Organizational and Economic Mechanisms of Energy Efficiency Management at Industrial Enterprises

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Abstract: The article discusses the main approaches to efficient energy management in a company using economic mechanisms that can lead to effective energy use, reducing energy costs and improving the competitiveness of the enterprise. Various economic mechanisms are used to achieve these goals, such as stimulating economic interests, tax incentives, conducting energy audits and benchmarking, as well as monitoring and controlling of energy consumption. The study also investigates barriers and conditions for successful implementation of energy saving programs at industrial enterprises. The author considers the application of benchmarking in energy-saving practices, its potential use as a tool for identifying and implementing effective energy-saving strategies, and its utilization as a part of comprehensive energy management program.

1 INTRODUCTION

Nowadays, various industries are making efforts to implement innovative solutions and technologies that reduce energy consumption in production. Saving energy leads to a significant decrease in the cost of production and an increase in profitability. Energy efficiency is particularly important for countries that do not have significant hydrocarbon reserves and is relevant in the context of the global economic crisis (Korovkina N.P., 2019).

Industrial enterprises are large consumers of energy resources and energy conservation is one of the most pressing issues, which is associated with the constant increase in the cost of electricity (Nikolaev, A.A., 2017).

According to the forecast of the International Energy Agency, by 2035, the industrial sector will occupy the second place in terms of energy consumption volumes after the transport sector (Kuznetsov, N.V., 2016).

Energy saving at industrial enterprises is one of the most important tasks in the context of modern challenges related to rising energy prices, stricter environmental requirements, and the need to optimize production costs. One of the key aspects of effective energy efficiency management at an enterprise is the use of economic mechanisms that help reduce energy resource costs, increase resource utilization efficiency, and reduce negative environmental impact.

Economic mechanisms of energy efficiency management include various tools and methods aimed at improving energy resource utilization efficiency at industrial enterprises. Among them are measures for energy saving, the use of energy-efficient technologies, the implementation of an energy consumption monitoring and management system, and the development of financial mechanisms to encourage enterprises to implement energy-saving measures.

One of the most important tasks within the framework of economic mechanisms of energy efficiency management is the development and implementation of an energy consumption accounting and control system at the enterprise. This allows not only for rational use of energy resources but also for the identification of possible

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leaks and losses as well as optimization of energy resource costs.

An important aspect of economic mechanisms of energy efficiency management at industrial enterprises is also the development of financial mechanisms that allow for attracting investments and stimulating enterprises to implement energy-saving measures. Such mechanisms may include subsidies, preferential loans, tax incentives, and other tools that help reduce energy-saving costs and increase the efficiency of energy resource utilization.

Today, in the conditions of rising energy prices, increasing environmental requirements, and the need to reduce production costs, energy saving becomes one of the main tasks for industrial enterprises. To achieve effective operation of the energy-saving system at the enterprise, a comprehensive approach that includes organizational, technical, economic, and legal aspects is necessary. Organizational and economic mechanisms of energy efficiency management at industrial enterprises play an important role in increasing the efficiency of energy resource utilization, reducing production costs, and improving the environmental situation in the region.

Organizational mechanisms represent a management system that includes the definition of energy-saving goals and objectives, the organization of work on collecting and processing data on energy consumption, as well as coordination of actions between various departments of the enterprise. Economic mechanisms of energy efficiency management include the development of financial mechanisms, the assessment of costs and the effectiveness of energy-saving measures, as well as the development of mechanisms to stimulate staff participation in energy-saving programs.

The proper use of organizational and economic mechanisms of energy efficiency management at industrial enterprises allows for significant reduction of energy resource costs, improvement of the environmental situation in the region, increase in enterprise competitiveness, and ensures sustainable business development in the conditions of the modern market.

The appeal of large industrial companies to the idea of energy management is associated with a pressing need to save resources, reduce indirect production costs, and reduce the level of environmental pollution (Gorbunova, V.S., et al., 2018)

Controlling, as a modern management concept, provides functional and instrumental support to improve the efficiency, transparency, and justification of managerial decisions, and its newest direction - energy controlling - extends its position to the energy field (Kuzubov, A.A. et al., 2021).

