

TRANSFORMATION OF THE CIRCULAR ECONOMY IN UZBEKISTAN: ANALYSIS OF WASTE MANAGEMENT INFRASTRUCTURE, POLICY, AND PRACTICAL REFORMS

<https://doi.org/10.5281/zenodo.20677384>

Hasanov Sh. Sh.

*Researcher at the Institute for Macroeconomic
and Regional Studies under the Cabinet of
Ministers of the Republic of Uzbekistan*

Annotation

This article provides a scientific examination of the circular economy as a key driver of economic sustainability. The research explores the state policy of the Republic of Uzbekistan focused on introducing circular economy principles, along with its regulatory foundations and practical initiatives aimed at upgrading and modernizing the waste management system. The study draws on statistical evidence concerning municipal waste generation, recycling performance, the expansion of specialized waste collection fleets, and improvements in landfill management and optimization. In addition, it highlights the ongoing development of recycling infrastructure, the formation of eco-industrial parks, the utilization of waste as an energy resource, and the integration of digital technologies into waste management processes. Based on the findings, the article formulates practical recommendations aimed at accelerating the development of the circular economy in Uzbekistan. These include strengthening waste segregation systems, supporting recycling industries, and raising public awareness regarding environmental responsibility and sustainable consumption practices.

Keywords

circular economy, economic sustainability, waste management, recycling, green economy, environmental sustainability, eco-industrial parks, resource efficiency, waste landfills, digital technologies.

Introduction

In recent years in Uzbekistan, the development of a circular economy has been becoming one of the strategic directions in the state's long-term economic and environmental policy. This approach is closely linked with the concept of a "green economy," the core essence of which is efficient and rational use of resources, minimization of waste generation, increasing the level of recycling, and the gradual introduction of closed-loop principles in production processes. The essence of a

circular economy lies in the fact that at every stage of the production and consumption chain, waste generated is reintegrated into the system as economically valuable resources and incorporated into the process of creating new products.

At the same time, large-scale reforms are being implemented in the country to put this direction into practice. In particular, systematic efforts are being carried out to introduce resource- and energy-efficient technologies in industrial sectors, expand infrastructure intended for waste recycling, and strengthen circular approaches in sectors such as agriculture and textiles. In addition, the industrial symbiosis model is being developed through the formation of eco-industrial parks, where a mechanism is gradually being established in which waste generated by one enterprise is used as raw material for another enterprise. Improving energy efficiency, as well as the widespread introduction of renewable energy sources, is also being developed as an integral component of the circular economy.

A key institutional basis for strengthening this direction is the Resolution of the President of the Republic of Uzbekistan No. PQ-436, adopted on 2 December 2022. This document is aimed at implementing the “Strategy for the Transition of the Republic of Uzbekistan to a Green Economy in 2022–2026,” and it defines specific mechanisms, priority directions, and a phased implementation roadmap for the formation of an environmentally sustainable economic model. Within the framework of this resolution, the efficient use of resources, reduction of energy and raw material consumption in production processes, reduction of waste, and development of waste recycling systems are defined as key strategic objectives.

One of the important aspects of this document is the expansion of waste sorting and recycling infrastructure, the formation of a secondary raw materials market, and the development of mechanisms for returning waste into economic circulation through the implementation of closed-loop production systems. On this basis, necessary conditions are being created for the deep integration of circular economy principles into industrial and production processes. Furthermore, the establishment and development of eco-industrial parks is also identified as one of the priority directions within the framework of the resolution. These parks serve to form a system of resource exchange among industrial enterprises, thereby enabling the practical implementation of the industrial symbiosis model in which the waste of one enterprise becomes additional raw material for another. As a result, the level of comprehensive and efficient resource utilization increases significantly.

At the same time, the resolution also places special emphasis on improving energy efficiency and expanding renewable energy sources. In this regard, reducing the energy intensity of economic sectors, decreasing greenhouse gas

emissions, and accelerating decarbonization processes are defined as the main objectives for achieving environmental sustainability. Moreover, mechanisms for financial support of the transition to a green economy are being developed, including attracting green investments, expanding cooperation with international financial institutions, and establishing a systematic approach aimed at incentivizing environmental projects.

In parallel, within the framework of the “Uzbekistan–2030” Strategy, issues of sustainable development, transition to a green economy, and rational use of resources are also defined as priority directions. This strategic document sets specific goals for the development of environmentally safe production, modernization of the waste management system, and expansion of the recycling industry. In practical terms, through annually adopted state programs and sectoral roadmaps, comprehensive measures are being consistently implemented to improve the waste management system, expand recycling capacities, and increase energy efficiency. These measures serve as a practical mechanism for the implementation of circular economy principles in real economic processes.

Literature review

The circular economy is one of the key conceptual directions of modern economic development, which prioritizes the rational use of resources, recycling of waste, and the stabilization of production and consumption processes as its main objectives. In the research conducted by local economist Z. Sodiqov, the advantages of this model, global practical experiences, and the possibilities of its implementation within the national economy have been deeply analyzed. According to his scientific conclusions, the circular economy is not merely an environmental approach, but a new paradigm of economic development that contributes to increasing resource efficiency and optimizing production processes. In general, the circular economy has been formed as a sustainable economic model aimed at ensuring resource conservation, reducing waste volumes, and protecting the environment. This approach fundamentally differs from the traditional linear economy, where products follow a “take–make–dispose” sequence, whereas in a circular system resources remain in continuous circulation and are directed toward maximum reuse and recycling.

