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Management of Energy Efficiency in the Operation and Management of Real Estate in the Housing and Communal Sphere

The paper explores cross-sector indicators and management methodologies in the housing and communal sphere, emphasizing their importance for improving energy efficiency and optimizing resources. In the context of global challenges such as climate change and the depletion of natural resources, the effective use of energy in housing and communal sphere becomes critically important. This sphere is one of the largest consumers of energy, and inefficient use of energy resources leads to high costs and negative environmental impacts.
Cross-sector indicators allow for the comparison of energy-saving efficiencyin housing and communal services with other sectors of the economy, facilitating the transfer of the best practices and technologies. For example, energy consumption management methods developed in industry can be adapted for heating and water supply systems in apartment buildings.
The paper highlights several key stages in the management methodology: setting goals for improving energy efficiency, analyzing the current state of systems, assessing energy efficiency, and developing energy-saving measures. The use of modern monitoring technologies enables real-time tracking of resource consumption and identification of inefficiencies.
An essential aspect is the need for a comprehensive approach to managing energy resources, which includes interaction with the population and local authorities. This collaboration fosters sustainable development in housing and communal services and enhances the quality of services provided. Implementing innovative solutions to improve system reliability and reduce utility costs is one of the crucial directions that ultimately relate to achieving the goal of enhancing citizens' quality of life.
Keywords: *energy efficiency, housing and communal sphere, cross-sector indicators, resource management, modern technologies, ecological aspects*

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In the context of global climate change and depletion of natural resources, the issues of energy saving and energy efficiency are gaining acute relevance.

Energy saving is a strategic trend in the development of the economy of the Russian Federation. The most part of energy consumption is accounted for by housing and communal sphere [1].

The housing and communal sphere is a significant consumer of energy and faces challenges such as inefficient use of resources, high costs, and environmental impacts. In order to address these issues, it is necessary to implement comprehensive energy efficiency regulations. The introduction of modern energy management technologies has the potential to reduce costs and improve the quality of life for those affected by these issues.

The significant functions of the energy management service are to ensure that the system meets the requirements of the relevant standard, and to implement action plans for consistent improvement of energy performance [2].

In the Russian Federation, the main document that regulates issues of energy saving and energy efficiency improvement is the Federal Law[1].

Compliance with its provisions contributes to saving energy resources, ensuring energy security and reducing energy intensity in the housing and communal services industry [3]. The law establishes specific responsibilities for developers and property owners, including in particular the obligation to ensure that buildings comply with energy efficiency standards at both the design stage and during operation. This involves the use of modern technologies and materials that help reduce energy consumption.

Moreover, there are also a number of additional regulations in place, enhancing control over energy efficiency requirements compliance. Thus, the Order[2] introduced energy efficiency requirements for buildings and structures [4].

The coverage of the issues of determining the balance and correlation between state and market self-regulation in the energy sector is studied on the basis of analyzing the development of the legal and regulatory framework in the field of energy saving and energy efficiency improvement [5].

Cross-sector indicators are key metrics for assessing energy savings and energy efficiency in different sectors, including housing and utilities. They allow analyzing and comparing the performance of different sectors, identifying linkages and facilitating the transfer of best practices.

These indicators provide opportunities for integrating approaches from other industries. This can improve resource efficiency and reduce utility costs, while also improving the quality of services. Energy management techniques from industry can be applied to heating and water supply systems in apartment buildings. By using cross-industry indicators,

1 Energy Conservation and Energy Efficiency Improvement : Federal Law No. 261-FZ dated 11/29/2009.

2 The Order of the Government of the Russian Federation dated 09/27/2021 No. 1628.

utility companies can identify deficiencies in their energy supply systems and borrow successful solutions from other industries.

Capital investments include not only the costs of construction, but also the expenses associated with design work, equipment purchase, and other assets required for the operation of the housing and communal services industry.

