Determinants of Developing a Regional Green Transformation Model

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Abstract. This article presents the development of the Green Transformation Index (GTI) model aimed at assessing the progress toward a green economy and identifying regional disparities across the regions of Uzbekistan. The index is constructed based on three key environmental indicators: solar energy capacity, waste recycling rate, and the share of water-saving technologies. Using the GTI model, a heatmap and ranking table were created to analyze the ecological status of each region by individual indicators. Specific proposals and strategic solutions were developed for regions with critical issues.

Keywords: Green economy, environmental indicators, Green Transformation Index, renewable energy, waste recycling, water-saving technologies, institutional factor

1 Introduction

In recent years, global ecological threats have been intensifying sharply on an international scale. According to the World Bank's 2024 report, approximately 4.8% of global GDP is lost annually due to environmental degradation, air pollution, climate change, and other ecological challenges [1]. Uzbekistan is also experiencing the impact of these global processes. The country is implementing decisive measures to reduce ecological footprints in the sectors of industry, energy, transport, and agriculture.

The Strategy for Transition to a Green Economy in the Republic of Uzbekistan for 2019-2030, adopted in 2019, sets a target of increasing the share of renewable energy to 25% by 2030. According to the results of 2023, 11.2% of the country's total electricity production came from solar and wind sources—a figure that has grown nearly fivefold compared to 2020 [2].

In particular, newly constructed photovoltaic power stations, waste recycling plants, and environmentally friendly transport systems in the Khorezm, Kashkadarya, and Navoi regions represent a practical manifestation of political will. At the same time, the institutional reforms and the introduction of innovative technologies necessary for ecological transformation are shaping the internal dynamics of these changes.

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According to the United Nations Development Programme's (UNDP) report on Uzbekistan, achieving sustainable development goals is impossible without aligning the economic growth model with environmental security [3]. Especially for a country with a rapidly growing population, the efficient use of natural resources such as water, air, and land has become not only an economic concern but also a matter of strategic security.

2 Methods

The ecological transformation of the economy is not only a pressing issue but also a necessary strategic direction for Uzbekistan's sustainable development. The success of this transformation largely depends on strong institutional foundations, advanced technologies, and innovative approaches.

Issues related to the ecological transformation of the economy, the transition to a green economy, and the achievement of sustainable development have become a central focus not only in practical terms but also from a theoretical and academic perspective. On a global scale, scholars such as Stiglitz, Stern, and Jackson have analyzed these issues from a scientific standpoint [4, 5, 6]. In their research, they emphasize the importance of aligning sustainable growth with ecological limits. In particular, Jackson's work on prosperity without growth presents well-founded theoretical approaches to the balance between economic growth and environmental sustainability [7].

In the context of Uzbekistan, the number of scientific studies devoted to this subject is steadily increasing. Researchers such as Akhmedov, Ruzmetov, Zamanbekov, Nurmetov, Hasanov, and Kadirov [8, 9, 10, 11, 12, 13] have published a number of articles on ecological economics, green financing, innovative governance mechanisms, and the integration of resource-saving technologies into economic sectors.

In addition, the Resolution No. 368 of the Cabinet of Ministers of the Republic of Uzbekistan, adopted on June 18, 2024, titled 'On Measures to Improve the System of Supporting Green Public Procurement,' established a framework for aligning state procurement processes with environmental criteria as part of the transition to a green economy. According to the resolution, by 2030, at least 30 percent of public procurement is to be classified as green, with priority and incentives granted to business entities holding environmental labeling [14].

Successful implementation of ecological transformation requires a robust institutional framework. This includes a comprehensive legal-regulatory base, policy continuity, inter-institutional coordination, active involvement of civil society, and the adoption of decentralized and democratic forms of environmental governance. In recent years, Uzbekistan has made significant progress in this direction. In particular: (1) A roadmap until 2030 has been developed under the framework of the Strategy for Transition to a Green Economy; (2) The Environmental Code has been introduced into practice, creating a unified legal foundation for natural resource use and waste management; (3) Coordination of environmental policy among governance institutions such as the Ministry of Ecology, the Green Energy Agency, the Center for Green Technologies, and local authorities is being strengthened.

3 Results and Discussion

According to the 2023 Monitoring Report of the United Nations Development Programme (UNDP), Uzbekistan ranked 4th among CIS countries in terms of the institutional development of environmental legislation [15]. At the same time, the effective implementation of this policy requires sufficient local-level capacity, adequate budgetary resources, and active cooperation with international financial institutions.

Innovative technologies play a decisive role in accelerating ecological transformation. Thanks to new technologies, energy consumption and waste generation in production processes are reduced, while the efficiency of resource utilization increases. In particular, the following areas have become the main focus of innovative approaches: renewable energy technologies (solar panels, wind turbines); smart water supply and irrigation systems (sensor-based control, drip irrigation); waste separation and recycling complexes; energy-efficient transportation systems (electric vehicles); and environmental monitoring systems based on artificial intelligence, IoT, and GIS technologies.

