and the amount of energy consumption).

One of the possible approaches to determining the level of energy-saving economic development of the enterprise should involve the implementation of the following sequence of actions:

1) construction of a scale for the indicator of the rate of increase in the value of a certain result of the enterprise's activity. This scale should provide for the presence of at least two ranges of values for this tempo. The smallest value must be zero. For example, ranges of very low, low, medium, high and very high values of the growth rate of a certain result of the enterprise's activity can be distinguished;

2) a similar scale is constructed for the indicator of the rate of increase (decrease) in natural volumes of consumption by the enterprise of a certain type (types) of energy resources. On this scale, zero will be the largest value. At the same time, the number of value ranges in the second scale should be the same as in the previous scale;

3) each range of indicator values in both constructed scales is assigned a certain number of points. At the same time, if the length of all ranges is the same, then the number of points for the range with the lowest (for the second scale — the highest) values of the indicator can be one. Then for each subsequent range in ascending order (for the second scale — decreasing) of the indicator values, one point should be added;

4) a point estimate is determined for the actual value of the growth rate indicator of the financial and economic result of the enterprise's activity;

5) a point estimate is determined for the actual value of the indicator of the rate of increase (decrease) in natural volumes of consumption by the enterprise of a certain type (types) of energy resources;

6) the results obtained at the previous two stages of the proposed sequence of actions are added up. As a result, it is pos-

sible to obtain a quantitative assessment of the level of energy-saving economic development of the investigated enterprise.

It should be noted that the application of the described sequence of actions makes it possible to carry out a qualitative assessment of the level of energy-saving economic development of the economic entity. For example, let only two ranges of possible values of the rate of growth of a certain financial and economic result of activity and the amount of energy consumption at the enterprise be distinguished, namely, unsatisfactory and satisfactory such values. Then it becomes possible to distinguish three qualitative levels of energy-saving economic development of the enterprise: low, medium and high, as shown in Table 2.

Estimating the level of energy-saving economic development of enterprises opens up an opportunity to analyze the impact of certain factors on it. Among these factors, it is worth mentioning information support for the management of the specified development.

It should be noted that the quality of information support for the management of energy-saving economic development of enterprises is largely determined by the completeness of the relevant array of information. This array of information should be divided into four general blocks, namely: blocks of basic primary, basic predictive, secondary and final information. At this, the nature of the relationship between the specified blocks will have a hierarchical nature, and the blocks themselves, in turn, will be divided into a number of partial blocks of information, as presented in Table 3.

Then, depending on how many blocks of information from the listed four blocks are properly formed at a specific enterprise, it is possible to perform a qualitative ranking of the information support of the process of managing the energy-saving economic development of the business entity under study. This ranking will involve the allocation of five levels of quality information support for the management of energy-saving economic development (Table 4).

Based on the division of business entities into classes according to the criteria for such division presented in Table 4, it is possible to evaluate the impact of the quality of information management of energy-saving economic development of enterprises on its level (Fig. 1).

In order to carry out an empirical analysis, data was collected on 150 Ukrainian enterprises that produce bricks, tiles and other construction materials from clay. This type of economic activity is generally characterized by a significant amount of natural gas consumption. Therefore, there is a need to assess the relationship between the change in certain financial and economic results of the enterprises under study and the change in their natural gas consumption. Therefore, there is a need to assess the relationship between the change in certain financial and economic results of the enterprises under study and the change in their natural gas consumption. At the same time, the net income, added value and operating profit of the studied business entities were selected as the specified results.

With regard to time intervals, the reporting period was 2021, and the base year was 2018. Applying the data contained

Table 2

Conditions for assigning the levels of energy-saving economic development of the enterprise to a certain group of them

Names of groups of levels of energy-saving economic development of the enterprise	Score, points	Qualitative characteristics of the growth rate of the financial and economic result of activity	Qualitative characteristics of the growth rate of natural volumes of consumption by the enterprise of a certain type (types) of energy resources
1. Low levels of energy-saving economic development	2	Unsatisfactory	Unsatisfactory
2. Average levels of energy-saving economic development	3	Unsatisfactory	Satisfactory
		Satisfactory	Unsatisfactory
3. High levels of energy-saving economic development	4	Satisfactory	Satisfactory

The composition of the array of information necessary for the management of energy-saving economic development of enterprises

