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Formation of the Index System to Assess the Efficiency of Energy Resources Use and the Selection of the Ways to Implement Energy Strategy of Enterprise

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Abstract: Increased competition in the market of goods and services determines the need to find ways to improve the efficiency of enterprises. The high level of energy consumption has a significant impact on enterprise's operation. Further improvement of fuel and energy use efficiency will be largely determined by the success of enterprise management of energy costs. Formation of the enterprise energy strategy is considered to be one of the reliable approaches to solve this problem. The selected choices for its implementation determine the need for a system of indicators to assess the efficiency of the energy resources use. The study considers the methodical bases of index system formation to evaluate the economic efficiency of energy use and the choice of the ways to implement enterprise energy strategy.

Key words: Energy efficiency, energy consumption, performance measurement, energy resources, indices

INTRODUCTION

In the face of limited natural resources the question of their rational use is particularly acute. One solution to this problem is to increase the efficiency of the use of all resources including energy. In recent years almost all countries have paid their particular attention to the solution of this problem. Vasauskaite and Streimikiene (2014) stated that energy efficiency is the main purpose of their policies for sustainable development. Meanwhile, the EU has set the task to reduce by 20% the annual primary energy consumption by 2020. The researchs of many researchers concern the issues of assessment of energy saving potential in industry across Europe and Asia. Lin and Long (2015) analyzed the energy efficiency and energy saving potential in a fairly energy-intensive chemical industry in China. The questions of optimization of energy consumption in the European industrial plants were discussed by Aughney and O'Donnell (2015). The study by Thollander *et al*. (2007) analyzed the implementation of energy efficiency measures in small and medium manufacturing industries in Sweden. Certain aspects of introduction of energy-saving technologies in different industries are reflected by Alkaya and Demierer (2015) and Muller *et al*. (2007). In addition, Tan and Yavuz (2015) analyzed the proposals of energy-saving technologies as a service paid for by future energy savings. However, Blass *et al*. (2014) and Martin *et al*. (2012) note that effective energy saving policy requires a serious adjustment of the role of top enterprise management.

In Russia, the issue of efficient use of energy resources is also given a lot of attention. Primarily, it is due to the fact that the energy intensity of GDP is higher compared to developed countries by 2-3 times (Anisimova, 2013). One reason for the high level of energy intensity of the national economy is not sufficiently effective use of all types of energy resources, especially in the industrial sector, accompanied by a constant rise in energy prices (Mustafina *et al*., 2015). All these factors predetermine the need for new approaches to managing energy costs through the use of an energy management system, the most important place in the formation of which is given to the energy strategy of the industrial enterprises.

The energy strategy is a set of measures that contribute to the objectives of enterprise operation in more efficient use of all energy resources. Formation of the energy strategy is aimed at reducing the quantity of energy costs in the production costs to increase its competitiveness. The implementation of the energy strategy can be done in different ways on the basis of a complex of measures. Wherein the realization of each direction of the energy strategy implies contribution costs in the form of investment and operating costs in the hope of getting some results, the achievement of which is limited by a number of external and internal factors. It raises the problem of assessing and selecting the most preferable embodiment of the strategy of the entire spectrum of potential alternatives (Mustafina *et al*., 2015). It stipulates the need to create a system of indices for the

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economical evaluation of efficient use of energy resources and the choice of the ways to implement enterprise energy strategy.

MATERIALS AND METHODS

As a methodological platform for the solution of the problem there was taken the performance measurement methodology. This choice is explained by the fact that this methodology brings together many of the existing system of indicators in different areas of enterprise operation (for example, costs, revenues, investment, innovation, marketing) to assess and analyze the efficiency of each organizational stage (Gleich, 2001). It includes the existing approaches to the formation of a system of indices, combined by the following names: Tableau de Bord, productivity measurement and enhancement system, performance pyramid, balanced scorecard and others. The characteristic feature of all the above approaches is including both financial and non-financial indicators of enterprise operation.

