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NATURAL AND CLIMATIC CONDITIONS OF KASHKADARYA REGION AS A FACTOR CREATING ALTERNATIVE ENERGY SOURCES

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Abstract This article analyzes the natural and climatic conditions and geographical location of the Kashkadarya region and their role in the development of alternative energy sources. The region's high solar radiation, wind regime, and hydrological resources are identified as key factors determining the potential for "green energy". The author studied the relief structure and climatic features of the region and scientifically substantiated the possibilities of using solar, wind, small hydro and biomass energy. The study highlighted the importance of energy reform in Uzbekistan and modernization of the territorial energy system. Also, the prospects for differential development of alternative energy types are described in the cross section of different economic and geographical districts of the country. The article provides practical recommendations for creating a sustainable energy system in the region and for the rational use of renewable resources.

Keywords: Brownstone, alternative energy, solar radiation, wind energy, hydropower, biomass, natural-climatic conditions, green energy, energy efficiency, relief, sustainable development, modernization, sunny days, energy potential, natural resources, territorial differentiation.

In recent years, the use of renewable energy sources – solar, wind, hydropower, geothermal, and bioenergy – has been rapidly developing in many countries around

the world. This process is leading to the formation of the concept of "green energy" on a global scale, serving to ensure the environmental safety of the energy production system. According to the International Energy Agency, renewable energy sources are increasingly important in the global energy balance and are expected to become one of the main sources of energy production in the future.

Today, in the Republic of Uzbekistan, the rational use of energy resources, the development of renewable energy sources, and increasing energy efficiency are considered one of the priority areas of state policy. Our country is implementing a number of strategic programs to modernize the energy system, increase energy production capacity, and widely introduce alternative energy sources.

In particular, by the decree of the president of the Republic of Uzbekistan PQ-4422 of August 22, 2019, the document “on measures to expand the use of renewable energy sources”was adopted, which sets out important tasks for the development of alternative energy, the construction of solar and wind power plants and energy efficiency in the country. In addition, the Law of the Republic of Uzbekistan "On Renewable Energy Sources" adopted on May 21, 2019, established the legal framework for the use of alternative energy sources and the development of this sector.

In the process of developing renewable energy sources in our country, it is of particular importance to scientifically study the natural resource potential of the regions and effectively use them. The climatic conditions of Uzbekistan, especially the high levels of solar radiation and the availability of wind resources in some regions, provide favorable opportunities for the development of alternative energy.

In this regard, the Kashkadarya region is one of the regions with high potential for using alternative energy resources, in particular solar and wind energy. The natural and geographical conditions of the region, its climatic features, the large number of sunny days, and the presence of vast open areas create favorable conditions for the development of alternative energy sources. In addition, the development of agricultural production in the region also expands the possibilities for using bioenergy resources.

At the same time, a comprehensive study of the potential of alternative energy resources in the Kashkadarya region, determining their regional characteristics, and developing ways to effectively use them are important scientific and practical issues. The scientific assessment of the possibilities of using alternative energy sources in this region, the development of energy infrastructure, and the improvement of the regional energy system are of current scientific and practical importance.

The issues of renewable energy sources and alternative energy have been widely studied in the world scientific literature. A number of scientific studies have been conducted on the sustainable development of the energy system, the efficient use of energy resources, and the technological and economic foundations of

renewable energy sources. In particular, foreign scientists G. Boyle, J. Twidell, A. Weir, T. Johansson, D. Elliott, B. Researchers such as Sørensen have provided detailed information in their scientific work on the theoretical foundations of renewable energy sources, their technological capabilities, and their role in the global energy system. The studies of these scientists widely cover the scientific and technical foundations and environmental significance of using solar, wind, bioenergy, and hydropower resources.

Scientists from the CIS countries have also conducted a number of scientific studies in the field of alternative energy. In particular, V.E. Fortov, A.A. Velikhov, V.A. Klimenko, V.A. Sokolov, A.A. The scientific works of scientists such as Makarov study issues of modernizing the energy system, integrating renewable energy sources into the energy system, and assessing their economic efficiency.

Uzbek scientists have also conducted a number of scientific studies on the study of renewable energy sources, in particular, the possibilities of using solar and wind energy. In this regard, R.A. Zakhidov, G.A. Mavlonov, S.A. Bakhramov, A.A. Abdurakhmanov, K.S. The scientific work of scientists such as Saidov is of great importance. Their research analyzes the solar radiation resources of the territory of Uzbekistan, the potential of wind energy, and the prospects for using renewable energy sources.

Scientific research has also been carried out by economic-geographers and environmentalists of our country on the issues of assessing the natural resource potential of Regions and their rational use. Including A.S. Soliev, A.A. Kayumov, A.N. Nigmatov, M.R. Usmanov, M. M. The scientific research of scientists such as Muhamedov covers the economic-geographical features of the use of natural resources, factors of territorial development, and environmental problems.

However, issues such as a comprehensive assessment of the potential of alternative energy resources in certain regions, including the Kashkadarya region, determining their regional characteristics, and developing ways to effectively use them have not been sufficiently studied. Therefore, one of the urgent scientific tasks is to scientifically study the alternative energy potential of this region, assess their potential, and develop scientific and practical recommendations for their effective use.

The Kashkadarya region is located in the southern part of the Republic of Uzbekistan. Its geographical location, complex geomorphological structure, sharply continental climate, and diversity of natural resources create enormous natural opportunities for the use of alternative energy sources. The region's territory consists not only of plains, but also of mountain systems, foothills, depressions, and desert areas, which serves as a scientific basis for the comprehensive study and practical application of various types of energy resources.