Levels of information	Names of blocks of information	Contents of blocks of information
Basic primary information	Data on new types of energy-saving technologies, equipment and other energy-saving measures	Investments in measures, expected saving of energy resources due to the implementation of measures, their technical, technological and other parameters
	Data on past and current energy consumption at the enterprise	Past and current volumes of consumption of each type of energy resources in terms of fixed assets of the enterprise (by equipment, premises, etc.), the specific value of these volumes
	Data on past and current prices for energy and other types of resources used by the enterprise	Past and current price levels for energy, financial and other resources used by the enterprise, fluctuations in these prices and trends in their level changes
	Data on past and current volumes of products manufactured and (or) sold by the enterprise	Past and current volumes of production and sales of all types of products of this enterprise in physical and value units of measurement
	Data on the available economic resources of the enterprise, in addition to data on the energy resources used by them	Volumes and qualitative characteristics of human, technical and other types of economic resources available at the enterprise, except for energy resources
	Data on the current costs of the enterprise	The amount of costs for the production and sale of the company's products, as well as other current costs by cost items for each type of product
Predictive primary information	Predictive primary information, on the basis of which decisions on the implementation of energy-saving measures at the enterprise are developed	Forecast values of those indicators, the availability of information about which is necessary for the development of decisions on the implementation of energy-saving measures at the enterprise
	Predictive primary information, on the basis of which decisions are developed on the implementation of other measures at the enterprise, aimed at increasing the financial and economic results of its activities	Predictive values of those indicators, the availability of information about which is necessary for the development of decisions on the implementation of other measures at the enterprise, aimed at increasing the financial and economic results of its activities
Secondary information	Data on the financial and economic and other results that are expected to be obtained from the implementation of each energy-saving measure	Expected profits, income, net cash flow, energy consumption volumes, etc. for each measure to save energy consumption
	Data on the expected duration of obtaining results for each energy-saving measure	Effective terms of operation of each energy-saving project of the enterprise
	Other data on the implementation of each energy-saving measure	Required investments for the implementation of each energy-saving project, discount rates for them, etc.
	Preliminary data on energy-saving measures, which are expedient to implement by the enterprise at the present time	A preliminary list of those energy-saving measures, the implementation of which is currently expedient, the main indicators of the implementation of these measures
	Data on other measures, in addition to energy-saving ones, the implementation of which can contribute to the growth of the financial and economic results of the enterprise	A preliminary list of other measures, the implementation of which can contribute to the growth of the financial and economic results of the enterprise, the main indicators of the implementation of these measures
Final information	Final data on energy-saving measures of the enterprise, which it is expedient to implement at the present time	The final list of energy-saving measures of the enterprise, which at the present time it is expedient for it to implement, data on the main indicators of their implementation
	Final data on other measures of the enterprise, in addition to energy-saving, which at the moment it is expedient to implement	The final list of other measures of the enterprise, which at the present time are expedient for it to implement, data on the main indicators of their implementation
	Data on the expected change in the value of the financial and economic results of the enterprise under study after the implementation of the selected measures	The increase in operating and net profit, changes in the size of the company's assets, the profitability of its products, the costs incurred by it for energy consumption, and other indicators

in Table 1, all the enterprises under consideration were divided into groups according to the types of the relationship between the change in the value of the corresponding financial and economic results of the activity and the change in the volume of natural gas consumption.

As evidenced by the data shown in Tables 5 and 6, group A was the most numerous group in terms of all types of economic activity results. As for enterprises of group C (i.e., enterprises in which energy-saving economic development took place), their share in the total number of investigated companies ranged from 34.67 % (in the case of consideration as a result of economic activity of net income) to 39.93 % (in the case of consideration as the result of economic activity of operating

profit). At the same time, the fact that the second number is greater than the first may result from the formalized condition presented above for the presence of energy-saving economic development at the enterprise based on the indicator of operating profit (expression (7)). Indeed, according to this condition, this type of development can occur even in the absence of growth in the net income of enterprises, since the increase in profit can be caused by a direct reduction in the specific consumption of certain types of energy resources.

Using the above-proposed approach to assessing the level of economic development of the studied enterprises for each of them, the distribution of enterprises in which such development took place during 2018–2021 was carried out by natural

Classes of enterprises according to the quality of information management of their energy-saving economic development

Designation of classes	The current level of quality of information management of energy-saving economic development	Criteria for assigning an enterprise to a certain class
P.1	Unsatisfactory	No block of information is properly formed
P.2	Very low	Only one block of information is properly formed
P.3	Low	Two blocks of information are properly formed
P.4	Average	Three blocks of information are properly formed
P.5	High	All blocks of information are properly formed

gas, according to its level. The results of the performed distribution are presented in Table 7. At the same time, the assessment of the dynamics of the financial and economic results of activities and the volumes of natural gas consumption by enterprises was carried out using scales with two ranges values of growth rates of indicators (satisfactory and unsatisfactory). Accordingly, the level of energy-saving development of enterprises could be equal to two, three or four points, as presented above in Table 2. Therefore, under such conditions, it is possible to distinguish three levels of energy-saving economic development of the studied enterprises, namely, low, high and medium ones. As evidenced by the data in Table 7, the most numerous in terms of all types of financial and economic re-

sults of economic activity is the group of studied enterprises with an average level of their energy-saving economic development for natural gas.

