In collaboration with
Boston Consulting Group

WORLD ECONOMIC FORUM

Green Logistics Innovation for Emerging Markets: Driving Competitiveness and Shared Value

INSIGHT REPORT

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Foreword

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Logistics is the backbone of global connections, enabling the movement of goods, services and people across and within regions, catalysing economic and social developments. Freight transport, including supporting facilities such as warehouses and ports, accounts for 11% of global greenhouse gas emissions and is also one of the hardest-to-abate sectors globally.

Digitalization and technological advancements, together with evolving and shifting trade flows, provide an opportunity to enhance operational efficiencies, cut emissions and drive industry growth and competitiveness.

Emerging markets and developing economies (EMDEs), at varying levels of technology and business model readiness, are already making notable progress by embracing state-of-the-art innovations to support the green transitions of the logistics sector.

As part of the Net-zero Opportunities for Value-chain Action (NOVA) initiative, this report, developed by the World Economic Forum in collaboration with Boston Consulting Group (BCG), provides an overview of innovative technologies and new business models that have been deployed to accelerate the sector's green transition in EMDEs.

Interviews and workshops were conducted with advisers and experts across the ecosystem to gather insights and best practices that can support logistics ecosystem leaders in advancing towards a more sustainable, resilient and inclusive future. The report further identifies actions that government and other stakeholders can take to scale deployment and adoption efforts.

We thank all community members for their valuable guidance, inputs and feedback.

Executive summary

The imperative green transition in logistics calls for collaborative value chain actions to deliver economic, environmental, and societal benefits.

The global logistics sector is a strategic enabler of trade and development, projected to reach nearly $8 trillion in value. Maritime transport remains the backbone of global freight, while road and rail transport are expanding rapidly, driven by supply chain reconfiguration, surging e-commerce and the adoption of digital and low-carbon technologies.

Beyond its economic importance, logistics carries a substantial environmental footprint, contributing 11% of global emissions. The sector also plays a vital role in inclusive growth, supporting 10% of global employment.

Yet logistics faces five major challenges:

1. Geopolitical disruptions and rising costs
2. Infrastructure gaps and inefficiencies
3. Decarbonization pressures and climate risk
4. Labour shortages and skills mismatches
5. Rising consumer expectations

These vulnerabilities highlight the need for sustainable, resilient solutions. Green logistics offers a pathway, harnessing technology and innovative business models to improve efficiency, reduce emissions, and align practices with evolving regulations and societal expectations.

Emerging economies make notable progress

Emerging economies, despite varying readiness, are making progress and demonstrating that green logistics is both feasible and economically viable.

Drawing on leading practices, this report showcases innovative levers and case examples that illustrate scalable pathways for transformation. It identifies 15 levers for systemic change across four themes:

- **Green fuel production and use**
- **Green vehicle and propulsion manufacturing and adoption**
- **Green infrastructure construction**
- **Digital and green operational enhancement**

These must work in combination to unlock system-wide decarbonization and efficiency.

However, scaling requires overcoming systemic barriers in emerging markets:

- Policy and regulatory fragmentation create uncertainty.
- Limited resources, high costs, and skills gaps constrain adoption.
- Lack of ecosystem-wide alignment and persistent data fragmentation impede progress.

To address these, the report offers a practical playbook:

- Build an integrated policy and regulatory framework.
- Mobilize green finance, including transition finance.
- Upskill the workforce.
- Cultivate ecosystem collaboration.

Call to action: a global agenda for green logistics

Scaling green logistics cannot be achieved by any single actor. It demands coordinated action by governments, industry, customers, finance, academia and civil society.

- **Governments:** Establish coherent regulation, mobilize capital through incentives, nurture industry development and encourage global collaboration.
- **Industry:** Engage in multistakeholder dialogue, upskill workforces and scale solutions through alliances and public-private partnerships (PPPs).
- **Shippers and cargo owners:** Secure long-term agreements and aggregate demand to reduce risk.
- **Financial institutions:** Expand blended financing to unlock large-scale investment.
- **Academia and civil society:** Build talent pipelines, translate research into application and provide knowledge support.

Together, these actors form a shared agenda. The window for pilots is closing, and the moment for scaling green logistics is now.

1 Green logistics: the key to resilient global value chains

Green logistics has emerged as a critical strategic priority, while emerging economies provide valuable lessons and practical pathways.

1.1 Logistics as a key driver for global development

> This vital role comes with a substantial environmental footprint, accounting for 11% of global GHG emissions from freight transport, ports and warehousing.

Logistics is increasingly recognized as a global strategic priority, with the industry estimated to be valued at nearly $8 trillion by 2028.[1] It encompasses a broad spectrum of activities (including freight transport) and infrastructure (such as ports, airports and warehouses), along with supply chain management and various related services that collectively enable the efficient movement and storage of goods across domestic and international markets. As globalization deepens and e-commerce expands, logistics plays a critical role in connecting producers, consumers and markets. In the wake of disruptions such as the COVID-19 pandemic, the unprecedented stress on global supply chains underscored the necessity of robust, agile and risk-resilient logistics networks. Businesses and governments are now placing significant strategic focus on enhancing logistics capabilities to safeguard supply continuity and mitigate potential vulnerabilities.

The global logistics sector is growing rapidly, especially in the road and rail sectors, driven by increasing market demand and sectoral transformation. Maritime transport will remain the backbone of global freight, accounting for more than 60% of the mode share. Rail freight is projected to reach approximately 2.7 times its 2019 level by 2050, and road freight is expected to more than double over that same period.[2] This expansion reflects demand-side shifts such as supply chain reconfiguration and regionalization, the rapid rise of e-commerce and innovation in last-mile delivery. Widespread adoption of digital and smart technologies and a stronger focus on sustainability and low-carbon logistics also support the expansion.

The logistics industry exerts a significant impact on global economic and social development, and its operations can lead to a significant environmental footprint. Economically, the sector accounts for a substantial share of nations' gross domestic product (GDP) – up to approximately 8% in most countries and exceeding 10% in certain economies such as Lithuania (11.0%) and Kenya (10.7%).[3] The sector also supports approximately 10% of global employment across regions.[4] This vital role, however, comes with a substantial environmental footprint, accounting for 11% of global greenhouse gas (GHG) emissions from freight transport, ports and warehousing, creating an urgent imperative for systemic transformation.

1.2 Green transformation as a strategic imperative for logistics growth

Despite the ever-growing importance of logistics systems worldwide, they face five critical challenges (see Figure 1):

- Geopolitical disruption and rising costs
- Infrastructure gaps and operational inefficiency
- Decarbonization pressures and climate risks
- Labour shortages and skills mismatches
- Rising consumer expectations and service pressures

FIGURE 1 | **Global logistics systems face five critical challenges**

Challenges

Global logistics system faces five critical challenges, with emerging markets bearing the heaviest burdens.

Geopolitical disruption and rising costs

Trade tensions, export controls and regional conflicts disrupt supply chains and increase logistics costs.

Example

Red Sea crisis rerouted over 2,000 ships, adding **10–14 days** per trip and extra **$1 million in fuel costs**; US–China tensions disrupt global logistics, driving costly shifts and market uncertainty.

Infrastructure gaps and operational inefficiency

Ageing, underdeveloped and overstretched infrastructure hampers flow efficiency and worsens congestion and delays.

Example

Empty miles have accounted for **15–20% of trucking miles**, leading to wasted fuel, greater driver time, higher costs across the logistics chain and added road congestion.

Decarbonization pressure and climate risks

Companies face mounting pressure to reduce carbon footprint, comply with environmental regulations and adapt to intensifying climate extremes.

Example

72% of 44 ports or terminals suffer impact from extreme weather events, causing delays, disruptions in services and impacts on the physical structures of ports.

Labour shortage and skills mismatch

The industry is confronting the dual challenge of attracting new talents and upskilling existing workforces for new technologies.

Example

United Arab Emirates' infrastructure development has led to a **69% increase** in demand for blue collar roles while hiring has declined, particularly in port operation and supply chain management.

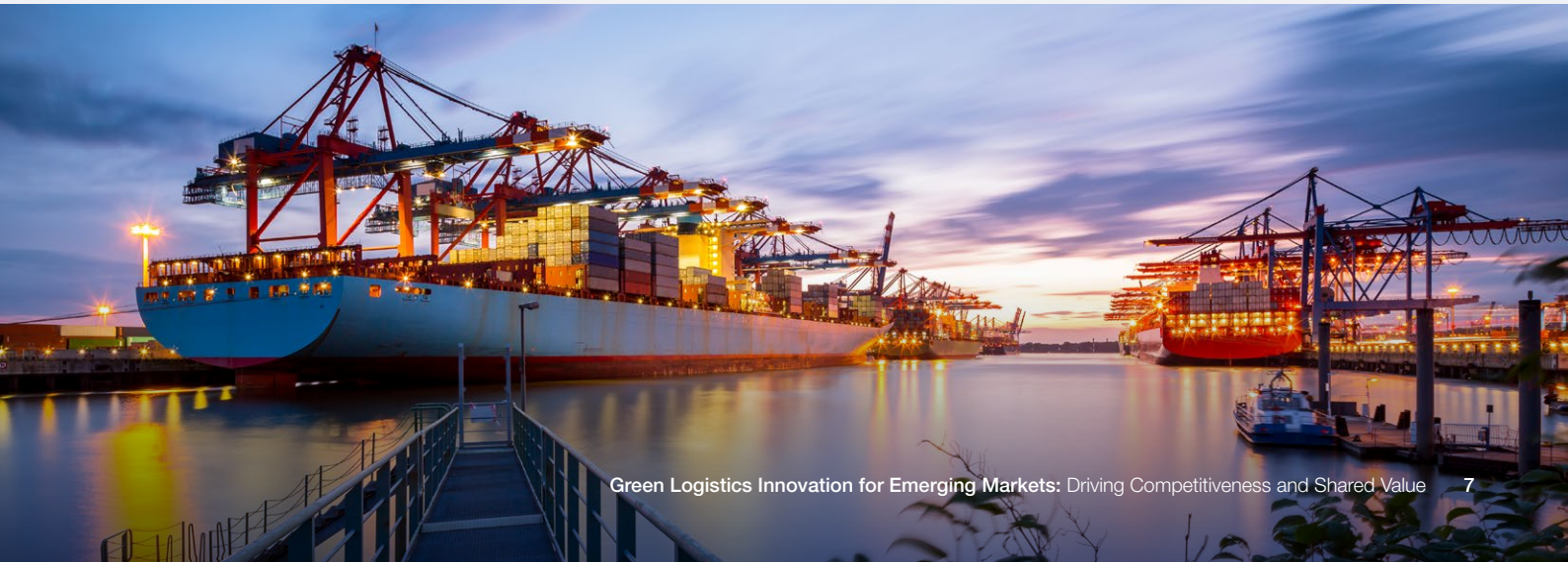
Rising consumer expectations and service pressure

Customers demand faster, more flexible, reliable and transparent delivery services.

