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Sustainable logistics in 2025: A review of key trends and strategic challenges

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Abstract:
The aim of this paper is to provide a comprehensive overview of current trends and strategic sustainability challenges in logistics in 2025 within the context of new legislation, technological innovations, and managerial practice. The development of sustainability trends and challenges in logistics is analysed based on available scientific literature and professional sources and categorized into five main areas – decarbonization of transport and infrastructure, circular and reverse logistics, digitalization and traceability, urban and last-mile logistics, and ESG/Scope 3 reporting. The paper highlights their interconnections and practical implications for companies operating within the European Union.

Key words:
Sustainable logistics, transport decarbonization, circular economy, digitalization, last-mile delivery, ESG reporting

Introduction

The year 2025 represents a turning point for the European logistics sector, as sustainability shifts from a voluntary commitment to a regulatory and strategic necessity. Logistics, as an integral part of global supply chains, faces increasing pressure from legislation, technological innovation, and corporate social responsibility (KPMG, 2025).

The most significant impact on the transformation of logistics systems arises from two key European regulations – the Corporate Sustainability Reporting Directive (CSRD) and the Packaging and Packaging Waste Regulation (PPWR). The CSRD expands mandatory ESG reporting and, for the first time, requires transparent disclosure of Scope 3 emissions, which cover the indirect impacts of activities across the entire value chain. These emissions constitute the dominant share of the overall carbon footprint for most enterprises, with the logistics and transport sectors being among the major contributors (European Commission, 2025a; IPOINT, 2025). The new European Sustainability Reporting Standards (ESRS) introduce requirements for harmonizing methodologies with the GHG Protocol and ensuring data auditability, creating pressure to develop internal ESG data marts, promote digitalization, and strengthen data interoperability (ERM, 2025).

Simultaneously, the PPWR regulation, which entered into force on 11 February 2025 and becomes fully applicable on 12 August 2026, replaces Directive 94/62/EC. Its primary goal is to reduce packaging waste, enhance recyclability, and promote reuse, thereby directly influencing packaging and reverse logistics, pooling systems, and packaging design (European Commission, 2025b; Hogan Lovells, 2025). PPWR introduces mandatory quotas for reusable packaging, reporting obligations on recyclability, and alignment with circular economy principles, which are becoming the foundation of environmental design in logistics processes (GT Law, 2025; Keller and Heckman LLP, 2025).

As a result of these developments, it is evident that sustainability in logistics is no longer a “nice-to-have” but a “must-have.” For companies, this means investing in transport decarbonization, intelligent route optimization, digitalization and supply chain transparency, as well as in circular models and reverse logistics (European Environment Agency, 2025). These trends are further reinforced by growing expectations from consumers and investors for environmental responsibility and supply chain resilience.

1 Methods and methodology

The literature review was prepared based on scientific articles published in the Web of Science, Scopus and Google Scholar databases, as well as relevant policy and expert reports issued by the European Commission, consulting firms (KPMG, Deloitte, ERM) and industry platforms (World Economic Forum, European Environment Agency).

The sources analysed cover the period 2022-2025 and focus on sustainability, circular economy, digitalization and decarbonization of logistics systems. The review emphasizes the identification of trends, implementation barriers and managerial implications for logistics companies operating in the European Union.

2 Decarbonization of freight transport and infrastructure

Decarbonization of freight transport ranks among the key priorities of European and global transport policy in 2025. According to Eurostat (2022), the transport sector accounts for 31% of the final energy consumption in the EU, with road transport representing as much as 73.6% of this total. From an environmental perspective, the impact is even more significant—according to the European Environment Agency (EEA, 2024), road transport generates approximately 73.2% of all greenhouse gas emissions from the transport sector. Total CO_2 emissions from road transport in the EU reached approximately 760 million tonnes in 2022, confirming the scale of the challenge faced by the industry in transitioning toward low-carbon solutions (Destatis, 2023).