In order to determine the effectiveness of energy management of an industrial enterprise in modern conditions, it is necessary to improve the methodology for determining the range of indicators and criteria for evaluating the interaction of the state and market mechanism (Koksharov, V.A., 2015).

2.1 Methods

In order to intensify energy conservation in enterprises, it is necessary to increase internal prices of energy resources, gradually eliminate cross-subsidization in tariff formation, and introduce a system of legal, administrative, and economic measures that stimulate efficient energy use.

These measures may include tightening energy-saving requirements, establishing energy consumption standards and equipment certification, monitoring effective energy resource consumption, creating incentives for energy conservation, and promoting effective energy use.

When determining norms for energy resource usage in industrial enterprises, important production features play a role, such as the use of various energy resources at all stages of the production process, continuous technological processes, high-quality energy resource requirements, uninterrupted energy supply, and a large amount and diversity of energy equipment. To solve the task of energy standardization, it is necessary to develop quantitative indicators for evaluating energy resource consumption at a specific object of the enterprise (for example, an installation, equipment, process, area, workshop, or the entire enterprise as a whole) and qualitative indicators that determine the quality of energy resources and processed materials.

For industrial enterprises, especially energy-intensive ones, it is necessary to develop a concept of energy conservation management, which should be based on the experience of leading enterprises and include new energy-saving technologies.

The concept should perform the functions of planning, accounting and supervision of energy resources, as well as regulation and control of energy use. The development of the concept includes stages of designing energy-saving potential, setting program goals and sub-goals, and developing programs and implementation plans.

The choice of the main goal of the energy conservation management concept depends on many factors, and the formation of sub-goals requires identifying possible directions and measures for energy conservation at the enterprise. The concept includes sub-programs aimed at improving the technological process, accounting and regulating energy resource consumption, identifying and eliminating losses, using alternative energy sources, as well as functional sub-goals, including ensuring a regulatory framework, developing methods for stimulating energy-saving processes, providing information support, and developing an organizational structure for energy conservation management.

To create and analyze energy balances at an enterprise, it is necessary to have information on the overall production and energy characteristics of the enterprise, material and energy flow diagrams, main energy-consuming equipment, energy resource costs, the state of rational energy resource use, and other factors. The analysis of energy balances includes both a quantitative and qualitative assessment of the energy management and energy consumption of the enterprise. This analysis allows identifying specific areas at the enterprise that can be optimized for energy conservation and determining necessary measures to improve energy efficiency. Figure 1 demonstrates the stages of analyzing the energy balance of an industrial enterprise.

Figure 1: Stages of energy balance analysis.

When implementing energy-saving measures in an industrial enterprise, it is necessary to consider factors that may lead to an increase in energy consumption, while simultaneously improving the production process and increasing the quality of the products. Energy-saving measures in an enterprise can be divided into several groups depending on how they affect energy supply and usage systems, as well as how they increase the reliability of energy installations. In addition, an important direction for increasing energy efficiency is energy conservation in buildings and structures, for which it is necessary to compile an energy balance of the buildings and develop appropriate measures.

One way to increase energy efficiency in the enterprise is through energy conservation in buildings and structures, which can be applied to both production and administrative buildings. This direction has great potential for energy savings with relatively low costs. To develop effective measures for energy conservation in buildings, it is necessary to conduct an energy balance of the building in order to forecast the effect of the measures. In addition, there are other directions for increasing energy efficiency, such as energy conservation in the areas of electricity supply, heating supply, ventilation and air conditioning, as well as water supply and sewage treatment at the enterprise.

In order to carry out energy conservation in industrial enterprises, it is necessary to manage the factors, create conditions, and implement measures for energy conservation. The mechanism for managing energy conservation in the enterprise is a set of tools that allow the implementation of energy conservation policies and the application of energy-saving technologies. It is necessary to analyze a limited number of economic mechanisms at the enterprise that can increase energy efficiency. There are three priority directions for increasing energy conservation: reducing consumption, implementing energy-saving technologies together with modernizing the production process, and reducing tariffs for energy resources. Optimization and rational use of existing energy resources are also important, but they can lead to a reduction in production volumes. Significant investment resources are required for the implementation of energy-saving technologies, which many enterprises do not possess.