It is also necessary to conduct a timely assessment of the effectiveness of capital investments [6]. Effective capital expenditures management (CapEx) is critical for optimizing budget costs, reducing construction and modernization costs, and improving the quality of services. It is essential to take into account both current costs and the introduction of new technologies that help reduce operating costs.

Estimating the cost of upgrading outdated infrastructure, such as pipelines and heating systems, is an important step in determining the feasibility of the upgrade. Replacing old systems not only helps prevent leaks but also reduces water costs.

To minimize power losses in housing and communal services, it is essential to implement several effective solutions. Upgrading existing systems is one of the main methods. It is also crucial to use energy-efficient technologies that help optimize resource consumption [7]. Regular network performance audits help identify problem areas and take steps to address them. This, in turn, helps reduce costs and increase the reliability of communal services by introducing modern technologies and regular infrastructure status' monitoring [8, 9].

Reliability indicators in housing and communal sphere are important criteria for assessing the ability of these systems to provide continuous service. These indicators can be measured through internal monitoring [10], and include the frequency of emergency outages, recovery time after failures, and user satisfaction levels. High reliability rate helps to build consumer confidence and improve an organization's reputation in the industry. Regular monitoring allows for the identification of problem areas and the implementation of measures to address them, ultimately improving the overall quality of service.

Fig. 1 illustrates the relationship between the content of relevant price categories, possible parameters, and methods for evaluating relevant indicators, as well as the timing of changes in these price categories.

These metrics allow to evaluate the extent of strain on the power grid, the electricity supply quality, the harmonic distortion level, and the effectiveness of resource utilization. By scrutinizing these metrics, we can pinpoint areas that demand particular attention when it comes to optimizing energy consumption and resource allocation. The implementation of smart metering devices becomes increasingly crucial for data collection and analysis essential for setting pricing policies and efficient energy management, as well as for the daily hourly consumption schedule leveling [11].