Figure 1 illustrates the distribution of CO_2 emissions from road transport in the European Union in 2022. Passenger cars and motorcycles accounted for 60% of total emissions, followed by heavy-duty trucks and buses (27%) and light commercial vehicles (12%). These figures highlight the dominant role of passenger and freight road transport in overall EU greenhouse gas emissions and underscore the strategic importance of decarbonizing both private and commercial vehicle fleets.

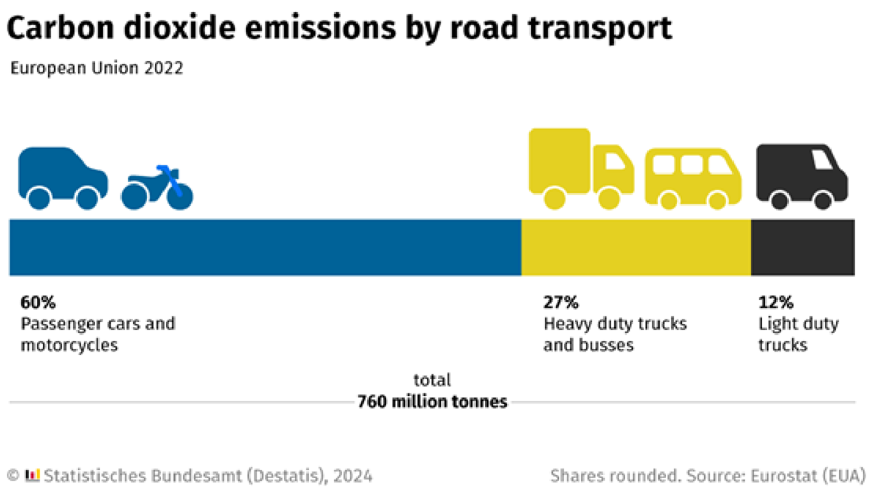

***Fig. 1** Carbon dioxide emissions by road transport*
Source: Destatis, 2023

In response to these facts, the transport sector is rapidly transforming toward low-carbon technologies, with a dominant role played by the electrification of heavy road transport, hydrogen propulsion, and LNG as a transitional solution (Hu et al., 2025; Maersk, 2025). The electrification of heavy-duty trucks (HDTs) remains at an early stage—according to the European Vehicle Market Statistics 2024/25 report, electric trucks accounted for only 1% of new registrations in this category in 2023 (ICCT, 2024). Nevertheless, 2025 is emerging as a breakthrough year for the expansion of infrastructure and the first large-scale fleet deployments.

A major impulse is represented by the establishment and expansion of the pan-European high-power charging network for e-trucks developed by Milence, a joint venture between Daimler Truck, Traton, and Volvo Group. New charging hubs in Germany, France, and the Netherlands are enabling the first scaled electric freight transport projects on middle-mile routes, while major corporations such as Amazon have already placed orders for hundreds of Mercedes-Benz eActros 600 trucks for deployment in Germany and the United Kingdom (Uber Freight, 2025).

At the same time, European and global initiatives are evolving toward green logistics corridors and hydrogen infrastructure, such as the MACBETH project (Modular Advanced Conversion Technologies for Sustainable and Efficient Transport), which explores the use of alternative fuels and the integration of decarbonization technologies into heavy transport systems (Di Nardo et al., 2025). These initiatives reflect the necessity of aligning technological innovation with the development of energy networks, charging infrastructure, and regulatory frameworks.

Despite the progress, decarbonization challenges remain complex. The main barriers include high capital expenditures (CAPEX) for vehicles, limited availability of fast-charging stations, and operational constraints related to route and energy window planning (Hu et al., 2025). The growth in the number of public charging points in the EU over recent years is shown in Figure 2. However, AI-based technological solutions and digital route optimization demonstrate promising results in reducing CO_2 emissions per tonne-kilometre (t·km) without compromising the reliability of logistics systems (Song et al., 2025).