To activate energy-saving processes, it is necessary to maintain the crucial role of the state in improving the economic mechanisms for energy conservation management. This can be achieved by influencing the external environment of enterprises and energy conservation participants, as well as determining the optimal composition of the system of administrative and economic levers for managing energy conservation for a particular period of time. It is necessary to ensure close interaction between energy-producing and energytransmitting enterprises with energy consumers. To improve the system of mechanisms for energy conservation management, it is necessary to determine common requirements, such as reducing demand for energy carriers, increasing the degree of use of primary fuel energy, and the participation of energy-consuming enterprises in reducing the cost of energy at all stages of its production and consumption.

The method of developing and analyzing an energy balance can be used to choose the direction for increasing energy efficiency of the enterprise. The main goal of the functioning of energy-saving mechanisms is to increase the profitability of the enterprise through modernization of the production process and improvement of the quality of products. The selection of the main goal is a key stage in the development of an energy conservation program. The use of the program-targeted method of energy conservation management allows planning the activities of the enterprise in the field of energy conservation based on the ratio between the volumes of work, resources, time, quality, and risks. This also allows for the modernization of the production process and improvement of the quality of products. Figure 2 shows the sequence of stages within the complete project cycle of energy conservation in an industrial enterprise.

Figure 2: Full project cycle.

The program-targeted method includes a stage of technical analysis, which is one of the main stages. Within the framework of technical analysis, the justification of technological and technical feasibility of project implementation is carried out, and the degree of influence on the goal of the energy conservation program is evaluated. The availability of energy-saving technologies and equipment necessary for project implementation is also determined, as well as the possibility of their mastering and effective operation in specific conditions. Technical analysis is usually carried out at the beginning of the development of project documentation and includes the study of techno-technological alternatives, evaluation of the terms of development and implementation of energy-saving measures, as well as the technological availability of energy-efficient equipment and technologies.

At the same time, normal technological parameters and modes of equipment operation, the dependence between energy resource consumption and technological parameters, the characteristics of raw materials and materials, as well as possible reserves for reducing energy resource consumption through the implementation of organizational-technical and economic measures for fuel and energy savings are taken into account. However, this method has drawbacks related to the consideration of irrational energy costs and excessive normative losses.

2.1.1 Benchmarking of Energy Efficiency

Currently, the concept of energy efficiency benchmarking is widely used, which involves disseminating advanced experience and best practices in various industries and enterprises. Organizational and stimulating factors play an important role in improving the efficiency of enterprises' operations in the energy-saving sphere. There are various benchmarking methodologies, including internal and external, which are conducted between objects within a single organization or between competing objects depending on confidentiality.

Energy efficiency benchmarking involves collecting and analyzing information to evaluate and compare the efficiency of resource utilization in objects such as processes, buildings, or industrial enterprises. The goals of benchmarking may vary from defining goals to increase energy efficiency to observing the dynamics of changes in the efficiency level of objects in the class.

Benchmarking is widely used to assess specific energy consumption and may require new assessments in case of the implementation of energy-saving measures, changes in technology, and management. This concept is closely related to energy management, energy audits, and methods for calculating energy efficiency levels.

There are two systems for classifying objects: facet and hierarchical. In the hierarchical system, objects are divided into subordinate subsets, and at each level, each object is characterized by a specific value of the selected classification attribute. The depth of classification is determined by the number of classification levels.

New energy consumption standards are established experimentally with the help of a special commission that draws up an act of testing the actual consumption of resources for the production of a new type of product and takes into account data developed by specialized organizations.

The existing system of energy resource standardization at enterprises has disadvantages, such as allocating energy costs for workshops and all-plant to separate types of products, the absence of a mechanism for taking into account the influence of the TER factor on standards, changes in the load of the enterprise's production capacities, and weak linkages between the standardization system and the analysis of energy consumption at the enterprise.