The core essence of this model lies in minimizing waste generated within economic processes as much as possible, while simultaneously reusing it as secondary raw material in other production cycles. In addition, at the product design stage, special attention is given to ensuring long service life, ease of repair, and environmentally safe decomposition properties. This, in turn, contributes to improving resource efficiency throughout the entire life cycle of products. The

transition to a circular economy requires not only a transformation of economic structures but also a fundamental reconsideration of traditional approaches to production and consumption. This process is closely associated with the introduction of new technologies, the development of innovative infrastructure, and the reorganization of production chains. Therefore, the effective functioning of the circular economy relies on strategic and institutional mechanisms that ensure the consistent implementation of its core principles throughout the entire product life cycle.

Furthermore, in this approach, consumers and producers also play a crucial role. By choosing environmentally sustainable products that have long service lives and are suitable for recycling, they actively contribute to environmental protection processes. This, in turn, not only increases ecological awareness but also supports efforts to combat climate change. As a result, the circular economy emerges as a complex economic system that ensures efficient resource use, significant waste reduction, and long-term sustainable development. Its main advantage lies in its ability to simultaneously integrate economic growth, environmental balance, and social well-being.

Another local researcher, A. Hakimov, in his studies pays special attention to green investment strategies based on the principles of the circular economy¹⁹. According to him, green investment strategies grounded in circular economy principles play an important role in ensuring environmental sustainability, economic growth, and social welfare. The study demonstrated that investments directed toward efficient resource use, renewable energy, and waste recycling serve as an effective tool in addressing both global economic and environmental challenges.

At this point, economists J. Kirchherr, D. Reike, and M. Hekkert, in their research, introduced the core “3R” principle (reduce, reuse, recycle) and further developed this approach into more complex hierarchies, such as 4R, 9R, and 10R frameworks²⁰. These extended strategies incorporate additional mechanisms such as “refuse,” “redesign,” “repair,” “refurbish,” “repurpose,” “remanufacture,” and “recover.” In our view, these scientific approaches serve to narrow resource flows through improved efficiency, slow them down by extending product lifespans, and close material loops through enhanced recovery and recycling processes. The primary objective is to preserve the functional and economic value of products,

¹⁹ Hakimov, A. (2025). Sirkulyar iqtisodiyot tamoyillariga asoslangan yashil investitsiya strategiyalari. GREEN ECONOMY AND DEVELOPMENT, 3. <https://doi.org/10.5281/zenodo.17111311>

²⁰ Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: An analysis of 114 definitions. Resour. Conserv. Recycl. 127, 221–232. <https://www.sciencedirect.com/science/article/pii/S0921344917302835>

components, and materials for as long as possible, thereby reducing the extraction of new raw materials and minimizing waste generation.

Researchers such as N. M. Bocken, I. De Pauw, and C. Bakker consider modern design approaches to be a significant opportunity for advancing the circular economy²¹. In particular, they place strong emphasis on product repairability and standardization. According to their perspective, products should be designed in such a way that they have long service lives and can adapt to various conditions. This constitutes one of the fundamental principles of strategic design. At the same time, they highlight the importance of distinguishing between ownership and usage. In other words, instead of purchasing products outright, systems are emerging in which products are accessed as services. These include service-based models known as Product-Service Systems (PSS), as well as leasing and rental arrangements. Such approaches contribute to ensuring sustainability.

Furthermore, studies by M. Geissdoerfer, M. P. Pieroni, and D. C. Pigosso emphasize the importance of considering the entire life cycle of a product²². These approaches take into account all stages, from product creation to use and end-of-life. For instance, systems such as “cradle-to-grave” and “cradle-to-cradle” are employed to evaluate the environmental impact of products. To conduct such assessments, specialized methodologies are utilized, including Life Cycle Assessment (LCA) and Material Flow Analysis (MFA). These tools enable a comprehensive and accurate evaluation of a product’s environmental impact.

In our view, the approaches advanced by these researchers constitute an important theoretical and practical foundation for the development of the modern circular economy concept. Supporting their arguments, it can be stated that designing products for long-term use, while ensuring repairability and adaptability, is particularly relevant under current conditions of resource scarcity. This is because the traditional model oriented toward short-term consumption exacerbates environmental problems. At the same time, although the idea of shifting from ownership to usage (i.e., Product-Service System (PSS) models) appears highly effective in theory, we believe that a number of challenges arise in its practical implementation. In particular, consumers’ psychological inclination toward ownership, the insufficient development of infrastructure, and the complexity of service delivery systems may slow down this transition. Therefore, in implementing such models, it is necessary to take into account not only design

²¹ Bocken, N.M., De Pauw, I., Bakker, C., Van Der Grinten, B., 2016. Product design and business model strategies for a circular economy. *J. Ind. Prod. Eng.* 33 (5), 308–320.