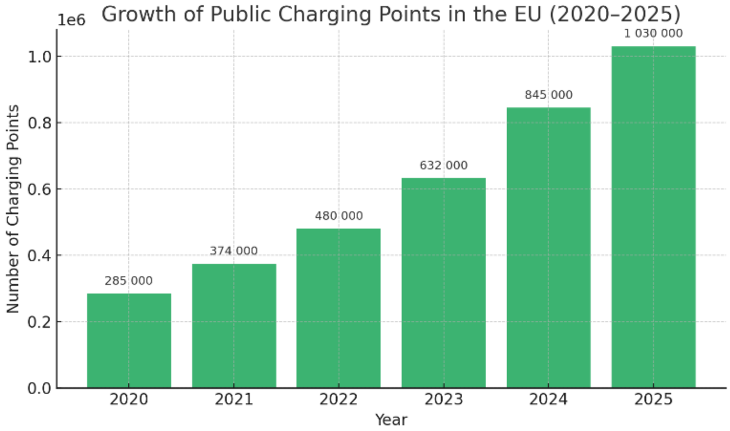

Fig. 2 *Growth of public charging point in the EU (2020-2025)*
Source: own processing from EAFO, 2024; EC, 2022; Electrive, 2025

From a long-term perspective, the combination of electrification, hydrogen-based solutions, AI-driven optimization, and intermodal transport corridors represents a realistic pathway toward achieving the European decarbonization targets by 2035. In addition to its environmental benefits, this transition also contributes to improving the ESG performance profile of enterprises, thereby enhancing their reputation and competitiveness within sustainable supply chains.

3 Circular and reverse logistics

Circular and reverse logistics represent key pillars of sustainable logistics, which are rapidly evolving in 2025 due to legislative frameworks, technological innovation, and increasing pressure for efficient resource use. New European regulations, such as the Packaging and Packaging Waste Regulation (PPWR), have significantly changed the paradigm of packaging flow management by establishing obligations for reuse, recyclability, and recycled material content (European Commission, 2025b). These requirements support the development of pooling systems, returnable packaging, and take-back mechanisms, which form the core of reverse logistics (Ji-Hyland et al., 2025).

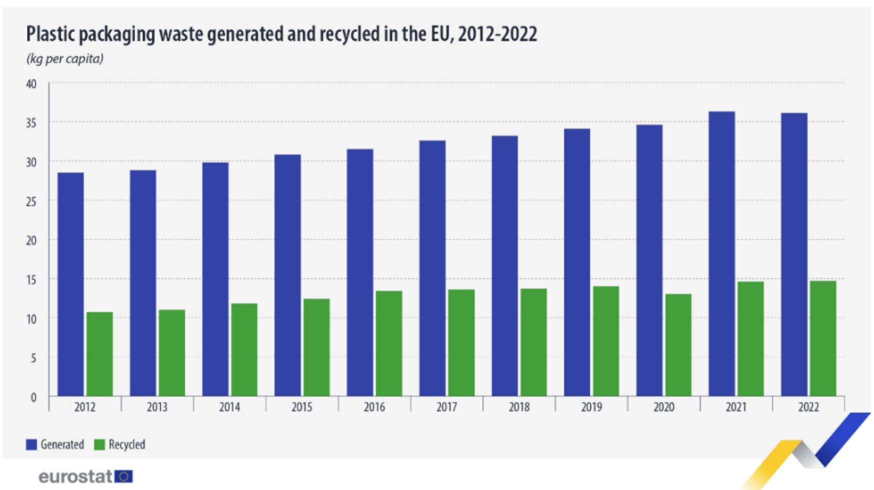

Fig. 3 *Plastic packaging waste generated and recycled in the European Union, 2012–2022 (kg per capita)*
Source: Eurostat, 2024

Despite policy efforts, recycling performance across the EU remains uneven. Figure 3 illustrates the trend in plastic packaging waste generated and recycled between 2012 and 2022, highlighting the persistent gap between total waste generation and actual recycling rates—a key motivation behind the introduction of the PPWR framework.

According to Amri et al. (2025), integrating the principles of the circular economy (CE) and closed-loop supply chains (CLSC) enhances both the environmental and economic performance of enterprises. Similarly, Garg and Vemaraju (2025) confirm that circular flows—such as reuse, repair, refurbish, and remanufacture—lead to reductions in CO_2 emissions, material consumption, and overall costs, especially when the quality of returned flows and the consolidation of reverse transport are effectively managed.

