Benchmarking sustainable energy technologies in cross-border regions: issues of economic efficiency

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Abstract. The long-term trends of world energy development envisage a radical increase in the energy efficiency, an increase in its quality indicators, and a transition from fossil fuels to the use of sustainable energy technologies. The article presents an algorithm developed by a team of authors for planning, implementing, and evaluating economic efficiency of benchmarking sustainable energy technologies in cross-border regions. Its use will allow optimizing the energy intensity of enterprises, ensuring energy security, economic efficiency and environmental stability of adjacent territories, preserving the mineral resource base, and improving the quality of life of the population.

1. Introduction
At present, the principles of sustainable development, which envisage achieving the parity of economic, ecological, and social values of modern society, are integrated into the world economic practice in the planning and management of organizations, which is reflected in various international studies [1-4]. The basic idea of the concept of sustainable development of a cross-border region provides that business processes aimed at improving the efficiency of using natural resources of the territory and using new technologies should be accompanied by an increase in the level and quality of life, compliance with environmental requirements, environmental management in the interests of present and future generations, using a number of opportunities for cross-border cooperation [12].

At the same time, territorial planning should focus on using sustainable energy technologies as spatially linked, environmentally friendly, reducing dependence on fossil fuel resources and providing opportunities for mitigating greenhouse gas emissions [5].

Possessing similar natural resources and climatic conditions, cross-border regions can carry out technology benchmarking, jointly solve problems of power supply of territories, and implement projects of interest to both parties.

2. Materials and Methods
The empirical basis of this study was the study and analysis of Russian and international experience in the use of alternative energy types. A systematic approach has allowed a comprehensive and holistic study of this issue. The methodological base of the research was the scientific and educational literature given in the list of sources.

In setting the goal and defining the main tasks at the initial stage, the team of authors used an abstract-logical research method to systematically explore the possibilities of benchmarking sustainable energy technologies in cross-border regions.
In the process of studying the advantages and disadvantages, as well as the possibilities of applying sustainable energy technologies, the method of comparative analysis and synthesis was used to identify patterns of development of its types and cause-effect relationships between them.

At the stage of developing an algorithm for planning, implementing, and evaluating the economic efficiency of benchmarking sustainable energy technologies in cross-border regions, the method of modeling accounting processes was used, as well as the methods of scientific knowledge – scientific abstraction, dialectical development, and statistical generalization.

In the course of our discussion, heuristic and logical methods were applied. The reliability and validity of the results are confirmed by using such methods as statistical and experimental ones.

3. Results

Results of the study is an algorithm for planning, implementing, and evaluating the economic efficiency of benchmarking sustainable energy technologies in cross-border regions include 5 steps.

Stage 1 “Planning results of production and economic activities of the enterprise for the upcoming period.” Based on the implementation of which, the enterprise management sets the planned indicators of production volume and unit cost of production.

Stage 2 “Assessing the possibilities of using and planning indicators of the economic efficiency of benchmarking sustainable energy technologies in cross-border regions.” This stage provides for: (a) determining the energy intensity of business processes of an enterprise, ensuring the achievement of planned indicators of production volume and production costs; (b) identifying factors that influence the energy intensity of processes (energy system characteristics, used technical means and equipment, etc.); (c) a study of benchmarking opportunities for using sustainable energy technologies in cross-border regions (collection and analysis of information on natural conditions and resources of transboundary regions, on the experience of using renewable (solar energy, water, wind, biomass, etc.) and other sustainable energy sources, such as biogas, when recycling urban waste; (d) calculating capital costs and evaluating effectiveness of an investment project for introducing sustainable energy technologies.