Example

Emerging markets are struggling to meet consumer demand (e.g. **delivery in under two days**).

Source: The Business Standard; Atlas Institute for International Affairs; Reuters; The American Transportation Research Institute; UN Trade and Development (UNCTAD); Zawya.



> The accelerated growth of green logistics is driven by the necessity of directly addressing and resolving persistent industry-wide issues.

In response to these systemic challenges, green logistics has emerged as a critical strategic priority within the global logistics industry. Green Logistics encompasses innovative technologies and new business models across the logistics value chain, advancing sustainability, generating social impact and enabling future development. The accelerated growth of green logistics is driven by the necessity of directly addressing and resolving persistent industry-wide issues – including supply chain inefficiencies, infrastructure gaps, emissions reduction targets, labour constraints and evolving consumer expectations. Through technological innovation and optimized operational practices, green logistics provides tangible solutions to these challenges, reinforcing its strategic relevance and prompting significant attention worldwide.

Against this backdrop, a practical pathway for green logistics includes these four themes:

1. **Green fuel production and use:** Developing and deploying low-carbon, sustainable alternatives to conventional fossil fuels for transport and logistics operations, e.g. biofuels, biogas, green hydrogen, electro fuels
2. **Green vehicle and propulsion manufacturing and adoption:** Advancing the development, production and use of zero- and low-emission vehicles across logistics, e.g. electric delivery vans and trucks, hydrogen fuel-cell trucks, cargo bikes, and cleaner ships and aircraft
3. **Green infrastructure construction:** Upgrading and investing in multi-energy infrastructure required to enable sustainable transport and supply chain operations, e.g. electric vehicle (EV) charging networks and sustainable ports and airports
4. **Digital and green operational enhancement:** Harnessing digitalization, automation and data analytics (as well as enhanced operating models such as circular logistics and modal shifts) to optimize logistics operations, improve efficiency and reduce environmental impact

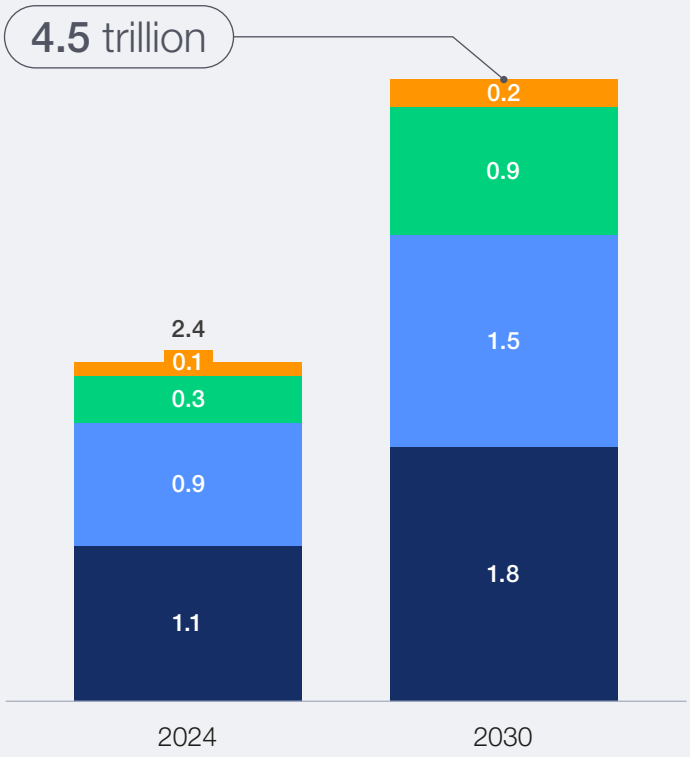
Green logistics helps turn ambition into implementation through technical and business-model innovation across the full value chain, as shown in Figure 3. It aligns technology, infrastructure and operations on an integrated pathway to address the challenges of the logistics industry.

FIGURE 2 **Green logistics technology innovations are driving significant global market growth**

Opportunities

Green logistics technology innovations are driving significant global market growth

Global green logistics market size ($, trillion)



Market segment	CAGR* 2024–2030
Green infrastructure construction and upgrade	20%
Green fuel production and use	18%
Green vehicle and propulsion manufacturing and adoption	9%
Digital and green operational enhancement	8%

Note: *Compound annual growth rate

Source: Grand View Research; Fortune Business Insight; Verified Market; Precedence Research; BCG analysis.

FIGURE 3 | **Green logistics encompasses a range of innovative technologies and business models designed to address the systemic challenges**

Green logistics include innovative technologies and business models to solve the systematic challenges in the logistics sector

Technology · Buisness model

Geopolitical disruption and rising costs	Infrastructure gaps and operational inefficiency	Decarbonization pressure and climate risks	Labour shortage and skills mismatch	Rising consumer expectations and service pressure
Resilient multimodal routing platforms	Green fuelling and charging networks	Renewable energy and biofuels	Automation and autonomous operations	Last-mile and specialized delivery solutions
Trade re-routing optimization algorithms	Smart and green transport hubs and networks	Hydrogen and derivatives	Wearable technology (AR* glasses, smart helmets etc.)	Circular logistics and reverse supply chains
Cross-border delay tracking systems	Green warehouses and distribution centres	Electrification	Intelligent parcel analytics system	Real-time transport data sharing system
Real-time freight disruption alert systems	Vehicle to everything (V2X) (infra, cloud etc.)	Carbon and energy management platforms	Automated multi-item recognition	Personalized delivery platforms
Adaptive sourcing and supplier reallocation tools	Infrastructure digital twins	Adaptative supply chains	Drone-based inventory management	Same-day delivery orchestration
Integrated proactive intermodal travel assistant (IPITA)	Intelligent route and schedule optimization	Early prediction and monitoring	Guided workflows and digital instructions	Smart lockers and urban micro-fulfillment

Note: *Augmented reality
Source: BCG analysis.

Green logistics plays a pivotal role in emerging markets by improving efficiency, creating jobs and reducing environmental pollution. It contributes to local economic growth. The burden of logistics costs is high in many emerging markets, for example, logistics costs are estimated to be around 14% of GDP in India,[5] 18% in Brazil[6] and 27% in the Philippines.[7] This makes green logistics an economic growth driver in emerging markets through lowered transport and inventory costs. Green logistics also drives local industry growth through improving reliability and expanding small and medium-sized enterprise (SME) market access. These efficiency gains also drive significant job creation and cultivate greater social inclusion. Environmentally, green logistics mitigates local pollution, minimizes waste through circular packaging practices and accelerates the adoption of renewable energy. Collectively, these benefits highlight the importance of ensuring that the transition is inclusive.

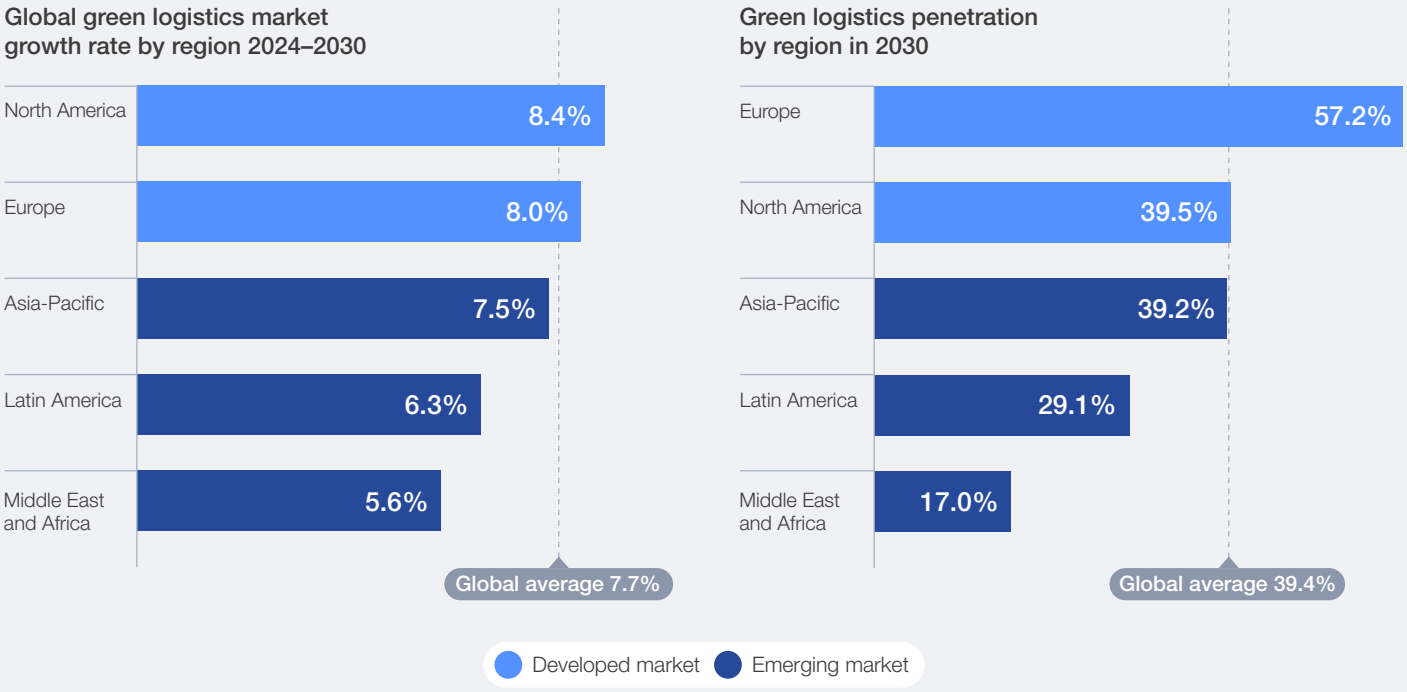
Emerging markets show different levels of maturity, reflecting their development stage, resource endowment and policy priorities. Beyond the shared areas of focus, distinct innovation pathways are shaped by local contexts:

- **China** demonstrates how to shift consumer behaviour at scale and upgrade market practices within a vast domestic market.
- **Viet Nam** offers a pathway for export-oriented economies that rely heavily on cross-border logistics to undertake a green transition.
- **United Arab Emirates**, as a global transport hub, is using green transformation to sustain long-term competitiveness and unlock new growth opportunities.
- **Saudi Arabia** shows how integrated, cross-sector planning can build a modern logistics sector and catalyse innovation through targeted pilots.
- **Brazil** highlights the importance of context-specific strategies that harness its bioenergy resources effectively.

