



Energy Efficiency Management Based on Innovative Development Indicators
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ABSTRACT

Structural changes that are currently taking place in the world economy significantly transform the foundations of innovation activities carried out at all levels of management. Energy efficiency is becoming increasingly important among the priorities of innovative development; the task of being energy efficient has been linked to the formulation and solution of other priorities in the field of innovation. The new quality of the influence of the energy factor on the content and results of innovative development predetermines the need for developing an indicative management system linking the energy efficiency indicators with the parameters of innovation development at different levels of management and reflecting the achievement of target milestones in the transition of the economy to the sixth technological mode. That is why the problems of the formation of such a system were given special attention during the research. It is established that for the formation of a system of energy efficiency indicators intended for use in the management of innovative processes in the economy, there is no need to develop a qualitatively new composition that was fundamentally different from the traditional practice of managing the efficiency of energy production, transmission and consumption. The conducted research has shown that the existing system can be based on existing indicators which must be filled with new content reflecting the specifics of the problem under consideration.

Key words: innovative development of the economy, technological structure, priorities, energy efficiency, indicative management.



1. INTRODUCTION

The sixth technological mode transforms the foundations of technological development of the world economy and influences the entire global system of socio-economic processes. The changes that have taken place have caused a number of national economies to plunge into a series of systemic crises, the dynamics of which is explained by the increasing scale of substitution of some basic technologies by others (Melnik, A.N., Lukishina, L.V., Sadriev, A.R. (2015)). Considering the impossibility of completely neutralizing the emerging threats to economic security, it seems expedient to develop measures to mitigate the negative consequences of the emergence and spread of innovation, creating the conditions for realizing the potential built into them.

The development of the indicative management system can be considered as a possible measure that allows actualization of the existing interrelationships between technological areas, ensuring their relatively predictable entry into the space of a new mode. The focus of this study is on the technological area associated with energy efficiency which development indicators are proposed to be linked to the parameters of innovation activity. The choice of such an object of research is determined by the system nature of energy processes that will continue to permeate all spheres of activity in the economy, predetermining to a large extent the achievement of strategic development guidelines for it.

It should be noted that considerable attention was given to the problems of energy efficiency in various studies. From the perspective of the interests of China's economy, energy efficiency is analyzed in the works of G. -M. Shi, J. Bi, J. -N. Wang (2010), J. Bing, L. Rui (2011) and J. -L. Hu, S. -C. Wang, F. -Y. Yeh (2006). A similar study for the Japanese economy was conducted by S. Honma and J. -L. Hu (2009). From the point of view of investment features, R. U. Ayres, J. C. J. M. van den Bergh, D. Lindenberger and B. Warr study the problem of increasing the energy efficiency of economies around the world (Ayres, R.U., van den Bergh, J.C.J.M., Lindenberger, D., Warr, B. (2013)). From the standpoint of identifying cross-country patterns, the problem of energy efficiency is raised and solved by M. Filippini and L. C. Hunt (2011) Sectoral cross-cultural comparisons conducted in the search for ways to improve energy efficiency can be found in the developments of E. Cagno, E. Worrell, A. Trianni and G. Pugliese (Cagno, E., Worrell, E., Trianni, A., Pugliese, G. (2013)).



Works of E. Worrell, J. A. Laitner, M. Ruth, and H. Finman (2003) are devoted to identifying areas of energy conservation and increasing energy efficiency at the level of individual enterprises.

However, the mentioned publications do not fully describe the problems of integrating energy efficiency objectives with the tasks of innovative development at various levels of management, which is of fundamental importance in the context of the transition of the world economy to the sixth technological mode.

2. METHODS

The regulatory and legal framework of various countries of the world was used in the process of carrying out the research; the framework regulates activities in the field of energy conservation and energy efficiency. Particular attention was paid to the analysis of legislative acts that determine the place and role of energy efficiency among priority areas for innovative development in economic systems. Formation of the matrix of the company's positions in the system of priorities in the field of energy efficiency was based on the use of the balanced indicators concept tied to the ideology of linear and systemic approaches to managing innovation processes in business. The limitation of the results of the study is the possibility of using them primarily at enterprises which activities are characterized by high energy intensity of the production process, or the importance of energy efficiency parameters in the consumer value of their products.

