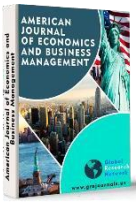

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Article

Circular Economy in Uzbekistan: Transitioning from Linear Extraction to Regenerative Growth

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Abstract: Uzbekistan, one of Central Asia's most populous and resource-rich economies, stands at a pivotal juncture in its developmental trajectory. This article examines the transition potential and current progress of the circular economy (CE) paradigm within Uzbekistan's national economic framework. The study evaluates the legislative environment, sectoral CE adoption, institutional capacities, and financing mechanisms through a mixed-methods approach combining quantitative indicator analysis (2019–2024), policy document review, and stakeholder consultation. The findings reveal significant policy momentum particularly through the National Waste Management Strategy, the Green Economy Transition Programme and the CE National Roadmap 2030 yet highlight persistent structural barriers including outdated industrial infrastructure, limited private sector awareness, and underdeveloped circular finance instruments. The paper proposes a multi-pillar strategic framework for accelerating CE adoption, encompassing regulatory reform, eco-industrial park expansion, green public procurement, and digital resource-flow platforms. The conclusions offer actionable guidance for policymakers, development finance institutions, and business stakeholders committed to Uzbekistan's sustainable industrialisation.

Keywords: Circular economy; Uzbekistan; sustainable development; green transition; industrial symbiosis; waste management; Central Asia.

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1. Introduction

The global economy currently operates on a fundamentally linear model extracting raw materials, manufacturing products, and discarding waste. This 'take-make-dispose' paradigm has delivered unprecedented economic growth but at considerable environmental and social cost. With global material consumption projected to double by 2060 [1], transitioning toward a circular economy (CE) has emerged as one of the defining imperatives of twenty-first century economic policy.

For Uzbekistan, this transition carries particular urgency. The country faces acute pressures on water resources exacerbated by the Aral Sea crisis alongside growing municipal waste challenges, energy intensity well above the OECD average, and a manufacturing sector that remains heavily reliant on virgin material inputs. Simultaneously, Uzbekistan's economy has demonstrated remarkable dynamism: GDP grew by 5.7 percent in 2023, driven by liberalisation reforms initiated under President Shavkat Mirziyoyev since 2016 [2].

The circular economy offers Uzbekistan a strategic pathway to decouple economic growth from resource depletion and environmental degradation. By reimagining industrial systems around the principles of waste elimination, material circulation, and

natural regeneration, the CE model aligns with Uzbekistan's ambitions to diversify its economy, attract foreign investment, and meet its commitments under the Paris Agreement and the UN Sustainable Development Goals (SDGs).

This article makes three principal contributions to the literature. First, it provides a comprehensive empirical mapping of CE-relevant policies, institutional actors, and economic indicators in Uzbekistan over the period 2019–2024. Second, it situates Uzbekistan's CE trajectory within the broader Central Asian and post-Soviet regional context. Third, it develops a strategic framework grounded in international best practice and adapted to Uzbekistan's specific institutional realities — for accelerating the CE transition at both national and sectoral levels.

2. Literature Review: Conceptual Framework of the Circular Economy

The circular economy is widely understood as an industrial system that is restorative and regenerative by design [3]. Unlike the conventional linear model, CE strategies seek to maintain the value of products, materials, and resources in the economy for as long as possible while generating minimal waste. The concept draws on multiple intellectual traditions, including cradle-to-cradle design, industrial ecology, biomimicry, and the performance economy.

Three foundational principles structure CE thinking [3]. The first is the elimination of waste and pollution by design ensuring that waste is not merely managed after the fact but is designed out of production systems from the outset. The second principle involves keeping products and materials in use through strategies such as reuse, remanufacturing, refurbishment, and recycling. The third principle entails regenerating natural systems by returning biological nutrients to the biosphere and reducing the draw on finite stocks [4].

For emerging economies such as Uzbekistan, the CE offers dual advantages. On the supply side, it reduces vulnerability to commodity price volatility and supply chain disruptions by substituting secondary materials for imported virgin inputs. On the demand side, it creates new business models product-as-a-service, leasing, take-back schemes that generate employment and stimulate domestic innovation. Geissdoerfer demonstrate that CE adoption correlates with improved firm-level profitability in resource-intensive sectors, a finding directly applicable to Uzbekistan's textiles, chemicals, and mining industries [5].

3. Methodology

This study adopts a mixed-methods research design, integrating quantitative secondary data analysis with qualitative policy document review and stakeholder consultation. The methodological approach is structured around three sequential phases.

