2024

Freight Logistics
Decarbonization Whitepaper:

LEAD the green wave, bring the DEEP impact

WESTWELL

Roland Berger

Executive Summary:

Green Freight Logistics, Intelligence-Crafted Future

The trend of net-zero transformation in the logistics industry has become inevitable, and node decarbonization[1] is the key. Since the adoption of the Paris Agreement, green and net-zero development has become a consensus for human social development. The freight logistics industry is one of the major sources of global carbon emissions. On one hand, the gradual improvement of policies and regulations, as well as the clear preference of investors, have injected a strong "driving force" for the industry's decarbonization; on the other hand, the expectations of shippers and end consumers have also formed a powerful "pulling force". Decarbonization transformation has become an urgent task for the freight logistics industry. Across the whole industrial chain, carbon reduction at the nodes is highly feasible, which is the key to decarbonization and should not be overlooked, with seaports offering the most promising prospect in green and net-zero transformation.

Green and net-zero transformation of nodes is not an overnight process, and digitalization is a prerequisite. Decarbonization of logistics nodes should not be limited to energy transformation or renovation of a single piece of equipment, but requires overall planning, systematic implementation, and gradual achievement of goals. Roland Berger, together with Westwell, has summarized the "LEAD" methodology for freight logistics decarbonization. Taking seaports as an example, logistics nodes can achieve the "DEEP" values of economical friendly, people friendly, and environment friendly while completing decarbonization goals through three stages: "Electrification", "AI-driven intelligence", and overall "Linked ecology" transformation. It is worth noting that digitalization plays a crucial role in the decarbonization of freight logistics nodes. Intelligent upgrades through digitalization at single points, systems, and across all scenarios, along with seamless data flows, are the necessary path to achieving green and low-carbon goals.

Node decarbonization will be continuously iterative and interconnected, moving towards a net-zero future. The green transformation of freight logistics not only relies on the decarbonization of individual nodes but also requires the joint efforts of the entire ecosystem. Taking seaport decarbonization as a prototype, the "LEAD" methodology will be gradually replicated and promoted to other logistics nodes such as air cargo terminals, and manufacturing hubs, and will be comprehensively optimized through road freight links. Through the synergy of multiple nodes and multiple links, a comprehensive green and net-zero transformation of the entire industrial chain will be achieved.

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1) Node decarbonization refers to the process of reducing or eliminating carbon emissions at key logistics nodes or hubs within the freight logistics network. These nodes can include seaports, air cargo terminals, and other intermodal facilities.

Contents

Chapter 1	Navigating the Green Wave: The impact of the global decarbonization wave on the freight logistics industry	— 02
Chapter 2	Seaport as Pioneer: Implementation path for decarbonization transformation of seaports	— 14
Chapter 3	Replication and Variation: Extend beyond the seaport to other freight logistics scenarios	— 50
Chapter 4	Call to Immediate Action: Implications for freight logistics companies	— 64

Chapter 1

Navigating the Green Wave: The impact of global decarbonization wave on the freight logistics industry

Decarbonization is the core consensus of the international community and is a highly certain trend that will dominate global industry and technological development in the next 30 years.

Decarbonization has emerged as a highly promising and rapidly evolving global trend across all industries. In recent years, the progress towards decarbonization has gained significant momentum worldwide, driven by the strengthening of various policies and initiatives. The Paris Agreement, which aims to limit global warming to well below 2 degrees Celsius, has prompted numerous international organizations to announce supportive policies in response to this target.

As the world's leading companies and organizations rally behind the decarbonization agenda, businesses that align their operations and strategies with the principles of decarbonization can not only reduce their environmental impact but also enhance brand reputation and future-proof their operations in an increasingly sustainability-conscious global marketplace. → 01

01 Decarbonization is the core consensus of the international community and will dominate global industry and technological development in the next 30 years

