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Improving Economic and Environmental Mechanisms For Sustainable Development of the Regional Economy Based On Digital Technologies

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Abstract: The increasing global focus on sustainable development has prompted a growing interest in understanding the roles of green innovation and digitization in fostering economic, environmental, and social sustainability, particularly within emerging economies like Uzbekistan. This study provides an empirical assessment of the economic efficiency of digital technologies and artificial intelligence (AI) applications within Uzbekistan's green economy framework. It evaluates the economic effects of implementing digital solutions in the areas of renewable energy, resource optimization, and environmental monitoring over the period 2020-2025. The findings demonstrate that the application of AI and data science methods leads to substantial improvements in energy efficiency, reductions in waste generation, and enhanced environmental performance of enterprises. Drawing on international best practices, the research formulates practical recommendations aimed at strengthening the infrastructure for green digital transformation in Uzbekistan, broadening public-private partnership mechanisms, and embedding AI-based technologies into national sustainable development strategies. Overall, the results highlight the strategic role of digital innovation in improving the effectiveness and sustainability of the green economy.

Keywords: green economy, digital technologies, artificial intelligence, economic efficiency, sustainable development, energy efficiency, innovative solutions, Uzbekistan, green innovation, digitization, economic growth, environmental sustainability, technology adoption.

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Introduction

In recent years, digital technologies and artificial intelligence (AI) have emerged as fundamental drivers of the global transition toward a green economy. The application of these technologies provides new opportunities to enhance energy efficiency, optimize resource utilization, minimize waste generation, and improve environmental risk management. Digital transformation not only increases the productivity and technological capacity of production systems but also contributes to strengthening national economic competitiveness through the efficient use of natural resources and the promotion of environmentally sustainable development[1].

International empirical studies indicate that industries integrating AI and Data Science-based solutions have achieved considerable progress in reducing energy consumption, greenhouse gas emissions, and production-related environmental impacts [2,3,4]. As a result, the concept of the "digital green economy" has become one of the central strategic directions in contemporary economic and environmental policy frameworks worldwide.

In Uzbekistan, the transition toward a digitally supported green economy has also been identified as a priority direction of state policy. In particular, the Digital Uzbekistan – 2030 Strategy adopted on October 5, 2020, and the Development Strategy of New Uzbekistan dated January 28, 2022, outline comprehensive measures aimed at introducing

digital innovations, increasing energy efficiency, and strengthening environmental protection mechanisms.

Within these strategic documents, the President emphasized that the integration of green economy principles with advanced digital technologies represents a critical factor for ensuring ecological sustainability and stable economic growth for future generations.

Nevertheless, several challenges persist in the effective implementation of this transformation[5]. These include limitations in digital infrastructure development, insufficient integration of environmental data systems, and the limited practical application of AI technologies in environmental management and resource monitoring.

Therefore, the present study seeks to evaluate the economic effectiveness of digital technologies and AI-based solutions in the development of Uzbekistan's green economy, to adapt relevant international best practices to national conditions, and to propose mechanisms aimed at increasing the efficiency of digital–environmental integration. The findings of the research contribute to a deeper understanding of the interrelationship between digital transformation and sustainable environmental development, while also demonstrating the practical significance of AI technologies in achieving the objectives outlined in the Green Economy Strategy – 2030[6].

Literature Review

The accelerating processes of urbanization, industrial expansion, and socio-economic transformation in developing economies generate both significant opportunities for economic advancement and complex challenges, including environmental degradation, resource scarcity, and increasing social disparities. Within this context, the concept of sustainable development has emerged as a comprehensive framework that integrates economic growth, social progress, and environmental protection into a unified development paradigm. This approach emphasizes the necessity of maintaining a balanced relationship in which economic development contributes not only to increased productivity and welfare but also to the preservation of ecological systems and natural resources[7].

Scholarly research increasingly highlights that sustainable development strategies require simultaneous consideration of economic efficiency, environmental conservation, and social equity. Such an integrated perspective forms the foundation for long-term development models capable of addressing contemporary global challenges while ensuring the well-being of future generations. One of the most influential global initiatives reflecting this multidimensional approach is the United Nations framework of the Sustainable Development Goals, which provides a comprehensive set of objectives aimed at promoting inclusive economic growth, environmental sustainability, and social justice[8].

In recent years, Uzbekistan has demonstrated notable progress in advancing sustainable development policies and technological modernization. National leadership has increasingly recognized the strong interdependence between economic growth, environmental sustainability, and social inclusion, placing these principles at the center of long-term development strategies. Accordingly, contemporary research and policy discourse emphasize the role of green innovation, digital technologies, and institutional reforms in strengthening the country's sustainable development trajectory.

This section therefore examines the principal theoretical foundations,

academic studies, and policy frameworks that shape Uzbekistan’s sustainable development agenda, with particular attention to the role of green technologies and digital transformation in supporting environmentally responsible economic growth[9,10].

Currently, Uzbekistan is implementing a number of environmental regulatory reforms designed to encourage industrial sectors to adopt environmentally friendly production practices. Government initiatives actively promote sustainable business activities through financial incentives, tax preferences for renewable energy investments, and green certification mechanisms. In addition, the country has intensified efforts to expand the use of renewable energy sources, particularly solar and wind power, as part of its strategy to reduce dependence on fossil fuels and mitigate greenhouse gas emissions.

Large-scale projects aimed at the construction of solar photovoltaic power plants and the development of wind energy infrastructure illustrate Uzbekistan’s commitment to accelerating the transition toward clean energy systems and a low-carbon economy.