FIGURE 4 | **Global green logistics is growing rapidly but unevenly across regions**

Emerging markets need to scale global innovations to close the gap and accelerate green logistics transformation

Global green logistics is growing rapidly but unevenly across regions.



Source: Grand View Research; BCG analysis.

The diverse trajectories and examples presented illustrate valuable learnings and highlight significant opportunities for stakeholders and investors. Yet, it is critical to acknowledge that no single country's experience can serve as a universally applicable blueprint. Successful green logistics transitions require balanced, inclusive and regionally tailored approaches that align short-term, economically viable actions with long-term sustainability objectives and actively engage cross-industry stakeholders to ensure practicality and relevance to local contexts. Given this inherent complexity, rather than offering prescriptive, one-size-fits-all solutions, the report identifies and summarizes key innovation levers from these diverse experiences. These levers, introduced in the next chapter, offer flexible frameworks that stakeholders can adapt and implement based on their unique infrastructure, market maturity and regional conditions.

> **From the perspective of TSCT's practical applications and the evolving trends of the global shipping industry, green transformation and smart transformation should not be regarded as 'supplementary options' in port development. Rather, they constitute the fundamental driving forces for breaking through structural bottlenecks and advancing sustainable growth. Through their synergistic advancement, ports are endowed with a redefined strategic positioning that integrates and balances economic, environmental and social value.**
>
> Ren Wei, Party Secretary, Tianjin Port Second Container Terminal

2 Innovation in action: technology levers and industry practices in green logistics

Emerging markets require systemic innovation aligned with forward-looking business models to scale green logistics and drive transformation.

2.1 The 15 innovation levers driving logistics transformation

Building on leading practices in emerging markets, scaling green logistics requires a systemic approach that aligns technological innovation with forward-looking business models. High-impact innovation opportunities in emerging markets were identified by mapping green logistics innovations along two key dimensions: their ability to address the identified challenges in the value chain, and their innovativeness and potential for future growth, particularly in terms of carbon abatement and commercial viability. Based on this, a detailed examination of pioneering public- and private-sector initiatives in the emerging market highlights 15 innovative levers under the four overarching themes. These levers hold significant potential to accelerate transformation, enabling a low-carbon logistics system in these regions while simultaneously driving business growth and capturing first-mover advantages.

TABLE 1 **15 innovation levers identified to drive green logistics transformation**

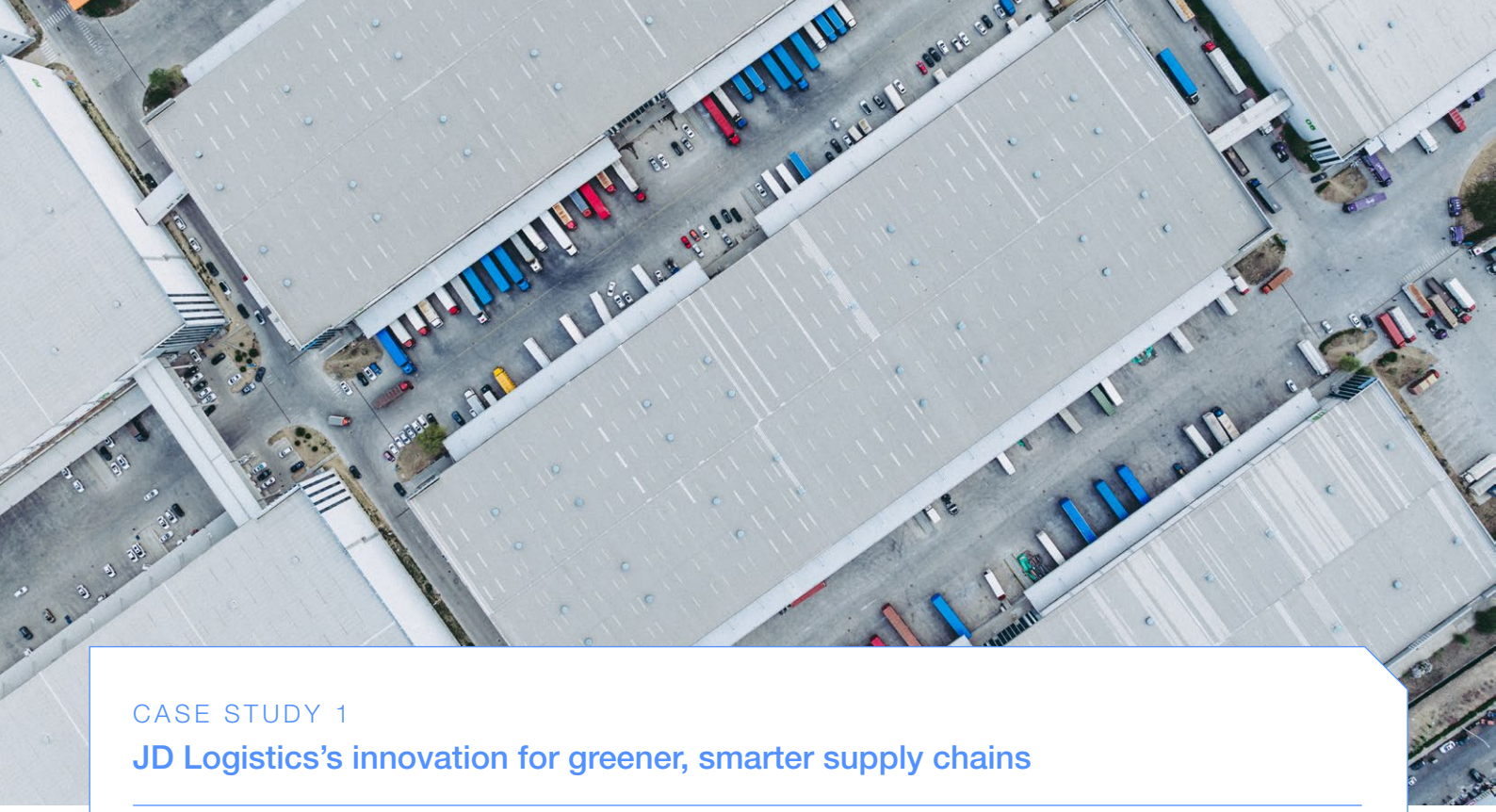
	Innovation lever	Impact
Green fuel production and use	**1 Renewable fuels generation** Low-carbon fuels produced from biomass or renewable sources, such as biodiesel, renewable diesel, or biomethane	– Reduce overall carbon footprint – Enable transition for hard-to-abate sectors – Use existing infrastructure
	2 Hydrogen and derivatives production Green hydrogen produced with renewable electricity and derivative fuels such as green ammonia or methanol	– Eliminate tailpipe emissions – Power heavy-duty and long-haul transport – Enable renewable energy storage
Green vehicle and propulsion manufacturing and adoption	**3 Electric and hydrogen-powered vehicles** Vehicles powered by battery or hydrogen fuel cells	– Cut freight transport emissions – Offer flexibility for different route lengths – Lower long-term operating costs
	4 Fully SAF-powered and light-weight cargo aircraft Aircraft operating on 100% SAF built with lightweight composites	– Improve fuel efficiency – Drastically cut life cycle CO_2 emissions – Increase payloads and ranges
	5 Alternative-propulsion maritime and inland vessels Ships and barges powered by hydrogen, ammonia, methanol, battery-electric and fuel-saving technologies, such as wind-assisted systems	– Significantly cut vessel emissions – Reduce fuel consumption – Meet international and regional mandates
	6 Low-emission freight locomotives Electric, hybrid, battery-electric and hydrogen-powered freight locomotives	– Lower rail transport emissions – Improve air quality near railways – Enable modal shift from road to rail
Green infrastructure construction	**7 Green fuelling and charging networks** Infrastructure delivering electricity, hydrogen, biofuels and ammonia for freight vehicles, vessels, aircraft and trains	– Enable adoption of clean energy fleets – Support a diverse range of fuel types – Improve grid stability and integration
	8 Smart and green transport hubs and networks Integrated intermodal hubs using IoT, AI and clean-energy systems	– Reduce hub emissions and energy use – Increase cargo throughput and capacity – Improve operational resilience
	9 Green warehouses and distribution centres Energy-efficient facilities with on-site renewables, smart HVAC, LED lighting and microgrids	– Reduce facility energy consumption – Increase adoption of green-certified logistics – Ensure operational uptime

TABLE 1 | **15 innovation levers identified to drive green logistics transformation** (continued)

	Innovation lever	Impact
Digital and green operational enhancement	**10 Intelligent route and schedule optimization** Digital tools for routing, load planning and delivery scheduling	– Reduce emissions via optimized routing – Speed up delivery times – Increase vehicle and network efficiency
	11 Automation and autonomous operations Robotics, AI and autonomous systems in warehouses, ports and vehicles	– Boost operational throughput and efficiency – Reduce fuel consumption and emissions – Address labour shortages
	12 Carbon and energy intelligence platforms Software for monitoring, reporting and optimizing carbon emissions and energy use across logistics networks	– Provide full supply chain emissions visibility – Identify energy and cost-saving opportunities – Automate ESG compliance and reporting
	13 Circular logistics and reverse supply chains Systems moving goods backward through supply chains for return, reuse, repair, recycling and disposal	– Reduce waste and pollution – Create new revenue from returned goods – Improve material efficiency and resilience
	14 Last-mile and specialized delivery solutions Low-emission, high-efficiency last-mile and niche delivery solutions	– Reduce urban emissions and congestion – Improve delivery access and efficiency – Catalyse new business models
	15 Modal shift and multimodal Shift from road to rail or waterways or integrate multiple transport modes	– Lower emissions shifting from road to rail/ waterways – Reduce long-haul transport costs – Relieve traffic and infrastructure strain

2.2 Industry applications and best practices in emerging markets

Leading players in emerging markets are deploying these levers to accelerate the shift to green logistics. Rather than acting in isolation, these levers are combined to unlock system-wide decarbonization and operational uplift. In advancing green logistics, especially in emerging markets, technological advancements provide the foundational capabilities required for efficiency and sustainability improvements. Meanwhile, business model innovation plays a crucial role in creating viable operational frameworks to address infrastructure gaps, cost sensitivities and local market complexities. Pioneers are translating this into action through strategies including circular packaging, alternative fuels, digital orchestration and collaborative ecosystems, demonstrating that systemic sustainability is both achievable and value-accretive.