Although ecological transformation is viewed within the framework of national policy, a regional approach must be considered a fundamental principle in its implementation. Each region should have its own transformation path based on its specific natural-climatic conditions, existing economic sectors, and infrastructure.

The transition of Uzbekistan's regions to a green economy has been assessed based on three key indicators: solar energy capacity, the level of waste recycling, and the share of water-saving technologies.

Table 1. Model indicators and scoring criteria*

NO.	INDICATOR	HIGH (1 POINT)	MEDIUM (0.5 POINT)	LOW (0 POINT)
1	Solar Energy capacity (MW)	> 200	150 – 200	< 150
2	Waste Recycling rate (%)	> 35%	25% – 35%	< 25%
3	Share of Water-Saving Technologies (%)	> 35%	28% – 35%	< 28%

Source: Authors' work.

The developed Green Transformation Index (GTI) model is based on the following three key indicators and is calculated for each region individually:

$$GTI = (SE \times B_1 + WR \times B_2 + WT \times B_3) / 3 \quad (1)$$

Where:

GTI = The regional Green Transformation Index (on a scale from 0 to 3)
SE = solar energy capacity in the region (MW)
WR = The waste recycling rate in the region (%)
WT = The share of water-saving technologies in the region (%)
B_1, B_2, B_3 = Scoring functions for each indicator (0, 0.5 or 1)

The purpose of the model is to systematically and quantitatively assess the status of Uzbekistan's regions in their transition to a green economy, to classify them based on their performance, and to develop tailored strategic solutions for each region.

Table 2. Status of Green Transformation Indexes in the Regions of Uzbekistan (2024)*

No	Region	Solar energy (mw)	score	Waste recycling (%)	score	Water-saving technologies (%)	score	Total score	Category
1	Tashkent City	210	1	41.0	1	44.0	1	3.0	Green Leader
2	Tashkent Region	190	0.5	37.5	1	39.5	1	2.5	Emerging Region
3	Andijan	135	0	31.0	0.5	30.5	0.5	1.0	Lagging Region
4	Namangan	130	0	28.0	0	28.5	0.5	0.5	Environmentally Risky Region
5	Fergana	145	0	34.5	0.5	32.5	0.5	1.0	Lagging Region
6	Syrdarya	118	0	24.0	0	26.0	0	0.0	Environmentally Risky Region
7	Jizzakh	125	0	25.5	0	27.0	0	0.0	Environmentally Risky Region
8	Samarkand	245	1	32.0	0.5	34.5	0.5	2.0	Emerging Region
9	Bukhara	215	1	36.0	1	35.0	0.5	2.5	Green Leader
10	Navoi	255	1	38.5	1	40.0	1	3.0	Green Leader
11	Kashkadarya	165	0.5	26.0	0	29.0	0.5	1.0	Lagging Region
12	Surkhandarya	155	0.5	18.0	0	23.0	0	0.5	Environmentally Risky Region
13	Khorezm	90	0	24.0	0	42.0	1	1.0	Lagging Region
14	Republic of Karakalpakstan	195	0.5	22.0	0	31.0	0.5	1.0	Lagging Region

*Source: Authors' work

The significance of this model lies in its ability to serve multiple levels of objectives. First, it acts as a scientifically grounded analytical tool that helps identify disparities between regions. Second, it provides a useful guide for policymakers in planning regional ecological transformation. Third, the model can be used to present concrete recommendations to international partners and donor organizations, allowing for well-justified allocation of grant funding.

Another important aspect is that the Green Transformation Index (GTI) model can be applied on an annual basis. This enables dynamic monitoring over time, assessment of reform effectiveness, and implementation of necessary adjustments.

According to the analysis results, Uzbekistan's regions are progressing at different levels in the transition toward green transformation. Tashkent City and Navoi Region, each scoring 3.0 points, were classified as Green Leaders. In these regions, renewable energy technologies have been widely introduced, and innovations in waste and water resource management are actively implemented.

4 Conclusion

The Green Transformation Index presents a strategic and effective tool for evaluating the ecological and economic development of Uzbekistan's regions. This research demonstrates that regional approaches to green economy transition must be tailored to local conditions, infrastructure capabilities, and existing economic structures. The model successfully identifies both leading regions and those requiring urgent intervention, enabling policymakers to allocate resources more efficiently. Future implementation of GTI on an annual basis will facilitate continuous monitoring and adaptive management of ecological transformation across all regions. The findings underscore the importance of integrating technological innovation, institutional reform, and inter-regional coordination as the foundation for Uzbekistan's sustainable economic development.

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