Year	Global General (non-exhaustive)	Freight Logistics Focus (non-exhaustive)
2015	• **Paris Agreement:** A global accord within the UNFCCC dealing with greenhouse-gas-emissions mitigation, adaptation, and finance. • **United Nations Sustainable Development Goals:** Goals to protect the planet and ensure prosperity include DG 13 on climate action.	
2018		• **IMO Initial GHG Strategy:** IMO set to reduce greenhouse gas at least a 50% reduction by 2050 compared to 2008 levels. • **Global Maritime Forum's Call to Action on Decarbonization:** Urges industry to zero-emission shipping by 2050
2019	• **European Green Deal:** The overall strategic objective of the European Union in addressing climate change, which aims to make Europe the first climate-neutral continent by 2050, covers various sectors.	• **Poseidon Principles:** A global framework for assessing and disclosing the climate alignment of financial institutions' shipping portfolios • **Getting to Zero Coalition:** An alliance of companies within industry, committed to getting commercially viable deep-sea zero-emission vessels powered by zero-emission fuels into operation by 2030.
2020	• **China's Carbon Neutrality Pledge:** China announced to peak carbon emissions by 2030 and achieve carbon neutrality before 2060. • **Japan's Green Growth Strategy**: Integrates ambitious carbon neutrality targets, promoting decarbonization and economic growth	• **IMO 2020 Sulphur Cap:** The IMO implemented a new rule for a 0.50% global sulfur cap on fuel content, lowering the amount of ship sulfur emissions • **Sea Cargo Charter:** A group of major energy, agriculture, mining, and commodity trading companies set a benchmark for responsible shipping, aligning chartering activities with responsible environmental behavior.
2021	• **Fit for 55 policy[1]:** Europe's latest ambitious target is to reduce emissions by at least 55% by 2030, compared to 1990 levels.	• **EU Emissions Trading System (ETS) - Maritime:** The European Union proposed to include the maritime sector in its ETS
2022		• **Long-term global goal - Aviation:** ICAO set a Long-Term Global Aspirational Goal (LTAG) for the aviation industry to achieve net-zero carbon emissions by 2050.
2023	• **The Green Deal industrial Plan:** Build a more supportive environment for the EU's manufacturing capacity for net-zero technologies and products that meet climate targets.	• **The Clean Shipping Act:** Enforces carbon intensity standards for maritime fuel, effectively regulating emissions from the sector.

No significant announcements lately

1) To support the European Green Deal policies, a package of policy measures has been formulated
Source: desktop research; Roland Berger

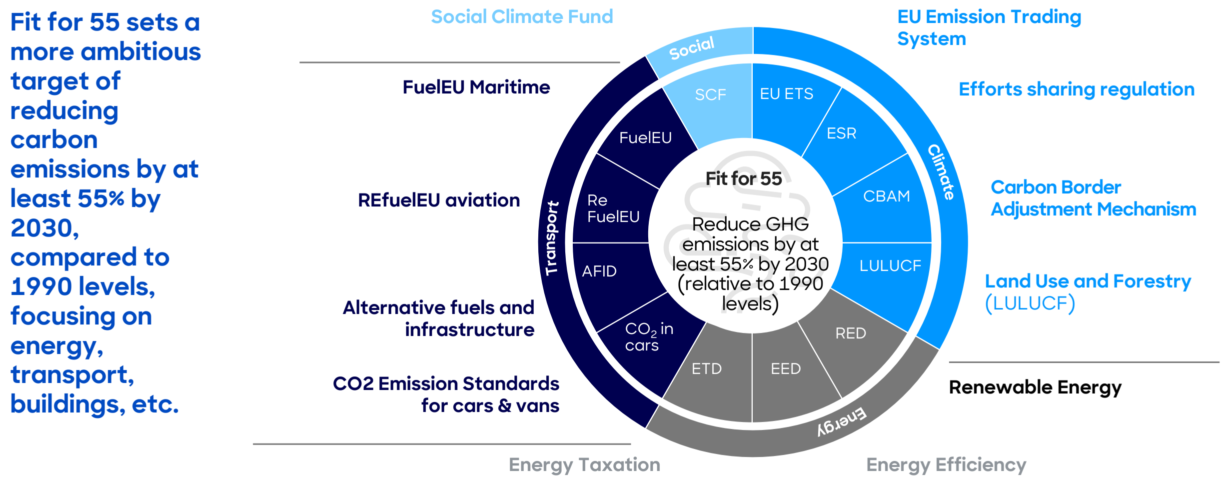
Policy - Europe is a pioneer of the overall global decarbonization progress, issuing a series of top-level guidelines and related implementation policies such as the European Green Deal and Fit for 55.