CASE STUDY 1

JD Logistics's innovation for greener, smarter supply chains

Overview:

JINGDONG (JD) Logistics is China's leading technology-driven supply chain solutions and logistics services provider. As of 2024, it operates over 1,600 warehouses and 19,000 delivery stations with over 490,000 members of staff. The company drives innovation in hydrogen vehicles, green warehouses, digital and autonomous technologies, and operation optimization to achieve seamless integration of cost reduction, operational efficiency and sustainability.

Innovation levers applied:

- **Electrical and hydrogen-powered vehicles (lever 3):** JD Logistics scales up the deployment of electric logistics vehicles and explores other clean energy options, for example, operating 64 hydrogen-powered vehicle transport routes across regions such as Beijing-Tianjin-Hebei.

- **Green warehouse and distribution centre (lever 9):** Select sites conduct holistic consideration of land and ecosystems – making use of geographic information system (GIS) overlay analysis. They also enhance energy efficiency and reduce carbon emissions through smart systems, upgraded equipment and renewables. For example, its Xi'an Asia No.1 logistics park became China's first carbon-neutral logistics park in 2021 by installing a 100,000 square-metre (m^2) rooftop solar photovoltaic (PV) and storage system, and offsetting the remaining emissions through China Certified Emission Reduction (CCER) purchases.

- **Digital carbon management platform (lever 12):** The Supply Chain Emission Management Platform (SCEMP) was the industry's first international certification carbon management software as a service (SaaS) platform covering International Standard Organization (ISO) 14064, ISO 14083, ISO 14068 and Smart Freight Centre Global Logistics Emissions Council (GLEC) framework. Using blockchain technology, SCEMP builds a distributed carbon ledger and enables product stock-keeping unit (SKU)-level traceability with the industry's finest granularity at the waybill level.

- **Circular logistic and reverse supply chains (lever 13):** JD Logistics's implementation of full life-cycle packaging management – with a focus on "reduction, reuse and degradation" – includes key measures such as the development of new cartons, waterproof bags and tapes to reduce raw-material use, the use of reusable cooler boxes and transit boxes, and initiatives to encourage the reuse of secondary cardboard packaging and delivery with original packaging.

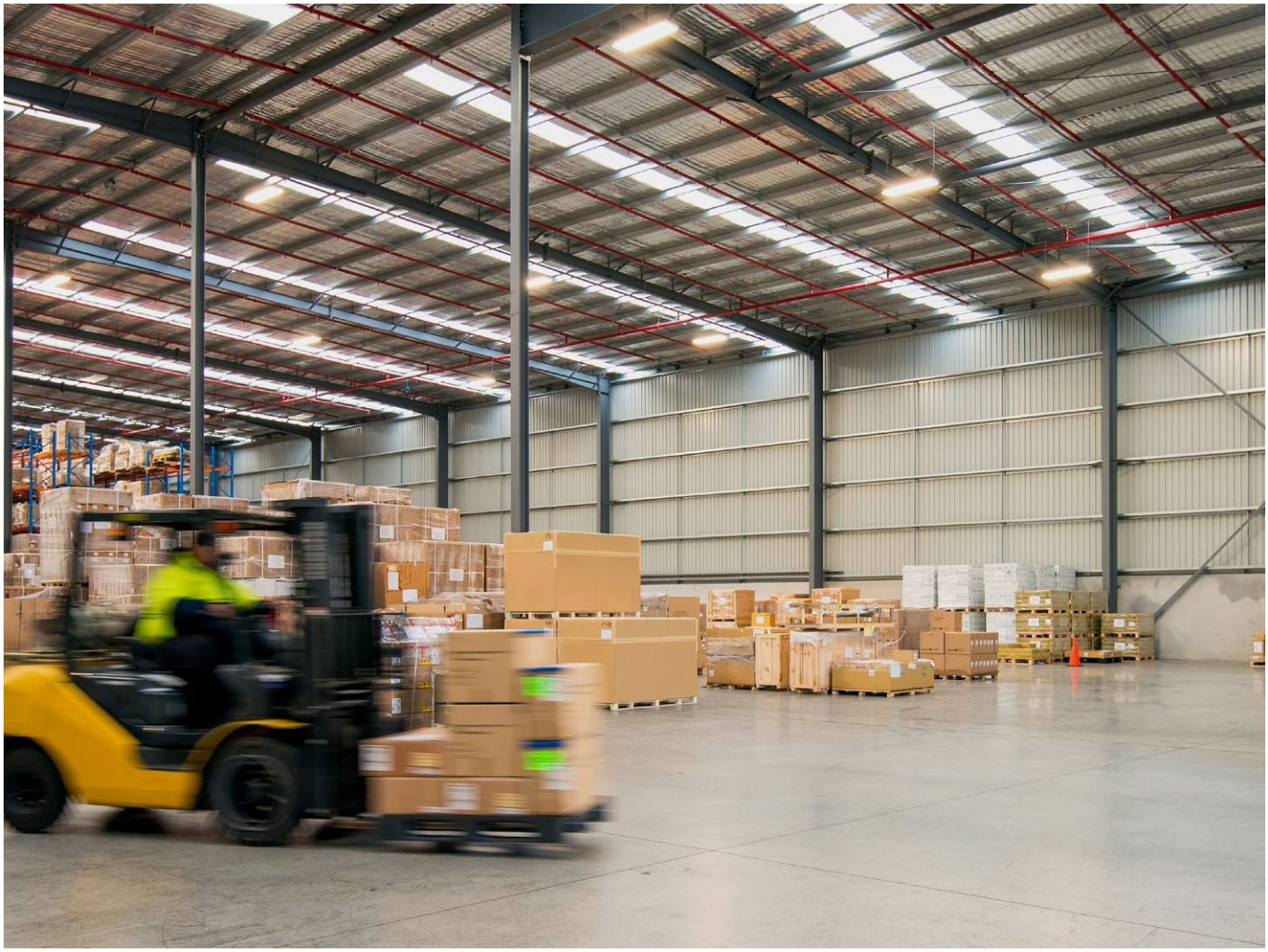
- **Last-mile and specialized delivery solutions (lever 14):** The company has built a three-tier, intelligent distribution network covering provinces, cities and counties, now reaching nearly all county-level regions nationwide. Advanced technologies, including autonomous delivery vehicles, are applied. New models such as Cloud Warehouse Delivery reduce intra-city delivery from the traditional 72 hours to just half a day, allowing clients to send goods to nearby courier stations, from which JD Express personnel handle the last-mile delivery.

- **Multimodal rail and road transport (lever 15):** The logistics hub cluster (encompassing one national hub, seven regional hubs and 23 provincial hubs) covers major economic regions in China. With dynamic scheduling optimization algorithms for intelligent coordination, it repurposes idle urban train station resources to facilitate resource use and cargo consolidation. A **dedicated environmental, social and governance (ESG) product service** was also launched to help clients shift long-distance orders to more efficient and sustainable rail transport.

Impacts achieved:

- **Emission reduction:** Hydrogen-powered vehicle transport reduces diesel consumption by approximately 600,000 litres annually, leading to a carbon dioxide (CO_2) emission reduction of nearly 1,000 tonnes. A comprehensive green transport solution that combines new-energy pickup vehicles and high-speed rail corridors achieved a cumulative carbon reduction rate of over 70% within the year. In 2024, solar panels installed on rooftops in parks and warehouses reduced carbon emissions by 50,902 tonnes compared with equivalent electricity generated from fossil fuels. Meanwhile, 960,000 reusable cooler boxes reduced 72,520 tonnes of CO_2, and secondary cardboard prevented 27,960 tonnes of emissions. SCEMP has served 100 brands worldwide, rolled out over 60,000 carbon accounts for multiple enterprises and calculated over 40 million waybills.
- **Cost reduction and efficiency gains:** Through intermodal transport, integrated terminals and dynamic scheduling optimization, logistics parks have boosted overall efficiency by 25%, cut city freight-node costs by 15%, raised network use by 30% and lowered comprehensive transport costs on underused routes by 25%. The fully deployed X-series cartons cut raw material use per box by 5–25%, the X-series waterproof bags now in service reduced material by approximately 20% and the switch to narrower 40 mm tape lowered annual plastic tape consumption by 13,352 tonnes. In 2024, JD Logistics reduced the use of secondary packaging by over 1 billion units through the Delivered with Original Package initiative.
- **Rural enablement:** With a logistics network covering over 99% of the national population, and through JD Farms, regional industry clusters and intelligent supply-chain bases, JD Logistics has helped more than 1,000 origin-based industry belts bring local agricultural specialties to wider markets, advancing rural revitalization.

Source: JD Logistics interview and documents review.



CASE STUDY 2

DHL's GoGreen Plus solution to decarbonize logistics services with sustainable fuels and low-carbon technologies

Overview:

DHL is a logistics provider that operates in over 220 countries and territories. It offers parcel, express and freight transport and supply chain management services as well as e-commerce logistics solutions. The company aims to reach net zero by 2050, and its GoGreen Plus Solution offers sustainable products and solutions to help clients across the supply chain reduce their carbon footprint.

Innovation levers applied:

- **Electrical vehicles and sustainable aviation fuels (SAF)-ready cargo with value chain collaboration (levers 3 and 4):** DHL provides green solutions such as sustainable fuels and an electric pickup and delivery fleet to reduce carbon emissions. DHL has partnered with Maxus and BYD for electric logistics vehicles, and with Neste and Envision for sustainable aviation fuel supply.
- **Supply chain optimization and modal shift (levers 10 and 15):** DHL also offers solutions for warehousing optimization, carrier selection, shipment consolidation and modal shifts from road to rail, while also supporting strategic network planning and cost-efficient routing.
- **Carbon intelligence platform (lever 12):** The platform provides customized carbon reports and interactive dashboards to offer clients a clear and detailed view of their GHG emissions by product and transport mode, and enhance data transparency.

Impacts achieved:

- **Green services adoption:** Over 10,000 corporate clients in Asia and 70,000 customers in China use DHL's GoGreen Plus service.
- **Clean energy mix:** The share of energy from renewable sources was 10.3% in 2024.
- **Electrification:** The share of EV use increased to 41.4% in 2024 in pickup and delivery, encompassing 39,100 vehicles.
- **SAF adoption:** 73 kilotonnes (kt) of voluntary SAF are used in DHL's own fleet. Including joint investments with partner airlines, DHL has used 9.8 % of global SAF.

Source: DHL interview and documents review.