Each enterprise and industry has its own features in technological processes, so individual evaluation of energy efficiency using physical and economic methods is required. Physical methods are based on general data on energy consumption and include total energy consumption and its distribution by objects. The evaluation of energy efficiency is carried out by comparing these figures with standards and taking into account factors such as seasonal temperature fluctuations to identify the least efficient objects and systems.

Economic analysis methods are used to develop specific recommendations for improving energy efficiency. Energy efficiency indicators depend on the fulfillment of operational goals, proper maintenance, technologies used, design standards, culture and professional knowledge, as well as achieving a balance of power, profit, and energy consumption.

To improve standardization efficiency, it is necessary to increase the substantiation and dynamism of energy resource consumption norms by using the calculation-statistical method. This method includes determining the main factors affecting specific energy consumption, forming an information base on statistical reporting data and operational accounting of energy resource consumption and the magnitude of factors affecting energy saving, as well as determining the expected energy consumption and calculating the energy standard for the planning period based on the identified values of energy saving factors and correlation dependencies.

The effect of energy efficiency measures can also take into account auxiliary indicators, in addition to the main ones. As noted earlier, the main indicators include those that reflect a reduction in irrational consumption, an increase in the efficiency of energy resource consumption, and in some cases, a reduction in transmission losses. Auxiliary indicators can include increased productivity, improved product quality, reduced staffing levels, and other possible options (Zhukov D.S., 2014).

The main elements of benchmarking are shown in Figure 3

Figure 3: The main elements of benchmarking.

2.1.2 Conditions of Energy Efficiency

The main list of conditions that must be met to improve energy efficiency in a company may include the following items:

1. The presence of understanding and support from the company's management on issues of energy conservation and sustainable development.
2. The presence of a team of specialists dealing with energy conservation issues who can conduct an analysis of energy consumption, develop a plan of measures to improve energy efficiency, and monitor its implementation.
3. The availability of financial resources to implement energy conservation measures such as installing energy-saving equipment or conducting building insulation.
4. The availability of technological and engineering resources to implement energy conservation measures, such as optimizing the operation modes of systems and developing new technologies.
5. The availability of information on the state of energy consumption in the enterprise and the reasons for its occurrence.
6. The presence of understanding and support from the company's employees on issues of energy conservation and sustainable development, as well as conducting campaigns to increase their awareness in this area.
7. The availability of monitoring and control mechanisms for energy consumption

at the enterprise to identify new opportunities for energy consumption reduction.

8. The presence of a system for incentivizing employees to reduce energy consumption, such as introducing bonuses for energy savings.

9. The availability of an analysis and control system for the effectiveness of implemented energy conservation measures.

10. The presence of an open dialogue with interested parties, such as customers, suppliers, and the public, on issues of energy conservation and sustainable development.

The main list of tasks that must be performed to improve energy efficiency in a company may include the following items:

1. Conduct an analysis of energy consumption at the enterprise using physical and economic methods to determine the least effective objects and systems.
2. Set goals to increase energy efficiency and develop a plan of measures to achieve them.
3. Implement measures to reduce energy consumption, such as installing energy-saving equipment, optimizing the operation modes of systems, conducting building insulation, and so on.
4. Train employees on energy conservation rules and conduct a campaign to increase awareness in this area.
5. Organize monitoring and control of energy consumption at the enterprise to identify new opportunities for energy consumption reduction.
6. Conduct an analysis of the possibility of using renewable energy sources, such as solar and wind energy, to reduce dependence on traditional energy sources.
7. Develop a system for incentivizing employees to reduce energy consumption, such as introducing bonuses for energy savings.
8. Conduct an energy audit and benchmarking to compare the level of energy efficiency of the enterprise with similar companies and identify new opportunities for energy consumption reduction.
9. Develop a program of continuous improvement of processes and systems aimed at reducing energy consumption, and update it in accordance with new technologies and requirements.
10. Maintain an open dialogue with interested parties, such as customers, suppliers, and the public, on issues of energy conservation and sustainable development.

