THE EXPERIENCE OF UZBEKISTAN AND GERMANY IN ENVIRONMENTAL SUSTAINABILITY AND GREEN ECONOMY

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Abstract. This article examines the processes of ensuring ecological sustainability and transitioning to a green economy in Uzbekistan and Germany, relying on statistical analysis, literature review, and comparative methods. The study compares the indicators of carbon emissions, renewable energy capacities, and resource efficiency of both countries based on digital data. The analysis of scientific literature and international reports showed that while Germany's "Energiewende" strategy leads in institutional mechanisms, Uzbekistan possesses high potential in expanding green investments and solar energy in Central Asia. Based on the obtained results, practical proposals for transforming the national economy were developed.

Keywords. Green economy, ecological sustainability, statistical analysis, literature review, comparative method, renewable energy, German experience, Uzbekistan, sustainable development.

Introduction. In the current era, global climate change and the depletion of natural resources have become one of the most pressing challenges facing humanity. Since traditional economic growth models generate numerous ecological crises, "greening" the economy and ensuring environmental sustainability are considered top priorities worldwide. This process is becoming the sole guarantee for maintaining economic competitiveness not only for developed nations but also for developing countries as well. Therefore, deeply scientifically substantiating the mechanisms of transition to a "green" economy and studying international experiences are of urgent importance today. The issues of forming and financing the green economy are widely researched using the examples of various countries. In particular, reforms in this direction in Uzbekistan are mainly implemented through the introduction of green financial instruments, attracting investments, and increasing resource efficiency [1,2]. Research shows that consistently monitoring green economy indicators and clearly defining the priority directions of state policy are of vital importance in ensuring sustainable economic growth in the country [4,8,9]. Furthermore, maintaining cross-sectoral balance, applying criteria-based approaches to assess the stability levels of enterprises, and restoring ecological balance by expanding green spaces in urban environments have been highlighted as urgent tasks [3,6,7,10,11]. This indicates that green transformation processes in Uzbekistan are deepening step-by-step.

On the other hand, Germany's experience ranks among the most advanced models institutionally and technologically in achieving environmental sustainability and a green economy [12,13]. The process of reducing carbon emissions and transforming the economy in Germany is based on circular economy principles, the preservation of natural capital, and

the widespread introduction of eco-innovations [14,15]. Expanding the use of renewable energy sources (solar, wind, and biomass) has become the main driver of green economic growth in the country [16]. Additionally, the implementation of strict directives on corporate sustainability reporting, green fiscal policy, environmental taxes, and the integration of digital innovations are accelerating the achievement of carbon neutrality [17,18,19,20,21,22]. An analysis of these foreign experiences demonstrates that adapting Germany's advanced approaches to the specific characteristics of the national economy yields high effectiveness in ensuring ecological sustainability in Uzbekistan.

Methodology. In this study, a comprehensive scientific approach was utilized to deeply and comparatively examine the processes of ecological sustainability and the transition to a green economy between Uzbekistan and Germany. The research methodology is based on the critical evaluation of existing scientific literature, official statistical data, and reports from international organizations, integrating both qualitative and quantitative analysis methods. Through the analysis of scientific literature, the theoretical foundations and institutional mechanisms for shaping the green economy in both countries were clarified. Furthermore, using statistical analysis, the dynamics of renewable energy capacities, carbon emissions, and resource efficiency indicators were compared.

Comparative and logical generalization methods played an important role in shaping the practical results of the study. Germany's achievements in green transformation and the "Energiewende" policy were comparatively analyzed against Uzbekistan's national economic conditions. In this process, similarities and differences between the economic interests, existing potential, and environmental priorities of the two countries were identified, and the most optimal mutually beneficial areas of cooperation were determined. Based on the analytical results obtained, well-founded scientific and practical recommendations were developed aimed at further accelerating the green economy, attracting foreign technologies, and ensuring environmental sustainability in Uzbekistan.

