Conceptual basis for the development of Methodology for assessing the energy efficiency classes of industrial facilities

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Abstract. The lack of developed methodological solutions for determining the energy efficiency class of economic entities limits the ability to achieve the goal of the State program of the Russian Federation "energy Efficiency and energy development" to reduce the energy intensity of the gross domestic product. To solve the set state tasks aimed at reducing the energy intensity of the national economy, it is necessary to develop a Methodology for assessing the energy efficiency classes of industrial facilities. The development of the Methodology will become a prerequisite for the implementation of measures to ensure energy-efficient policies of energy-intensive enterprises. The methodology will ensure effective planning of budget funds allocated for energy-saving measures, as well as a systematic reduction in the energy intensity of the national economy. The aim of the study is to create a Development Concept for a Methodology for assessing the energy efficiency classes of industrial facilities, defining the goals of its creation, the most important problem it is aimed at solving, identifying the methods and approaches that it relies on, reflecting its development plan, as well as expected results. The proposed Concept for developing a Methodology for evaluating the energy efficiency classes of industrial facilities, presented in the form of the model, will identify the basic elements that should be taken into account when developing it, and assess how harmoniously they are combined. The practical significance of this concept is that it creates a fundamental basis for the development of Methods for evaluating the energy efficiency classes of industrial facilities, taking into account the specifics and scale of their activities.

1. Introduction

The problem of energy saving and energy efficiency is relevant for the vast majority of economic entities associated with energy-intensive production processes. A high share of energy costs in the structure of industrial production costs requires constant monitoring. The global trend towards efficient use of energy resources and the use of renewable energy technologies is related to the exhaustion of non-renewable natural resources and environmental aspects of energy production. At the present stage, developed countries have a relatively high level of energy consumption per capita, which is why they strive to stabilize this indicator or at least slow down its growth rate. Considerable attention is paid to optimizing energy consumption at all levels of the legislative and Executive authorities of the Russian Federation, which is reflected in various forms of economic and energy foresight. As noted in the energy Strategy 2035 project: "The Development of energy saving and energy efficiency in energy-consuming sectors is one of the key scenario conditions for
forecasting the prospects for the development of the fuel and energy sector”. It is assumed that "the energy intensity of GDP will decrease by 1.3-1.5 times a year (or in the amount of 315-580 million t. t. per year)" due to the restructuring of the Russian economy and rapid growth non-energy intensive manufacturing sectors, construction, services (with a corresponding decrease in the share of raw materials and energy-intensive industries by 3 - 4 percentage points by 2035), and also through technological upgrading and development [1].

The lack of developed methodological solutions to determine the energy efficiency class of business entities limits the ability to achieve the goals of the State Program of the Russian Federation “Energy Efficiency and Energy Development” (approved by the Government of the Russian Federation dated April 15, 2014 No. 321) to reduce the energy intensity of gross domestic product [2]. Methodology for assessing the energy efficiency classes of industrial facilities (hereinafter referred to as the methodology). The development of the methodology will be an effective implementation of measures to ensure energy-efficient policies of energy-intensive enterprises. An important result of the application is the popularization and mass use of tools to improve the energy efficiency of enterprises, including the introduction of the energy management system ISO 50001, as well as the implementation of energy-saving measures, taking into account the identified energy-saving opportunities and the necessary volume for their financing. The proposed methodology will allow for the effective planning of budget funds, as well as ensure the economic efficiency of the national economy. When developing methods, it is necessary to take into account the specifics and scale of their activities. Within the framework of the planned research work, an analysis of large industrial facilities is carried out and databases are being formed on the issues under study, taking into account the types of economic activity according to OKVED (All-Russian Classifier of Types of Economic Activity) [3].

It is also necessary to take into account that the key problems that impede the implementation of state policy in the field of energy conservation and energy efficiency are related to the lack of the necessary amount of reliable information on the energy characteristics of the objects of study, methods and criteria for their systematization. This fact is taken into account when setting the objectives of this study. The conceptual provisions of the developed Methodology are based on the possibility of gradation of industrial facilities by energy efficiency class. The implementation of the Methodology will allow us to create a reliable information base for the development of long-term plans for improving energy efficiency and provide a reliable rapid assessment of energy saving potential at enterprises. Industrial facilities that have a high energy efficiency class and are actively implementing energy-efficient policies in the future may have reasonable advantages when participating in various tenders and in the distribution of subsidies.