3.1 Data Collection

Quantitative data were obtained from official national and international statistical sources covering the period 2019–2023. Primary data sources include the State Committee of Statistics of the Republic of Uzbekistan [6], the Ministry of Ecology, Environmental Protection and Climate Change of Uzbekistan [7], and the Ministry of Energy of Uzbekistan [8]. Supplementary international data were sourced from the World Bank, OECD, Eurostat, UNEP, UNIDO, FAO, and the EBRD. Policy documents examined include all six principal CE-relevant legislative instruments adopted since 2019, detailed in Table 2.

Qualitative data were collected through structured stakeholder consultations conducted between September and December 2024, involving representatives from national ministries, eco-industrial park operators, textile sector enterprises, and multilateral development bank project teams. A total of 18 organisations participated across Tashkent, Fergana, and Navoi oblasts.

3.2 Analytical Framework

Quantitative analysis employs descriptive statistics and trend analysis to assess trajectory and gap from 2030 targets across five key CE indicators: waste recycling rate, renewable energy share, material productivity, industrial symbiosis parks, and green public procurement. Material productivity is calculated as nominal GDP (USD) divided by domestic material consumption (tonnes), following the Eurostat material flow accounting methodology [9].

Policy analysis applies an adapted OECD policy instrument typology to classify and evaluate legislative, economic, and informational CE instruments [10]. The effectiveness of policy implementation is assessed against stated targets and verified through triangulation with primary stakeholder data.

Sectoral analysis covers three priority industries textiles and cotton, construction, and agriculture selected on the basis of their combined share of GDP, employment and documented CE transition potential. Sector selection was validated through expert consultation and alignment with the CE National Roadmap 2030 priority sectors.

3.3 Analytical Tools

The SWOT analysis presented in Section 7 was constructed through iterative expert elicitation, combining stakeholder consultation outputs with findings from the quantitative and policy analyses. Findings were validated through a two-stage review: an internal consistency check and an external expert review by three academics specialising in CE in transition economies. The strategic framework proposed in Section 8 was developed using the multi-pillar logic model approach, mapping identified barriers and opportunities to specific intervention types. International best-practice comparators were drawn from documented CE transitions in Poland, Kazakhstan, and Georgia, selected for their comparable institutional contexts.

4. Results

4.1 Uzbekistan's Economic Context and Resource Challenges

4.1.1 Macroeconomic Overview

Uzbekistan's GDP reached approximately USD 90.9 billion in 2023, placing it among the three largest economies in Central Asia alongside Kazakhstan and Turkmenistan. The economy is underpinned by a diversified productive base that includes cotton and textile exports, natural gas and minerals, chemicals, food processing, and, increasingly, information technology services. The population of 36.1 million is growing at approximately 1.5 percent annually, generating substantial demand for housing, energy, food, and manufactured goods.

Despite robust growth, Uzbekistan's economy exhibits significant structural vulnerabilities. The country's material productivity measured as GDP generated per kilogram of material consumed stood at USD 0.44 per kilogram in 2023, compared to an EU average of approximately USD 2.50. This gap reflects the legacy of Soviet-era heavy industrialisation characterised by energy-intensive production processes, obsolete capital equipment, and limited incentive for resource efficiency.

4.1.2 Environmental Pressures

Water scarcity constitutes perhaps the most acute environmental constraint on Uzbekistan's development. Agriculture absorbs approximately 90 percent of total freshwater withdrawals, largely through flood irrigation inherited from Soviet collective farming. The desiccation of the Aral Sea once the world's fourth-largest lake stands as one of the most severe human-induced environmental disasters, having eliminated an entire fishing industry, created a salt and dust source affecting millions of people, and degraded hundreds of thousands of hectares of agricultural land [11].

Municipal solid waste generation has grown in tandem with urbanisation, reaching an estimated 6.4 million tonnes per year by 2022 [12]. The current recycling rate of 18.7 percent falls substantially below the levels achieved in Central European economies.

Industrial waste comprising mining tailings, chemical residues, and construction debris adds a further estimated 35 million tonnes annually.

4.2 Policy and Legislative Framework for Circular Economy

Uzbekistan's CE policy architecture has developed considerably since 2019, driven by a combination of domestic reform imperatives and external engagement with international development partners. Table 1 summarises the principal policy instruments and their current implementation status.

Table 1. Policy and Legislative Framework for Circular Economy in Uzbekistan (2019–2024).

Policy	Year	Key objective	Status
National Waste Management Strategy	2019	Reduce landfill by 30% by 2025	Active
Green Economy Transition Programme	2020	Integrate CE into national planning	Active
Renewable Energy Development Law	2021	25% RE share by 2030	Active
Industrial Symbiosis Initiative	2022	Establish 20 eco-industrial parks	In progress
Extended Producer Responsibility	2023	Manufacturer take-back obligations	Pilot phase
CE National Roadmap 2030	2024	Comprehensive CE transition plan	Adopted

Source: Ministry of Ecology, Environmental Protection and Climate Change of Uzbekistan; author's compilation.