For example, when using the system Tableau de Bord for each unit of the enterprise there is a general goal related to the critical success factors which are evaluated by a set of indicators (Vayre, 2015). Productivity Measurement and enhancement system is built on the principles of combining the objectives, evaluation of actions to achieve them, the combination and introduction of information of the previous periods. Concept performance pyramid is based on the financial and non-financial indicators, focused on domestic customers (Parida *et al*., 2015). However, it should be noted that of all the models of evaluation of enterprise operation balanced scorecard has become the most widespread in practice. It is based on the formation of goals and indices according to the enterprise's strategy on 4 perspectives including finance, customer relationships, internal business processes, staff training and development (Kaplan and Norton, 2000). Each of the subsystems defines the critical success factors for achieving the set goals. It studies the causal relationships between them which are displayed on the strategic map of the enterprise (Kaplan and Norton, 2004). On the basis of established dependence indicators are elaborated which are the values to measure the impact of the relevant success factors. The balanced scorecard has indices linked to each other logically, not only to evaluate the results but also reflect the process of obtaining these results. Each balanced scorecard index is provided by established indicators to monitor the achievement of goals. At the same time the basis for the formation of a system of indicators comrises the principles shown in Fig. 1.

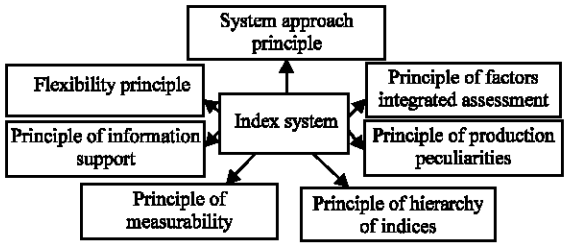

Fig. 1: The principles of formation of index system to assess the efficiency of economic energy resources use

RESULTS AND DISCUSSION

The methodical approach for evaluating the efficiency use of energy resources: In accordance with the above methodological basis there was considered the process of formation of the system to assess the impact of economic energy efficiency on the final enterprises' results. To do this, we set out goals of formation of the energy strategy and indices to assess the efficiency and its implementation on 4 subsystems, including financial (S1), marketing (S2), production with the emphasis on energy aspect which we are interested in particular (S3) and Human Resources management (S 4).The strategic map of the impact of various success factors on the economic results of the enterprise is shown in Fig. 2. The 1st step is to determine the purpose of functioning of each subsystem of the enterprise in terms of the formation of the energy strategy. The purpose of its formation is to increase the enterprise's competitiveness through more efficient use of all energy resources. Accordingly the main objective in the financial subsystem is the growth of the profitability of operating activities (block 1.1.) due to the increase in sales volume (block 1.2) and the reduction of production costs (box 1.3).

Attracting new customers (block 2.2.) also enhances sales besides saving the existing customers (block 2.1). All these factors characterize the so-called marketing subsystem in the frameresearch of balanced scorecard concept. To keep the existing clients and to attract new ones it is necessary to increase production efficiency through the use of various factors including, first of all, reduction of the production price (block 3.1). In terms of the impact of the energy factor it can be achieved by reducing the energy intensity of production (block 3.2). The most important condition to achieving this goal is to increase the energy management (block 3.3) through the introduction of various energy-saving measures (block 3.4). In their turn, energy saving measures can be introduced in different areas, among which there should be noted more efficient use of Basic Production Assets

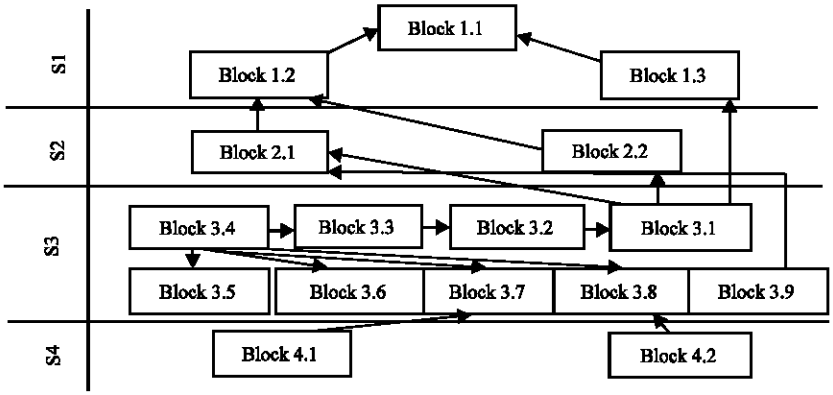

Fig. 2: The strategic map of the impact of various success factors on the economic results of the enterprise

(BPA) (block 3.5), the use of secondary energy resources (block 3.6), increase staff efficiency (block 3.7), the organization and management improvement including control of energy consumption (block 3.8). In addition, in many technological processes the improved monitoring of energy consumption often contributes to increase product quality (block 3.9). To reach the targets of the energy subsystem operation, special attention should be given to staff development (block 4.1) and the use of management information systems (block 4.2).

