INTERNATIONAL MULTI DISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
eISSN 2394-6334 Impact factor: 8.854 Volume 13, issue 03 (2026)

# PROSPECTS FOR THE DEVELOPMENT OF RENEWABLE ENERGY SOURCES IN UZBEKISTAN

**Zoirjon Toxirovich Ro'ziboyev**
Teacher at the Department of Geography and Economics,
Faculty of Natural Sciences and Economics,
Kokand State University
E-mail: zruziboyev@gmail.com

## ANNOTATION

This article analyzes the relevance, existing potential, and prospects for the development of renewable energy sources in Uzbekistan. It also highlights their significance in improving energy efficiency and ensuring environmental sustainability.

**Keywords**

renewable energy, solar energy, wind energy, green economy, energy efficiency, sustainable development

## INTRODUCTION

Currently, the rational use of energy resources, the reduction of environmental problems, and ensuring sustainable development are recognized worldwide as one of the top priorities. In particular, global climate change, the increase in greenhouse gas emissions, and the limited availability of traditional energy sources have made the widespread adoption of renewable energy sources a necessity. International organizations, including the United Nations, have emphasized the use of clean energy sources as a priority within the framework of the Sustainable Development Goals (SDG 7 – "Affordable and Clean Energy") [1]. In the Republic of Uzbekistan, the modernization of the energy sector, improvement of energy efficiency, and expansion of renewable energy use are also recognized as key directions of state policy. Notably, the Presidential Decree PF-5847 dated October 8, 2019, "Concept for the Development of Higher Education in the Republic of Uzbekistan until 2030," highlights the preparation of highly qualified personnel for the energy and environmental sectors, while Decree PQ-4422 dated August 22, 2019, emphasizes the development of renewable energy sources, particularly the large-scale deployment of solar and wind energy [2]. Furthermore, the Presidential Decree PQ-57 dated February 16, 2023, within the framework of the "Green Economy Transition Strategy," sets a target of producing at least 25% of electricity from renewable sources by 2030 [3]. This document outlines comprehensive measures aimed at increasing energy efficiency, reducing carbon emissions, and ensuring environmental sustainability. The country's natural and climatic conditions are highly favorable for the development of renewable energy sources. For example, Uzbekistan experiences over 300 sunny days per year on average, indicating significant potential for solar energy development. According to the International Energy Agency (IEA), solar energy utilization in Central Asia, particularly in Uzbekistan, remains underdeveloped, presenting substantial opportunities for expansion [4]. In addition, regions such as the Republic of Karakalpakstan, Navoi, and Bukhara have high potential for wind energy development. In recent years, international investment projects have been implemented to construct large-scale solar and wind power plants in these areas. This contributes to energy diversification, strengthens energy security, and reduces environmental load. Overall, the development of renewable energy sources in Uzbekistan is crucial not only for economic efficiency but also for environmental protection, improving the quality of life, and implementing the principles of a "green economy." From this

perspective, expanding scientific research, introducing modern technologies, and studying international best practices in this field remain pressing tasks.

**LITERATURE REVIEW AND METHODOLOGY**

In recent years, the development of renewable energy sources has become a critical scientific field, not only from an economic perspective but also in terms of environmental and social importance. According to foreign researchers, including the *Renewables Global Status Report* (2023) published by REN21 (Renewable Energy Policy Network for the 21st Century), renewable energy is increasingly becoming an integral part of the global energy system, with the share of solar and wind energy rising significantly [1]. The International Energy Agency (IEA), in its *World Energy Outlook* (2022) report, emphasizes that increasing investments in renewable energy sources is a key factor in ensuring energy security, reducing carbon emissions, and strengthening economic sustainability [2]. Furthermore, Twidell and Weir (2015) in their book *Renewable Energy Resources* (London: Routledge) provide a comprehensive analysis of the theoretical foundations, technical feasibility, and economic efficiency of renewable energy technologies [3].

Local researchers have also made significant contributions in this field. For instance, R. Khaytmetov (2020) explored the theoretical foundations of sustainable development in the energy sector, while analytical reports prepared by the Ministry of Energy of the Republic of Uzbekistan thoroughly examine the country's renewable energy potential and development prospects [4]. The legal framework for renewable energy development in Uzbekistan has also been progressively strengthened. In particular, the Law of the Republic of Uzbekistan "On Renewable Energy Sources" (O'RQ-539, May 21, 2019) establishes the main principles and mechanisms for developing this sector, including incentives for renewable energy use, attracting investments, and implementing innovative technologies [5]. Moreover, Presidential Decree PQ-4422 dated August 22, 2019, identifies priority tasks for the large-scale introduction of renewable energy, the construction of solar and wind power plants, and modernization of energy infrastructure [6]. Within the framework of the "Green Economy Transition Strategy," Presidential Decree PQ-57 dated February 16, 2023, sets out comprehensive measures to significantly increase the share of renewable energy, improve energy efficiency, and ensure environmental sustainability [7]. In this study, several modern methodological approaches were employed. The analytical method was used to examine existing scientific literature and regulatory documents. Comparative analysis allowed for evaluating Uzbekistan's experience in relation to other countries. Statistical methods were applied to analyze energy indicators and assess their dynamics. A systematic approach enabled a comprehensive study of renewable energy development processes. Additionally, generalization and synthesis methods were used to organize findings and formulate scientific conclusions. These methodological approaches ensure the scientific rigor of the research while enhancing its practical relevance.