However, implementation barriers remain significant. These include organizational complexity, insufficient coordination among partners, lack of standardized material-sorting procedures, and quality issues in returned products (Di Nardo et al., 2025). Reverse logistics is inherently more complex, requiring planning of return flows, collection and sorting of products, and multi-tier supply chain collaboration (Liu et al., 2024). Digitalization has emerged as a key enabler for overcoming these challenges. The application of IoT, blockchain, and big data analytics enhances product traceability, material flow transparency, and process efficiency in collection and recycling (Moktadir et al., 2024). These technologies enable automated tracking of returnable packaging, more accurate route planning, and the integration of carbon footprint data into sustainability metrics such as Life Cycle Assessment (LCA) and the Material Circularity Indicator (MCI) (Ellen MacArthur Foundation, 2023).

Empirical studies from 2024–2025 document that companies implementing circular economy practices achieved 10–15% improvements in sustainability and 5–8% cost reductions through re-collection models and network optimization (Amri et al., 2025; Garg and Vemaraju, 2025). Transitioning from a linear to a closed-loop model, however, requires systematic investments in reverse logistics infrastructure, including facilities for collection, sorting, sanitization, and redistribution network redesign. The decisive factor for long-term sustainability remains the economics of cycles—the balance between the number of returnable packaging rotations, additional transport kilometres, and cleaning costs (Ji-Hyland et al., 2025).

From a managerial perspective, it is recommended to use MCI and LCA metrics to compare single-use and returnable packaging solutions, and to incorporate Total Cost of Ownership (TCO) analysis when implementing circular models. Effective CLSC management requires combining economic, environmental, and social indicators to comprehensively assess the contribution of circular strategies to both business performance and societal sustainability.

4 Digitalization, traceability and data interoperability

Digitalization and the development of data interoperability represent one of the most significant strategic trends in logistics and supply chain management in 2025. The goal is to achieve end-to-end visibility and traceability of material flows—an essential requirement not only for improving operational efficiency but also for meeting the demands of new regulatory frameworks such as the Corporate Sustainability Reporting Directive (CSRD), European Sustainability Reporting Standards (ESRS), and the GHG Protocol Scope 3 (Mankata et al., 2025). These standards require precise collection and reporting of environmental and social data, making digitalization an integral component of ESG management.

Systematic literature reviews by Moktadir et al. (2024) and Sharma and Goswami (2025) confirm that the most influential technologies driving logistics digitalization include the Internet of Things (IoT), Artificial Intelligence (AI), blockchain, and digital twins. These tools enable the collection of granular data on product flows, energy use, emission intensity, capacity utilization, and returnable packaging. In practice, companies track indicators such as km, t·km, energy consumption, OTIF (On-Time-In-Full), percentage of empty kilometres, Material Circularity Indicator (MCI), and recycling rates (Mankata et al., 2025). Such datasets allow both operational optimization and transparent compliance reporting.

Blockchain plays an increasingly important role in enhancing data credibility and auditability across multi-tier supply chains. According to Abeyratne et al. (2024), its primary value lies in providing a "single source of truth" for product origin, emissions, and supplier data. Wu et al. (2024) emphasize that AI algorithms, when integrated with IoT, enable automated emission profiling and predictive route management, reducing both CO_2eq per tonne-kilometre (t·km) and overall costs (€ per t·km).

From a data interoperability perspective, system fragmentation, format incompatibility, and inconsistent data granularity—particularly in Scope 3 emissions—remain persistent challenges (Sharma and Goswami, 2025). As a response, firms in 2025 are increasingly developing ESG data marts and integrated dashboards that consolidate environmental and economic KPIs such as CO_2eq/t·km, €/t·km, Total Cost of Ownership (TCO), recycling rate, and MCI. These platforms facilitate real-time performance management, improve reporting efficiency, and enhance supply chain resilience against disruptions (BITO, 2025).