The next stage of the development of balanced scorecard is the formation of the composition to assess the achievement of the relevant success factors. One of the most important indicators that determine the effectiveness of financial activity is the gross profit margin costs (block 1.1). Furthermore, other indices can be used to characterize the effectiveness of financing activities, including liquidity ratios, the net profit of the enterprise, etc. Indicators characterizing the volume of sales and the amount of expenses of the enterprise are the proceeds (block 1.2) and total production costs (block 1.3), respectively. The most important factor determining the position of the enterprise on market is its market share (block 2.1) which reflects the extent of its participation in the market in terms of volume sales. For a deeper analysis of the achievement of the marketing subsystem it is expedient to use the factor of customer retention (block 2.1) and its extension (2.2) indicating the source of the revenue growth. For example, if a customer retention rate is 1, the increase in sales can be only due to the increase in the volume of purchases of the same customers. On the other hand, the value of the customer retention index at a level of <1 indicates attracting new customers. One of the most important indicators that assess the efficiency of the production subsystem is the unit cost (block 3.1). The reduction of this index leads to the reduction in the total cost of the enterprise, greatly contributing to keep the existing customers and attract new ones, followed by the increase of the total sales.

It is appropriate to combine the indices that characterize the energy aspect of the production functioning subsystems into 2 groups. The first group includes general indices characterizing the efficiency of the energy management system (block 3.2 and 3.3). The second includes separate indices that characterize the efficiency of the implementation of energy saving measures (block 3.4), the use of basic production assets (block 3.5), secondary energy resources (block 3.6) and staff performance (block 3.7).

The first group includes the following indices: the energy intensity of production and the share of energy costs in the production cost (block 3.2). They enable to compare the efficiency of energy resources use with the same type production in the enterprises which have a different method of production and use different equipment or the types of energy consumed; the cost of energy consumption (block 3.2). It estimates amount of enterprise's costs on its energy supply; a general efficiency index of energy management (block 3.3). In combination it takes into account the main factors determining energy production efficiency: energy saving, selection of fuel and energy suppliers, operation of energy facilities, its own energy potential, energy business of enterprises (sale of energy resources and energy technology services), etc. Energy performance which shows the impact of energy use, i.e., the outcome is either on 1 toe. (tce) or unit cost of fuel and energy resources.

Among separate indices of energy efficiency there are: indices of energy use rate, energy savings growth of 1 ruble of additional costs, the share of energy savings

Table 1: The indicators characterizing the results of production and business enterprises

	Years		
Index designation/Units	2011	2012	2013
Gross profit (thous. rub.)	12025.5	12339.8	14933.9
Profitability cost (%)	4.20	4.17	4.34
Proceeds (thous. rub.)	298171.7	308549.3	359211.2
Production costs (thous. rub.)	286146.2	296209.5	344277.3
Unit costs (thous. rub.)	1.46	1.63	1.69
Energy consumption (toe.(tce)./item; toe.(tce/rub.)	0.05; 0.03	0.05; 0.03	0.05; 0.03
The share of energy costs in the cost (%)	4.95	4.21	4.29
The cost of energy con-sumption (thous. rub.)	14170.5	12479.7	14754.9
The volume of energy con-sumption (toe.)	10037.8	9346.2	10042
Cost of 1 toe. (thous. rub./toe.)	1.41	1.34	1.47
Energy performance (thous. rub./toe.; rub./rub.)	29.70; 21.04	33.01; 24.72	35.77; 24.35
Installed power of labor (toe./person)	13.66	14.36	15.35
Labor productivity (item/person)	265.40	278.49	310.55

due to the introduction of energy saving equipment and technologies in total energy savings (block 3.4). They enable to assess the relative effectiveness of energy-saving measures implemented in comparison with the costs of their implementation, indices of energy savings from the introduction of organizational and technical measures (block 3.4). They estimate the absolute value of saving fuel and energy resources in the production of a specific type of product, energy intensity of BPA and capital productivity (block 3.5), participation rate of secondary energy resources in the energy supply enterprises (block 3.6). It shows the share of energy consumption which is "covered" by secondary energy resources.

Installed power of labor index (block 3.7) evaluates the energy consumption per employee a year and indicates the technical equipment of production and labor. Control of energy consumption (block 3.8) is based on data on the implementation of the planned rules and regulations both as the consumption of energy resources on a specific product and the enterprise as a whole.

