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The Development of a New Approach to the Energy Management System Formation and the Estimation of its Efficiency on the Basis of the Consumer Quality Theory

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Abstract: According to ISO 50001 standard, the efficiency of the energy management system functioning is estimated through the system of energy efficiency indicators. As a rule, these indicators reflect the efficiency of management of different kinds of resources inside the enterprise. On the basis of their calculation, the following conclusions can be made: how well the enterprise has governed the energy resources in the current year in comparison with the previous one, how efficiently the energy saving activities have been held and so on. Is it possible to estimate the influence of the consumers of the output with the help of these indexes? apparently, no. However, that is consumers who form the demand for the enterprise output and determine the financial result of its activity. So, the energy management allows to solve only the local management tasks that determine its low priority in the system of strategic aims and goals of an enterprise. The researchers has made an attempt to form a new approach to design a system of energy management and estimate its efficiency, under which the energy efficiency of an enterprise and the consumers preferences for the energy efficiency of the output can be analysed through the system of indicators of energy efficiency of the energy management system. From the researchers point of view, this approach can be utilized in different enterprises, producing energy-consuming items.

Key words: Energy management system, new approach, indicators of energy efficiency, energy efficiency strategy, theory of consumer quality

INTRODUCTION

Studying the practices of domestic enterprises implementing the 50001 standard, the researchers established the following tendency: at the expiration of a short period of time after the energy management system has been introduced, its efficiency decreases gradually (Anisimova, 2014). As a rule, the dynamics of energy efficiency of an enterprise shows this tendency quite clearly. In the course of time in the process of energy efficiency indicators analysis, the less dynamics of their change is determined and accordingly the less clear economic effect gained from energy management system functioning is revealed. It takes place even in the case of full adequacy to the requirements of ISO 50001:2011 "Energy management system requirements with the application guide" and the continuous improvement of management of enterprise activity efficiency as suggested in the standard.

Thus, it can be noted that ISO 50001 standard is, undoubtedly, a rather convenient instrument for energy management system maintenance in the enterprise but it is not an instrument for its development. According to the theory of life cycles, if we concentrate all our attention on the stage of maintenance without taking any actions directed on the system development, it will lead to the end of life cycle in any case (Melnik *et al*., 2014).

As we know, each life cycle can be divided into two stages: the stage of development and the stage of maintenance. Examining the life cycle of energy management system, it can be noted that on the stage of development we spend money on the system design and its implementation in the company. On the stage of maintenance, one can see the natural process of the return of funds that have been invested before. Gradually, the economic effect of the system implementation becomes less and in some time it can either finish or be rather insignificant. From the researchers point of view, the fixed tendency for the decrease of energy efficiency in the activity of an enterprise can be overcome however, it will require the change of the existing approach to the energy management system formation and the evaluation of the efficiency of the system operation.

MATERIALS AND METHODS

Strategy of the research: In the researchers opinion, the application of the theory of consumer quality, that is not well-known among Russian top managers but is popular enough in the enterprises of Japan and in some enterprises of the EU and the USA and its instruments can further the development of a new approach to the energy management system formation and the evaluation of the efficiency of its application. The analysis of the existing researches in the field of quality control made it possible to establish that one of the most important conditions of the increase in the efficiency of the companies activity and their competitive ability is the compiling of the consumer wants into the productive characteristics of a product (Akao, 1972; Akao and Mazur, 2003; Kano *et al*., 1984; Juran, 1988; Hauser and Clausings, 1996). The academician of the International academy of quality J. Juran, analysing the double nature of quality, singled out that productive quality itself does not guarantee the consumer quality, i.e., the degree of satisfaction of wants. The first one does not guarantee the second one, it is a necessary but not a single condition (Juran, 1988). Investing in the increase of productive quality we can raise our competitive ability, if thereby we raise the utility of the goods for a consumer or even worsen it if our investments have not lived up to the consumer's expectations. The postulate that the buyers of the goods are the main source of finance increase in the company is the basis of the theory of consumer quality. The development of the theory of consumer quality has become possible due to the increase of the corresponding knowledge in the process of application of the total quality management conception, Quality Function Deployment strategy (QFD), Hoshin Kanri strategy that started developing particularly in Japan even in the 60's of the 20th century. The attempts to adapt the theory of consumer quality in the countries of the West and the USA in the 80's did not develop broadly as its strategy and instruments were not studied enough. Such instrument as QFD is still not well-known in the circle of modern western top-managers and even less known by the Russians. Nevertheless, Xerox, Ford Motors, Mitsubishi, Toyota are among the companies that broadly use the QFD strategy in their activity. Hoshin Kanri strategy was worked out while the "management by aims" system was developed. At and T, Xerox, Exxon Chemical, Florida Light and Power, Hewlett Packard can be mentioned here as the companies that apply Hoshin Kanri strategy successfully (Hunt and Xavier, 2003).