Moktadir et al. (2024) also highlight cybersecurity, implementation costs, and methodological harmonization as critical adoption challenges. The alignment of the GHG Protocol and ESRS standards is particularly important for ensuring comparability of ESG performance across industries. From a managerial standpoint, digitalization is no longer viewed merely as a technological innovation, but as a strategic tool for strengthening competitiveness, ensuring compliance, and building more resilient and transparent supply chains.

5 Urban and last-mile logistics

Rising urbanization, the expansion of e-commerce, and the growing pressure to reduce CO_2 emissions are fundamentally transforming the nature of urban logistics. In 2025, the sector is shifting from pilot projects to scalable low-emission delivery models that combine electric vans, cargo bikes, consolidated urban hubs, and micro-fulfilment centres (MFCs) (World Economic Forum, 2024; Maersk, 2025). The primary objective of these systems is to reduce congestion, noise, and emissions while simultaneously shortening delivery lead times, thus improving both sustainability and customer satisfaction.

According to the World Economic Forum (2024) and the European Commission (2022), urban logistics is evolving toward an integrated and data-driven infrastructure. Key components include Urban Consolidation Centres (UCCs), micro-fulfilment centres located close to consumers, and electrified delivery fleets supported by intelligent time-slot planning systems. These solutions enable more efficient use of urban space and reduce empty-run kilometres (DHL, 2025).

From a research perspective, increasing attention is being paid to the optimization of the last mile through AI-based routing systems, simulation models, and digital twins, which allow testing of transport scenarios and minimizing the overall carbon footprint (Song et al., 2025). Gonzalez et al. (2023) report that combining data analytics with low-emission transport modes can reduce CO_2 emissions by 25–40% compared to conventional delivery models.

Nevertheless, significant challenges persist, including limited urban space, diverse regulatory frameworks (e.g., delivery time windows, parking policies), and insufficient coordination among municipalities, transport providers, and private sector actors (Uber Freight, 2025). The effective implementation of sustainable delivery models therefore requires collaboration between cities and enterprises, as well as the integration of city logistics with corporate decarbonization and circular economy strategies.

Current trends in both research and practice suggest that the future of urban logistics will be built on the synergy of electrification, consolidation, and digitalization, supported by regulatory initiatives such as the EU Urban Mobility Framework (2023) and the Green Deal Urban Logistics Plan (2025). These models offer a pathway toward logistics systems that are not only efficient and reliable, but also environmentally and socially sustainable.

6 ESG reporting and Scope 3 emissions: from compliance to value creation

Between 2025 and 2029, ESG reporting—and particularly the disclosure of Scope 3 emissions—is becoming an integral part of corporate management in logistics and industry. While in the past this process was largely driven by regulatory compliance, current trends indicate a shift toward the strategic use of sustainability data as a source of value creation and innovation (European Commission, 2025a).

According to the latest updates to the Corporate Sustainability Reporting Directive (CSRD) and European Sustainability Reporting Standards (ESRS)—the "quick-fix" version of July 2025—companies must demonstrably document their carbon footprint calculation methodologies, including data on Scope 3 emissions, i.e., indirect emissions from supply chains, packaging, and logistics. As a result, firms are developing ESG data platforms (datamarts) and establishing reporting flows across supplier tiers to ensure data consistency, completeness, and auditability (KPMG, 2025; PwC, 2024).

However, this transition is not without challenges. The short implementation timeframe leads to increased operational costs related to data collection and validation, as well as investments in systems and staff training (Deloitte, 2024). The lack of harmonized methodologies (GHG Protocol vs. ESRS) and the need to link environmental KPIs with financial metrics—such as €/t·km, carbon pricing, TCO, or OPEX/CapEx decision-making—represent major barriers (McKinsey and Company, 2025).

At the same time, companies that adopt a "measure-to-manage" approach rather than treating Scope 3 reporting as a mere obligation are discovering new competitive advantages. Transparent and auditable emissions data enable better supplier management, optimized routing, reduced fuel consumption, and improved access to green financing and ESG investment funds (European Investment Bank, 2025; UBS, 2025). In logistics, these mechanisms are increasingly intertwined with digitalization and traceability, where IoT and blockchain technologies enhance data quality and traceability throughout the supply chain (Mankata et al., 2025).