CASE STUDY 3

Tianjin Port: a new generation of intelligent zero-carbon terminals

Overview:

The Tianjin Port Second Container Terminal (TSCT) represents a paradigm shift in seaport operations, establishing itself as the world's first fully automated, zero-carbon and internet of things (IoT)-enabled terminal with a horizontal layout. The 200,000-tonne-class terminal, with three berths and a total quay length of 1,100 meters, is designed to handle an annual capacity of 2.5 million 20-foot equivalent units (TEUs). The TSCT's pioneering Automation 2.0 model offers a replicable solution for over 90% of the world's conventional container terminals that are seeking to upgrade.

Innovation levers applied:

- **Smart and green transport hubs and networks (lever 8):** The terminal is equipped with an integrated wind-solar storage system that features 24 megawatts (MW) of wind turbine capacity and 16,000m^2 of PV panels. This green infrastructure is managed by a proprietary smart terminal operating system and harnesses 5G and Beidou navigation to create a truly intelligent, zero-carbon hub.
- **Automation and autonomous operations (lever 11):** TSCT has deployed a fleet of 92 L4 autonomous intelligent horizontal transport robots and 42 automated rail-mounted gantry cranes. These assets are centrally managed by an advanced fleet management system that automates and optimizes all container-handling processes throughout the terminal.

Impacts achieved:

- **Enhancement of operational efficiency:** TSCT's model has streamlined workflows, cutting container re-handling steps by 50% and improving the at-berth efficiency for mainline vessels by 28%.
- **Establishment as a world-class green port:** The terminal has now achieved 100% green energy self-sufficiency and 100% zero-carbon emissions across all energy consumption points, and has lowered its overall integrated energy consumption by 17% compared to last-generation automated container terminals.

Source: Tianjin Port interview and documents review.

CASE STUDY 4

Geely Farizon's green methanol strategy driving vertical integration to accelerate green transformation

Overview:

Geely, with its subsidiary Geely Farizon focused on new energy commercial vehicles, operates more than 50,000 vehicles and targets operational carbon neutrality by 2030 and life cycle carbon neutrality by 2045. Farizon has pursued innovation in green methanol and developed a complete industrial chain covering methanol production, storage, transport and filling, methanol vehicles and CO_2 capture.

Innovation levers applied:

- **Methanol production (lever 1):** A 100,000-ton-scale green methanol project was launched in Anyang, Henan, establishing a circular production model that converts captured industrial emissions into low-emission methanol fuel. This innovative approach significantly reduces overall carbon emissions by repurposing industrial waste streams, creating a replicable model of circularity at scale.
- **Methanol-powered commercial vehicles (lever 3):** In regions such as Gansu and Xinjiang, thousands of methanol commercial vehicles are used for local bulk commodities transport.
- **Methanol filling network (lever 7):** Partnering with players such as PetroChina and Sinopec will help build a national network of 4,000 methanol refuelling stations by 2027. Most stations are being converted from existing fuel stations at a low cost of only CNY 50,000–100,000 (Chinese yuan).

Impacts achieved:

- **Cost efficiency:** Methanol vehicles are comparable in cost to traditional gasoline and diesel vehicles, but 25-30% less than electric models. In particular, methanol vehicles have 32–45% lower fuel costs, enabling payback in 1–2.5 years.
- **Extended range:** Its Xingzhi H9M methanol light trucks offer over 1,000km of range, helping to address long-haul transport needs. While frequent refuelling may be required due to methanol's lower energy density compared to conventional fuels, the extended range still represents a significant improvement over purely electric alternatives, particularly for scenarios requiring long-distance operation.
- **Emission reduction:** Methanol commercial vehicles cut particulate matter by 98%, carbon monoxide by 88% and nitrogen oxides by 82% compared with China VI diesel vehicles. The Anyang green methanol project can lead to CO_2 reductions of 160,000 tonnes annually by capturing CO_2 from industrial exhaust to synthesize 110,000 tonnes of methanol.

Source: Geely Farizon interview and documents review.

CASE STUDY 5

Maersk drives green transition through energy shifts and efficiency improvements

Overview:

Maersk's energy transition strategy is anchored in two core decarbonization drivers: efficiency improvements and the green energy replacement. Its efficiency measures include schedule, network and asset performance optimization, while the company's energy replacement initiatives emphasize the urgency of transitioning from fossil fuels to low-emission alternatives, including alternative marine fuels and electrification solutions.

Innovation levers applied:

- **Methanol-capable vessels (lever 5):** Maersk plans to deploy 18 large dual-fuel methanol vessels by 2025. To secure enough bio- and e-methanol supply for its owned dual-fuel methanol vessels, the company signed a memorandum of understanding (MoU) and purchase agreements with leading suppliers, for example LONGi and Goldwind.
- **Green warehouses and terminals (lever 9):** It is replacing its diesel-powered equipment with electric alternatives and powering warehouses and terminals with renewable energy. Its investments in infrastructure such as EV charging stations and automatic operation systems support electrification and sustainability. To decarbonize terminal operations, the company collaborates with Contemporary Amperex Technology (CATL) to accelerate the electrification of container handling equipment.
- **Intelligent route and schedule optimization (lever 10):** Maersk's AI-driven platform StarConnect analyses 2.5 billion data points from over 700 vessels yearly to optimize fuel consumption and safety, while also taking into account environmental impacts. In a collaboration with Hapag-Lloyd, the company has launched the Gemini network in order to improve reliability, speed and fuel efficiency by using streamlined, single-operator mainliner loops that reduce stops between origin and final destination by nearly half.
- **Modal shift and multimodal (lever 15):** Its inland transport from ocean terminals is being seamlessly integrated with end-to-end inland transport of both containerized and non-containerized cargo via an extensive truck, rail and barge network.

Impacts achieved:

- **Fuel shift and emission reduction:** Bio- and e-methanol reduce GHG emissions by at least 65% compared to conventional fossil fuels. Maersk's combined methanol offtake agreements now meet more than 50% of the dual-fuel methanol fleet demand in 2027. Delivery projects are already under way. For example, Goldwind will begin supplying 500,000 tonnes of green methanol annually from 2026.
- **Energy efficiency improvement:** The Energy Efficiency Operational Indicator (EEOI) of Maersk's vessels has improved to 11.1 gCO_2e/t-nm (grams of CO_2e per tonne-nautical mile) in 2024 (down from 11.7 in 2023).

Source: Maersk interview and documents review.

2.3 Lessons learned for scaling impact

> The absence of clear, stable and harmonized regulatory frameworks – especially for cross-border logistics – deters long-term capital commitment.

An analysis of the pioneering efforts mentioned previously across emerging markets reveals how industries are harnessing technology and new business models to accelerate the green logistics transformation. While these cases illustrate practical pathways for innovation, their broader adoption and scaling are contingent on overcoming critical systemic barriers.

First, despite global efforts such as those taken by the International Maritime Organization (IMO), important steps have been taken towards a unified global framework for shipping decarbonization. Policy and regulatory fragmentation add further uncertainty to an already unpredictable investment landscape in emerging markets. The absence of clear, stable and harmonized regulatory frameworks – especially for cross-border logistics – deters long-term capital commitment. Inconsistent and/or unreliable incentive structures further undermine investor confidence, impeding the scalable deployment of proven green technologies and stifling innovation. Moreover, the absence of unified standards hinders the widespread adoption of such innovation.

BOX 1 **Five major EV charging standards exist worldwide**

- Chinese standard based on GB/T 20234
- North American standard CCS1 based on J1772
- European standard CCS2 based on IEC 62196
- Japanese standard based on CHAdeMO
- Tesla standard based on NACSx

Inconsistent charging interfaces in different regions have caused issues to the production and sales of automobiles and the production and construction of charging piles.

Source: Bonnen Battery. (2024). *Understanding The Diversity Of The Five Electric Vehicle Charging Standards Worldwide*.

Second, adoption faces critical resource gaps: limited financial resources to cover high upfront and operational costs, compounded by a shortage of skilled labour necessary for implementation. Advanced technologies, such as hydrogen systems and automated infrastructure, demand substantial initial capital and often entail extended payback periods, while green fuels remain considerably more expensive than traditional fuels. In emerging markets, this financial hurdle is compounded by end-user reluctance to absorb the "green premium", which challenges the commercial viability of cleaner alternatives. The substantial upfront investment required for infrastructure, such as charging networks, further slows the broader uptake. Concurrently, a critical shortage of a skilled workforce, including technicians, engineers and data analysts proficient in new energy systems and digital platforms, impedes both the implementation and effective operation of these advanced solutions in emerging markets.

BOX 2 **High cost of green fuels**

Sustainable aviation fuel costs more than conventional jet fuel, though the premium varies widely by technology. In 2024, the airline industry used all SAF produced at a price of **3.1 times** that of jet fuel.

Source: International Air Transport Association (IATA). (2025). *Fuel Fact Sheet*.

> **While a good number of our clients, especially multinational corporations, are willing to work together with us even with a green premium for logistics services to meet decarbonization targets and compliance requirements, broad scaling will require stronger demand-side incentives and clearer policy signals.**
>
> Elaine Chen, Vice-President, Corporate Public Affairs, DHL Group

Third, a lack of ecosystem-wide alignment and persistent data fragmentation impede coordinated progress. In emerging markets, collaboration across the value chain remains segregated, leading to disparate technology choices, interoperability gaps and missing standardized industry-wide development pathways. This misalignment between upstream technology providers and downstream logistics operators results in inefficient resource allocation. Concurrently, pervasive data segregation limits end-to-end supply chain visibility, hindering performance benchmarking, accurate progress measurement and the implementation of systemic optimization opportunities.

> **Building an integrated green supply chain requires systematic innovation and collaboration. JINGDONG Logistics is working with partners and clients to advance sustainable logistics through company-wide low-carbon initiatives. By aligning technology, resources and sustainability goals, we can accelerate the transition to a green logistics system that delivers sustainable value for both business and society.**
>
> Wang Ying, Vice President, JD.com

> **Partnerships between producers and end users are the key to unlocking green fuel at scale. Our collaboration with demand-side players such as DHL exemplifies this approach. In this partnership, we supply SAF to support DHL's decarbonization goals. By driving systematic innovation, Envision is making SAF cost-competitive and transforming this 'new oil' into a scalable solution for the global energy transition.**
>
> Zhang Lei, Founder and Chairman, Envision Group

3 Blueprint to scale green logistics transformation

Ecosystem-wide collaboration and coordinated enablers are essential to overcoming systemic barriers and unlocking the potential for scalable green logistics.