The examination of methodical approaches and the instruments of the theory of consumer quality made it possible to suggest that with their help the characteristics of energy efficiency, that are not obvious for the producer but are rather significant for the consumer can be revealed. In this case the notion of energy efficiency of the activity will be understood broader. When it is estimated, the use of standard indicators of energy efficiency including power intensity of the production, specific consumption of separate kinds of energy resources against the volume of output, etc. will not be enough. It should be noted that when standard indicators are formed as a rule, the specifics of the enterprise activity, the character of utilized energy resources, the size of the enterprise and other factors, that relate to the factors of the internal environment of an enterprise, are taken into consideration. In some degree, the indirect influence of the factors of the external environment like the energy resources suppliers can be reflected in these indicators. However, the influence of the consumers can be followed only through the dynamics of their demand and the indicators of the volume of output. Thus, in the researchers opinion, the consumer quality theory application predetermines the necessity of the changes in the standard approach to the formation of the key indicators for the estimation of energy efficiency in the enterprise activity.

The formation of conditions for realization of the new approach to the energy management system: According to the ISO 50001 standard, the energy management system functioning in the enterprise should be carried out in accordance with the PDCA cycle. In this case, the existing problems are analysed on the stage of planning and the activities aimed at their solving are determined. On the stage of adoption the decisions, made at the previous stage, are realized. On the stage of control, the level of the solutions of the problems, that have been determined before is estimated. On the last stage, the process is corrected and improved in accordance with those activities that have given the necessary result. The first stage of the cycle is the most creative and at the same time the most difficult for its practical application. Firstly, the arrangement of the energy management system itself, the formulation of the system requirements, the aims and goals which are worked out within the system, depends on it. Secondly, the system functioning inside the enterprise, the information flow movement, the responsibility assignment also depends on it. That is why the changes in the existing approach to the energy management system formation and the evaluation of the effectiveness of the system operation on the basis of the theory of consumer quality must be arranged on the first stage of the cycle. From the researchers point of view, a

range of attendant conditions are necessary for its successful realization. Firstly, the proper understanding of the exceptional importance of overcoming of stereotypes in the energy management system working only within its operation is quite necessary. It means that the instruments of strategic planning should be applied for the system functioning. Secondly, the methodical support that makes possible to realize the researchers ideas covering the formation of the energy management system on the basis of the theory of consumer quality is necessary.

The energy efficiency strategy formation: The necessity to apply the instruments of strategic planning and the energy efficiency strategy development is one of the most important conditions of the functioning of energy management system on the basis of the consumer quality theory. It will allow to go beyond the scope of the operational activity which restricts us to the stage of the system maintenance. Due to it, the researchers suggests the following sequence of activities aimed at the enterprise energy efficiency strategy formation.

The strategy must be formulated on the first stage (Melnik and Lukishina, 2014). In this connection, the following demands for the process of its formulation must be made. Firstly, the main aims and goals of the energy efficiency strategy must be coordinated with the development strategy of an enterprise as a whole. It raises the significance of the energy efficiency strategy, the degree of its influence on the general development strategy of an enterprise and its performance control as the evaluation of the fulfillment of separate indicators of the general strategy of an enterprise must be realized through the indicators of the energy efficiency strategy fulfillment. Secondly, not only the internal interests of the company but also the interests of its stakeholders (Hax end Majluf, 1994) and particularly, the interests of the consumers being very important from the position of the consumer quality theory should be taken into account in the energy efficiency strategy. However, it should be noted that when the strategy is formulated for the first time, a number of difficulties connected with the responsiveness to the interests of consumers can arise. It can be made after the implementation of the voice of the customer technique (Pardee, 1996), allowing to establish the energy efficiency characteristics that are not clear for the producer on the further stages of the activities. Such instruments of strategic planning as strategic session and foresight can be applied in the process of the strategy stating (Postaliuk *et al*., 2013; Kirshin and Kuzminov, 2014).