3. RESULTS AND THEIR DISCUSSION

Despite power industry retains its significance as one of the most important infrastructure sectors; its place in the newly formed technological structure of the economy will be largely reviewed. The tendency of outstripping development of high-tech industries began to develop even in the economy of the fifth mode and in the outline of the sixth mode it should finally shift energy-intensive activities from priority positions. From this it follows a reduction in the degree of direct influence of the power industry on the functioning of enterprises in different sectors in the structure of production costs of which the cost of energy begins to occupy a share that is not capable of having a significant impact on their competitiveness. To some extent, these trends, of course, smooth out the growth of absolute values of energy consumption in the world. However, on the whole, a decrease in the concentration of large energy-intensive enterprises in the total number of energy consumers indicates an intensifying of



dominance of the business model in which the energy factor ceases to be decisive (Anisimova, T. (2016), Melnik, A.N., Mustafina, O.N. (2014)).

Meanwhile, such an external decrease in the significance of a previously important sector of economy does not mean that energy secures the status of a secondary sphere of activity. In reality, the fundamental changes lie behind this, the general meaning of which is reduced to the fact that the content of the processes of production and consumption of energy acquires a qualitatively different meaning. Energy remains the most important resource, the rational use of which will be considered as a priority development of almost all economic systems. At the same time, the evolution of the content of the problem under consideration is clearly viewed, which has a clearly expressed specificity for each stage of power industry development (Fig. 1).

If at the initial stage of electrification development, efforts were concentrated in ensuring effective extraction of primary energy resources and the production of secondary energy resources on their basis, in recent decades, the focus was on the process of rational use of secondary energy resources within the production cycle of enterprises.

The trend of today is an even deeper and more distributed penetration of the processes of energy use into the structure of value chains at the enterprises of the processing branches of the economy.

With a view to a more detailed study of these trends, let us consider the content of the stages of energy development from the point of view of their influence on the dynamics of economic development.

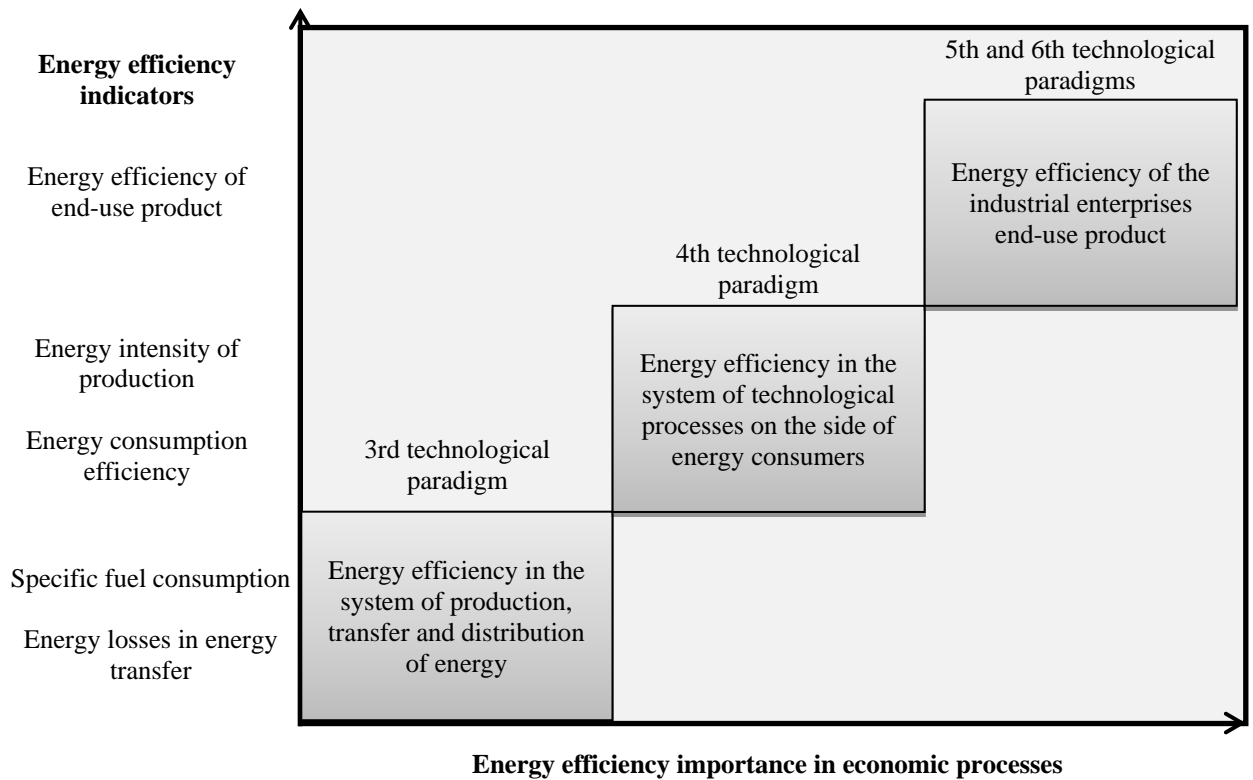


Fig. 1. Energy efficiency meaning of evolution within different techno-economic paradigms

The main driving force that has initiated the very first stage of development of energy technologies was a technological push caused by the accumulation of knowledge about electromagnetic fields, electric current and electrical circuits by the 18th century.