Recognizing the barriers observed from industry experience, as outlined in section 2.3, and given the sector's inherent complexity, green logistics transformation in emerging markets not only relies on technological advancement, but calls for coordinated, cross-cutting ecosystem enablers:

- **Integrated policy and regulatory frameworks** to steer direction and align incentives
- **Green finance, including transition finance instruments** to de-risk investment
- **Workforce upskilling** to ensure operational readiness
- **Ecosystem-wide** collaboration to enhance interoperability and resource efficiency

Unlocking the green logistics sector's full potential requires an integrated blueprint for action across the logistics value chain. The framework that follows (sections 3.1–3.4) is structured around four identified enablers, collectively designed to dismantle the systemic barriers. Together, these interventions provide a coherent playbook – from policy and capital to execution – designed to systematically unlock a rapid and scalable transition to green logistics in emerging markets.

3.1 Build an integrated policy and regulatory framework

> Policies can help ensure technology neutrality, supporting a diverse spectrum of mature, feasible and affordable solutions tailored to local contexts.

An effective regulatory framework can set direction, coordinate stakeholders and create enabling conditions for innovation and investment, particularly in emerging markets where systemic gaps in infrastructure, technology and finance persist.

Build a robust regulatory framework: Clear national strategies can be translated into sector-specific roadmaps, underpinned by aligned policies and technical standards to drive implementation. Targeted demand-side incentives, such as tax benefits, green procurement mandates and low-emission zone regulations, need to be deployed where economic barriers and behaviour barriers exist to further accelerate market uptake and de-risk private investment. This would ensure a synchronized transition across the value chain. It is also critical to maintaining a regulatory framework that's stable over time and consistent across various sectors and regions. National strategies could be clearly aligned with sector-specific policies and local implementation, cultivating coherence across all levels of policy execution.

Institutionalized cross-regional and inter-departmental coordination: Ensuring a consistent and stable regulatory framework requires effective cross-regional and inter-departmental collaboration. Close coordination among local, regional, national and even cross-border stakeholders is crucial to harmonize implementation and avoid policy fragmentation. Additionally, innovation sandboxes such as pilot zones and economic free zones serve as valuable platforms to test new policies, business models and technologies, providing empirical evidence that supports adaptive, evidence-based refinement of regulations. Such comprehensive coordination ensures long-term stability, clarity and predictability within the regulatory environment.

Ensure technological neutrality: Particularly in emerging markets, it is essential to recognize the practical constraints of deploying overly advanced or costly technologies. Policies can help ensure technology neutrality, supporting a diverse spectrum of mature, feasible and affordable solutions tailored to local contexts.

CASE STUDY 6

China's target-driven, coordinated policy and local pilots driving scaled green logistics

China demonstrates how a multi-tiered policy framework – integrating national targets, coordinated development, standards, incentives and local pilots – can effectively accelerate and scale up the green logistics transition. The following are specific aspects of such a framework, including examples of each:

- **National strategies highlight the importance of green logistics development**
  - *Guiding Opinions on Fully Implementing the New Development Philosophy to Achieve Carbon Peaking and Carbon Neutrality (2021)*: Accelerate the development of a low-carbon transport system by optimizing transport structures, encouraging the use of energy-efficient, low-carbon vehicles and promoting low-carbon travel modes.
- **Medium-to-long-term master plans to set development direction**
  - *The 14th Five-Year Plan for Modern Logistics Development (2021)*: Systematically drive the low-carbon and sustainable transformation of the entire modern distribution system by developing green infrastructure, promoting clean transport solutions and cultivating a circular economy.
- **Sector-specific policies, regulations and standards**
  - *Guidelines for Building a Standard System for Smart Logistics in Transportation (2022)*: Establish unified data and technical standards to drive the digitalization and intelligence of the entire logistics chain.
  - *Implementation Plan for National Logistics Hub Construction (2021)*: Build a modern **corridor, hub and network** logistics system and steadily advance the development of approximately 120 national logistics hubs.
  - *Regulations on Express Delivery Packaging (2021):* Systematically promote the reduction, standardization and recycling of express packaging, and establish a green governance mechanism across the entire supply chain.
- **Regional pilot policies**
  - *Management Measures for Urban Green Freight Distribution Demonstration Projects (2022)*: Accelerate the green transformation of urban freight distribution systems in over 75 cities by integrating logistics resources, upgrading freight hub facilities, optimizing vehicle access policies and promoting the adoption of new energy delivery vehicles.
  - *Notice on Launching Fuel Cell Vehicle Demonstration Projects (2020)*: Build a **technical research, scenario demonstration and policy support** framework in the five major urban clusters, providing systematic support for the application of fuel cell vehicles in the green logistics sector.

Impacts achieved:

Policy support spans energy transition, infrastructure development, industrial integration and digital transformation – ensuring the coordinated advancement of all essential enablers for green logistics. This integrated approach has laid a solid foundation for transformation and achieved notable progress, including the following:

- **High adoption of non-fossil fuels:** The share of non-fossil-fuel power generation capacity in China's energy mix has exceeded 50%,[8] enabling logistics to shift towards clean technologies such as green hydrogen.
- **Infrastructure development:** Over 150 national logistics hubs have been established.
- **Industrial integration:** In the latest batch of 30 national logistics hubs, 63% were designated as production service or commercial service hubs.[9]
- **Digital transformation:** Over 3,500km of roads have been upgraded with smart infrastructure to support intelligent freight operations.[10]

CASE STUDY 7

Green logistics is a national-level strategic priority in Viet Nam

Under the *Prime Ministerial Decision No. 882*, logistics is identified as one of 18 priority areas in the *National Action Plan on Green Growth* in Viet Nam.[11] Green logistics is emerging as a key component of both Viet Nam's sustainable development strategy and its roadmap to achieving net-zero carbon emissions by 2050.

Impacts achieved:

- **Enhanced competitiveness and cost efficiency:** Embracing green logistics can help reduce Viet Nam's notoriously high logistics costs, thereby improving economic competitiveness. For example, the application of digital tools such as IoT, big data and automation has enabled many local enterprises to reduce logistics costs by approximately 23% and shorten order processing time by approximately 35%.[12]
- **Job creation and workforce development:** A recent United Nations Development Programme (UNDP)-supported study finds that Viet Nam's adoption of green transport policies, such as electrifying road freight and using renewable energy, could generate approximately 99,000 new jobs by 2030.[13] The government and industry are responding by investing in training and upskilling programmes to support the logistics workforce in adapting to new technologies.

CASE STUDY 8

Strategic deployment of bioenergy benefits through mandatory policy in Brazil

As the second-largest biofuel producer worldwide, Brazil is harnessing its biofuel advantage to promote green logistics transformation with strong policy mandates and decarbonization targets.

Mandatory biofuel use for the logistics sector:

- Brazil has had a mandatory ethanol blend since the 1970s and now has one of the largest global fleets of flex-fuel on-road vehicles[14] – most fuelling stations nationwide provide ethanol-blended fuel or pure-ethanol fuel.
- Brazil's **Fuel of the Future** law mandates a 1% reduction in aviation-sector GHG emissions through the use of SAF starting in 2027, with a phased increase to 10% by 2037.[15]

Impacts achieved:

- **Domestic economic growth driver:** Brazil's push for ethanol and biodiesel has created a robust domestic industry that helps bolster the economy. Sugar and ethanol are among Brazil's top export earners (about $11 billion, fourth in agribusiness exports[16]) and provide opportunities for the country to expand into greener fuel exports.
- **Employment opportunities and rural development:** The biofuel industry's growth has led to significant social impact by both creating jobs and supporting rural communities. It is estimated that the expansion of sugarcane cultivation for ethanol and biodiesel production has generated 4.5 million direct and indirect jobs.[17]

3.2 Mobilize green and transition finance

> Scaling green logistics solutions in emerging markets requires long-term capital commitments, especially in environments dominated by fragmented and undercapitalized SMEs.

The public sector plays a pivotal role in bridging financing gaps for logistics decarbonization in emerging markets by strategically absorbing risks that deter private capital – particularly in research and development (R&D), early-stage tech, scaling solutions, and SME participation. Doing so requires deploying blended financial instruments that both de-risk investment and mobilize green capital at scale by turning uncertainty into investable opportunities.

Support R&D and early-stage technologies through innovative funding

Early-stage innovations such as hydrogen-powered freight solutions and AI-enabled logistics optimization often lack a proven track record of commercial performance, making them difficult to finance through traditional channels. To bridge this "valley of death", public-sector actors can play a catalytic role by offering development-stage support, including grants and state-backed venture funding. Additionally, governments can deploy concessional instruments such as risk guarantees and technical assistance to de-risk private capital while also enabling the use of innovative financing tools tailored to nascent technologies.

Scale proven solutions and empower SMEs through blended finance

Scaling green logistics solutions in emerging markets requires long-term capital commitments, especially in environments dominated by fragmented and undercapitalized SMEs. This is due to the fact that these actors frequently lack access to affordable financing for sustainable upgrades. Governments can play a catalytic role by directing capital to SMEs through concessional instruments and encouraging financial institutions to develop sector-specific blended finance mechanisms.

BOX 3 China's National Key R&D Program drives technology innovation through funding support

China's National Key R&D Program allocated **CNY 254 million (around $35 million)** for hydrogen development in 2024, and policy-oriented industrial funds are also supporting hydrogen fuel value chain development from critical materials and core equipment to original technology breakthroughs.

Source: National Energy Administration. (2024). *Notice of the National Energy Administration on Issuing the 2024 Project Application Guidelines for Four Key Special Topics under the National Key R&D Program, Including "Clean and Efficient Coal Utilization Technologies"*.

BOX 4 Financial incentives in India and Mexico for scaling green fleets and empowering SMEs

India's FAME II programme (2019–2024) catalysed a nationwide EV ecosystem and corridor charging network by allocating **INR 115 billion (Indian rupees) (around $1.4 billion)** to subsidize over 1.7 million electric light vehicles (89% two-wheelers, 9% three-wheelers, 2% four-wheelers), 7,200 e-buses and the installation of 2,700 charging stations.

Mexico's development bank, NAFIN, has rolled out a green-fleet programme that offers scrappage incentives and long-term loans to support SMEs in upgrading to cleaner vehicles, including compressed natural gas (CNG), hybrid and electric trucks.

Source: Kohli, S. (2024). *Electric vehicle demand incentives in India: The FAME II scheme and considerations for a potential next phase.* International Council on Clean Transportation (ICCT); García Coyne, R. (2023). *Expanding Access to Financing for Zero-Emission Trucks in Latin America and The Caribbean.* Global Commercial Vehicle Drive to Zero.