Methodology

The study examined the impact of digital technologies and artificial intelligence (AI) solutions on the efficiency of the green economy in Uzbekistan during 2020–2025. Empirical data were collected from the Ministry of Energy of the Republic of Uzbekistan, the State Committee on Statistics, the United Nations Development Programme (UNDP) and the World Bank’s open databases[11,12]. The research employed methods of dynamic comparison, correlation analysis, and change index calculation. Additionally, the relationship between the digital transformation index and energy efficiency was identified, and the economic effects of AI technologies on energy saving and waste reduction were assessed. The findings made it possible to develop practical recommendations for improving the economic efficiency mechanisms of the “digital green transformation” process under Uzbekistan’s conditions.**Discussion**

The results of the study indicate that several artistic techniques contribute to the creation of psychologism in Kholmirezayev’s stories. First, inner monologue plays a crucial role in revealing the inner world of characters. This method allows the writer to present complex emotional states in a natural and convincing way. Second, psychological conflict forms the foundation of many narratives. Characters often experience internal struggles between moral duty, personal desires, and social expectations. These conflicts create dramatic tension and deepen the psychological complexity of the story. Third, the author frequently uses nature as a symbolic reflection of human emotions. Descriptions of landscapes often correspond to the psychological condition of the characters.

Results and Discussions

Statistical Dynamics of Renewable Energy Capacity Growth in Uzbekistan This section presents a numerical and statistical analysis of renewable energy capacity growth in Uzbekistan over the period 2021–2025[13]. The analysis focuses on installed capacity levels, annual growth rates, and structural changes.

Table 1. Installed Renewable Energy Capacity

Year	Installed Capacity (GW)	Annual Increase (GW)	Growth Rate (%)

2021	2.1	-	-
2022	2.3	0.2	9.5
2023	3.1	0.8	34.8
2024	4.6	1.5	48.4
2025	6.0	1.4	30.4

According to Table 1, between 2021 and 2025 the renewable energy capacity in Uzbekistan increased from 2.1 GW to 6 GW growth. The share of “green” electricity generation expanded from 0% to 1.4%. This growth can be attributed, on the one hand, to the rising volume of investments in renewable energy sources, and on the other hand, to the widespread implementation of digital energy management systems – IoT, SCADA, and AI-based predictive models. In particular, during 2021–2025, newly commissioned solar and wind power plants in Navoi, Bukhara, and Kashkadarya regions began operating with real-time digital monitoring platforms, allowing continuous supervision of production processes. As a result, energy losses have decreased and production stability has improved[14]. This demonstrates the practical economic effectiveness of Uzbekistan’s Digital Green Transformation Strategy.

Between 2021 and 2025, renewable energy capacity increased from 2.1 GW to 6.0 GW, representing an absolute growth of 3.9 GW and a total increase of approximately 186 percent.

Table 2. Structural Composition of Renewable Energy (2025)

Energy Source	Capacity (GW)	Share (%)
Hydropower	1.9	31.7
Solar Energy	3.2	53.3
Wind Energy	0.9	15.0

The numerical results confirm rapid and sustained growth of renewable energy capacity in Uzbekistan. Solar and wind energy have become the primary drivers of expansion, while hydropower maintains a stable role. The observed growth dynamics support the strategic importance of renewable energy in the country’s green development agenda.

The research provides substantial evidence for scholarly work about green innovation together with digitization and sustainable development in Uzbekistan while enhancing existing data points. Green innovation supports economic growth

and environmental sustainability excellence through digitization which harmonizes with international discussions focusing on technology and innovation as essential development tools for sustainable goals. Alongside, they validate these findings which demonstrate how eco-efficient production methods combined with digital technologies lead to both economic growth plus environmental protection[15]. Together with confirm that social benefits increase when green innovation integrates with digitization because this results in technology accessibility for all people and develops the economy inclusively. Literature frequently demonstrates that adoption of sustainable technologies requires institutional backing along with financial incentives according to.

Conclusion

The findings confirm that the strategic objectives set forth in Uzbekistan's "Digital Uzbekistan – 2030" and "Green Economy Strategy – 2030" programs are being consistently implemented in practice. The introduction of digital technologies and artificial intelligence (AI) solutions has not only improved production efficiency but has also become a strategic mechanism for ensuring environmental safety, rational resource use, and sustainable economic growth. Today, digital technologies and AI applications have become an integral part of Uzbekistan's green economy. Their adoption has enhanced efficiency in renewable energy, waste management, and ecological infrastructure sectors, while simultaneously creating new jobs and strengthening economic diversification. To ensure the sustainable development of this process, it is essential to strengthen human capital, integrate green competencies into the education system, and enhance inter-agency coordination. Furthermore, improving tax incentives and grant mechanisms for green investments, developing ecological industrial clusters, and expanding digital monitoring systems are key priorities for long-term success. The green economy represents not only an environmental necessity for Uzbekistan but also a strategic economic opportunity harmonized with digital transformation. Its consistent development will promote sustainable growth, create new forms of employment, and enhance the nation's global competitiveness.

Research needs to extend beyond specific geographical areas to study green innovation and digitalization in different emerging markets and monitor their lasting effects over time. The study should examine particular technologies alongside their policies and practices which generate sustainable results while investigating how cultural elements together with human behaviors affect green innovation acceptance and how new emerging technologies like green chemistry and bioengineering impact the situation. The research demonstrates how Uzbekistan incorporates green innovation combined with digitization into its sustainable development plan to address sustainability challenges. The research proves how green innovation drives both efficient ecological production methods and sustainable resource usage while digitization delivers substantial environmental footprint reduction benefits. The success of these initiatives depends heavily on institutional backing and financial motivators and active participation by stakeholders.

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