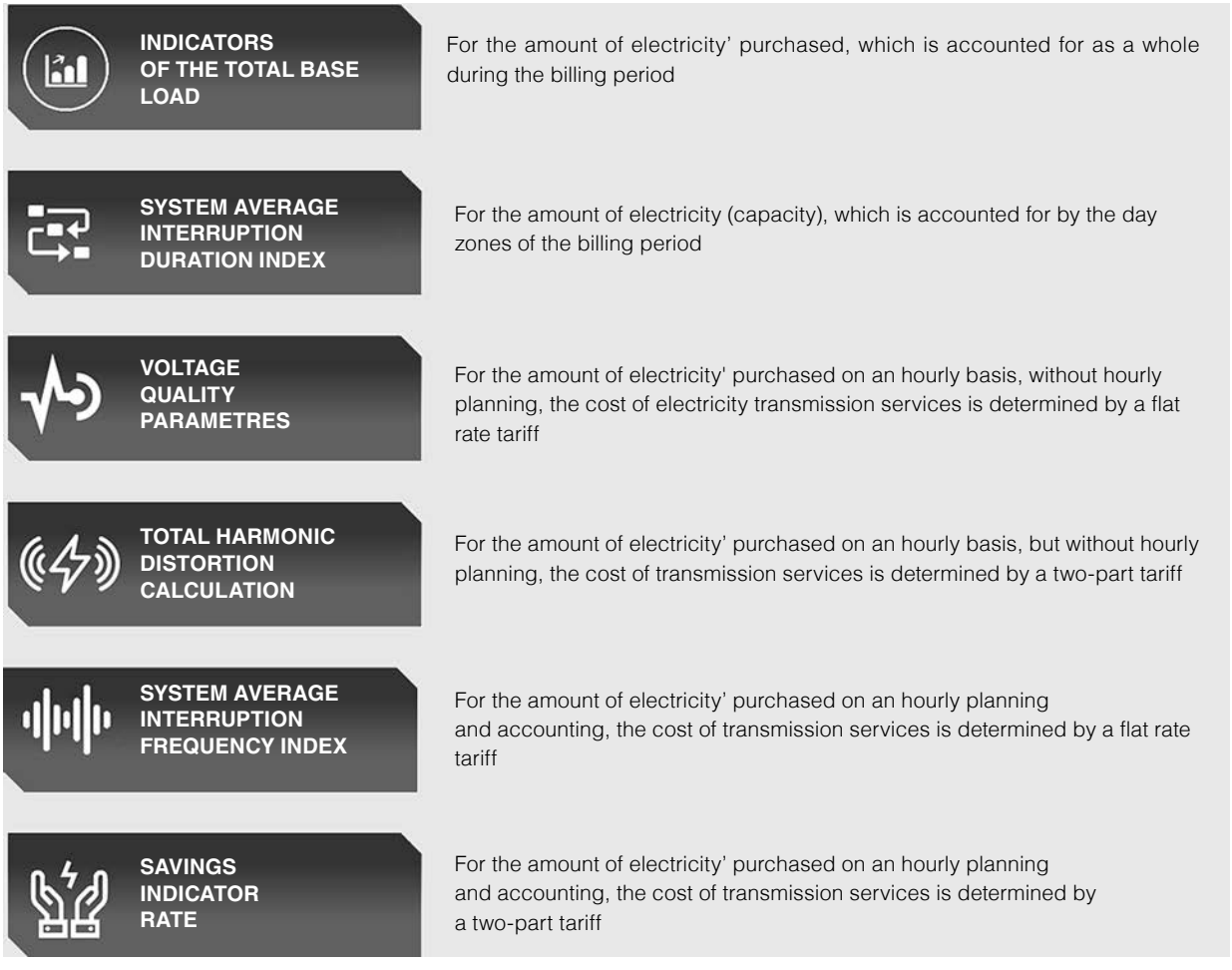

Fig. 1. Anchor indicators for the price categories defining. Source: compiled by the authors