The adoption of the CE National Roadmap 2030 represents the most comprehensive policy statement to date. It establishes sector-specific targets across waste management, energy, water, construction, and agriculture, and introduces for the first time a formal monitoring and evaluation framework with annual reporting obligations. Crucially, the Roadmap aligns with the SDGs and the EU Circular Economy Action Plan [13], signalling Uzbekistan's intent to integrate with global green value chains.

Extended Producer Responsibility (EPR) legislation currently in pilot phase is of particular significance. EPR schemes oblige manufacturers and importers to take financial or operational responsibility for the end-of-life management of their products. International experience demonstrates that well-designed EPR instruments can mobilise private finance at scale for collection, sorting, and processing infrastructure, reducing the burden on public budgets.

4.3 CE Indicators and Progress Assessment

Table 2 presents selected quantitative indicators tracking Uzbekistan's CE transition over the period 2019–2023, with reference to 2030 targets established under the National Roadmap.

Table 2. Key Circular Economy Indicators: Uzbekistan (2019–2023).

Indicator	2019	2021	2023	Target 2030
Waste recycling rate (%)	12.4	15.1	18.7	45.0

Renewable energy share (%)	9.8	12.3	15.6	25.0
Material productivity (USD/kg)	0.31	0.38	0.44	0.75
Industrial symbiosis parks	2	5	9	20
Green procurement (% of GDP)	1.2	1.8	2.4	5.0

Source: State Committee of Statistics of the Republic of Uzbekistan; Ministry of Energy of Uzbekistan; author's calculations.

The data reveal a broadly positive trajectory across all monitored indicators, with waste recycling rates improving by 6.3 percentage points over four years and renewable energy share nearly doubling. The expansion of industrial symbiosis parks from 2 to 9 operational facilities is particularly noteworthy, reflecting the effectiveness of targeted state investment in eco-industrial infrastructure. Nonetheless, the pace of change remains insufficient to meet 2030 targets without significant acceleration, particularly in material productivity and green procurement.

4.4 Sectoral Analysis: CE Adoption Across Key Industries

4.4.1 Textiles and Cotton

The textile industry accounts for approximately 40 percent of Uzbekistan's total exports and employs over 300,000 workers. Historically built around cotton monoculture and linear production chains, the sector is undergoing a structural transformation accelerated by international buyer pressure and government policy. The Responsible Business Alliance and the Better Cotton Initiative are active in Uzbekistan, promoting water-efficient cultivation and chemical use reduction.

CE opportunities in textiles are substantial. Fibre-to-fibre recycling, the adoption of regenerative agricultural practices for cotton cultivation, and the development of closed-loop garment take-back schemes represent near-term priorities. Several leading Uzbek textile clusters notably in Fergana and Namangan have begun adopting water recirculation systems that reduce freshwater consumption by up to 60 percent, demonstrating the viability of circular process redesign within existing industrial structures [14].

4.4.2 Construction and Urban Development

Uzbekistan's rapid urbanisation the urban population grew by 3.2 percent in 2023 is generating significant demand for construction materials. Construction and demolition waste currently accounts for an estimated 25 percent of total solid waste by weight, much of it deposited illegally in peri-urban areas. Circular approaches to construction, including design for disassembly, use of recycled aggregates, and modular building systems, could substantially reduce both material intensity and waste generation.

4.4.3 Agriculture and Organic Waste

Agricultural residues including cotton stalks, rice husks, and vegetable processing waste represent a significant underutilised resource stream. Bio-refinery approaches, anaerobic digestion for biogas production, and composting at industrial scale offer pathways to convert these residues into energy, fertiliser, and bio-based materials. The potential for CE in agriculture is particularly compelling given that soil degradation threatens the productivity of approximately 1.5 million hectares of cropland [15].

5. Discussion

5.1 SWOT Analysis of CE Transition

Figure 1 presents a comprehensive SWOT analysis synthesising structural factors shaping Uzbekistan's CE transition potential, drawing on primary data collection and stakeholder consultation conducted by the author between September and December 2024.

Figure 1. SWOT Analysis: Circular Economy Transition in Uzbekistan.