Additionally, to organize work on the implementation of energy policy, an energy management system should be created. The structureof energy management should be organically integrated into the management system structure that exists within the enterprise (Shapovalova, E.Yu., et al., 2019).

2.2 Results

The main problems of energy efficiency in industrial enterprises may include the following items:

1. Lack of information and understanding of energy conservation and sustainable development principles among the management and employees of the enterprise.
2. Presence of outdated equipment and technologies that consume a large amount of energy.
3. Insufficient implementation of energy-efficient technologies and equipment at the enterprise.
4. Insufficient attention to processes and systems related to energy consumption management at the enterprise.
5. Insufficient attention to optimizing the operation modes of systems and processes, leading to excessive energy consumption.
6. Insufficient attention to employee training on energy conservation rules and conducting campaigns aimed at increasing their awareness in this area.
7. Insufficient investment attractiveness of energy conservation and sustainable development measures for enterprises.
8. Insufficient participation in the government support program for energy conservation.
9. Insufficient collaboration with other organizations and enterprises in the field of energy conservation and sustainable development.
10. Insufficient attention to the development and implementation of long-term strategies and programs for energy conservation and sustainable development at enterprises.

2.2.1 Main risks of Energy Efficiency

Energy efficiency programs in industrial enterprises may have several risks, including:

1. Insufficient efficiency. In case the energy saving program is not efficient enough, the potential economic benefits may not offset the costs of its implementation.
2. Incorrect planning. Incorrect planning of the program, including insufficient research

and evaluation of technical and economic parameters, may lead to unexpected costs and low program efficiency.

3. Insufficient employee participation. Energy efficiency programs often require changes in behavior and employee participation. If employees are not included in the program or its goals are not realized, the program may not achieve its goals.

4. Incorrect risk assessment. Some programs may lead to additional risks that were not taken into account during planning. For example, the use of new technologies may lead to additional costs for employee training and equipment maintenance.

5. Legislative changes. Changes in legislation may affect energy efficiency programs, including changes in tax incentives or subsidies, which may significantly affect the program's payback.

6. Internal competitors. Competition between internal enterprise units may lead to individual units ignoring the energy efficiency program to preserve their budget and resources.

7. Changes in energy resource prices. Changes in energy resource prices may affect the payback of the energy efficiency program, which may lead to a significant delay in achieving expected results.

The result of analyzing the energy efficiency of an enterprise is the development of plans to create new strategic initiatives in managing energy consumption processes. Based on this, key goals and objectives are set for further management work in the field of energy conservation at the enterprise (Podbornova, E.S., 2022)

2.2.2 Algorithm for Improving Energy Efficiency in Enterprises

The algorithm for improving energy efficiency in industrial enterprises may include the following elements:

1. Assessment of the current energy efficiency of the enterprise and identification of potential areas for improvement.
2. Development of an energy-saving program, setting goals and tasks, and determining the necessary budget.
3. Formation of a team responsible for implementing the program and training them on the basics of energy efficiency.
4. Conducting an energy consumption audit and identifying opportunities to improve energy use efficiency.
5. Development of a plan for implementing energy-saving measures, setting deadlines, and tracking progress.
6. Implementation of new technologies and upgrading old equipment to increase energy efficiency.
7. Optimization of production processes to reduce energy consumption.
8. Implementation of a system for monitoring and managing energy consumption.
9. Involvement of employees in the energy-saving process, conducting training, seminars, and workshops.
10. Evaluation of the program's results and regular adjustments to improve efficiency.

Figure 4 is proposed for use in making decisions to increase energy efficiency.

The first column lists various methods that can be used to increase energy efficiency in an enterprise, while the second column describes possible risks that may arise during the implementation of these methods.

Such a table can help assess risks and make informed decisions to improve energy efficiency in the enterprise.