<https://www.tandfonline.com/doi/full/10.1080/21681015.2016.1172124>

²² Geissdoerfer, M., Pieroni, M.P., Pigosso, D.C., Soufani, K., 2020. Circular business models: A review. *J. Clean. Prod.* 277, 123741. <https://www.sciencedirect.com/science/article/abs/pii/S0959652620337860>

considerations but also social and economic factors in a comprehensive manner. While the approaches proposed by these scholars represent a significant step toward sustainable development, their effective implementation requires the integrated advancement of technological solutions alongside social awareness, economic incentives, and public policy frameworks.

Empirical studies conducted by foreign scholars F. Psarommatis and G. May demonstrate that higher-level strategies—such as recycling, refurbishment (i.e., product restoration), and extending product service life—yield the greatest environmental benefits²³. The primary reason for this is that such approaches significantly reduce the need for the production of new products. As a result, less raw material and energy are consumed, while the utilization period of existing materials is substantially prolonged. For example, in the construction sector, reusing certain structural elements of existing buildings or infrastructures (such as metal or concrete components) causes considerably less environmental harm compared to producing new materials or even recycling them. In particular, this process leads to a substantial reduction in harmful emissions released into the atmosphere.

Moreover, these contemporary approaches are increasingly being implemented more effectively through the use of digital technologies. For instance, Internet of Things (IoT) technologies enable continuous monitoring of the condition of products and materials. Blockchain technology ensures data transparency and reliability, allowing for precise tracking of the origin and usage history of products. In addition, additive manufacturing (i.e., 3D printing technologies) makes it possible to produce complex components quickly and with high precision, thereby facilitating the restoration of spare parts. Consequently, reverse logistics (i.e., the processes of collecting and reprocessing used products) becomes more streamlined, and overall circular economic operations can be organized more efficiently.

The approaches proposed by the above-mentioned scholars clearly identify the most practically effective directions of the circular economy. In our view, their emphasis on recycling, refurbishment, and extending product lifespans is both justified and well-founded, as these strategies enable the maximum utilization of resources. In particular, the idea of reducing environmental burdens by decreasing the volume of new production is relevant under the conditions of today's global climate challenges. At the same time, we argue that the effectiveness of these approaches largely depends on the sector and the specific conditions in which they are applied. For instance, in the construction industry, the reuse of structural

²³ Psarommatis, F., May, G., 2025. A cost-benefit model for sustainable product reuse and repurposing in circular remanufacturing. *Sustainability* 17 (1), 245. <https://www.mdpi.com/2071-1050/17/1/245>

elements may not always comply with technical and safety requirements. The strength, compliance with standards, and long-term reliability of reused materials require thorough testing and monitoring. Therefore, alongside environmental benefits, issues of technical safety must also be treated as a priority.

The application of digital technologies – such as the Internet of Things (IoT), blockchain, and additive manufacturing – can significantly enhance these systems. However, their implementation requires substantial investment, advanced technological infrastructure, and a highly skilled workforce. This process may be particularly slow in developing countries. Moreover, excessive reliance on digital systems may introduce new challenges related to cybersecurity and data protection.

Nevertheless, researchers such as T. Makov and D. Font Vivanco have pointed out that there are inherent limitations in the implementation of circular strategies. Although recycling plays a central role in many circular systems, it faces challenges such as quality degradation (downcycling), high energy consumption, and inefficient material recovery systems²⁴. Furthermore, as highlighted in the works of J. Warmington-Lundström and R. Laurenti, the “rebound effect” – where increased efficiency leads to lower costs and consequently higher consumption – may partially or even completely offset environmental benefits. For this reason, other scholars have also emphasized that high-impact strategies, such as long-life design, should be prioritized, and that circular practices need to be supported by robust sustainability assessment tools.

In addition, other international scholars, including E. J. Prosman and R. Cagliano, in their scientific studies, have demonstrated that refurbishment and repair are emerging as key pillars of the circular economy, offering significant opportunities for resource savings and value recovery. Case studies from the manufacturing sector, particularly those involving advanced technologies such as automation and digital twins, illustrate the economic and environmental advantages of refurbishment. At the same time, successful implementation depends on several critical factors, including product design, consumer acceptance, and institutional support mechanisms such as standardized certification systems and reverse logistics

From our perspective, the approaches advanced by the aforementioned researchers contribute to the formation of a more critical and realistic view of the circular economy. Their observations regarding the challenges inherent in recycling processes – such as quality degradation, high energy consumption, and low system efficiency – are well-founded and reflect situations frequently encountered in

²⁴ Rigamonti, L., Mancini, E., 2021. Life cycle assessment and circularity indicators. *Int. J. Life Cycle Assess.* 26, 1937–1942.

practice. In particular, the concept of the “rebound effect” is highly significant, as it demonstrates that increased efficiency may lead to higher levels of consumption, thereby diminishing the anticipated environmental benefits. At the same time, prioritizing refurbishment and repair appears, in our opinion, to be one of the most appropriate directions, since these approaches not only conserve resources but also preserve existing value to the greatest possible extent. However, the large-scale implementation of such strategies depends not only on technological advancements but also directly on consumer attitudes, product design, and institutional support systems. Thus, the above-mentioned approaches reveal not only the opportunities of the circular economy but also its limitations, thereby substantiating the need for a more balanced and comprehensive framework.