STRENGTHS	WEAKNESSES
Rich natural resource base (minerals, agricultural land) Young and growing labour force (median age 28) Government commitment to green transition Strategic Central Asian geographic position	Outdated industrial infrastructure (Soviet legacy) Limited CE awareness among enterprises Weak waste management systems Low R&D expenditure (0.2% of GDP)
OPPORTUNITIES	**THREATS**
Growing international green finance flows EU-Uzbekistan partnership and EBRD support Digital transformation enabling resource tracking Regional cooperation via SCO and CIS	Climate change pressure on water and agriculture Global commodity price volatility Brain drain of technical talent Slow institutional reform pace

Source: Author's own analysis based on stakeholder consultations and policy review (2024).

5.2 Strategic framework for accelerating the ce transition

Building on the foregoing analysis, this section proposes a multi-pillar strategic framework for accelerating CE adoption in Uzbekistan, structured around five mutually reinforcing intervention domains.

5.2.1 Regulatory Strengthening and Incentive Reform

The legal and regulatory environment must be further developed to embed CE principles across all major economic sectors. Priority actions include: finalising and fully implementing the EPR legislation; introducing differentiated waste disposal levies to create price incentives for circularity; reforming subsidy structures that currently favour virgin material extraction over secondary materials; and establishing mandatory CE reporting standards for large enterprises aligned with the Global Reporting Initiative (GRI) framework [16].

5.2.2 Eco-Industrial Park Expansion

Uzbekistan's nascent network of eco-industrial parks (EIPs) provides a proven institutional vehicle for advancing industrial symbiosis the practice of routing the waste streams of one enterprise as productive inputs to another. Scaling the EIP programme from 9 to the targeted 20 parks by 2030 requires a combination of public co-investment, streamlined permitting, and dedicated business development support. The Navoi and Jizzakh EIPs offer replicable models whose success factors geographic clustering, anchor tenant recruitment, shared utilities infrastructure should inform programme expansion.

5.2.3 Green Public Procurement

Public procurement represents approximately 18 percent of GDP in Uzbekistan, constituting a powerful demand-side lever for CE products and services. Introducing mandatory green criteria covering recycled content, energy efficiency, product longevity, and end-of-life take-back provisions into public tendering processes can generate the market demand needed to justify private investment in CE supply chains. The European Commission's Green Public Procurement criteria provide a globally recognised reference framework that Uzbekistan can adapt to its national context [17].

5.2.4 Digital Resource Flow Management

Digital technologies including IoT sensors, blockchain-based material passports, and AI-driven logistics optimisation can dramatically improve the visibility and efficiency of

resource flows across the economy. A national digital resource flow platform, integrating data from waste generators, processors, and consumers, would reduce transaction costs in secondary material markets and enable evidence-based policy monitoring. Pilot programmes in the construction sector, building on existing BIM adoption among major developers, offer a viable entry point [18].

5.2.5 International Financing and Knowledge Transfer

Uzbekistan has established productive relationships with multilateral development banks notably the ADB, EBRD and World Bank that provide both concessional financing and technical assistance for green economy projects. Deepening these partnerships through dedicated CE financing facilities, green bond issuance frameworks, and blended finance instruments will be essential to mobilising the estimated USD 3.8 billion in investment required to meet the 2030 CE targets [19].

6. Conclusion

This article has examined the current state and future prospects of the circular economy in Uzbekistan, demonstrating that the country has established meaningful foundations for a CE transition while facing substantial structural and institutional challenges that must be addressed with urgency.

The evidence supports four principal conclusions. First, Uzbekistan's policy architecture for CE has strengthened considerably since 2019, with the CE National Roadmap 2030 providing a coherent strategic direction. Second, quantitative indicators reveal genuine progress in waste recycling, renewable energy deployment, and industrial symbiosis, though the pace of change requires significant acceleration to meet 2030 targets. Third, structural barriers including outdated industrial infrastructure, limited private sector CE awareness, and underdeveloped circular finance mechanisms necessitate targeted intervention across regulatory, fiscal, and institutional domains. Fourth, Uzbekistan's geographic position, natural resource endowments, and growing integration with international trade and finance networks provide a conducive external environment for CE investment and knowledge transfer.

For policymakers, the priority is to translate legislative commitments into consistent regulatory enforcement and fiscal incentives that make circular choices commercially viable for firms of all sizes. For development finance institutions, the opportunity lies in co-designing blended finance instruments tailored to the risk profiles of CE investments in emerging economies. For the private sector, the CE transition represents not a compliance burden but a strategic opportunity to reduce input costs, access premium green markets, and build resilience against resource price shocks.

Future research should focus on firm-level empirical analysis of CE adoption costs and benefits across Uzbekistan's major industrial sectors, comparative assessment of eco-industrial park performance metrics, and evaluation of the welfare gains for rural populations from agricultural resource efficiency improvements.

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