The 4th component of the balanced scorecard identifies indices relating to personnel training and development, includes retraining strategic factor (block 4.1) and the strategic information rate (block 4.2). Retraining strategic factor represents the ratio of the number of researchers trained for specific activities in the field of energy management to the total number of professionals required in this field. Currently, there are different approaches to staff training and retraining. With regard to solving the problem the most preferable approach is the use of a strategic retraining program or development program of basic professional competences depending on the goals and enterprises' financial opportunities. Recently an increasingly important component of the management process has become valid data availability. An indicator of strategic awareness helps to evaluate the effectiveness of information systems which determines the share of information available on the overall need for it.

The results of practical testing: To pursue the goal of practical testing of this approach we determined the effect of increasing energy efficiency use on the final performance of the machine-building enterprise in one of the most industrially developed regions of the Russian Federation, the Republic of Tatarstan. The indicators characterizing the performance of the enterprise are presented in Table 1. Analyzing the values of the indicators, we can conclude that in the period from 2011-2013 the gross profit of the enterprise increased by 1.24 times. Its profitability also increased costs while marginally from 4.20-4.34%. In 2011-2012 cost margins declined due to the excess of the rate of growth cost (132.3 and 103.6%) over the growth of sales revenue (132.2 and 103.5%).

The analysis showed that the energy intensity of production over the estimated period decreased both in volume and in value terms. This is owing to a decrease in energy consumption while increasing production capacity. The developments in this area happened because of energy-intensive equipment decommissioning, the total installed capacity of which amounted to 1630 kW. During the reporting period the total capacity of the equipment decreased by 33.4%. Energy performance characterizing the return on each ruble spent on the acquisition of energy resources, increased both in volume and in value terms. All this testifies to the more efficient energy resources use. For a more detailed analysis we assessed the impact of increasing energy efficiency on the production efficiency as a whole. It should be noted that the decline in energy intensity represents the change in energy intensity index (I_{pe}) as follows:

$$I_{pe} < 1 \quad (1)$$

However, in addition to reducing the energy intensity of production it is necessary to achieve and fulfill the following Eq. 2-4:

$$I_{Ip}>1; I_{RA}>1; I_o<1 \quad (2)$$

$$I_{pI}>1; I_{PFA}>1; I_c>1 \quad (3)$$

$$I_{Ip}>I_{pI}; I_{RA}>I_{PFA}; I_o>I_p \quad (4)$$

Where:

I_{pe} = Production energy intensity index
I_c = Energy consumption index
I_o = Output index
I_{pI} = Installed power of labor index
I_{Ip} = Labor productivity index
PFA = Installed Power of Fixed Assets
I_{RA} = Return on Assets Index

Only the fulfillment of these conditions will be evidence of increasing efficiency production as a result of better energy resources use. During this period the growth rate of labor productivity exceeded growth rate of installed power of labor indicating more efficient use of energy resources (Table 2). The year of 2011 faced the decline in production while increasing the energy resources consumption. Besides, the growth rates of labor productivity were lower than the growth rates of installed power of labor which was a negative factor led to a decrease in energy efficiency use and growth of energy intensity of production by 3%. In 2012, the situation improved slightly since the decrease in production volume and reducing energy consumption corresponded to 1%. However, productivity growth remained below the growth rate of installed power of labor. In 2013, the energy intensity of production decreased by 5%. This 1% increase in the volume of production accounted for 0.58% growth in energy consumption and 1% increase in labor productivity-0.62% growth in installed power of labor which corresponded to more efficient use of energy resources.

Analysis of the results obtained in the study of considered above proportions may be used in the formation of areas of implementation of the energy strategy of industrial enterprises, as well as the selection of actions to promote not only more efficient use of energy resources but also improve the production efficiency as a whole.

Table 2: Results of various indicators change index calculation

	Years		
Index designation	2011	2012	2013
Production energy intensity index (I_{pe})	1.03	1.00	0.95
Output index (I_o)	0.98	0.93	1.12
Energy consumption index (I_c)	1.01	0.93	1.07
Installed power of labor index (I_{pI})	1.06	1.05	1.07
Labor productivity index (I_{Ip})	1.03	1.05	1.12

CONCLUSION

Developing energy strategy is becoming the necessary instrument in the strategic management of the industrial enterprise, aimed at improving its competitiveness by reducing the quantity of energy costs in the production cost. The proposed balanced index system for the economic evaluation of the energy efficiency use allows us to represent the energy strategy of the enterprise as a sequence of cause and effect relationship between the implementation of various measures and their effect on the enterprise performance as a whole and therefore it can be used, firstly, for the economic evaluation of the implementation effectiveness of separate energy-saving measures and secondly, for selecting the possible ways to implement the energy strategy.

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