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Global practice of applying approaches to energy efficiency improvement in energy companies

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Abstract: The article presents an analysis of international experience in the implementation of methods aimed at improving the energy efficiency of energy industry enterprises. The importance of studying foreign practice for the development of strategies and tools that take into account the relevance of energy efficiency in the context of modern industrial development is emphasized. These tools fit seamlessly into the overall system of industrial policy strategies, complementing energy conservation initiatives to optimize the use of energy resources.

Keywords: Efficiency, energy efficiency of enterprises, energy resources, strategy, industry, sector, energy conservation, global economy, technological progress.

Introduction: In recent years, there has been increased attention to energy efficiency issues in different countries, which stimulates the active development of scientific research in this area. Given the importance of energy efficiency for modern industrial progress, a number of approaches and mechanisms have been developed at the global level. These mechanisms are included in the general system of industrial policy, which is combined with energy conservation measures to optimize the use of energy resources. Scientific research focuses on the analysis of the effectiveness of the use of energy resources in order to support informed management decisions. Energy efficiency assessment methods vary depending on the objectives of the study, the depth of analysis, and the specifics of the industry or economic sector. This highlights the need for further study of modern approaches to energy efficiency assessment.

World practice demonstrates that countries and regions achieve the greatest results in the field of energy conservation and energy efficiency improvement using integrated approaches that include from 5 to 8 different measures. These include information, technological, financial, institutional, and economic measures. These measures are interrelated and reinforce each other, creating a synergistic effect. Scientists identify several strategies for improving energy efficiency, classifying them as “Northern European”, “American” and “Asian” models, while noting that their effectiveness is generally comparable. However, it is important to keep in mind that the success of such strategies may vary depending on a number of factors, such as the current level of energy consumption, socio-economic conditions, industry specifics, and the effectiveness of energy reduction methods used. This highlights the need for a more detailed study of energy efficiency assessment issues and the development of measures to improve it, taking into account the specifics of each individual industry.

METHODOLOGY

The methodological basis of the study was the work of domestic and foreign experts devoted to the analysis of world experience in the implementation of approaches to improve energy efficiency in the energy sector. In the course of the work, legislative and regulatory documents were studied, as well as materials from scientific and practical events related to this topic. The research was based on a systematic approach, and methods of logical, comparative, and statistical analysis were used to solve the tasks.

RESULT AND DISCUSSION

Energy efficiency measures can be divided into two types. The first type includes direct methods that directly influence the behavior of companies in the field of energy conservation and energy efficiency. The second type covers indirect methods that contribute to

improving the efficiency of production, transportation and use of energy resources through innovation, stricter environmental standards, technological improvements and the development of new industrial areas. This is due to the fact that technological progress plays a key role in the transformation of the energy industry. Energy efficiency programs should cover not only the energy sector, but also other industries.

When analyzing methods for improving energy efficiency in industry, it is important to take into account potential contradictions. First, an increase in production volumes may lead to an increase in demand for energy resources. In addition, economic development can stimulate the growth of energy consumption even with increased energy efficiency, which indicates that improved efficiency does not always lead to a proportional reduction in energy consumption, as noted by I.A. Bashmakov. In addition, lower energy costs as a result of increased energy efficiency can directly or indirectly increase energy demand by increasing available income. This can cause a “rebound effect”, which limits the effectiveness of energy conservation and energy efficiency policies.[6] Therefore, it is important to analyze the price and cross-elasticity of demand for energy goods and services, as well as to take into account the general economic equilibrium.

According to I.A. Bashmakov, the resolution of these contradictions largely depends on the consistency of industrial policy with measures to improve energy efficiency. This implies a change in the structure of the industry and a transition to more technologically advanced production methods characterized by reduced energy consumption. It is also important to take into account the current structure of energy consumption in the industrial sector of the economy. In addition, when developing energy efficiency measures, it should be borne in mind that the effectiveness of individual tools increases significantly when they are used together, including the integration of various types of policies and the integration of measures within a single software platform. In other words, it is necessary to create an integrated system that integrates policies, programs and mechanisms, linking the measures taken with their results not only in the field of energy conservation, but also in the industrial complex as a whole.[6] This is important for both demand and supply in the energy market. This is particularly relevant in the light of data from the International Energy Agency (IEA), according to which more than half of total energy consumption is in the industrial sector, and in electricity generation this figure reaches 80%. [7]

According to a study commissioned by the European Commission, it is expected that by 2030, the potential for reducing energy consumption in the field of industrial engines could reach 13,286 terawatt-hours, which corresponds to about 1,140 million tons of oil equivalent. However, the effectiveness of various measures may vary during their implementation, which underlines the importance of a deeper analysis and synthesis of international experience in the field of energy efficiency.[6]

The International Energy Agency (IEA) has extensive experience in this field and has developed a comprehensive strategy aimed at using existing energy-efficient technologies. The implementation of this strategy can lead to a doubling of energy efficiency levels. The agency's specialists emphasize the importance of widespread adoption and application of the best available technologies. This will significantly reduce energy losses at all stages — from production to distribution and final use, as well as achieve a 50% reduction in carbon dioxide emissions without adversely affecting economic growth. The use of such technologies can double energy efficiency, which will lead to a reduction in the total amount of energy consumed. The introduction of such innovations will also provide a rapid economic effect by reducing operating costs.