Empirical studies indicate that the application of circular strategies across various sectors yields positive outcomes in terms of environmental performance and efficient resource utilization. However, these results are not uniform and vary depending on specific conditions and contexts. In other words, the success of the circular economy is directly contingent upon how and under what circumstances it is implemented. In some cases, trade-offs arise between different strategies, making strategic balance essential for achieving optimal outcomes. This implies aligning product service lifetimes with the level of technological development, improving the efficiency of recycling processes, and mitigating the rebound effect (i.e., the increase in consumption resulting from improved efficiency) through appropriate public policies and regulatory measures.

In implementing the circular economy, reverse logistics (i.e., the collection and return of used products) and closed-loop supply chains play a crucial role. However, these systems often encounter difficulties due to insufficient regulatory harmonization and high operational costs. Researchers such as B. Corona, L. Shen, D. Reike, and J. R. Carreón emphasize the need to further refine assessment methodologies. They propose the combined use of dynamic and outcome-oriented Life Cycle Assessment (LCA) alongside indicators such as the Material Circularity Indicator (MCI)²⁵. This integrated approach enables a more accurate evaluation of a product’s environmental impact and circular performance over multiple use cycles.

At the same time, it is acknowledged that LCA methodologies still require further development. In particular, there is a need to improve existing methods in terms of accounting for multiple life cycles, the quality degradation of secondary materials, and long-term temporal factors. Overall, the scientific literature confirms that circular strategies can be applied across a wide range of sectors. However, in

²⁵ Corona, B., Shen, L., Reike, D., Carreón, J.R., Worrell, E., 2019. Towards sustainable development through the circular economy—A review and critical assessment on current circularity metrics. *Resour. Conserv. Recycl.* 151, 104498

practice, high-value strategies (such as refurbishment and reuse) are less frequently implemented. This is primarily due to their complexity, institutional constraints, and issues related to consumer behavior. In contrast, relatively simpler and more easily implementable strategies, such as recycling, are more widely adopted. To address these challenges, scholars emphasize the importance of bridging the gap between theoretical approaches and practical implementation. Achieving this requires systemic approaches, multi-level reforms, and the coherent alignment of public policy frameworks.

We argue that these approaches contribute to a deeper understanding of the effectiveness of the circular economy not only from a theoretical perspective but also in practical terms. In particular, the assertion regarding the need to adapt strategies to different contexts is well-founded, as each sector and region possesses its own specific economic, technological, and institutional conditions. Therefore, it is correctly emphasized that no single universal solution exists, and that a flexible, context-sensitive approach is required in each case. Moreover, the consideration of the “rebound effect” is of critical importance. In many instances, despite improvements in efficiency, the overall volume of consumption increases, thereby preventing the full realization of the expected environmental benefits. This underscores the necessity of supporting circular strategies not only through technical measures but also through public policy, regulatory frameworks, and transformations in consumption culture.

At the same time, the limited practical adoption of high-value strategies (such as refurbishment and reuse) emerges as a significant challenge. In our view, this situation is обусловлено not only by their inherent complexity but also by the predominance of short-term economic interests for businesses. As a result, relatively simpler and more rapidly implementable strategies, such as recycling, are more widely applied in practice. In conclusion, these approaches provide an important scientific foundation for the advancement of the circular economy. However, their effective implementation requires strengthening the coherence between systemic approaches, policy support, and practical mechanisms.

Analysis and Evaluation

The reforms implemented in Uzbekistan’s waste management sector in 2025 can be observed across several key areas. As a result of measures carried out during the year by the Waste Management and Circular Economy Development Agency under the State Committee for Ecology, 8,105 out of 9,452 mahallas across the country – covering 23.9 million out of a total population of 37.5 million – were provided with sanitary waste collection services at the community level. By the end of 2025, a total of 15.1 million tons of municipal solid waste had been generated

nationwide, while payments collected from the population for waste management services amounted to 1.304 trillion soums. It is important to note that outstanding receivables from the population for these services reached 622.7 billion soums. Additionally, 211.9 billion soums of non-real receivables – previously accrued for services not actually rendered – were removed from the electronic billing system.

In 2024, municipal waste generation was reported at 14.8 million tons, indicating an increase in both economic activity and consumption levels among the population. At the same time, waste transportation operations were also carried out, including the removal of 41.3 million cubic meters of municipal and other types of waste. However, one of the key indicators of a circular economy – the waste recycling rate – remains relatively low. In 2024, only about 5–5.2% of the total 14.8 million tons of generated waste was recycled. Other sources similarly indicate that only around 5% of the approximately 14 million tons of annual waste in Uzbekistan is recycled. For instance, during the first half of the year, out of 5.2 million tons of waste generated, only 270,000 tons (5.2%) were processed.

Significant steps toward the development of a circular economy include the continuous operation of the “Toza Makon” unified electronic billing system, the establishment of eco-industrial zones in six regions, and the creation of 14 transfer stations across 11 regions. Furthermore, waste-to-energy plants utilizing thermal processing technologies are being constructed in Andijan, Kashkadarya, Namangan, Samarkand, Tashkent, and Fergana regions. In addition, projects for generating thermal energy through the incineration of medical waste have been implemented in Tashkent city, as well as in Samarkand and Bukhara regions. These initiatives represent substantial progress toward building a circular economic model.