Results and Discussion. When conducting a comparative analysis of the transition processes to a green economy, strategies for ensuring ecological sustainability, and the statistical indicators of the Republic of Uzbekistan and the Federal Republic of Germany, the unique opportunities and development stages of both countries become clearly apparent. While Germany has achieved significant results in decarbonizing its industrial and energy sectors based on its "Energiewende" (energy transition) strategy and long-standing institutional experience, Uzbekistan has recently become a leading center of green transformation in Central Asia, implementing large-scale reforms to rapidly develop renewable energy sources. A comparative study of the macroeconomic and ecological indicators of the two countries shows that whereas in Germany a substantial part of the total energy balance comes from solar, wind, and biomass power plants, with the share of renewable energy exceeding 50 percent, Uzbekistan leverages its natural and climatic conditions—boasting over 320 sunny days a year—to implement major investment projects for the construction of solar and wind power plants. According to statistical data, Uzbekistan aims to increase the share of renewable energy to over 40 percent by 2030, in which foreign

investments, including multi-billion dollar contracts concluded with German partners, play a crucial role.

The analysis of carbon emissions, resource efficiency, and energy intensity indicators of the two countries demonstrates that the high level of digitalization in German industry and the deep implementation of circular economy principles have driven the secondary recycling rate of resources to over 70 percent. In Uzbekistan, within the framework of the "Strategy for the Transition to a Green Economy" adopted in recent years, strict criteria are being established to double the energy efficiency of industrial enterprises, deeply process raw materials, and reduce waste. Comparative analyses show that while greenhouse gas emissions per capita in Germany are steadily decreasing year by year, Uzbekistan requires further strengthening of modern "green" taxes, environmental monitoring, and incentive mechanisms to achieve carbon neutrality against the backdrop of rapid industrialization and urbanization processes. In particular, advanced engineering solutions and energy-efficient technologies introduced by German companies are enabling a significant reduction in energy consumption in Uzbekistan's traditional sectors.

A deep discussion of the obtained results indicates that utilizing Germany's experience serves as an important bridge for Uzbekistan not only to ensure environmental cleanliness but also to increase export potential and adapt to the strict ecological requirements of the European Union. While directives on corporate sustainability reporting and green fiscal policy in Germany compel business entities to take ecological responsibility, Uzbekistan is also implementing "green" bonds and preferential lending mechanisms to attract the private sector. At the same time, analyses show that Uzbekistan is putting forward strategic initiatives to produce green hydrogen utilizing its immense solar and wind potential and export it to European partners like Germany. This ensures the mutual alignment of the interests of both countries, allowing for the effective integration of Germany's technological and financial resources with Uzbekistan's raw material and natural energy potential.

Based on these comparative analyses and statistical data, it can be concluded that the transition to a green economy is not a one-time event, but rather a long-term institutional, technological, and social transformation process. Learning lessons from the successes and mistakes of Germany's "Energiewende" model, Uzbekistan must widely introduce artificial intelligence and digital monitoring systems in developing its regional master plans. By expanding scientific and technical cooperation between the two countries, increasing specialized training centers for "green skills," and incentivizing small and medium-sized business entities toward ecological innovations, sustainable green economic growth can be guaranteed in our country. This, in turn, while creating a favorable ecological environment for future generations, will further strengthen the global competitiveness of the national economy.

