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FROM CARBON FOOTPRINT TO COMPETITIVE ADVANTAGE: FRAMEWORK FOR GREEN LOGISTICS INTEGRATION

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Supply chains generate over 60 % of global greenhouse gas emissions, with Scope 3 emissions 26 times greater than direct operational ones. By 2025–2026, green logistics has shifted from a niche initiative to a strategic asset: CBAM mechanisms, mandatory reporting, and changing consumer preferences make sustainability a market survival factor. Research confirms that carbon-neutral distribution networks reduce fuel costs, increase loyalty, and strengthen brand reputation.

Three-Level Integration Framework

Operational Optimization. AI route optimization reduces fuel consumption by 15 %...25 %. Electric vehicles, intermodal transport, and smart warehousing near consumption centers cut distances and emissions. Packaging minimization and closed-loop reverse logistics complete the foundation.

Digital Technologies. Digital twins model carbon scenarios before implementation. IoT sensors monitor energy use in real time, blockchain ensures transparent traceability, and AI agents autonomously reroute cargo and adjust inventory.

Institutional Alignment. Carbon criteria are embedded into procurement, with standards cascading down the supply chain. Staff incentives tie to environmental KPIs, leadership drives cultural change, and transparent reporting (ISO 14001, SBTi) builds trust. Green financing and cross-industry collaboration provide policy support.

Measuring Effectiveness

Target indicators: 30 % CO₂ reduction per ton-km over five years, 10 %...15 % lower logistics costs, 85 % transport utilization, and 20 % growth in eco-conscious customer loyalty.

Barriers and Solutions

High investments are addressed through phased implementation and green financing. Regulatory fragmentation is overcome via international standards and proactive CBAM adaptation. Unequal technology access for SMEs is lowered through cloud solutions and tech partnerships. Cultural resistance is broken through clear communication and quick-win pilots.

Conclusion

In 2025–2026, green logistics shifts from compliance tool to competitive advantage. Carbon footprint indicates operational efficiency, innovativeness, and resilience. Companies investing in three-level integration gain new markets, loyal customers, and sustainable financial results. When carbon efficiency determines supplier selection, green logistics becomes an investment in the future.