Based on the processing of the results of the survey of the owners and managers of the investigated enterprises, these enterprises were divided into five classes according to the level of information support for the management of their energy-saving economic development. At the same time, the criteria for such a division were used, which are presented above in Table 4. In addition, the studied enterprises were divided into three groups according to the level of efficiency of their use of natural gas in 2018 according to each of the selected types of financial and economic results of economic activity. Then, for each class and group of enterprises, the average level of their energy-saving economic development based on natural gas was calculated. The results of such a calculation are given in Table 8.

From the data presented in Table 8, it follows that in enterprises with low efficiency of natural gas consumption, there is a trend towards an increase in the average level of energy-saving economic development with an improvement in the quality of information support for the management of this development. As for enterprises with an average and high level of natural gas consumption efficiency, no such trend was found for them. This can be explained by the fact that such enterprises have objectively smaller reserves for further growth of the specified efficiency. It is also worth noting that most of the enterprises with an average and high level of natural gas consumption efficiency belong to classes C.3, C.4 and C.5. In other words, the level of information support at most of these enterprises is satisfactory.

In order to assess the statistical significance of the above dependence, which is inherent in enterprises with a low level of natural gas consumption efficiency, the method of variance analysis was applied [22]. The use of this method, which is based on the additivity property of the dispersion of a random variable, makes it possible to establish the presence of the in-
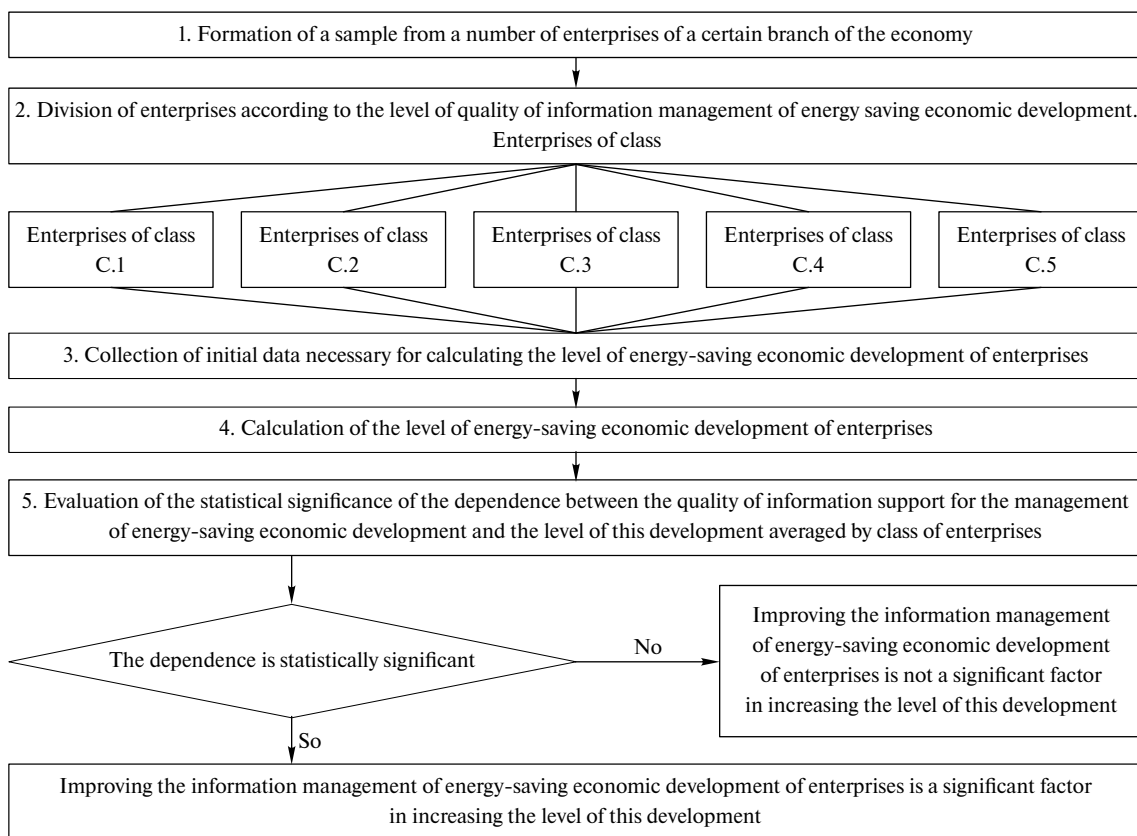