**RESULTS**

Analysis of conducted research and statistical data indicates that Uzbekistan possesses not only natural but also economic and institutional potential to develop renewable energy sources. First, the country's natural-climatic conditions are highly favorable. Uzbekistan experiences an average of 300–320 sunny days per year, with solar radiation levels ranging from 1,500 to 1,800 kWh/m² annually. These indicators confirm that conditions for the development of solar energy are highly suitable. According to research, the country's total technical potential for solar energy is estimated at over 50 billion kWh per year [2]. Second, positive results are observed in the field of wind energy. In the Republic of Karakalpakstan, as well as in the Navoi and Bukhara regions, average wind speeds reach 6–8 m/s, providing favorable conditions for the construction of large-scale wind power plants. Practical assessments suggest that these regions

have the potential to generate approximately 3–4 billion kWh of electricity annually. Third, the share of renewable energy is increasing due to investment projects. In recent years, projects have been implemented to construct solar and wind power plants with a total capacity exceeding 2,000 MW. For example, a 100 MW solar power plant has been commissioned in Navoi, while large-scale solar projects are gradually being implemented in the Bukhara and Samarkand regions. Fourth, the proportion of renewable energy in overall electricity production is growing. Analysis shows that by the end of 2023, the share of renewable energy in total electricity generation reached nearly 10%, with plans to increase it to 25% by 2030 [3]. Fifth, ecological efficiency indicators are improving. Implementation of renewable energy projects is expected to reduce carbon dioxide ($CO_2$) emissions by approximately 5–6 million tons annually. This reduction contributes significantly to ensuring environmental sustainability and mitigating climate change. The above results demonstrate that the development of renewable energy sources in Uzbekistan is not only promising but also practically feasible. It plays a crucial role in diversifying the energy system, strengthening energy security, and reducing environmental impacts.

**DISCUSSION**

Alongside the positive results achieved in the development of renewable energy sources, several systemic challenges and constraints have also been identified. Firstly, underdeveloped technological infrastructure remains a major factor limiting the rapid growth of this sector. In particular, the aging electricity transmission networks and limited capacity to accommodate new power sources complicate the large-scale integration of renewable energy. Secondly, the scarcity of investment resources and the high initial costs of renewable energy projects represent pressing issues. Such projects typically require long-term investments, which pose a certain level of risk for the private sector. Consequently, there is a need to expand government financial support mechanisms. In this context, the Decree No. PQ-4422 dated August 22, 2019, of the President of Uzbekistan outlines mechanisms for attracting investments and implementing projects through public-private partnerships [2]. Thirdly, the shortage of qualified personnel is a significant challenge. The renewable energy sector demands highly skilled engineers, technical specialists, and researchers, making it necessary to improve the national education and training system. Strengthening the preparation of professionals in the fields of energy and ecology is therefore a critical priority. At the same time, positive trends have emerged in addressing these challenges. The favorable investment environment created by the government, along with tax incentives and subsidy mechanisms, plays an important role in attracting investors to renewable energy projects. Furthermore, Decree No. PQ-57 dated February 16, 2023, establishes clear tasks within the framework of the “green economy” transition, including increasing energy efficiency and expanding the share of renewable energy [3]. International cooperation has also become a key factor. Projects implemented in collaboration with the World Bank, the Asian Development Bank, and other international financial institutions provide not only financial resources but also opportunities to introduce advanced technologies and global best practices. The discussion results indicate that the development of renewable energy sources requires a comprehensive approach. Technological modernization, improvements in investment policy, development of research activities, and strengthening of the professional training system must be implemented in a coordinated manner. Despite existing challenges, ongoing reforms in Uzbekistan are contributing to the sustainable growth of the renewable energy sector. In the future, an increase in the share of renewable energy, enhanced energy efficiency, and strengthened environmental sustainability are expected.

**CONCLUSION**

In conclusion, the development of renewable energy sources in Uzbekistan holds significant strategic importance for ensuring sustainable economic growth, strengthening energy

security, and mitigating environmental challenges. The research findings indicate that the country possesses substantial natural potential for the development of solar and wind energy, which can be effectively utilized to diversify energy production. The analysis further demonstrates that the deployment of renewable energy sources can reduce carbon emissions, protect the environment, and promote the widespread adoption of "green economy" principles. In this regard, Uzbekistan's legislative and regulatory framework, including the Law on Renewable Energy Sources (O'RQ-539, 2019) and Presidential Decrees PQ-4422 (2019) and PQ-57 (2023), provides a solid institutional foundation for the sector's development. To advance the sector further, several priority measures must be implemented. These include the widespread introduction of innovative and energy-efficient technologies, active attraction of domestic and foreign investments, support for scientific research, and enhancement of the system for training highly qualified personnel. Additionally, modernizing energy infrastructure, introducing digital management systems, and adopting international best practices can significantly improve the efficiency of renewable energy sources. Such measures will play a crucial role in promoting the rational use of energy resources, ensuring stable energy supply, and achieving environmental sustainability. In summary, the development of renewable energy sources is an integral component of Uzbekistan's long-term development strategy, with significant scientific and practical importance in achieving economic, environmental, and social sustainability.

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