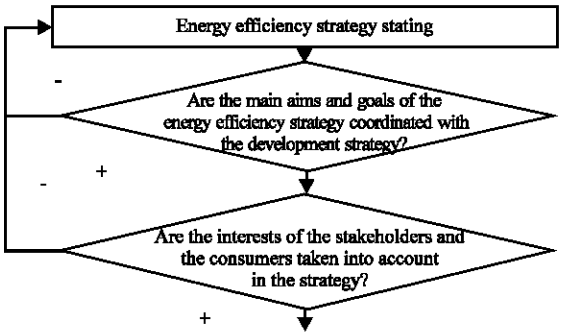

Fig. 1: The first stage in the algorithm of the energy efficiency strategy formation

Analysing the second condition of the successful energy management system formation on the basis of the consumer quality theory, it should be noted that the researchers has already worked out the methodical support of the energy management system and suggested an algorithm of the energy economic analysis of the activity of an enterprise (Anisimova, 2013). By the results of the analysis the enterprise got the opportunity to determine a range of problems existing in the sphere of energy efficiency and form the energy efficiency indicators. However as it has been noted earlier, only the factors of the internal environment of an enterprise were taken into consideration in these indicators. Thus, it can be stated that with the help of the developed algorithm of the energy economic analysis only a part of energy efficiency indicators can be received (Fig. 1).

Within the approach to the formation of key indicators for the energy efficiency evaluation for the activity of the company, suggested by the researchers the influence of the consumers of the enterprise production should be taken into account. In this case it is most reasonable to apply the voice of the customer technique. It is a hierarchical, full (necessary and sufficient) set of needs, explained by the consumer's language and measured at the scale of consumer's valuables. The realization of this technique requires the fulfillment of the following sequence of activities:

- Organization of the information about the existing consumer needs (by polls, context interviews, prototype testing, etc.)
- Data processing
- Affine structuring of the material within which the revealed needs are placed in a logical hierarchy as approximate as possible to the one, existing in the consumer's mind
- Scaling and prioritization of needs

As a rule, the given technique is applied for the evaluation of the quality of new output or new modifications of existing goods. The researchers will make an attempt to apply this technique for the evaluation of one of the constituent elements of the output quality its energy efficiency. Thus, on the stage of energy management system planning the researchers suggests the application of two techniques: the technique of energy economic analysis of the activity of an enterprise, allowing to determine the internal problems of the enterprise connected with its energy efficiency and voice of the customer technique, allowing to establish the energy efficiency characteristics that are not clear for the producer.

The examination of the information that has been received due to the application of these techniques, its systematization and the determination of the most significant spheres with the regard of which further decisions will be made will be implemented by the use of the appropriate instruments. The results of the energy economic analysis of the activity of an enterprise can be processed further with the help of a range of instruments including histogram making, Pareto-analysis ishikawa diagram making, etc. Under these conditions the choice of an instrument depends on the result that is needed. If a simple visualization of the frequency of a characteristics emergence along the axis of its values is needed, a histogram is made. If it is necessary to set the main problem, the elimination of which will make it possible to achieve the significant improvement in the results of the activity, pareto diagram is chosen. The expert structured scheme, visualizing the impact of the supposed reasons on the result under study, results from the use of Ishikawa diagram.

RESULTS AND DISCUSSION

The results of the research conducted with the help of voice of the customer technique are further processed with the help of the main QFD diagram, known as house of quality, the goal of which is the transformation of the consumer wants into the measurable technological characteristics of a product.

Analysing the second stage of energy efficiency strategy formation, it should be noted that its main goal is energy efficiency indicators formation. To a great extent, it is an analytical stage as a range of activities, connected with the energy-economic analysis of the activity of an enterprise, the energy efficiency analysis from the part of a consumer, data processing, the determination of existing problems and the formulation of suggested decisions are in its network (Fig. 2).

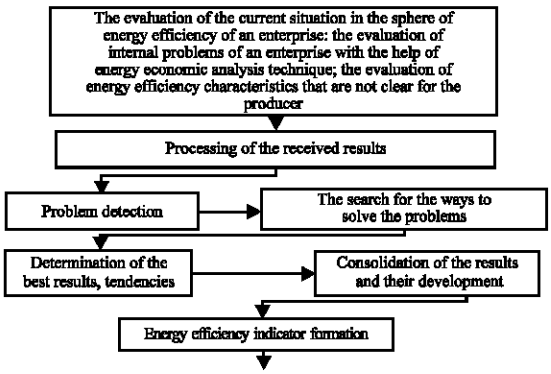

Fig. 2: The second stage of the algorithm of energy efficiency strategy formation

Among the main requirements for the second stage of the activities the requirement for the continuous improvement can be singled out. The researchers borrowed it from the quality management system. Its main idea is that while comparing plans against facts, along with the search for negative results and formulation of suggestions covering their correction, the researchers notes the best results and tries not only to repeat them but to improve them even more.