Close infrastructure financing gaps through public-private partnerships: Enabling green freight transport through the rollout of national charging and refuelling networks is central to the development of the green logistics sector. In parallel, urban and port authorities are establishing specialized logistics zones equipped with energy-efficient warehouses, cold-chain facilities, multimodal terminals and renewable-powered microgrids. Public-private partnerships (PPPs) can close the financing gap for green logistics infrastructure by pairing public policy and de-risking tools with private capital and execution. For example, the World Economic Forum's recent *Financing the Airports of Tomorrow* report highlighted how New York's LaGuardia Airport became the world's first to achieve LEED Gold v4 certification through a public-private partnership model. Governments can provide site access, clear permitting and standardized contracts, and also use viability gap funding, credit guarantees and/or availability payments to improve bankability for projects such as shore power at ports, electric yard equipment, truck charging depots and hydrogen/methanol bunkering. Private partners also bring capital, delivery capability, asset management and digital systems that raise use and revenue certainty.

BOX 5 Nigeria's Lekki Deep Sea Port: a $1.5 billion, 45-year PPP project

Through a public-private partnership valued at $1.5 billion over 45 years, the project is designed to accommodate larger and more efficient vessels, and to automate cargo handling operations – delivering both operational efficiency and emissions reduction.

Impact:

- **Doubled** Lagos's container throughput
- Slashed average dwell times from over 50 days to just 2 days
- Expected to catalyse **$361 billion** in economic activity and create **170,000 jobs** over its concession life

Source: Maritime Gateway. (2023). *Nigeria's Lekki deep seaport doubles cargo capacity*.

BOX 6 Jeddah Port: a $250 million sustainable logistics park

At Jeddah Port, Saudi Arabia's port authority Mawani partnered with Maersk to develop a logistics park with a $250 million investment and covering 225,000m^2, embedding sustainability into the project's core, integrating features such as renewable solar energy and digital and multimodal solutions from the design stage.

Impact:

- The development will handle **200,000 TEUs (20-foot equivalent units)/year**
- Creates **2,500 jobs**
- **Carbon-neutral facility** powered by renewable solar energy and equipped with electric forklifts, reach stackers, empty container handlers and trucks

Source: Maersk. (2024). *Maersk opens the doors to its largest Logistics Park at Jeddah Islamic Port in Saudi Arabia*; Maersk. (2021). *Maersk Saudi Arabia to set up the first Integrated Logistics Park at Jeddah Islamic Port.*

BOX 7 Envision advances Brazil's energy transition with clean energy expertise

Announced strategic collaboration with the Brazilian government to build Latin America's first net-zero industrial park: The industrial park will centre on the production of SAF and aims to establish a full green fuel value chain while also supporting the growth of green hydrogen and green ammonia sectors.[18] It will combine public-sector policy support, land allocation and infrastructure investment with Envision's technological and operational expertise.

Partner with Fotowatio Renewable Ventures (FRV), a leading developer of sustainable energy solutions, on a hydrogen project in Brazil's Pecém Port: The partnership combines FRV's experience in clean energy solutions and its long presence in Brazil with Envision's AI-integrated total renewable energy system to build a 500 MW electrolysis facility and an integrated ammonia plant, which is expected to be operational by 2030 and targets key markets in Brazil, Europe and Asia.

Source: PR Newswire. (2025). *FRV Announces Strategic Partnership with Envision, a Leader in Total Renewable Energy Solutions, for H_2 Cumbuco Project in Brazil*. https://www.prnewswire.com/news-releases/frv-announces-strategic-partnership-with-envision-a-leader-in-total-renewable-energy-solutions-for-h$_2$-cumbuco-project-in-brazil-302518579.html.

Ensure long-term development through climate investment: Climate-aligned investment is emerging as a critical enabler of long-term value creation in green logistics. By directing capital towards sustainable infrastructure and innovation, climate finance – including transition finance that supports sectors in gradually decarbonizing and shifting towards low-carbon operation – helps mitigate future regulatory, environmental and operational risks in emerging markets. In parallel, it supports the structural shift towards low-emission, resilient logistics systems. Investment instruments aligned with climate and ESG objectives increasingly reflect both return potential and risk reduction, making them powerful drivers of transformation. As green logistics transformation continues to accelerate, integrating such financing mechanisms into national and corporate strategies will be key to unlocking scalable, future-ready solutions.

BOX 8 IFC investment in sustainable logistics estates to boost Indonesia's E-commerce logistics

The International Finance Corporation (IFC) is extending up to **$120 million** in green debt financing to Logos, a leading Asia-Pacific logistics property group, for the development of two modern logistics estates in Greater Jakarta, Indonesia.[19] This strategic investment aims to deliver high-quality, sustainable warehousing infrastructure to support the country's booming e-commerce market, thereby cultivating business expansion and enhancing overall competitiveness in the national logistics sector.

Source: International Finance Corporation (IFC).

BOX 9 By signalling bankability, the Asian Infrastructure Investment Bank's climate finance in Hubei mobilizes co-investment and speeds green logistics buildout

The Asian Infrastructure Investment Bank's (AIIB's) investment focus is on green logistics infrastructure.

- The AIIB's mission is to finance "infrastructure for tomorrow", with a core strategic focus on green infrastructure and connectivity. This mandate is highly synergistic with green logistics development, and the bank aims to deploy $75 billion by 2030[20] to narrow the infrastructure financing gap, creating a substantial pool of capital for this high-priority sector.

Hubei Global Air Cargo Logistics Project as a regional flagship of blended finance.[21]

Project background:

- The project will develop a 134.9-hectare bonded logistics park adjacent to Hubei Ezhou International Huahu Airport – Asia's first dedicated freight airport. It will be configured as a climate-resilient, low-carbon, smart comprehensive bonded zone offering customs operations, bonded warehousing and processing, and integrated trade/freight services. Sustainability is foundational, with climate-resilient infrastructure, low-carbon energy and equipment, and smart digital systems optimizing operations across the park.

AIIB's involvement:

- AIIB has issued a $400 million strategic loan with an ultra-long tenor of 24.5 years and an average annual interest rate of 2.5%.

Impact:

- **Stable funding anchor:** A $400 million AIIB loan provides long-term, stable financing for the Hubei International Air Cargo Zone, underpinning on-time delivery and de-risking the buildout.
- **Industry transformation:** Capital is directed to green, low-carbon, smart infrastructure, accelerating the sector's upgrade through special supervision zones, digital trade platforms and a zero-carbon logistics system.
- **Local capability-building:** The programme develops local project-management capacity, embedding international ESG and operations standards within the implementation team.
- **Harness effect:** The investment is expected to dedicate over CNY 10 billion for aviation manufacturing, cold-chain logistics and digital trade industrial clusters, amplifying the project's impact.

3.3 Upskill the workforce

> Linking individual actions to measurable sustainability goals creates a shared sense of ownership and accountability, turning the workforce into active agents of the green transition rather than passive recipients of top-down mandates.

A successful green logistics transition relies not only on technology and infrastructure but also on a skilled and motivated workforce. This includes equipping workers with the skills and knowledge to thrive in low-carbon digital logistics environments, e.g. training workers in areas such as automation system operation and digital supply chain management. It also involves cultivating behavioural changes, for example prioritizing sustainability in decision-making and day-to-day operations, which affects drivers, warehouse staff, fleet managers and logistics planners alike. Together, these efforts ensure that sustainability becomes an integral part of logistics practices.

Design, contextualize and deliver cross-sector training using digital tools: Governments, industry associations, leading enterprises and vocational institutions could co-design contextualized training programmes for emerging markets. These focus on, for example, new energy vehicles, smart equipment and carbon management, with particular emphasis on frontline roles such as truck drivers, warehouse operators and dispatchers. Enhancing digital literacy is equally critical, and hands-on training in digital tools/systems and telematics platforms needs to be made accessible to workers to ensure inclusive participation in the digital economy. In parallel, cultivating a new generation of professionals with integrated expertise across logistics, energy, digital technologies and finance is essential to driving system-wide transformation and innovation.

Build green behavioural incentives into the logistics workforce: In addition to skills development, enabling behavioural change is vital to accelerating the green transition at the organizational level. Logistics companies could integrate sustainability considerations into their decision-making by embedding behavioural incentives into daily operations and performance management systems. These can include green performance bonuses, energy-saving points systems for drivers, gamified carbon reduction challenges and/or team-based sustainability scorecards. When well-designed, such mechanisms not only improve environmental outcomes but also increase employee engagement, morale and retention. Moreover, linking individual actions to measurable sustainability goals creates a shared sense of ownership and accountability, turning the workforce into active agents of the green transition rather than passive recipients of top-down mandates.

CASE STUDY 9

Siemens harnesses AI to build a future-ready workforce and enable people to stay resilient and competitive

Siemens has harnessed AI-empowered digital technologies to accelerate industry sustainability transformation. The comprehensive hardware and software technology, like digital twins, and software-defined automation and electrification support and empower industries and society to be more sustainable. Additionally, Siemens invests in workforce upskilling, cultivating future-ready skill development ecosystem partners and ensuring people stay resilient and competitive.

- **Empowering industries' high-quality growth with cross-domain know-how and expertise:** Siemens aims to reach 3 million people in business ecosystems and society with learning offerings focused on digitalization and sustainability by 2030.
  - **Open digital business platform:** Siemens Xcelerator marketplace integrates innovative technology from Siemens and esteemed partners, sellers and developers, making it easier for companies to navigate digital and sustainable transformation.
  - **Learning offerings across industries:** For example, Siemens 1847 industrial learnings empowers engineers, like those in the logistics and manufacturing industry, with comprehensive skill advancement in industrial automation and digitalization, e.g. exclusive access to more than 6,000 technical videos, articles and live expert-led Q&A sessions.
  - **AI-enabled automatic grab ship unloader:** Through the integration of automation with AI vision, high-risk on-site grabbing operations are transformed into safe, indoor remote mode. Customized remote training and a crane simulation platform equip operators with the skills to perform complex tasks efficiently, resulting in reduced safety risks, shorter operation times and fewer equipment failures, with an operation automation rate increase from 50% to 80%.

Source: Siemens interview and document review.

3.4 Cultivate ecosystem collaboration

The green transition of logistics cannot happen in segregation; in emerging markets, cross-value-chain collaboration is essential to overcoming systemic fragmentation. Governments can set direction, provide testbeds and enable scale, while leading enterprises act as orchestrators to align stakeholders and accelerate system-level change.

