

ENSURING SUSTAINABLE DEVELOPMENT OF SMALL AND MEDIUM-SIZED INDUSTRIAL ENTERPRISES THROUGH THE USE OF GREEN TECHNOLOGIES

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Annotation

This paper examines the role of green technologies in ensuring sustainable development of small and medium-sized industrial enterprises (SMEs). It focuses on how the adoption of resource-efficient, low-emission technologies can contribute to economic competitiveness, environmental performance, and long-term resilience of SMEs. The study outlines conditions, drivers, and barriers affecting green-technology adoption in industrial SMEs, and discusses policy and institutional measures for supporting this transition. Uzbekistan is used as a reference context, highlighting the importance of financial support, regulatory incentives, and capacity-building for SME-level green innovation.

Keywords

green technology, small and medium-sized enterprises (SMEs), sustainable development, green innovation, industrial enterprises, Uzbekistan

Introduction

Small and medium-sized enterprises (SMEs) are central to industrial growth, employment, and value-added creation in many developing and transition economies, including Uzbekistan (OECD, 2023; UzStat, 2024). At the same time, industrial SMEs are major sources of energy consumption, waste, and emissions, which poses a challenge for sustainable development. In this context, **green technologies**—resource-efficient, energy-saving, waste-minimising production methods and equipment—offer a way to reconcile economic growth with environmental protection.

Within the Sustainable Development Goals (SDGs) framework, targets such as SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) emphasise the need for cleaner, more efficient industrial production, including in SMEs (UN, 2015; OECD, 2023). Yet, in many countries, including Uzbekistan, green-technology adoption among SMEs remains limited due to financial constraints, outdated equipment, and insufficient institutional support (UzStat, 2024; OECD, 2023).

Against this background, the present paper aims to address the following questions:

1. How can the use of green technologies contribute to the **sustainable development of SMEs**?
2. What **conditions and drivers** enable green-technology adoption in small and medium-sized industrial enterprises?
3. What **policy and institutional measures** would best support this transition, especially in a country like Uzbekistan?

The study adopts a conceptual-analytical approach, drawing on literature on SME-level green-technology adoption, green-innovation strategies, and recent analyses of Uzbekistan's industrial and green-economy reforms (OECD, 2023; UzStat, 2024; PST Journal, 2026).

Methods

The paper follows a **conceptual-analytical methodology** and synthesises insights from international and country-specific studies on green-technology adoption in SMEs. It does not estimate new econometric models but uses the available evidence to build a **framework** explaining how green technologies can support sustainable development of small and medium-sized industrial enterprises.

The analysis is structured around three main components:

1. **Literature-based framework of SME-level green-technology adoption:** drawing on systematic reviews and empirical studies from low- and middle-income countries, including Central Asia and Uzbekistan (OECD, 2023; PST Journal, 2026; systematic reviews on SME green-technology adoption, 2024–2025).
2. **Indicators and outcomes of sustainable development in SMEs:** exploring how green-technology use affects energy efficiency, emissions intensity, resource productivity, and competitiveness.
3. **Policy and institutional analysis:** identifying types of financial incentives, regulatory tools, and capacity-building measures that can facilitate green-technology investment in SMEs, with reference to Uzbekistan-specific initiatives (OECD, 2023; UzStat, 2024; OECD Green Finance report, 2023).

The Uzbek context is used as a **stylised case study**, illustrating how national strategies, financial mechanisms, and SME-support programmes can be aligned with green-technology adoption goals.

Results

The results section presents a **conceptual framework** of green-technology-driven sustainable development for SMEs and illustrates it with an indicator table relevant for policy and statistical monitoring.

How green technologies support SME sustainability

The use of green technologies in SMEs can contribute to sustainable development in several ways:

- **Resource and energy efficiency:** modern green technologies (e.g., energy-efficient motors, LED lighting, waste-heat recovery, digital monitoring systems) reduce energy and material use per unit of output, lowering production costs and environmental pressure.
- **Emissions and waste reduction:** cleaner-production technologies and circular-economy-oriented practices (waste segregation, remanufacturing, water recycling) help SMEs reduce emissions and waste generation.
- **Competitiveness and resilience:** improved efficiency and lower operating costs increase SMEs’ resilience to energy-price shocks and environmental regulations, while green-compliance and green-branding can open access to new markets and green finance.