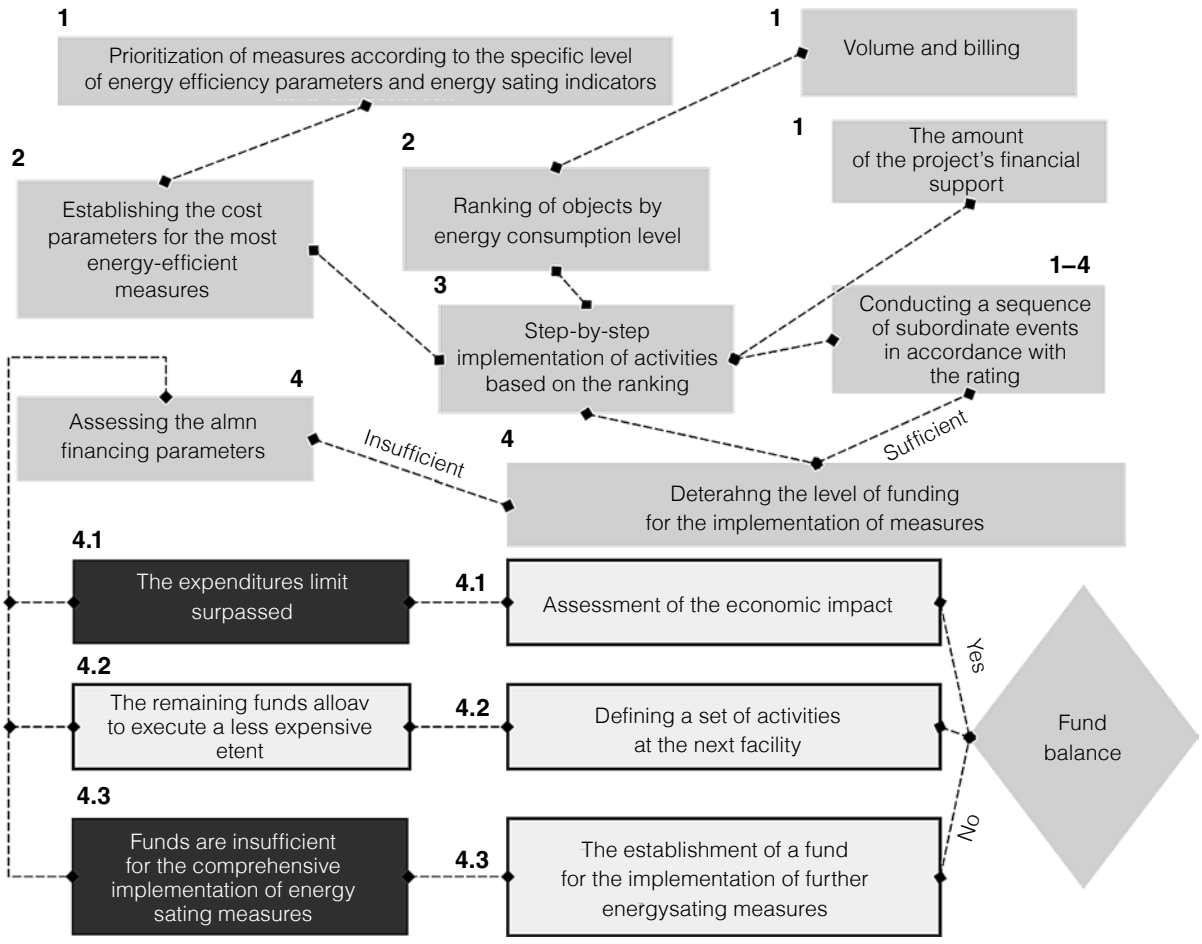

Fig. 2. The structure of the assessment of the initiatives 'economic efficiency. Source: compiled by the authors

Environmental aspects of management are becoming increasingly relevant in the context of sustainable development. Incorporating environmental criteria into the decision-making process can reduce the negative impact on the environment. This may include the use of renewable energy sources, waste recycling and the introduction of technologies to reduce pollutant emissions.

The quality of voltage in power grids also plays an important role in ensuring the reliability of electricity supply to consumers, which can in one way or another influence its quality [12]. Voltage quality measurement methods include monitoring of voltage, frequency and harmonic distortion. Regular monitoring of these indicators allows to detect deviations and take measures to eliminate them, which is important for stable operation of electrical equipment and user satisfaction. Effective power loss management, reliability monitoring, environmental considerations and voltage quality control contribute to the efficiency of the utilities sector by reducing costs and improving service quality, which has a positive impact on the lives of citizens and the environment. Thus, the reconstruction of heat supply systems implies an increase in the efficiency of fuel utilization, contributes to the increase of heat capacity and to the purchase of electricity [13].

The methodology of energy efficiency management in the housing and communal sphere is designed to optimize resources, reduce costs and enhance service quality. It comprises several critical stages.

The first step is to set specific and measurable targets for energy efficiency improvements, taking into account the views of residents and authorities. It is also important to develop strategies for infrastructure modernization and technology deployment. The next step is to analyze the current state of the systems, which identifies the strengths and weaknesses of the resources. Energy audits help identify inefficient areas for optimization.

At the stage of assessing energy efficiency, a range of methods for analyzing energy consumption are employed, encompassing the use of specialized software and the implementation of comparative analysis. These findings serve as a foundation for identifying critical areas that require immediate attention in terms of implementing energy-saving initiatives.

The key step is to analyze the financial situation, which includes assessing the current costs and forecasting the benefits of implementing energy saving technologies, as well as considering different financing scenarios.

The economic impact of energy-saving measures is characterized by a multitude of indirect effects arising from alterations in the fundamental process of energy consumption. These modifications affect auxiliary processes that are not inherently linked to energy consumption, but rather have their own financial aspects [14].