The evaluation of the strategy fulfillment and its correction takes place on the third stage. It is the most important stage in the formation of the energy management system on the basis of the consumer quality theory as on this very stage there is a possibility to formulate the energy efficiency strategy, allowing to take mutual requirements into consideration in full. The researchers suggests using QFD technique for the strategy correction. The process of the strategy correction is the following sequence of actions:

- Inspection of the compliance of aims and goals of en
- Ergy efficiency strategy with the aims and goals of the general strategy of the company development
- Inspection of the validity of choice of energy efficiency indicators by the determination of their ability to reflect the degree of the achievement of aims and goals of energy efficiency strategy

Each of the actions, above, will be realized on the basis of making and analysing the house of quality diagram (Fig. 3). For its realization the main aims (goals) of the energy efficiency strategy should be enumerated in square 3 horizontally in the diagram. The main aims (goals) of the company in the accordance with its development strategy should be enumerated in square In square 2 one should specify the influence and rating of each aim (goal) of the company development strategy,

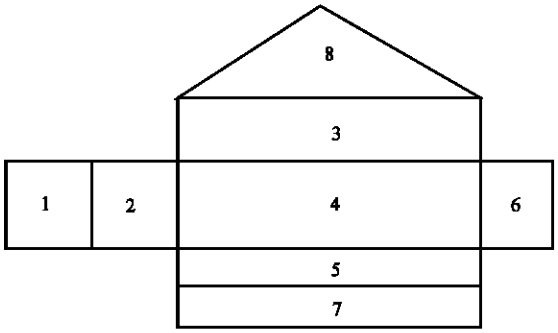

Fig. 3: The schematic mapping of the house of quality

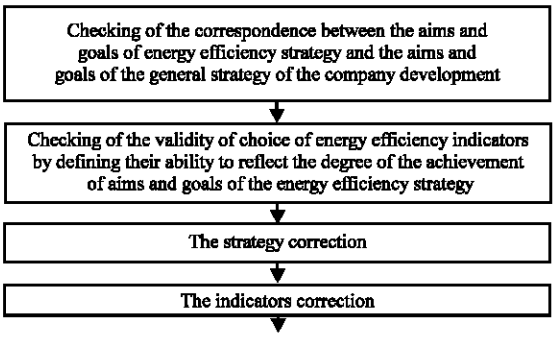

Fig. 4: The third stage of the algorithm of the energy efficiency strategy formation

showing the degree of their importance for the increase of efficiency of the enterprise activity as a whole. Relational matrix composes the central part of house of quality or square 4. It is completed in the following way. For each aim (goal) of the energy efficiency strategy one should determine if it influences the achievement of the aims (goals), enumerated in square 1 and show the degree of this influence. The degree of influence can vary from weak to strong one. When the influence is weak, it is given the value when it is medium, the value is and when the influence is strong, it is valued as 9. The corresponding mark is put in the cell on the point of intersection of the aim (goal) of the development strategy of an enterprise and the aim (goal) of energy efficiency strategy.

On the next stage square 5 is filled. For this purpose in each cell in the columns of square 4 the value of influence or the value of rating, indicated in the corresponding cell in square 2 is multiplied by the degree of influence in square 4. The values received in each column are summed up and the results are put down in square 5. The values of the coefficients of correlation between the aims (goals), marked in square 3 are indicated in square 3. In a classical diagram, composed when new output is developed or product modification is released etc., one should fill in the squares 6 and with the results of the consumer benchmarking and technical benchmarking correspondingly.

As the result of the house of quality diagram fulfilling on the stage of checking of the correspondence between the aims and goals of energy efficiency strategy and the aims and goals of general strategy of the company development, it can be stated that the realization of an aim (goal) of energy efficiency strategy to a great extent promotes the achievement of the aims of the development of an enterprise as a whole.

The house of quality diagram can also help to check the validity of choice of energy efficiency indicators by defining their ability to reflect the degree of the achievement of aims and goals of the energy efficiency strategy. As a result of the analysis, firstly, the degree of the sufficiency of proposed energy efficiency indicators and secondly, their ability to reflect the degree of achievement of aims and goals of energy efficiency strategy can be stated. Thus, as a result of the third stage of the algorithm of energy efficiency strategy formation (Fig. 4) the energy efficiency strategy and the corresponding indicators will be corrected to make the following realization of the energy management system on an enterprise possible.

CONCLUSION

The given research makes it possible to form the energy management system where there are conditions for taking into consideration not only the enterprise owners' interests but the consumers' interests as well. The formation of such approach is connected with supplementary investigations covering the consumer demands and provides for the fulfillment of certain demands, including the integration of aims and goals of energy efficiency strategy of a company with its business-strategy.

The staged fulfillment of the given requirement on the basis of using the house of quality model of the QFD method was shown in the research. Further researches will be carried out in the direction of the proposed algorithm automation for their further application in enterprises.

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