As of 2025, 79 waste collection vehicles and 220 containers have been delivered to sanitation enterprises. GPS tracking devices have been installed on 3,230 specialized waste collection vehicles. The performance efficiency of 113 sanitation enterprises is now being systematically evaluated. Moreover, 21,300 appeals from individuals and legal entities related to the sector have been reviewed, demonstrating increased public engagement and attention to the field. Additionally, the operations of 23 municipal solid waste landfills covering nearly 100 hectares have been terminated²⁶.

Data on waste composition indicate that plastic waste constitutes a significant share of total municipal waste. Specifically, approximately 10.3% of annual waste is composed of plastics. Other statistics suggest that this share may be increasing, with some estimates placing plastic waste at around 15% of total waste, while also

²⁶ <https://gov.uz/oz/sanitation>

highlighting insufficient recycling capacity for such materials. Infrastructure-related data further show that during 2024–2025, a total of 42 landfills were closed and rehabilitated as part of efforts to improve the waste management system, with an additional 18 landfills planned for closure by the end of 2025. These developments reflect ongoing infrastructural reforms aimed at strengthening the waste management system.

Overall, the statistical data demonstrate that Uzbekistan is gradually achieving progress in transitioning to a circular economy by reducing waste volumes, expanding recycling capacity, and developing infrastructure. However, the current recycling rate remains low. If government policies continue and cooperation between businesses and citizens is strengthened, it will be possible to establish a more efficient and sustainable waste management system. In the Republic of Uzbekistan, the effective and active use of specialized waste collection equipment plays a crucial role in advancing the circular economy. Accordingly, the number of such specialized vehicles has been steadily increasing over the years. Specifically, the number of waste collection vehicles in Uzbekistan was 1,461 in 2017, 1,893 in 2018, 2,565 in 2020, and 3,044 in 2022, reaching 3,390 units by 2024 (Figure 1).

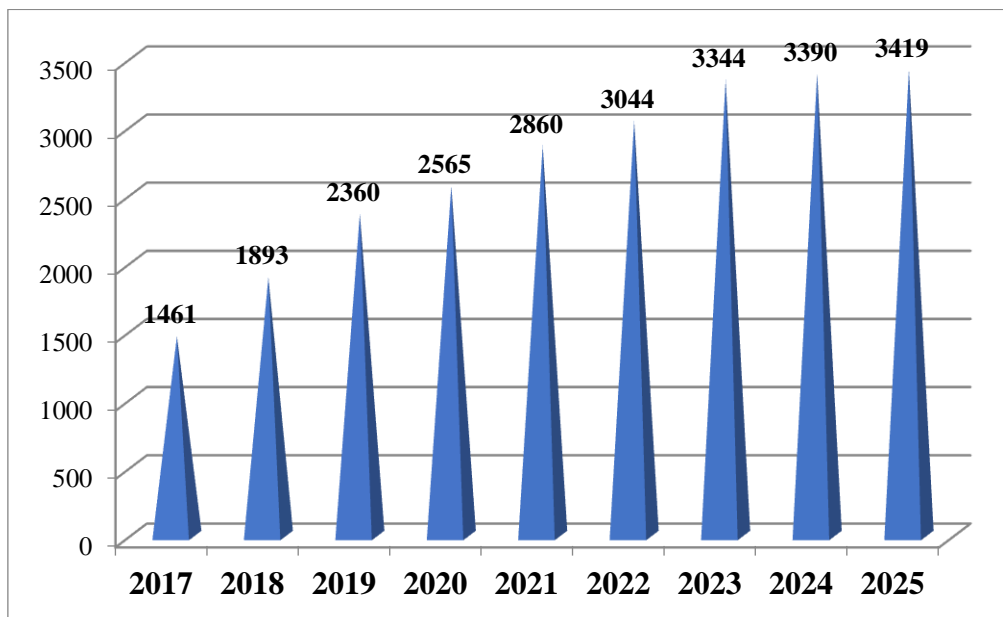


Figure 1. Number of specialized waste collection vehicles in Uzbekistan”²⁷

First, an increase in the number of waste collection vehicles expands the capacity to collect waste in a timely and comprehensive manner. This, in turn, reduces the negative environmental impacts of improperly managed waste and

²⁷ <https://gov.uz/oz/sanitation>

helps prevent instances of illegal dumping. One of the core principles of the circular economy is the treatment of waste as a resource to be recovered and reused. The expansion of specialized collection equipment enhances the efficiency of centralized waste collection and facilitates the effective transportation of waste to recycling and processing facilities.

Second, the growth in the number of waste collection vehicles contributes to the development of the necessary infrastructure for waste sorting and recycling systems. Within the framework of a circular economy, the transformation of waste into secondary raw materials is of critical importance. When a sufficient number of specialized vehicles is available, opportunities increase for the separate collection of paper, plastic, metal, and organic waste streams. As a result, recycling rates improve, and the reliance on primary natural resources in the production of new goods is significantly reduced.

Third, the increase in waste collection vehicles plays a vital role in improving sanitary conditions in both urban and rural areas. A cleaner environment alleviates the burden on public health systems and enhances the overall quality of life for the population. This aligns closely with the socially sustainable development principles embedded in the circular economy paradigm.