Stage 3 “Development of measures for introducing sustainable energy technologies” involves (a) planning a set of measures for introducing sustainable energy technologies at the responsibility centers; (b) assessing the resource intensity of carrying out activities in each responsibility center; (c) assessing the impact of the proposed measures on the company’s financial result (cost savings in the areas of heat supply and electricity, profit, net present value, return on investment, payback period of capital investments) and of the region (subsidies and investments for developing the region’s energy potential, savings in budget funds for heat and power supply), indicators of the organization’s energy efficiency (energy savings, energy intensity of business processes and organization’s overall activities, specific energy consumption per unit of product) and of the region.

Stage 4 “Implementing measures for introducing sustainable energy technologies” involves the organization of work on the introduction of sustainable energy technologies for the responsibility centers; improving professional skills of workers involved in the introduction and use of sustainable energy technologies; monitoring results of the measures being implemented.

Stage 5 “Analyzing results of introducing and using sustainable energy technologies, assessing the replication experience” includes studying the results of investment projects, implementing corrective measures, and working on investment projects involving the extension of business practices to other business processes or organizational structures.

4. Discussion

In modern conditions, the companies seek to ensure sustainable, competitive, and financially successful operation in the market, including through the use of management tools based on an analysis of Russian and international experience in the application of sustainable energy technologies [6, 7].
The hypothesis of the study was to identify the ability of the company’s management on the basis of the developed algorithm for planning, implementing, and evaluating the economic efficiency of benchmarking sustainable energy technologies in cross-border regions to achieve the planned financial and economic indicators, to respond promptly and accurately to the deviations arising to ensure the enterprise’s stable development, as well as to improve the quality and standard of living as a whole.

As a result of the study, we found that implementing the concept of reliable, efficient, socially acceptable, and environmentally safe energy supply with universal access to sustainable energy technologies without compromising the ability of future generations to meet their needs is designed to reduce the total energy consumption by 40%, ensuring the growing share of sustainable energy up to 30% and increasing energy efficiency of activities of organizations and society as a whole [8].

Incentives for using sustainable energy technologies include ensuring energy security; environmental protection; conservation of mineral fuel resources; coverage of new markets. The types of sustainable energy sources include solar energy, water, wind, biomass, geothermal energy, wave and sea energy, hydrogen. In addition, nuclear energy and waste of cities, while not being renewable, are at the same time sustainable as it would not run out in the foreseeable future.

In the research process it was found that the main directions of the energy policy of most countries of the world include the development and improvement of wind and photogeneration technologies, biomass processing, and searching for safe technologies to use hydrogen [9]. With new construction, the development of eco-city technologies is possible, with the aim of providing a closed cycle of energy supply [10]. Recycling through anaerobic decomposition with the production of biogas (which is based on methane) can solve the problems of recycling and replace fossil fuels in the energy balance of cities [10]. Also, the use of biomass (agricultural and forestry waste) can significantly increase the production of fuel for energy content (in terms of energy intensity, the total amount of 420-550 million tons of biomass waste in Russia is equivalent to 85-128 million tons of gasoline). At the same time, the main task is to develop efficient technologies for their processing [11].

The studied experience of applying sustainable energy technologies of the world is not systematized in terms of the impact of their application on the energy efficiency of regions and presents isolated studies on the analysis of the results of the implementation of certain alternative energy technologies.

This study proposes a comprehensive algorithm for planning, implementing, and evaluating the economic efficiency of benchmarking sustainable energy technologies in cross-border regions. The results of the study can be used to further improve the methodology for assessing the economic efficiency of using sustainable energy technologies in cross-border regions in order to minimize energy costs and environmental damage.

5. Conclusion

The algorithm proposed by the authors for planning, implementing, and evaluating the economic efficiency of benchmarking sustainable energy technologies in cross-border regions will allow for more efficient management, strengthening the responsibility of enterprise employees, on the one hand, and reducing the level of relevant costs, on the other. At the same time, benchmarking sustainable energy technologies of companies with best business practices is important not only for those enterprises interested in saving energy resources and increasing operational efficiency. Its results are beneficial to the state, which finances energy development through direct investment and through tariff regulation, indirectly. And the state is interested in increasing the efficiency of spending these funds.

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