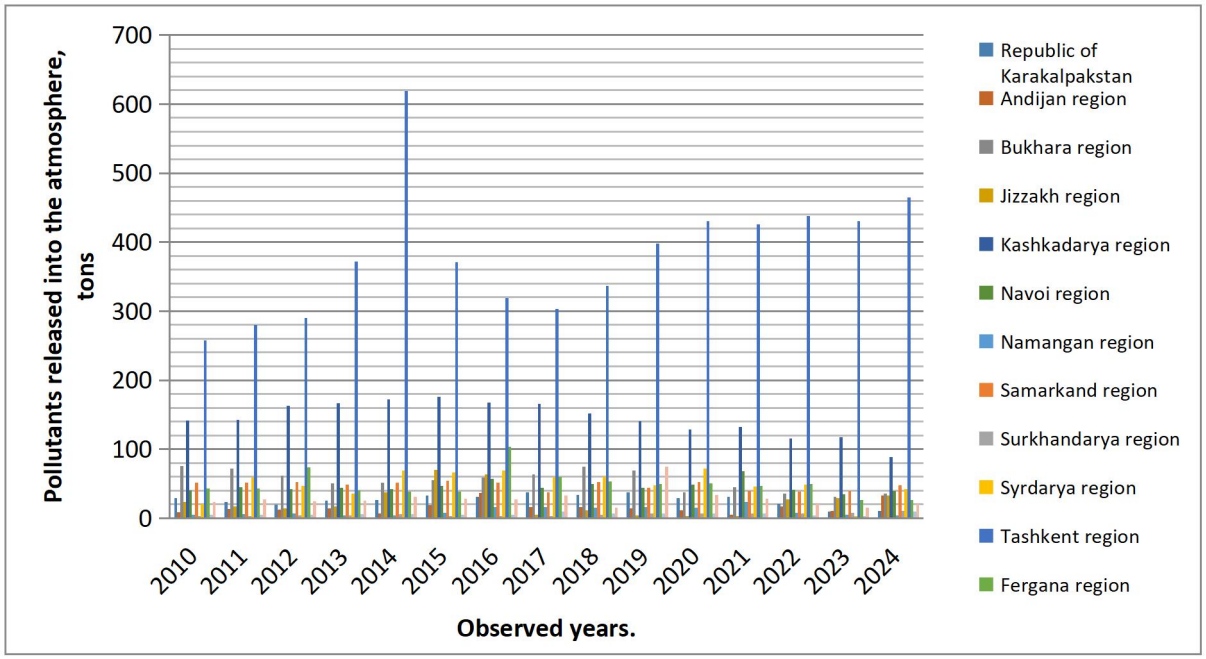

Figure 1. Pollutants released into the atmosphere, tons

The analysis of the statistical data reveals that studying the processes of ensuring ecological sustainability and transitioning to a "green" economy in Uzbekistan requires not only theoretical approaches but also deep empirical evidence. Specifically, the dynamics of harmful substance emissions into the atmosphere across the republic between 2010 and 2024 clearly demonstrate that rapid industrialization, urbanization, and population growth are placing a severe burden on the country's ecological environment. According to the statistical data, the total volume of polluting substances in the Republic of Uzbekistan changed over the years, experiencing sharp spikes in certain periods (for instance, reaching 1162.1 thousand tons in 2014) from 729 thousand tons in 2010, and settling at 866.7 thousand tons by 2024. This situation necessitates the accelerated implementation of strategic decisions aimed at increasing energy efficiency in industrial sectors, reducing carbon emissions, and strengthening environmental monitoring. Particularly at the regional level, the persistence of high emission volumes in major industrial centers such as Tashkent Region (465 thousand tons in 2024) proves how vital it is to "green" the economy and promptly adopt advanced foreign technologies.

Overcoming these ecological challenges makes the experience of the Federal Republic of Germany a crucial comparative benchmark for Uzbekistan, as Germany has successfully achieved a steady reduction in harmful atmospheric emissions while maintaining industrial growth through its "Energiewende" strategy and circular economy principles. Given that Germany's secondary resource recycling rate exceeds 70 percent and its green fiscal policy is firmly established, similar positive outcomes can be attained in Uzbekistan by incentivizing the private sector toward ecological responsibility and expanding "green" taxes and preferential lending mechanisms. Therefore, strengthening scientific and technical cooperation between the two countries, and integrating Germany's advanced engineering solutions and digital monitoring systems with Uzbekistan's natural and climatic potential, will accelerate the achievement of carbon neutrality. Ultimately, this will not only help cut

the energy intensity of the national economy in half but also ensure global competitiveness while creating a safe, clean, and sustainable ecological environment for future generations.

Conclusion. The comparative analysis of the experiences of Uzbekistan and Germany clearly demonstrated that ensuring ecological sustainability and transitioning to a green economy is a top and urgent priority on a global scale. Germany's long-standing institutional reforms, the "Energiewende" strategy, circular economy principles, and corporate sustainability mechanisms are of immense scientific and practical importance for developing countries. In turn, it is noteworthy that in recent years, Uzbekistan has been implementing massive investment projects in solar and wind energy, becoming the center of green transformation in Central Asia. The study revealed that mutually beneficial cooperation between the two countries-integrating Germany's advanced engineering and digital technologies with Uzbekistan's natural-climatic potential and raw material capabilities-will significantly accelerate the achievement of carbon neutrality in the region. Applying these positive foreign experiences in Uzbekistan, particularly introducing regional master plans and artificial intelligence-based analytical systems, incentivizing small and medium-sized businesses toward green innovations, and strengthening the system for training specialists in "green skills," is of vital importance. This, while increasing the global competitiveness of our country's economy, will guarantee a safe, clean, and sustainable ecological environment for future generations.

Conclusion.

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