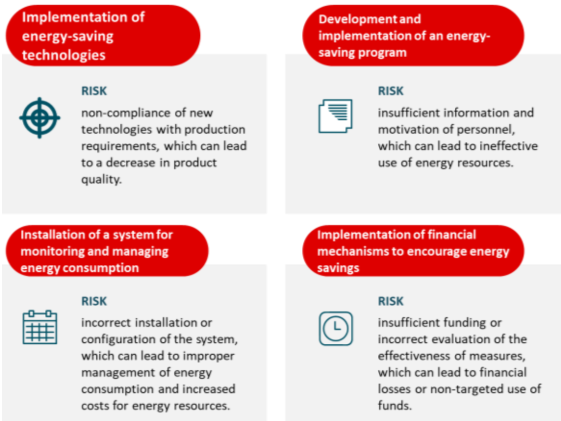

Figure 4: The algorithm for decision-making.

The algorithm proposed by the author will simplify the development and implementation of an energy-saving business process, as well as create a new organizational structure within the enterprise. In combination, this will allow for the systematization of the requirements of existing legislation and activities related to organizing energy conservation. Thus, the developed algorithm can become a scientific and methodological basis for implementing a process-oriented approach in an industrial enterprise.

3 DISCUSSION

The situation becomes serious when there is a need for improvement in the methodological and conceptual foundations of effective management of energy consumption of an industrial enterprise in order to provide a more advanced theoretical and methodological basis for practice (Koksharov, V.A., 2014).

The results of the study on organizational and economic mechanisms for energy saving in industrial enterprises showed that the development and implementation of energy-saving programs are critical for achieving effective energy consumption management and reducing energy costs. The importance of developing algorithms for energy-saving programs lies in identifying the most effective strategies and methods for energy conservation based on analysis of energy consumption data.

The study also emphasized the importance of benchmarking as a tool for comparing energy-saving performance between enterprises and identifying best practices in the industry. Benchmarking can help companies understand their position in relation to energy-saving compared to other companies in the industry and determine which methods and strategies may be most effective in achieving their energy-saving goals.

However, it is important to note that there are risks associated with developing and implementing energy-saving programs, such as high equipment costs and increased complexity of production processes. To successfully overcome these risks, it is necessary to focus on defining optimal strategies and increasing awareness and motivation of personnel regarding energy-saving issues and improving the culture of energy consumption within the organization.

Thus, the results of the study showed that organizational and economic mechanisms for energy-saving are an important tool for improving energy efficiency in industrial enterprises. The development of energy-saving programs, the use of benchmarking, and the focus on increasing awareness and motivation of personnel are key factors for the successful implementation of these mechanisms.

4 CONCLUSIONS

Energy saving has become one of the most important tasks for industrial enterprises due to contemporary challenges such as rising energy prices, stricter environmental requirements, and the need to optimize production costs. The effective management of energy efficiency at an enterprise requires the use of economic mechanisms aimed at enhancing the utilization efficiency of energy resources, reducing energy resource costs and minimizing negative environmental impacts. These mechanisms include measures for energy saving, the use of energy-efficient technologies, the implementation of an energy consumption monitoring and management system, and the development of financial mechanisms to encourage enterprises to implement energy-saving measures.

To achieve effective operation of the energy-saving system at the enterprise, a comprehensive approach involving organizational, technical, economic, and legal aspects is necessary. Organizational mechanisms represent a management system that includes the definition of energy-saving goals and objectives, the organization of work on collecting and processing data on energy consumption, as well as coordination of actions between various departments of the enterprise. Meanwhile, economic mechanisms of energy efficiency management include the development of financial mechanisms, the assessment of costs and the effectiveness of energy-saving measures, as well as the development of mechanisms to stimulate staff participation in energy-saving programs.

The proper utilization of organizational and economic mechanisms of energy efficiency management at industrial enterprises can lead to a significant reduction of energy resource costs, improvement of the environmental situation in the region, an increase in enterprise competitiveness, and sustainable business development in the conditions of the modern market. Therefore, the implementation of such mechanisms is necessary for industrial enterprises to ensure their long-term success and contribute to the sustainable development of society as a whole.

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