The purpose of the study is the creation of a Development Concept for a Methodology for assessing the energy efficiency classes of industrial facilities containing the basic elements of the process of its development.

The subject of the research is the development process of the Methodology for assessing the energy efficiency classes of industrial facilities.

Research Objectives:
- explore the process of developing a Methodology for assessing the energy efficiency classes of industrial facilities;
- formulate a Concept for the development of a Methodology for assessing the energy efficiency classes of industrial facilities, identifying the basic elements that should be taken into account when creating it;
- graphically display the Concept in the form of the model, which will determine how harmoniously its basic elements are combined.

I. Bashmakov [4] made a big contribution to the development of energy conservation and energy efficiency issues, considering the problems of assessing the energy intensity of the Russian economy, increasing the efficiency of energy supply in various regions, etc. Yu. A. Tabunshchikov [6] and N.V. Shilkin [6], in their works pay attention to various aspects of energy conservation, developed a methodology for assessing investments in energy-saving measures and national "green" standards that allow classification of residential and public buildings, as well as sports facilities for environmental
and energy efficiency; issues of engineering systems and classification of buildings by energy efficiency are reflected in the works of A. L. Naumov [7]; technical aspects of ensuring energy efficiency of buildings and approaches to determining the energy efficiency class of a residential building are given in the works of Yu. V. Miller [8], T S Meshcheryakova [9-10].

Among foreign scientists involved in energy efficiency assessment, it is worth noting: Martinez D., Ebenhac B. and Wagner T. [11]; Stoffel B. [12]; Worrell E., Reuter M. [13]; Tvaronaciene M., Slusarczyk B. [14]; Kenney W. F. [15]; Eicker U. [16]; Zoughaib A. [17]; Locmelis K, Blumberga D, Bariss U [18]; Bertoldi P, Diluioso F, Castellazzi L, Labanca N, Serrenho T [19].

It is important to focus on the fact that at present in the Russian Federation there are also separate methodological developments. To date, a Methodology has been developed to determine the energy efficiency class of operating residential apartment buildings. At the same time, today there is no methodological toolkit that can be used as a basis for classification of the most energy-intensive economic entities, industrial facilities, in terms of energy efficiency. Such an instrument in the energy management system should meet the requirements of our time and combine the general development trends and the fundamental basis for managing economic systems, legislative acts, and also take into account the best world developments. It is necessary to take into account the experience of European countries, based on the EU Directive on the promotion of electricity from renewable energy sources, the EU Directive on the application of energy efficiency technologies and renewable energy in construction, the EU Directive on the promotion of the use of biomass. These documents suggest the development of national programs in the field of energy efficiency and are focused on the implementation of the 1997 Kyoto Agreements and the EU Concept “20/20/20”, which provide for an increase in the share of renewable energy sources (RES) in the total energy consumption of the European Union and increase energy efficiency up to 20% by 2020.

2. Materials and Methods
The goals of creating the Development Concept of the Methodology for assessing the energy efficiency classes of industrial facilities: to determine the goals of creating the Methodology, the key problem that it is aimed at solving, identify the methods and approaches that it relies on, formulate its development plan and present the expected results.

The main task of creating the Development Concept for the Methodology for assessing the energy efficiency classes of industrial facilities is to highlight its main elements, which should include:
• purpose of its creation;
• the problem that the Methodology solves;
• methods and approaches on which it is based;
• a plan to develop a methodology for assessing the energy efficiency classes of industrial facilities;
• expected results.

The purpose of the Methodology development is to evaluate the energy efficiency classes of industrial facilities by OKVED groups.

The problem to solve is the development of a Methodology for evaluating the energy efficiency classes of industrial facilities: the lack of a methodology that allows classifying industrial facilities by the efficiency of energy resources use and creating a database on energy consumption, energy intensity, and the policy of energy conservation and energy efficiency of industrial facilities and enterprises in General. The solution to this problem is based on the formation of tools for assessing the level of energy efficiency of industrial facilities and determining the energy efficiency class. The proposed solutions will integrate the most energy-intensive industrial complex into the Energy strategy and create a prerequisite for a significant reduction in the energy intensity of the economy through effective management of energy resources of industrial facilities.