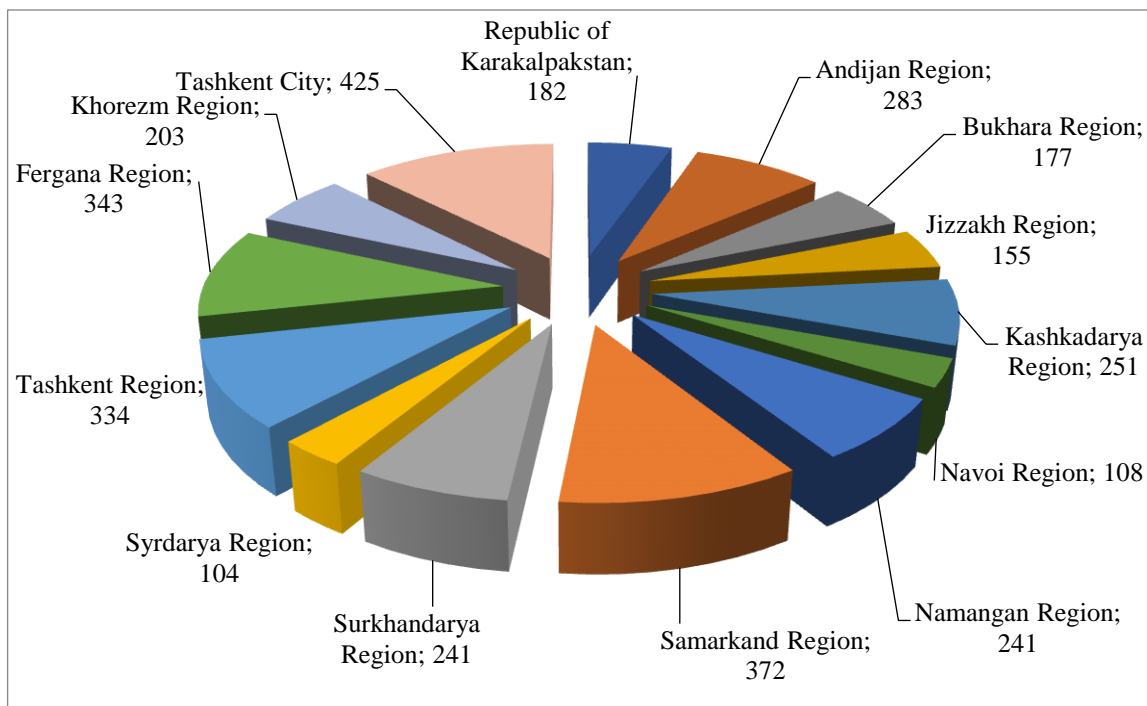


Figure 2. Distribution of specialized waste collection equipment across the regions of Uzbekistan, units (2025) ²⁸

²⁸ <https://gov.uz/oz/sanitation>

Fourth, the development of the waste collection system contributes to the creation of new jobs and the expansion of the service sector. The operation of specialized equipment, maintenance services, waste sorting, and recycling processes all increase the demand for additional labor resources. This, in turn, has a positive impact on economic growth and employment levels. Fifth, the increase in the number of specialized waste collection vehicles enhances the economic efficiency of the circular economy. Through recycling processes, the production volume of secondary raw materials rises, the demand for certain imported raw materials declines, and opportunities for local production expand. As a result, the overall efficiency of resource utilization within the economy improves.

In general, the continuous increase in the number of specialized waste collection vehicles in Uzbekistan serves as a key factor in strengthening the infrastructure of the circular economy, ensuring effective waste management, promoting environmental sustainability, and improving economic efficiency. This process creates a solid foundation for increasing recycling rates and for the formation of a modern economic model based on the rational use of resources in the future. The improvement of the waste management system and the implementation of circular economy principles in the Republic of Uzbekistan are among the priority directions of state policy. In this regard, the Presidential Decree No. 5, dated January 4, 2024, serves as an important regulatory and legal framework. In accordance with this decree, regular monitoring of waste landfills has been established by the Directorate for Waste Landfill Management under the Agency for Waste Management and Circular Economy Development, and their activities are being systematically regulated in order to enhance the efficiency of waste management, ensure environmental safety, and protect the environment.

According to available data, there are currently 228 waste landfills operating across the republic, occupying a total area of 1,824 hectares. Of these, 199 are designated for municipal solid waste, 15 for hazardous chemical waste, and 14 for construction waste. In recent years, consistent measures have been undertaken to optimize landfill operations and strengthen environmental safety. In particular, during 2024–2025, a total of 47 municipal solid waste landfills were reclaimed and decommissioned in eight regions of the country—namely the Republic of Karakalpakstan and the regions of Andijan, Bukhara, Kashkadarya, Namangan, Samarkand, Tashkent, Fergana, and Khorezm. As a result of these measures, approximately 243 hectares of land have been restored to nature. At the same time, based on an approved schedule, regular soil covering operations are being carried out at 132 active landfills across the republic. These measures are aimed at ensuring compliance with sanitary and hygienic standards, reducing the emission of harmful

substances into the atmosphere, and minimizing negative environmental impacts. According to statistical data, between January and October 2025, a total of 2.6 million tons of waste were received at landfills. As a result of strengthened monitoring mechanisms, the daily volume of waste accepted in the regions increased from 8,500 tons to 13,000 tons, creating an additional capacity to receive up to 4,500 tons of waste per day²⁹.