Ghisetti and Rennings’ research demonstrates that innovations aimed at reducing energy or material consumption have a significant positive impact on companies' operational profitability. At the same time, innovations focused solely on reducing negative external impacts, such as emissions of harmful substances, CO2 or noise, can significantly reduce the profitability of enterprises.[6]

Scientists note that the effectiveness of energy saving projects largely depends on the interest rate on loans used to finance them.[2] This highlights the importance of financial measures that the state, as a macro-regulator, can apply to support initiatives to improve energy efficiency in industry. In addition, budgetary financing of energy efficiency programs also plays a key role, as it not only contributes to the implementation of specific projects, but also stimulates the attraction of additional investments in this area.

Global practice shows that countries that have achieved significant success in energy conservation have actively attracted a variety of sources of financing for projects aimed at improving energy efficiency. Financing in this area includes a wide range of sources, from public to private investors, offering a variety of financial instruments. These include commercial financing at the initial stages, loans from suppliers, leasing, securities issuance, risk insurance, funds from

commercial and emerging banks, as well as the creation of specialized funds focused on improving energy efficiency.

In modern scientific literature, information measures are highlighted as an important tool for improving energy efficiency. Such measures include the use of energy certificates, conducting energy audits, as well as the introduction of specialized information and PR programs. The relevance of these approaches is confirmed by a study conducted by the Analytical Center,[6] according to which about 40% of industrial managers believe that the potential for saving electricity and heat does not exceed 5% of total consumption. However, the experience of enterprises that successfully implement energy-saving measures shows that due to organizational solutions and the implementation of low-cost projects, a reduction in electricity consumption can reach 5-6%. At the same time, 72% of experts are confident that the main production processes have the greatest potential for energy saving.

As part of the implementation of the sustainable development strategy, the transition to more rational energy consumption requires a revision of the energy balance in favor of increasing the share of renewable energy sources (RES), as well as the use of various financial incentives to attract the private sector to the field of renewable energy. Such incentives include the formation of a favorable institutional environment, the removal of bureaucratic barriers, the provision of tax incentives, duty-free import of equipment, the establishment of standards for the share of renewable energy in the energy portfolio, and other measures.

According to a 2017 report by the International Energy Agency (IEA), renewable energy sources will account for two thirds of all investments in the electric power industry.[6] In the European Union, the share of renewable energy sources will reach 80% of the total new energy capacity, and wind energy will become the main source of electricity after 2030. Recognizing the key role of government measures in improving energy efficiency, it is also important to pay attention to creating economic incentives for energy conservation at the level of individual industrial enterprises.[4]

Research in the industrial sector shows that most enterprises are able to reduce total energy consumption in technological processes by 10% with minimal investment and by 35% with more substantial investments. For example, integrated steel companies in Europe and the United States have an energy saving potential of 10-15%, while chemical plants have an energy saving potential of 10-20%. To achieve such results, it is necessary to carefully analyze and plan the structure of energy consumption at each stage of production processes, taking into account possible losses and potential savings. This requires the application of lean manufacturing principles, which are actively used to improve energy efficiency in industry.

These tasks can be solved within the framework of the "Industry 4.0" concept, which is being implemented at enterprises through the development of the Industrial Internet of Things (IIoT), the creation of "smart factories", "smart grids", "smart wells" and other similar technologies. In this case, a set of advanced technologies is used, appropriate management decisions are made and organizational mechanisms are formed that contribute to the creation of effective cyber-physical systems. Such systems provide energy savings at all stages — from design to production and product introduction.

Thus, the integration of digital technologies is crucial for improving energy efficiency, offering a wide range of solutions and positive effects. Experts note that the use of digital technologies in oil and gas production processes can reduce costs by 10-20% and increase hydrocarbon production by 5%.[6] This is just one example of how digital technologies are able to solve a variety of tasks: from ensuring data transparency between enterprises and government agencies to optimize taxation and attract investment to fine-tuning industrial policy, increasing competitiveness and reducing accident risks.[5]

Experts from the International Energy Agency predict that in the coming decades digitalization will radically change the energy infrastructure, making it more integrated, intelligent, efficient, reliable and environmentally sustainable. Modern advances in data processing, analytical tools, and communication technologies are opening up new opportunities for digital innovations such as smart devices, decentralized transportation solutions, and 3D printing technologies. In the future, digital energy systems will be able to adapt to energy needs, ensuring its supply at the right time, place and at minimal cost. Already today, digitalization contributes to improving the security, efficiency, accessibility and sustainability of energy systems, while simultaneously creating new challenges in the field of cybersecurity and data protection. [6] It transforms market conditions, business processes and employment, contributing to the emergence of new models of energy production and consumption. In addition, the integration of interconnected energy systems is gradually erasing the traditional boundaries between supply and demand.