Thanks to these data it was possible to create the first samples of technical solutions in the field of generation, transformation, transmission and use of electric power.

Expanding the scope of energy use has predetermined the need for radical decisions affecting the fundamentals of the organization of energy supply. Under the influence of market demand, there a transition has taken place to a power industry functioning model, the most important characteristic of which was the power generation at large power plants connected by power lines to power systems. The multiply increased volumes of production and consumption of energy products ensured the achievement of the scale effect and allowed experience to accumulate in the field of energy supply what contributed to reducing the costs of energy supply. This was reflected in the reduction of energy prices, which further supported the positive dynamics of the development of



national economies. In addition to direct positive influence on the development of the economy, energy also has an indirect impact on it. Formed by the end of the XIX century, the paces of economic growth were largely caused by the accumulation and application of knowledge about the methods of energy production and consumption. It is this knowledge that made it possible to create in the economy a whole range of new sectors, and to give the impetus to technological and economic development of the existing spheres of activity.

At present, there is a reformatting of the sector, which is characterized by a convergence of economic and technological interests in the sphere of production and the sphere of energy consumption. At the same time there are changes in the perception of the very concept of "energy". Increasingly, the level of energy efficiency of products becomes the main parameter which its customers pay attention to. In this regard, the characteristics of energy efficiency are critical in the flow of value creation determining the requirements for a number of other parameters concerning different types of products. Not surprising in this situation is the transformation of energy efficiency into a factor around which the innovative development of enterprises of different sectors and spheres of activity takes place.

In this case, the positioning of this factor in competition can be considered in two main aspects. On the one hand, new solutions in the field of energy efficiency can manifest themselves in the form of product innovations designed for implementation in the external environment of an enterprise and, accordingly, capable of bringing direct financial benefits to it. On the other hand, the task of increasing energy efficiency can be solved within the system of improving its internal business processes, finding its reflection in innovations that provide financial returns in an indirect way.

The process of selecting a specific position for an enterprise in the system of priorities in the field of energy efficiency should be oriented towards strict compliance with the requirement to balance four corporate values. These include customer satisfaction, competition with competitors, the implementation of domestic growth strategies, as well as making a profit. Table 1 shows the performance indicators for energy efficiency in the innovative development system of a company, grouped with the need to comply with this requirement.



Table 1. Performance indicators in energy efficiency in the system of innovative development of an enterprise

Enterprise activity aspect being under examination	Values of corporate activities on energy efficiency advancement	Indicators
Competitive	To differ from competitors offering the market new standards of consumer value in the field of energy efficiency	The degree of market novelty of the product from the point of view of the parameters of its energy efficiency
		Stability of competitive advantages with crucially important parameters of energy efficiency throughout the time
Customeroriented	To satisfy client's demands creating product and services with crucially important parameters of energy efficiency	Energy efficiency class of product
		Demand sustainability for product with crucially important parameters of energy efficiency
Organizational	To rise quality of inner business processes of enterprises on the basis of innovative implementation in the field of energy efficiency	Enterprise power capacity
		Enterpriseheatstoragecapacity
		Enterprise power supply capacity
		Innovative activity on energy efficiency advancement and lowering of costs on production and realization of product
Financial	To provide profitability from innovations in the	Profit from product realization with crucially important parameters of energy efficiency



	field of energy efficiency	Profit share from product realization with crucially important parameters of energy efficiency in total profit
		Change of enterprise market value under influence of its activity in the field of energy efficiency advancement

Achieving a balance between all competing values implies establishment of equilibrium between the desire to create an attractive product for consumers, meeting the requirement of opposing the actions of competitors, the need to develop business processes of the enterprise, as well as ensuring the profitability of its activities. The dynamic nature of such an equilibrium means that the position of the enterprise in the system of innovative priorities should be regularly adjusted. Fig. 2 presents possible options for positioning an enterprise in the system of innovative priorities in the field of energy efficiency. The four main positions are differentiated depending on the current and projected energy intensity of the production process and the value of the energy efficiency parameters in the created value of the output.

