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РАЗВИТИЕ МАЛОЙ И ЗЕЛЕНОЙ ЭНЕРГЕТИКИ В УСЛОВИЯХ КЛИМАТА СИБИРИ

Аннотация: В данной статье исследуется развитие малой и зелёной энергетики в условиях сурового сибирского климата, с фокусом на особенностях северных регионов. Проведён анализ понятия "зелёной энергетики" и её компонентов. Рассмотрены ключевые факторы, влияющие на развитие альтернативных источников энергии. Подробно изучены преимущества и недостатки данного подхода, а также преодолеваемые препятствия. Подчеркнута важность комбинированных энергетических систем, адаптированных к особенностям климата, для обеспечения устойчивого энергоснабжения и снижения затрат. Поднят вопрос о необходимости комплексного подхода к интеграции альтернативных источников энергии с традиционными методами в энергетической системе северных регионов.

Ключевые слова: изолированные территории, нетрадиционная и малая энергетика, интеграция альтернативных технологий, децентрализованное электроснабжение, гибридные энергетические системы, климатические условия Сибири, экологическая устойчивость

DEVELOPMENT OF SMALL AND GREEN ENERGY IN THE CLIMATE OF SIBERIA

Abstract: This article examines the development of small and green energy in the harsh Siberian climate, with a focus on the features of the northern regions. The analysis of the concept of "green energy" and its components is carried out. The key factors influencing the development of alternative energy sources are considered. The advantages and disadvantages of this approach, as well as the obstacles to be overcome, are studied in detail. The importance of combined energy systems adapted to the peculiarities of the climate to ensure sustainable energy supply and reduce costs is emphasized. The question of the need for an integrated

approach to the integration of alternative energy sources with traditional methods in the energy system of the northern regions is raised.

Keywords: isolated territories, unconventional and small-scale energy, integration of alternative technologies, decentralized power supply, hybrid energy systems, climatic conditions of Siberia, environmental sustainability

Currently, the issue of greening the economy in Russia is being actively discussed, especially in the context of the climatic conditions of Siberia. Methods for estimating greenhouse gas emissions are becoming more sophisticated, both domestically and globally. In the global community, more and more countries recognize that the traditional fossil fuel energy sector is the main source of greenhouse gases, emphasizing the need to switch to alternative energy.

Foreign countries, having thought about this transition for a long time, are already presenting plans for a complete transition to renewable energy sources by 2050 [1]. Over the past 15 years, investments in renewable energy have reached $3.3 trillion, and statistics show a significant increase in the production of "green" energy.

In Russia, the Energy Strategy until 2035 also provides for an increase in the share of alternative energy. However, due to the vast reserves of fossil fuels and the presence of operating power plants, renewable energy sources cannot yet fully compete with other energy production technologies in Russia.

Despite the availability of energy resources, the northern regions of Russia face the problem of energy supply due to isolation from the unified energy system of the country [2]. This creates a need for competitive solutions in the field of alternative energy, and our work is aimed at analyzing the features of its development in these Siberian regions.

The concept of "green energy" is currently widely used, but its definition is ambiguous. Alternative energy covers sources other than traditional ones, including renewable and inexhaustible resources. It is extracted from natural processes and provided for technical use.

Renewable energy includes sunlight, water flows, wind, tides and geothermal heat, as well as biofuels. Within the framework of sustainable development, alternative energy should be efficient, economically and financially sustainable, safe, diverse and accessible [3].

In Siberian conditions, where the climate has its own unique specifics, the development of small and green energy becomes an integral part of the strategy. Renewable energy in Siberia is becoming important as a means of adaptation to climate change, where it is necessary to take into account and control the impact on the environment.

Reducing local air pollution is a priority in regions where caring for clean air becomes a matter of health and comfort. In this context, the transition to green

energy becomes an effective solution that contributes to improving air quality and reducing premature deaths associated with air pollution [4].

Energy security in the conditions of the Siberian climate acquires additional importance, reducing dependence on energy imports and ensuring the stability of energy supply in difficult climatic conditions.

Taking into account frequent climatic and natural disasters, the development of distributed renewable energy systems and the integration of microgrids are becoming means of ensuring the sustainability of the energy system of the region. Such approaches also strengthen energy supply reserves and reduce vulnerability to extreme events.

An important aspect of the development of green energy in Siberia is the expansion of access to energy, providing energy accessibility for residents of remote northern regions. At the same time, investments in small and green energy projects are becoming attractive, providing high profitability in comparison with traditional fuels [5].

Creating jobs and adding value through the development of small and green energy are becoming not only economically feasible, but also important for the social development of Siberian territories. Thus, these measures, together with projects focused on specific features of the region, raise the importance of the development of small and green energy in the conditions of the Siberian climate.

However, Siberian regions face a number of factors that hinder the development of alternative energy. Weather and climatic conditions characterized by low temperatures impose technical limitations and cause heat loss. The location of production facilities prevents the use of alternative energy due to the need to generate large amounts of energy and occupies significant territories [6]. The low level of infrastructure and seasonal changes in daylight hours also create difficulties for the deployment of renewable energy sources.

Difficulties with transportation of equipment and high infrastructure costs in the Siberian regions require additional resources. Differences in daylight hours and seasonality also impose their limitations on the operation of solar and mini-hydroelectric power plants.

In the conditions of northern latitudes, including Siberia, where settlements depend on diesel power plants, the cost of electricity production is high. In this regard, it is recommended to use combined installations, combining solar panels, wind generators and diesel generators [7]. This approach reduces the cost of energy and ensures uninterrupted power supply. Despite the challenges associated with climate and infrastructure, the use of combined energy systems, as well as on-site energy production, represent promising solutions for the development of green energy in Siberian conditions.

Thus, when considering the development of small and green energy in the climate of Siberia, it is necessary to take into account the unique challenges and

opportunities provided by this region and develop integrated solutions that contribute to sustainable and efficient energy development.

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