Fig. 1. The sequence of assessment of the impact of information management of energy-saving economic development of enterprises on its level

The number of enterprises by types of the ratio between the change in the amount of financial and economic results of activity and the change in the volume of natural gas consumption during 2018−2021

Labels of relationship types	The number of enterprises depending on the selected type of financial and economic results of their activity		
	Net profit	Added value	Operating profit
A	59	62	64
B	18	19	17
C	52	54	59
D	3	2	1
E	8	7	5
F	10	6	4
Together	150	150	150

The structure of enterprises by types of the relationship between the change in the amount of financial and economic results of activity and the change in the volume of natural gas consumption during 2018−2021

Labels of relationship types	Shares of enterprises in their total number depending on the selected type of financial and economic results of their activity, %		
	Net profit	Added value	Operating profit
A	39.33	41.33	42.67
B	12.00	12.67	11.33
C	34.67	36.00	39.33
D	2.00	1.33	0.67
E	5.33	4.67	3.33
F	6.67	4.00	2.67
Together	100.00	100.00	100.00

Distribution of enterprises that underwent energy-saving economic development using natural gas during 2018−2021, according to the level of this development

The level of energy-saving economic development	The number of enterprises depending on the selected type of financial and economic results of their activity		
	Net profit	Added value	Operating profit
Low	16	12	13
Average	29	33	32
High	7	9	14
Together	52	54	59

fluence of a certain factor, which is characterized by a limited number of its possible values (levels), on the average values of a certain resulting indicator corresponding to each of these values. In our case, the factor is the quality of information management of the energy-saving economic development of the studied enterprises, which is characterized by five values, and the resulting indicator is the level of this development. At the same time, it is important that the set of enterprises that meet each of the values of the quality of information support for the management of energy-saving economic development should be sufficiently numerous. Therefore, some of the classes of this support were combined, as a result of which three

Indicators of the average level of energy-saving economic development of natural gas enterprises

The level of efficiency of natural gas consumption in 2018	Types of financial and economic results of enterprises	Average level of energy-saving economic development of enterprises by natural gas, points				
		C.1	C.2	C.3	C.4	C.5
1. Low	1.1. Net profit	1.9	2.0	2.8	3.2	3.6
	1.2. Added value	1.9	2.1	2.7	3.3	3.7
	1.3. Operating profit	2.0	2.2	2.9	3.3	3.8
2. Average	2.1. Net profit	2.1	2.2	2.4	2.3	2.5
	2.2. Added value	2.3	2.2	2.5	2.4	2.4
	2.3. Operating profit	2.2	2.3	2.7	2.6	2.5
3. Tall	3.1. Net profit	1.9	2.1	2.0	2.3	2.2
	3.2. Added value	1.8	1.9	2.0	2.4	2.3
	3.3. Operating profit	2.0	2.2	2.1	2.4	2.3

classes of enterprises were formed depending on the quality of information support for the management of their energy-saving economic development (Table 9).

As it follows from the data in Table 9, for all three types of financial and economic results, the described dependence is statistically significant, since the actual values of the $F-$ test with a significance level of $\alpha = 0.05$ exceed its critical values. Therefore, for those enterprises under investigation, in which the efficiency of natural gas consumption remains low, improving the quality of information support for the management of energy-saving economic development can lead to a significant increase in the level of this development.

Conclusions. As the research showed, in order for energy-saving economic development to take place at the enterprise, it is necessary that the rate of growth of the value of a certain financial and economic result of activity exceeds one, but is less than the value inverse of the rate of growth of energy efficiency. Regarding the assessment of the level of energy-saving economic development, it should be carried out by summing the point estimates of two indicators, namely: growth rates of a certain type of financial and economic results of activity and rates of reduction in the consumption of a certain type (types) of energy resources.