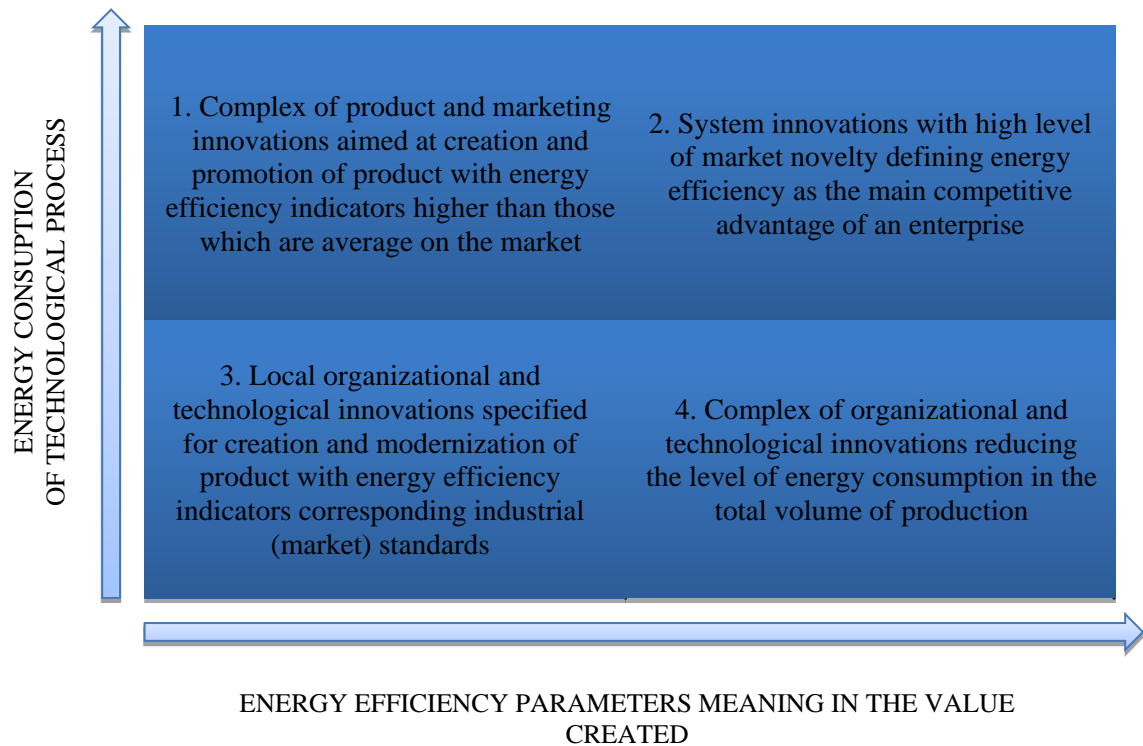


Fig. 2. Enterprise position matrix in the system of priorities for energy efficiency

The first position in the matrix, characterized by a high value of energy efficiency parameters in the created value and low energy intensity of the production process, directs the enterprise to implement a set of product and marketing innovations. The second position targets the company to follow the model, in which system innovations in the field of energy efficiency should become its main competitive advantage. High energy intensity of the production process at low share values of energy efficiency parameters in the created value of products is characteristic for the third position in the matrix. The fourth position closes the cycle in question, orienting the company's development strategy for the implementation of local organizational and technological innovations designed to create or modernize products with energy efficiency indicators that meet industry standards.

4. SUMMARY

Innovative activity in the field of developing technologies for the production, transmission and consumption of energy was one of the factors that determined the dynamics of scientific and technological progress at all stages of innovative



development of economic systems. At the same time, the increasing depth of the integration of energy technologies into the structure of technological processes is clearly viewed, as a result of which the energy factor to the fourth mode has consolidated itself as a system-forming global economic chain of world economic ties.

The increasing depth of penetration of energy-related processes into the structure of technological processes predetermines the need to use indicators of innovative development in the energy sector to manage innovation processes in various technological areas. One of the directions of solving this problem is the development of an indicative management system linking the energy efficiency indicators with the parameters of innovative development.

There is no need to develop a qualitatively new composition of energy efficiency indicators intended for use in the management of innovation processes for the formation of their system. As the study showed, the system being developed can be based on existing indicators which must be filled with new content reflecting the specifics of the problem under consideration.

5. CONCLUSIONS

According to the results of the conducted studies, it was established that the structural changes taking place in the world economy transform the fundamentals of innovation activity. Among the priorities of innovative development, the increasing importance is acquired by energy efficiency. Its increase has increasingly become associated with the formulation and resolution of other priorities in the field of innovation. The study shows that a new quality of the influence of the energy factor on the results of innovative development necessitates the development of an indicator management system linking the indicators of energy efficiency with the parameters of innovative development.

6. ACKNOWLEDGMENTS

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