Government-orchestrated, integrated value-chain partnerships: Green logistics transformation depends on end-to-end coordination across the value chain, connecting upstream suppliers and downstream customers to consolidate fragmented demand for low-carbon transport and synchronize the deployment of enabling technologies. Leading industry players can maximize use of clean vehicles and sustainable fuels, reduce empty mileage and enhance asset productivity through schedule alignment, volume aggregation and shared infrastructure. Multistakeholder industry partnerships among shippers, carriers, ports, technology providers, cities and academia play a central role by facilitating data sharing, establishing interoperability standards and coordinating joint actions. Meanwhile, governments primarily offer regulatory frameworks and supportive platforms to enable these industry-driven collaborations.

CASE STUDY 10

Ecosystem collaboration in building the Shenzhen zero-emission road freight corridor

Project introduction: Shenzhen, China, is proactively developing the country's first government-approved zero-emission road freight transport corridor pilot project, which focuses on two main initiatives:

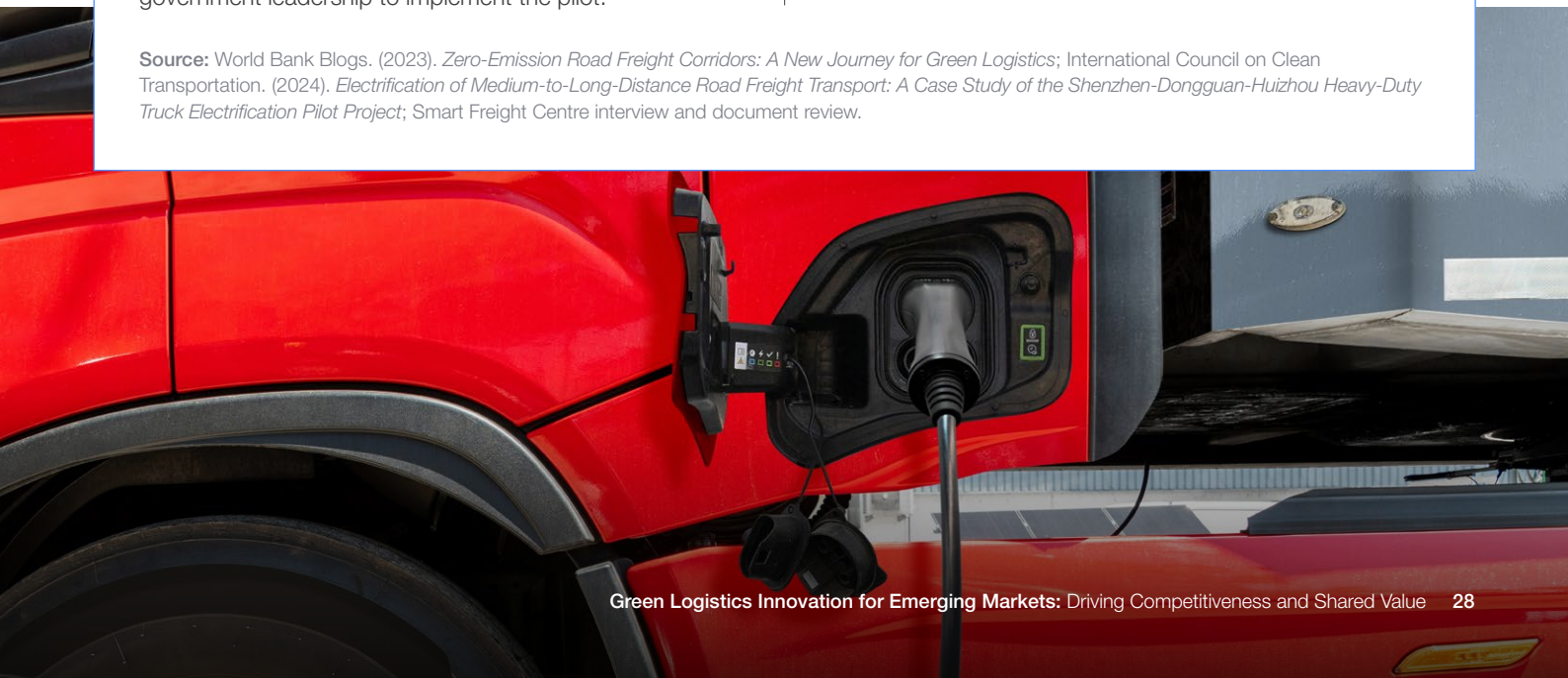
- **Deploying zero-carbon fleets:** The project will establish five zero-carbon truck fleets with at least 200 pilot vehicles.
- **Upgrading green infrastructure:** It will build charging and battery-swapping infrastructure to provide reliable energy support for both the pilot corridor operations and future expansion.

These initiatives will be applied across various scenarios, including port logistics handling, Shenzhen–Hong Kong cross-border fresh food transport and Shenzhen–Guangdong regional freight transport.

Various value chain stakeholders, including industry players, technology providers, non-governmental organizations (NGOs) and research institutions, are collaborating under government leadership to implement the pilot.

- **Government guidance:** The government clearly defines the project's objective and provides incentives to encourage clusters of electric heavy-duty trucks, which in turn attracts charging and swapping infrastructure providers.
- **Industry participation and collaboration:** More than 40 companies are engaged in the trial programme, including shippers, fleet operators, original equipment manufacturers (OEMs) and charging/swapping providers (such as IKEA, Walmart, SAIC and BYD) to help validate project technical feasibility, economic viability and environmental benefits.
- **Civil society and research institution enablement:** Civil society initiatives, such as the Smart Freight Centre, also play a vital role by providing technical and knowledge expertise, facilitating cross-sector collaboration, and helping to monitor, evaluate and share best practices in programme design and implementation.

Source: World Bank Blogs. (2023). *Zero-Emission Road Freight Corridors: A New Journey for Green Logistics*; International Council on Clean Transportation. (2024). *Electrification of Medium-to-Long-Distance Road Freight Transport: A Case Study of the Shenzhen-Dongguan-Huizhou Heavy-Duty Truck Electrification Pilot Project*; Smart Freight Centre interview and document review.



Leadership role of industry pioneers: Industry leaders are uniquely positioned to accelerate the transition to green logistics by setting direction, building coalitions and de-risking innovation. By championing common standards and shared infrastructure, top players can shape the operating norms for the broader ecosystem. Through inclusive alliances, they can jointly define critical protocols, such as unified carbon accounting and circular packaging frameworks, that reduce fragmentation and align suppliers, partners and customers. Leading firms also have the scale to pilot cost-sharing models for high-risk investments, including pooled decarbonization funds and/or collaborative platforms for testing next-generation technologies such as electric and hydrogen-powered fleets. By anchoring competitive advantage in collective progress, industry champions can transform sustainability from a compliance obligation into a long-term driver of resilience, efficiency and growth.

BOX 10 **CATL launches standardized swappable batteries to accelerate EV adoption**

CATL, the world's largest battery supplier, has unveiled number 20, number 25 and number 75 standardized swappable batteries (analogous to gasoline numbers at gas stations) to scale up the EV adoption through shared infrastructure and a collaborative ecosystem. In so doing, the company:

- Unified dimensions and ensured compatibility across chemistries
- Ensured compatibility with battery swapping models through a high degree of standardization
- Built an interoperable battery-swapping ecosystem with nearly 100 partners

Source: Contemporary Amperex Technology (CATL). (2024). *CATL Launches Battery Swap Ecosystem with Nearly 100 Partners*; Contemporary Amperex Technology (CATL). (2025). *CATL Unveils 75# Standardized Battery Swap Block, Builds "Eight Horizontal and Ten Vertical" Battery Swap Network*.

Call to action: a global agenda for green logistics

The successful implementation of the innovative levers and enablers discussed in chapters 2 and 3 requires actions from different ecosystem players.

Governments

The role of government entities is pivotal in spearheading the development of a cohesive and comprehensive regulatory framework that enables and accelerates the scaling of green logistics infrastructure and solutions. To catalyse the necessary investment, stable polices, targeted subsidies and incentives that encourage financial institutions to develop innovative blended finance tools are essential. Addressing the human capital gap is also a key responsibility; governments could promote the upskilling of logistics professionals by formally integrating green logistics into national curricula and sponsoring specialized training programmes. Additionally, national governments could take active roles at the international level, engaging in intergovernmental cooperation to standardize green logistics practices, harmonize regulatory frameworks, and facilitate cross-border investments and knowledge transfer. Finally, to ensure sustainable development, governments should collaborate with private-sector players in the construction of green infrastructure and establish robust communication channels to continuously solicit industry feedback, which can support the development of relevant and effective policies.

Logistics industry players

Logistics industry players, for their part, could adopt a proactive stance in driving the green transition. Proactive communication with stakeholders is essential to convey actionable insights and align efforts. This involves providing governments with practical feedback on regulatory effectiveness, clearly articulating financial needs to financial institutions, aligning services with the evolving demands of the market and collaborating with academia to tailor R&D for commercialization. This commitment also extends to the internal upskilling of their workforces to effectively adopt advanced technologies. Furthermore, active participation in industry alliances is crucial for co-creating industry-wide standards and developing shared infrastructure, while deeper engagement in PPP projects will be essential for executing large-scale, transformative initiatives.

Shippers and cargo owners

Securing bankable, long-term offtake agreements is key to providing the certainty needed by suppliers and investors. To achieve this, demand-side actors can engage proactively with logistics providers and financial institutions, clearly communicating anticipated volumes and timelines while jointly developing contractual frameworks that address cost uncertainties and shifting regulatory environments. Additionally, demand-side companies could consider collaborative procurement strategies, aggregating demand with industry peers to create sufficient scale and mitigate individual risk.

Financial institutions

The financial sector has a critical role in creating innovative financing models tailored to the unique characteristics of green logistics (e.g. through long life cycle asset renewals and large-scale infrastructure projects). Traditional financing mechanisms are often inadequate for this transition. Multinational development banks play a pivotal role by designing and deploying bespoke financial instruments that can de-risk investments and effectively blend public and private capital. Therefore, it is imperative for these institutions to continue expanding such solutions, unlocking the necessary funding for the sector's comprehensive transformation.

Academia and civil society

Academia and civil society form the knowledge and talent backbone of the green logistics ecosystem. Their primary mandate is to cultivate a new generation of logisticians equipped with advanced skills in data analytics and green technology. Through strategic partnerships with industry and financial institutions, they can bridge the gap between research and practical application, helping to translate R&D projects into commercially viable opportunities. Additionally, they can provide vital knowledge support through targeted sessions and workshops, empowering industry players with the latest insights and best practices required to navigate the complexities of the green transition.

This shared agenda, targeting everything from fuel standards to fleet financing, provides the roadmap. The time for pilots is over. The moment for scaling green logistics is now.

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