In the industrial sector, one of the key elements of the energy saving strategy is the introduction of modern

process monitoring systems, the integration of intelligent sensors with analytical platforms for predicting equipment performance, as well as the use of 3D printing technologies to create lightweight materials and other innovative solutions.

According to experts, the use of digital technologies in the electric power industry can provide annual savings of about 80 billion US dollars, which is about 5% of the total annual cost of electricity production. This is achieved by reducing maintenance and operating costs, improving the efficiency of power plants and networks, reducing unplanned downtime, and extending asset life.

In recent years, companies in the energy sector have significantly increased their investments in the development of digital technologies. For example, since 2014, international investments in digital infrastructure and software in the electric power industry have grown by more than 20% annually, reaching $47 billion by 2016. Thus, digital investments in 2016 almost doubled the amount of financing in the gas-fired power industry segment, which amounted to $ 34 billion. Interactive digital networks have the potential to radically transform electricity markets by providing flexible demand management, integrating various predominantly renewable energy sources, and contributing to the development of decentralized energy systems.[6]

To maximize the benefits of digitalization in the field of energy efficiency and address related issues such as cybersecurity, data protection, and job preservation, it is essential to develop effective sectoral and cross-sectoral policies at the levels of strategic management and regulatory regulation.

The integration of digital technologies into the energy systems of enterprises and organizations is determined by a number of factors. These include the complexity of production processes, the financial capabilities of the company, the degree of dependence on fluctuations in energy prices, the level of competition in the market and the flexibility of supply chains. Cultural aspects also play a significant role: an enterprise's willingness to take risks by introducing new technologies or changing established business models and workflows directly affects the speed and scale of digital transformation.

Thus, the successful implementation of innovative digital solutions and energy saving policies at the enterprise level requires the formation of an appropriate corporate culture and management systems. This largely depends on the professional training of the employees. In this regard, the assessment of labor potential, the ranking of employees according to their ability to solve energy efficiency problems, as well as the creation of an effective system of motivation and evaluation of energy management in industrial enterprises are of key importance.[1]

Taking into account the above, methods for improving energy efficiency can be systematized as follows:

According to the phase of production and distribution of energy resources, since it must be taken into account that about 20% of energy is lost before it reaches the end user, which requires appropriate measures;[6]

According to the type of impact, including direct and indirect effects;

According to the time frame, taking into account short-, medium- and long-term plans. In the current environment, when countries set ambitious goals to modernize the economy and achieve technological breakthroughs, it is important to focus on measures that will bring results in the near and medium term, since without their implementation, the economy will continue to lag behind the leading countries;

According to the participants in the implementation, where government agencies are responsible for implementing measures that promote energy conservation and energy efficiency, and enterprises and organizations are engaged in the practical implementation of initiatives aimed at improving relevant indicators.;

By areas of action, including technological, financial, managerial, institutional, and information measures.

However, using only one type of measure without taking into account the others is not considered an effective approach.

CONCLUSION

Recognizing the importance of all measures and conditions aimed at improving energy efficiency and studied abroad, it is also necessary to take into account the barriers that make it difficult to work in this area. Such obstacles include insufficient motivation, limited access to information resources and successful project implementation experience, as well as poor organization and coordination of work.

Particular attention should be paid to the development of an energy efficiency assessment methodology that will take into account various factors and performance indicators in this area. Using such a methodology will not only help to assess the current level of energy efficiency, but will also allow for the development of sound regulatory strategies, both direct and indirect, with respect to factors affecting energy efficiency. In addition, it will provide an opportunity to analyze the

effectiveness of the implementation of these strategies in the future.

Given the importance of energy efficiency for industrial development in modern conditions, a certain set of strategies and tools has developed in world practice, which together form a system of industrial policy measures. These measures are closely linked to the energy conservation policy and are aimed at improving energy efficiency.

To increase energy efficiency, both direct methods aimed at changing the behavior of economic entities in the field of energy conservation and indirect approaches aimed at improving the efficiency of production, transportation and consumption of energy resources are used. This implies the introduction of innovations, greening of processes, improvement of technologies, development of new industrial directions and other solutions related to the field of industrial policy. Such measures are important because technological progress plays a key role in the transformation of the energy sector.

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