Based on the analysis, a range of energy-saving measures are being developed, encompassing the modernization of heating systems, the implementation of automation for optimized consumption, regular audits of facilities, and the professional development of staff. These initiatives not only contribute to reducing energy expenses but also enhance the overall quality of services provided.

Modern monitoring technologies, such as sensors and automated metering, allow you to track the status of networks and resource consumption in real time. Building Management Systems (BMS) help to optimize the operation of engineering systems.

Energy conservation planning includes prioritization, action plan development, technology implementation and staff training. Effective planning prevents delays and cost overruns. Monitoring results involves regular collection of data on resource consumption after measures have been implemented. This can be done through automated accounting systems or periodic audits [15].

Determining the level of adequacy of funds involves assessing the required investments, including the housing and utilities organizations' own funds and external sources of funding. It is important to conduct a detailed budget analysis for successful implementation of initiatives.

Thus, the management of rationing and energy efficiency in the housing and utilities sector is a complex process that requires a careful approach at all stages, from setting goals to monitoring results, which contributes to increasing resource efficiency and improving the quality of life of citizens.

The use of a hierarchical structure in the assessment of economic efficiency contributes to a more accurate definition of energy saving and energy efficiency strategies (Fig. 2).

The hierarchical structure in the assessment of the cost-effectiveness of measures aimed at improving energy saving and energy efficiency in the housing and communal sector is a critical element, as it ensures prioritization of measures based on cost analysis and expected results, as well as ranking of facilities by energy consumption level to identify the most vulnerable elements for improvement. In addition, this structure allows for the verification of the main financing parameters against expenditure limits, which helps to prevent overspending, as well as the assessment of the economic impact of the implemented solutions, which in turn contributes to a more informed allocation of resources. It is also important to take into account the volume and tariffication of payments, which affect the financial sustainability of projects and their attractiveness to investors, thus forming a comprehensive package of resources. for investors, thus forming a comprehensive approach to energy management and cost optimization in this area.

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Вопросы управления энергоэффективностью при управлении и эксплуатации объектов недвижимости в жилищно-коммунальной сфере

Статья исследует кросс-отраслевые показатели и методики управления в жилищно-коммунальном хозяйстве, акцентируя внимание на их значимости для повышения энергоэффективности и оптимизации ресурсов.

В условиях глобальных вызовов, таких как изменение климата и истощение природных ресурсов, эффективное использование энергии в жилищно-коммунальном хозяйстве становится критически важным.

Отрасль жилищно-коммунального хозяйства является одним из крупнейших потребителей энергии, и неэффективное использование энергетических ресурсов приводит к высоким затратам и негативным экологическим последствиям.

Кросс-отраслевые показатели позволяют сравнивать эффективность энергосбережения в жилищно-коммунальном хозяйстве с другими секторами экономики, что способствует переносу лучших практик и технологий. Например, методы управления энергозатратами из промышленности могут быть адаптированы для систем теплоснабжения и водоснабжения многоквартирных домов. В статье выделяется несколько ключевых этапов методики управления: постановка целей по повышению энергоэффективности, анализ текущего состояния систем, оценка энергетической эффективности и разработка мероприятий по энергосбережению.

Использование современных технологий мониторинга позволяет в реальном времени отслеживать потребление ресурсов и выявлять неэффективные участки. Важным ас-

пектом является необходимость комплексного подхода к управлению энергоресурсами, который включает взаимодействие с населением и местными властями. Это сотрудничество способствует созданию устойчивого развития жилищно-коммунального хозяйства и улучшению качества предоставляемых услуг. Внедрение инновационных решений для повышения надежности систем и снижения затрат на коммунальные услуги является одним из важнейших направлений, что в конечном итоге связано с достижением цели повышения уровня жизни граждан.

Ключевые слова: *энергоэффективность, жилищно-коммунальное хозяйство, кросс-отраслевые показатели, управление ресурсами, современные технологии, экологические аспекты*

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