In the long term, ESG and Scope 3 reporting are evolving from regulatory requirements into core tools of corporate strategy, risk management, and value creation. This transformation marks the emergence of a new paradigm in which sustainability and economic performance are no longer perceived as opposites but as mutually reinforcing dimensions of modern business competitiveness.

7 Results

The logistics sector is undergoing a systemic transformation driven by regulatory changes, technological innovation, and increasing pressure for efficient resource utilization. Based on the conducted literature analysis and current empirical findings, five key pillars shaping the framework of sustainable logistics in 2025 can be identified.

These pillars represent an interconnected framework that enables enterprises not only to reduce their ecological footprint but also to optimize operational costs, enhance supply chain resilience, and strengthen corporate reputation. Regulatory frameworks—particularly the Packaging and Packaging Waste Regulation (PPWR) and the Corporate Sustainability Reporting Directive (CSRD/ESRS)—define the fundamental boundaries of sustainability, while technologies and new business models create opportunities for measurable improvements in both CO_2 reduction and economic performance. Each pillar encompasses specific trends, challenges, and opportunities, summarized in Table 1.

***Tab. 1** Overview of the Five Pillars of Sustainable Logistics in 2025: Key Trends, Challenges, and Opportunities*

Area	Trends	Challenges	Opportunities
1. Decarbonized Transport	• Electrification of trucks • Hydrogen & LNG corridors • AI route optimization	• High CAPEX • Limited charging network • Energy costs	• CO_2 reduction • ESG performance • Green partnerships
2. Circular & Reverse Logistics	• PPWR enforcement • Returnable packaging • Digital reverse flows	• Complex coordination • Quality of returns • Lack of metrics	• Material savings • New circular models • Cost efficiency
3. Digitalization & Traceability	• IoT, AI, blockchain use • ESG datamarts & dashboards	• Data fragmentation • Cybersecurity • Method harmonization	• Transparency • Real-time control • Reliable ESG data
4. Urban & Last-Mile Logistics	• e-Vans, cargo bikes • Micro-hubs & MFCs • Smart routing	• Urban space limits • Local regulations • Coordination issues	• Less congestion • Faster delivery • City–business synergy
5. ESG & Scope 3 Reporting	• CSRD/ESRS disclosure • Supplier data flows • Value-based management	• Reporting costs • Data consistency • Auditability	• Green finance • Risk reduction • Competitive edge

Source: own processing based on literature review (2022–2025)

Table 1 provides an overview of the five pillars of sustainable logistics in 2025: decarbonization of transport and infrastructure, circular and reverse logistics, digitalization, traceability and data interoperability, urban and last-mile logistics, and ESG/CSRD reporting with Scope 3 emissions management. It simultaneously represents a synthesis of insights that can serve as a foundation for corporate strategic decision-making and future research in sustainable logistics.

8 Conclusions

The overview indicates that sustainable logistics in 2025 is built upon mutually interlinked pillars that combine technological innovation, environmental objectives, and regulatory compliance. While the dominant trends are related to digitalization, decarbonization, and circular business models, the challenges are concentrated in areas such as implementation, data standardization, and infrastructure investments.

Conversely, emerging opportunities—including the transition to low-emission transport, the integration of ESG metrics with economic indicators, and the use of artificial intelligence for route optimization—represent significant potential for improving efficiency and strengthening business competitiveness. In the long term, integration—technological, data-driven, and organizational—remains the key to success. The synergy between decarbonization, circular flows, and digitalization forms the foundation for developing intelligent and sustainable logistics systems that combine economic efficiency with environmental and social responsibility. At the same time, the growing emphasis on digitalization, new sourcing strategies, and the expansion of e-commerce will continue to shape the logistics and supply chain landscape in the coming years.

Ultimately, the year 2025 confirms that sustainable logistics is no longer merely a response to regulatory change but a strategic platform for innovation, efficiency, and long-term resilience in a dynamically evolving global environment.

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