In order to improve efficiency in waste management processes, an additional 22 units of specialized equipment were procured on a leasing basis and delivered to regional landfills. Consequently, the total number of specialized machinery used in waste management—including vacuum trucks, dump trucks, loaders, bulldozers, compactors, excavators, trailers, semi-trailers, and truck cranes—has reached 333 units. Within the framework of technical base modernization, since the beginning of the year, 154 units of specialized equipment have undergone current and capital repairs, financed by 1.7 billion Uzbek soums. In addition, GPS devices have been installed on 218 units of existing machinery, enabling the introduction of a remote monitoring system for tracking their movement. These measures contribute to the optimization of logistics processes and the improvement of equipment efficiency. In order to enhance the landscaping of landfill areas and strengthen environmental sustainability, 1.2 million trees and shrubs were planted around landfill sites during 2024–2025 as part of the nationwide “Green Space” initiative. Furthermore, nearly 10 kilometers of drainage ditches and canals were cleaned, and 36,000 square meters of internal roads were gravelled. These measures contribute to improving ecological infrastructure and strengthening the sanitary condition of the territories.

To raise environmental awareness and improve local surroundings, a nationwide “Cleanliness Month” campaign was conducted from October 15 to November 15, 2025. Within the framework of this initiative, more than 422,000 tons of waste were removed, over 95,000 neighborhood areas and 61,000 public spaces were cleaned. Approximately 369,000 employees of sanitation and landscaping services actively participated in these activities, with the involvement of more than 66,000 units of specialized equipment. According to monitoring results, 448,000 violations were identified over the course of one month, and appropriate penalties were imposed on individuals responsible for illegal waste disposal. Representatives of the прокуратура, internal affairs bodies, the National Guard, and environmental control authorities collaborated closely in these processes.

To further develop the waste recycling system, Presidential Decree No. 56, dated March 24, 2025, was adopted, setting a target to reduce municipal solid waste

²⁹ <https://gov.uz/oz/sanitation>

landfills by at least 50 percent by 2030. To achieve this goal, the introduction of innovative technologies and the increase of recycling rates have been identified as priority areas. In addition, projects for generating electricity through the thermal processing of municipal solid waste are being implemented in nine regions, with the aim of enhancing environmental efficiency by utilizing waste as an energy source. These projects are planned to be implemented in stages in the regions of Andijan, Kashkadarya, Namangan, Samarkand, Tashkent, Fergana, Bukhara, Jizzakh, as well as in the Republic of Karakalpakstan. The total investment value of these projects amounts to 1.3 billion US dollars, with construction scheduled for 2025–2027. As a result, it is expected that 13,000 tons of waste will be processed daily, generating 2 billion kWh of electricity annually and creating approximately 1,400 new jobs.

Currently, around 300 waste recycling enterprises operate in the republic, collectively processing an average of 800,000 tons of waste per year, which accounts for 5.2 percent of the total municipal solid waste generated. In this context, strict compliance with environmental safety requirements at recycling facilities, minimizing emissions of harmful substances into the atmosphere, and protecting public health are considered top priorities. In order to improve the evaluation system of sanitation service providers, 105 sanitation enterprises were assessed based on a rating system. According to the results, 41 enterprises were classified as “green,” 53 as “yellow,” and 11 as “red.” During monitoring, penalties were imposed on 14 enterprises that remained in the “red” category for six consecutive months; contracts with one enterprise were terminated, and the service area of another was transferred to the “Toza Hudud” system. Furthermore, a mechanism has been introduced to terminate contracts with enterprises that fail to exit the “red” category for three consecutive months even after penalties. These comprehensive measures—aimed at modernizing the waste management system, optimizing the number of landfills, expanding the implementation of recycling technologies, and promoting environmental awareness—serve to consistently advance the principles of a green economy in the country. Efforts in this direction are of strategic importance not only for ensuring environmental sustainability but also for creating a clean and healthy environment for future generations.

Conclusion and Recommendations

The analyses presented above indicate that, in recent years, the Republic of Uzbekistan has undertaken large-scale institutional, organizational, and technological reforms aimed at implementing the principles of the circular economy and modernizing the waste management system. In particular, significant regulatory and legal frameworks have been established to support the formation of

an economic model based on “green economy” principles. Among these, special importance is attributed to the Resolution of the President of the Republic of Uzbekistan No. PQ-436 dated December 2, 2022, the Presidential Decree No. 5 dated January 4, 2024, and the Presidential Decree No. 56 dated March 24, 2025. Within the framework of these documents, specific tasks have been defined for the development of waste recycling systems, the efficient use of resources, the reduction in the number of landfills, and the expansion of renewable energy utilization.

The results of scientific and statistical analyses demonstrate that the volume of waste generated in the country is steadily increasing year by year, while the level of waste recycling remains relatively low. In particular, although an average of 14.8–15.1 million tons of municipal waste is generated annually, only about 5–5.2 percent of this volume is recycled. This indicates that there remains substantial untapped potential for the full implementation of a circular economy system. At the same time, the measures being implemented to develop waste management infrastructure are yielding positive outcomes. Notably, the increase in the number of waste collection vehicles—from 1,461 units in 2017 to 3,390 units in 2024—reflects a significant expansion of the logistics system. Furthermore, initiatives such as landfill reclamation, the introduction of modern technologies, and the implementation of projects for electricity generation based on the thermal processing of waste provide clear evidence of the progressive development of circular economy infrastructure.