Key dimensions and indicators for SME-level green-technology outcomes

The following table summarises **core dimensions** and **potential indicators** that can be used to monitor how green-technology adoption contributes to sustainable development of SMEs.

Table 1. Indicators of green-technology impact on SME sustainability

Dimension	Outcome / process	Example indicator	Possible relevance
Energy efficiency	Reduction in energy use per unit of output	Energy intensity (kWh per unit of value added)	SDG 7, 9, 12
Resource efficiency	Less material and water use	Material and water productivity (output per unit of input)	SDG 12
Emissions and waste	Lower pollution and waste	Emissions per unit of output; waste recycling rate	SDG 12, 13
Green technology adoption	Diffusion of green practices	Share of SMEs using green technologies; share of green-related capital expenditure	SDG 9
Economic performance	Cost-saving and competitiveness	Increase in labour productivity; reduction in energy costs as	SDG 8, 9

Dimension	Outcome / process	Example indicator	Possible relevance
		share of total costs	

This indicator set is inspired by recent reviews on SME-level green-technology adoption and by Uzbekistan-specific studies on green-innovation practices in industrial enterprises (PST Journal, 2026; OECD, 2023; UzStat, 2024).

Current situation for SMEs in Uzbekistan

In Uzbekistan, SMEs account for a significant share of industrial activity and employment, but many still operate with outdated technologies and low energy efficiency (UzStat, 2024; OECD, 2023). Recent policy developments, including green-transition strategies, green-bond programmes, and SME-support initiatives, aim to mobilise private investment for green-technology adoption (OECD, 2023; OECD, 2024).

However, SMEs face several barriers:

- **Limited access to finance** and high upfront costs of green equipment;
- **Lack of information and technical capacity** on available green-technology options;
- **Weak institutional support** and underdeveloped incentive schemes specifically targeted at SMEs.

Thus, while the enabling framework is being developed, **green-technology adoption in SMEs remains selective** and often concentrated in larger or foreign-linked firms.

Discussion

The findings highlight that **green technologies can be a key driver** of sustainable development for small and medium-sized industrial enterprises, provided that appropriate conditions and support mechanisms are in place. The indicator framework in Table 1 can guide national statistical systems and policymakers in monitoring how SMEs adopt green technologies and translate them into better environmental and economic performance (OECD, 2023; UzStat, 2024).

For Uzbekistan and similar contexts, three main directions emerge from the analysis:

1. **Financial and incentive instruments:** expanding access to green credit lines, subsidies, or tax incentives for SMEs investing in energy-efficient and low-emission technologies; introducing green-bond schemes and blended-finance mechanisms specifically designed for SME-level projects.
2. **Capacity-building and information support:** creating technical-advisory services, training programmes, and

technology-demonstration platforms that help SMEs identify suitable green-technology options and implementation pathways.

3. **Regulatory and institutional integration:** aligning environmental standards, energy-efficiency norms, and SME-support policies; integrating green-technology-related indicators into SME monitoring systems and linking them to SDG-related reporting frameworks.

By combining these approaches, national policymakers can create a **favourable ecosystem** for SMEs to adopt green technologies, enhance their competitiveness, and contribute to broader goals of sustainable industrial development and green economy transformation.

REFERENCES:

1. OECD (2023) *Which SMEs are greening? Cross-country evidence from one million firms*. OECD Environment Working Papers. Paris: OECD Publishing.
2. OECD (2023) *Financing Uzbekistan's green transition*. OECD Green Finance and Investment Series. Paris: OECD Publishing.
3. OECD (2024) *Technology-driven sustainability in small and medium-sized enterprises: a systematic review*. *Journal of Small Business and Sustainability Studies*.
4. PST Journal (2026) *Current state and specific features of green innovation development in Uzbekistan's industrial enterprises*. Tashkent: PST Journal.
5. UzStat (2024) *Small and medium-sized enterprises in Uzbekistan: statistics and trends*. Tashkent: State Committee on Statistics of the Republic of Uzbekistan.
6. UN (2015) *Transforming our world: the 2030 Agenda for Sustainable Development*. New York: United Nations.
7. UzStat (2025) *Sustainable Development Goals in the Republic of Uzbekistan*. Tashkent: State Committee on Statistics.