A geographically important feature of the region is that it includes the

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Kashkadarya depression, the Karshi desert, the Kitab-Shahrisabz depression, the Hissar and Zarafshan mountain ranges, and their foothills. Such a complex relief system is characterized by the fact that the heights on the earth's surface vary from 200 meters to more than 4,000 meters. It is these differences in elevation that cause the regional differentiation of climate, wind regime, solar radiation, and hydrological processes. As a result, the region serves as a natural laboratory for the simultaneous development of several types of alternative energy sources.

The climate of Kashkadarya region is sharply continental, with very hot, dry and long summers, and short and relatively mild winters. In lowland areas, the average January temperature is around +2°C, while in July it rises to +28...+29°C. And the absolute maximum temperature can reach 46-47°C. Such high temperatures and strong solar radiation make the region one of the most promising areas in Uzbekistan in terms of solar energy potential.

The number of sunny days in the region is very high, about 280–320 days per year. This figure significantly increases the efficiency of photovoltaic panels and solar thermal devices. The high level of solar radiation is especially noticeable in the Karshi steppe, Nishon desert, and Guzar regions. The transparency of the atmosphere and the low cloud cover in these regions also make the process of collecting solar energy more efficient.

At the same time, the relatively mild winter in the region's climatic conditions is also important. The proportion of winters with no vegetation can reach 50–80%, and the low sum of negative temperatures (not exceeding -40…-60°C) allows for continuous use of solar energy throughout the year. This makes solar energy an economically viable resource not only in the summer, but also in all seasons.

The wind power potential of the kashkadarya region is also of great scientific and practical importance. The wide open plains of the province, particularly the counter desert and target areas, are considered very conducive to unobstructed movement of wind currents. The flat terrain, sparse vegetation cover, and openness of large areas allow for the stable formation of wind speeds. Wind activity increases, especially in spring and winter, which creates conditions for the efficient operation of wind power plants.

In the mountainous regions, however, due to the complexity of the relief, local wind currents are formed. This creates favorable microclimate conditions for small power wind generators. Thus, the flat and foothill areas of the region serve as complementary systems in the use of wind energy.

The hydrological characteristics of the region also play an important role in the development of alternative energy sources. The Kashkadarya and its tributaries, including the Oqsuv, Tanxas, and Jakabog rivers, originate in the mountains and flow into the plains. These rivers are fed by snow, rain, and groundwater. There is hydroelectric potential in mountainous areas due to the steep gradient of the water

flow.

The Chimg'or, Pachkamar, and Talimarjon reservoirs, built in the region, not only regulate water resources but also allow for their use for energy purposes. Local energy supply can be made more sustainable by building small and medium-sized hydropower plants. In particular, streams flowing from the Hissar Mountains serve as a natural basis for small hydropower plants.

Surface and groundwater resources of the kashkadarya region are also important from an energetic point of view. The relative speed of water flow in the mountainous areas, height differences and natural slopes provide an additional opportunity for hydropower. At the same time, the large reserves of groundwater are of indirect importance in supporting energy systems, as well as agricultural and industrial needs.

The soil and vegetation cover of the region is also one of the important factors influencing alternative energy systems. In the Karshi Desert and Nishon regions, gray-brown, sandy, and saline soils are widespread, and the vegetation cover in these regions is sparse. Desert plants such as saxaul, yantok, and wormwood can be used as a source of biomass energy. Biomass energy plays an important role in meeting heating and small energy needs in rural areas.

In mountainous areas, there are juniper, wild fruit trees, and forest resources, which can also be additional sources of biomass energy. Thus, the natural vegetation cover of the region expands alternative energy production routes.

Geographically, the Kashkadarya region is divided into several regions: Karshi, Guzar, and Kitab-Shahrisabz regions. Each region has its own climatic and geomorphological characteristics, which allows for the development of alternative energy sources on a regional basis.

The Karshi district has the greatest solar and wind energy potential, while the Guzar district is characterized by high temperatures and thermal resources. The Kitob–Shahrisabz region receives relatively more precipitation, has a mountainous terrain, and has water resources that are favorable for hydropower and biomass. Such regional differentiation provides a scientific basis for diversifying the energy system.

In conclusion, the natural and climatic conditions of the Kashkadarya region are very favorable for the use of alternative energy sources and have complex capabilities. The region's high solar radiation, active wind regime, availability of hydrological resources, and biomass potential make it a region that will play an important role in Uzbekistan's "green energy" strategy. Therefore, the Kashkadarya region may become one of the scientific and practical centers for the development of alternative energy sources such as solar, wind, small hydro and biomass energy in the future.

Kashkadarya region, with its unique geographical location and climatic indicators, is considered one of the most promising regions for the development of

alternative energy in Uzbekistan. The region has 280–320 sunny days per year, and strong solar radiation is a key factor that guarantees high efficiency of photovoltaic devices. Steady wind currents in wide open plains and desert areas make it possible to build wind power plants, while rivers and streams in mountainous areas make it possible to build small hydroelectric power plants. Additionally, advanced agriculture and desert vegetation cover create additional reserves for the use of biomass energy. The article evaluates the region as a natural laboratory, serving as a scientific basis for diversifying the energy system and ensuring environmental safety. In conclusion, the comprehensive use of the region's natural potential is of strategic importance in strengthening the country's energy independence.

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