The analyses also show that the circular economy serves not only as a mechanism for ensuring environmental sustainability but also as an important factor in enhancing economic efficiency, creating new employment opportunities, and strengthening the competitiveness of the national economy. In particular, expanding the production of secondary raw materials through recycling, reducing dependence on imported resources, and introducing innovative technologies create broad opportunities for sustainable development. In this context, the following priority recommendations are proposed to accelerate the development of the circular economy in Uzbekistan.

First, it is necessary to gradually introduce a mandatory waste sorting system. Expanding the separate collection of waste by households and economic entities according to waste type would increase the availability of raw materials for recycling. For this purpose, it is important to implement modern container systems in residential areas and to widely utilize digital monitoring tools.

Second, it is essential to strengthen incentive mechanisms for the establishment and modernization of waste recycling enterprises. In particular,

improving the investment climate through the provision of tax incentives, subsidies, and preferential loans to businesses operating in this sector would be beneficial. At the same time, attracting foreign investment to introduce advanced technologies should be considered a priority direction.

Third, expanding the system for the establishment and development of eco-industrial parks is of significant importance. Within such parks, it is possible to create closed-loop production cycles by using the waste of one enterprise as raw material for another. This approach enhances resource efficiency and contributes to reducing overall waste volumes.

Fourth, it is necessary to accelerate the introduction of waste recycling and energy generation technologies. In particular, increasing the number of waste-to-energy plants based on thermal processing would not only reduce waste volumes but also diversify energy supply sources.

Fifth, expanding the use of digital technologies in the implementation of circular economy principles is crucial. Specifically, the application of IoT technologies, blockchain systems, and artificial intelligence-based monitoring platforms would enable effective tracking of waste flows, reduction of logistics costs, and improved resource efficiency.

Sixth, raising public environmental awareness and expanding knowledge of circular economy principles is one of the key tasks. In this regard, it is necessary to strengthen environmental education and awareness campaigns through schools, higher education institutions, and mass media.

Seventh, it is important to promote scientific research in the field of waste recycling and to support research projects aimed at developing innovative technologies. Strengthening the role of higher education institutions and research centers in developing and implementing new circular economy technologies is highly advisable.

In general, the widespread implementation of circular economy principles in Uzbekistan is of strategic importance for ensuring sustainable economic development, improving environmental conditions, and enhancing the efficient use of resources. The implementation of comprehensive measures in this direction in the future will create a solid foundation for significantly increasing recycling rates, reducing the number of landfills, and establishing an environmentally sustainable economic model.

REFERENCES:

1. Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: An analysis of 114 definitions. *Resour. Conserv. Recycl.* 127, 221–232. <https://www.sciencedirect.com/science/article/pii/S0921344917302835>
2. Bocken, N.M., De Pauw, I., Bakker, C., Van Der Grinten, B., 2016. Product design and business model strategies for a circular economy. *J. Ind. Prod. Eng.* 33 (5), 308–320. <https://www.tandfonline.com/doi/full/10.1080/21681015.2016.1172124>
3. Geissdoerfer, M., Pieroni, M.P., Pigosso, D.C., Soufani, K., 2020. Circular business models: A review. *J. Clean. Prod.* 277, 123741. <https://www.sciencedirect.com/science/article/abs/pii/S0959652620337860>
4. Psarommatis, F., May, G., 2025. A cost-benefit model for sustainable product reuse and repurposing in circular remanufacturing. *Sustainability* 17 (1), 245. <https://www.mdpi.com/2071-1050/17/1/245>
5. Makov, T., Font Vivanco, D., 2018. Does the circular economy grow the pie? The case of rebound effects from smartphone reuse. *Front. Energy Res.* 6, 39. <https://www.scopus.com/pages/publications/85046623880>
6. Warmington-Lundström, J., Laurenti, R., 2020. Reviewing circular economy rebound effects: The case of online peer-to-peer boat sharing. *Resour. Conserv. Recycl.*: X5, 100028. [Reviewing circular economy rebound effects: The case of online peer-to-peer boat sharing - ScienceDirect](https://www.sciencedirect.com/science/article/abs/pii/S0921344920302835)
7. Rigamonti, L., Mancini, E., 2021. Life cycle assessment and circularity indicators. *Int. J. Life Cycle Assess.* 26, 1937–1942.
8. Prosman, E.J., Cagliano, R., 2022. A contingency perspective on manufacturing configurations for the circular economy: Insights from successful start-ups. *Int. J. Prod.Econ.* 249, 108519. <https://www.sciencedirect.com/science/article/abs/pii/S0925527322001128>
9. Corona, B., Shen, L., Reike, D., Carreón, J.R., Worrell, E., 2019. Towards sustainable development through the circular economy – A review and critical assessment on current circularity metrics. *Resour. Conserv. Recycl.* 151, 104498
10. <https://gov.uz/oz/sanitation>