At the same time, it is possible to distinguish six types of relationship between the change in the value of a certain financial and economic result of the enterprise's activity and the change in its consumption of a certain type (types) of energy resources. Each of these types has clear criteria for its

Output data and results of dispersion analysis of the relationship between the quality of information support for the management of energy-saving economic development and its level in relation to natural gas consumption (for enterprises with low efficiency of such consumption in 2018)

Types of financial and economic results of enterprises	The average level of energy-saving economic development of enterprises by their classes, points			Actual values of the $F-$ criterion
	C.1, C.2	C.3, C.4	C.5	
1. Net income	1.9	2.8	3.4	6.11
2. Added value	2.0	2.7	3.5	5.65
3. Operating profit	2.1	2.9	3.6	6.29

presence, which have the form of chains of corresponding inequalities.

The quality of information support for the management of energy-saving economic development of enterprises is largely determined by the completeness of the relevant array of information. This array of information should be divided into four general blocks, namely blocks of basic primary, basic predictive, secondary and final information. At the same time, the nature of the relationship between the specified blocks will be hierarchical, and the blocks themselves, in turn, will be divided into a number of partial blocks of information. Then, depending on how many blocks of information from the four listed ones are properly formed at a specific enterprise, it is possible to perform a qualitative ranking of the information support of the process of managing the energy-saving economic development of the business entity. This ranking will involve the allocation of five levels of quality information support for the management of energy-saving economic development.

In order to carry out an empirical analysis, data was collected on 150 Ukrainian enterprises that produce bricks, tiles and other construction materials from clay. The conducted research showed, in particular, that the share of enterprises in which energy-saving economic development took place in the total number of investigated companies ranged from 34.67 % (in the case of consideration as the result of economic activity of net income) to 39.93 % (in the case of consideration as the result of economic activity operating profit). At the same time, in enterprises with low basic efficiency of natural gas consumption, there is a trend towards an increase in the average level of energy-saving economic development with an improvement in the quality of information support for the management of this development. Therefore, such an improvement can be a powerful way to increase the level of energy-saving economic development in those enterprises in which the efficiency of using natural gas still remains low.

Further research on the topic of the article should involve the construction of a factor model of the level of energy-saving economic development of enterprises. The application of such a model could help identify factors other than the quality of information provision that have a significant impact on the specified level.

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Інформаційне забезпечення управління енергозберігаючим економічним розвитком підприємств

В. В. Прохорова[1], *О. Ю. Ємельянов*[*2], *О. Я. Колещук*[2], *Н. С. Антоненко*[1], *А. С. Зайцева*[3]

1 — Українська інженерно-педагогічна академія, м. Харків, Україна

2 — Національний університет «Львівська політехніка», м. Львів, Україна

3 — Харківський національний університет імені В. Н. Каразіна, м. Харків, Україна

* Автор-кореспондент e-mail: Oleksandr.Y.Yemelianov@lpnu.ua

Мета. Формування теоретико-методологічних підходів до структурування інформаційного забезпечення та оцінювання його значущості для досягнення енергозберігаючого економічного розвитку підприємств.

Методика. У процесі дослідження використані методи: економіко-математичного моделювання, групування, узагальнення, системного аналізу тощо.

Результати. Формалізовані умови, за яких на підприємствах відбувається енергозберігаючий економічний розвиток. Запропоновані методологічні засади кількісного та якісного оцінювання рівня такого розвитку. Структуровано масив інформації, необхідної для управління енергозберігаючим економічним розвитком підприємств. За вибіркою 150 українських підприємств — споживачів природного газу оцінено рівень енергозберігаючого економічного розвитку. Обґрунтована важливість інформаційного забезпечення управління цим розвитком.

Наукова новизна. Набули подальшого розвитку способи групування типів економічного розвитку підприємства шляхом виділення нової класифікаційної ознаки, а саме: характеру співвідношення між зміною величини певного фінансово-економічного результату діяльності підприємства та зміною обсягів споживання ним деякого виду (видів) енергоресурсів. Удосконалені методичні засади оцінювання впливу якості інформаційного забезпечення на результати діяльності підприємств через обґрунтування підходу, за якого встановлюється вплив повноти інформаційного забезпечення управління енергозберігаючим економічним розвитком підприємств на його рівень. Запропоновано підхід до структурування масиву інформації для управління енергозберігаючим економічним розвитком підприємств, що, на відміну від існуючих, передбачає врахування ієрархічного характеру масиву даних.

Практична значимість. Отримані результати можуть бути використані підприємствами при оцінюванні динаміки їх економічних результатів у зіставленні зі змінами обсягів споживання енергетичних ресурсів і при формуванні інформаційного забезпечення управління енергозберігаючим економічним розвитком.

Ключові слова: *підприємство, інформація, енергозбереження, економічний розвиток, управління, природний газ*