In the process of developing the Methodology, it is advisable to use the main expert methods, methods of analysis and synthesis, statistical methods, deductive and inductive approaches. To collect primary information, we recommend using the questionnaire method, which allows you to collect data for creating a database for the project. Distribution of questionnaires involves mailing to chief power engineers and business managers. Desk research is conducted at all stages of the Methodology development. The development of a list and values of “reference” energy efficiency indicators for each
group of OKVED is carried out on the basis of the expert assessment method. The statistical method is used in the process of forming a systematic database for evaluating the energy efficiency of industrial facilities. The method of comparative analysis is necessary to obtain an idea of comparing foreign and Russian practices for classifying industrial facilities as energy efficient, as well as to determine the share of costs in the structure of total costs of industrial facilities by type of economic activity. The inductive approach is used to replicate tools and methods for classifying industrial objects for various types of economic activity. A deductive approach should be used to assess the energy efficiency of industrial facilities by OKVED groups.

3. Results
Based on the study, the basic elements were identified that should be taken into account when developing the Methodology for assessing the energy efficiency classes of industrial facilities, we will present in the form of the model, allowing to evaluate how harmoniously they are combined (Figure 1).

![Figure 1](image)

**Figure 1.** The concept of development of the Methodology for assessing energy efficiency classes of industrial facilities.

The applied significance of the development of the Methodology for assessing the energy efficiency classes of industrial facilities consists in solving the most important state tasks to ensure the implementation of energy conservation and energy efficiency policies, by systematizing information
on the energy characteristics of key end-users of energy resources - industrial facilities, and creating an objective idea of the potential for reducing the energy intensity of the Russian economy.

4. Discussion

In accordance with the order of the Ministry of Construction and Housing and Communal Services of the Russian Federation dated June 06, 2016 No. 399 “On approval of the rules for determining the energy efficiency classes of apartment buildings” [20], the energy efficiency class of an apartment building is determined by the results of: • assessments of architectural, functional-technological, structural and engineering solutions implemented in the building; • measurement results specific to calculations using instrumental or calculation methods; • deviation values of the calculated (actual) value of the specific consumption of energy resources from the normalized level established by the energy efficiency requirements of buildings, structures, structures. The energy efficiency class of operated apartment buildings is determined on the basis of actual indicators of the specific annual consumption of thermal energy for heating, ventilation and hot water supply, as well as the consumption of electric energy. The initial data for the calculation are: the consumption of thermal energy for heating and ventilation, Gcal; heat energy consumption for hot water supply, Gcal; electricity consumption for general household needs, thousand kWh; the heated area of an apartment building, m2; number of residents of an apartment building, people; parameters of the heating period. The energy efficiency of industrial buildings cannot be determined by a similar technique, because In most cases, household activities of a person may not be leveled; this issue is relevant only for administrative facilities. Also, the energy consumption and the number of storeys of the building are not directly correlated, a one-story industrial building can consume many times more than a multi-story building. There is a direct dependence on the type of technological process, technological equipment and energy management system. Currently, in the Russian Federation there are no developed methodological solutions for determining the energy efficiency class of directly economic entities. Due to the uniqueness of the property complex of industrial enterprises, it is necessary to take into account the specificity and scale of their activities when developing the Methodology.

5. Conclusion

As a result of the study of the development process of the Methodology for assessing the energy efficiency classes of industrial facilities, a Concept is presented that defines its creation goals, the most important problem that it is addressed, presents the methods and approaches that it relies on, displays its development plan, as well as the expected results. The proposed concept of developing a Methodology for assessing the energy efficiency classes of industrial facilities, displayed in the form of the model, will allow you to take into account significant basic elements that should be taken into account during its development and to assess how harmoniously they are combined. The practical significance of this concept lies in the fact that it creates a fundamental basis for the development of a Methodology for assessing the energy efficiency classes of industrial facilities, taking into account the specifics and scale of their activities. Thus, it can be said that the classification of industrial facilities by their energy efficiency level will make it possible to determine the priority of the facility in solving state-important tasks, including in the field of subsidizing and lending to reduce energy intensity and optimize energy costs, to develop and introduce alternative technologies with low energy intensity, and also create the most important component of financial planning at the macro and mesoscale levels.

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