The Fit for 55 package is the latest addition to Europe's decarbonization policy. It sets a more ambitious target of reducing greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. The policy includes measures to drive emission reductions across sectors such as energy, logistics, buildings, and industry. → 02

In logistics, the Fit for 55 package includes several key measures (non-exhaustive):

- Road: Achieve a 55% carbon emission reduction for cars, 50% for vans, 45% for trucks and buses, with additional upcoming rules to lower air pollutants from road vehicles.
- Railway: The target of blending 14% renewable fuels in railway fuels (calculated based on energy units).
- Aviation: By 2050, the share of sustainable aviation fuels will increase to 70%, and air traffic management will be further optimized.
- Maritime: Reduce the greenhouse gas intensity of the energy used on-board by ships by up to 80% by 2050, by promoting the use of more sustainable fuels by ships using EU seaports, while ensuring the smooth operation of maritime traffic and avoiding distortions in the internal market.
- Multimodal: Build a reliable, seamless, and high-quality transport network that ensures sustainable connectivity across Europe without physical interruptions, bottlenecks, and missing links.

02 **Policy:** Europe is a pioneer in the global decarbonization progress, issuing a series of top-level guidelines and implementation policies such as Fit for 55



Source: desktop research; Roland Berger

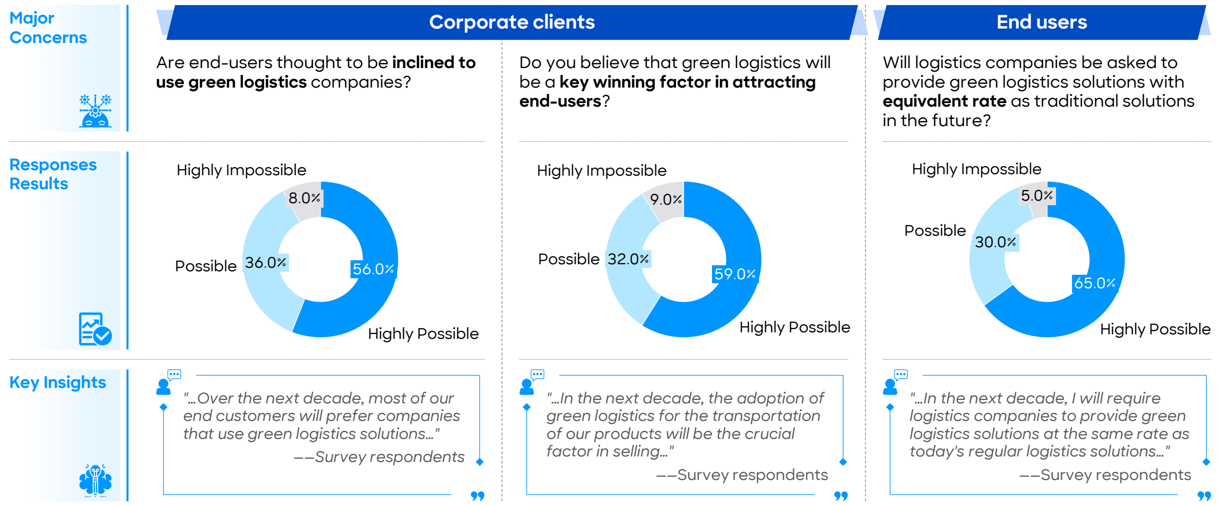
Market - On the market side, the international community's recognition of the value of decarbonization is gradually increasing.

This is reflected in the steady growth of carbon trading prices, as well as the rapid increase in consumers' willingness to pay a premium for net-zero products. Net-zero is becoming a new source of competitiveness.

- The volume and value of global carbon trading markets have reached a record high. According to the '2023 Carbon Market Annual Review' report by London Stock Exchange Group (LSEG), the global emissions market traded approximately 12.5 billion tons of carbon allowances, with a value of a record-breaking 881 billion euros, representing a 2% increase compared to the previous year. The value of the EU ETS (Emissions Trading System) was approximately 770 billion euros, a 2% increase compared to the previous year.
- Customers will be more inclined to use and demand freight logistics service companies to provide green products and solutions. Based on the online survey conducted by a global leading comprehensive freight logistics group in six major markets (United States, Germany, United Kingdom, China, India, and Brazil) targeting 1,800 corporate customers and 1,800 end consumers, more than half of the corporate customers believe that using green freight logistics transportation products will become a winning strategy to attract

03 Market: On the market side, the international community's recognition of the value of decarbonization is gradually increasing

Survey results of customer decarbonization preference



Source: DHL, desktop research; Roland Berger

customers in the next decade. More than 60% of end consumers believe that they will require freight logistics companies to provide green freight logistics products at the same cost. → 03

Capital - In recent years, with the continuous fermentation of the concept of "carbon neutrality" in the capital market, targets related to sustainable investment have gradually gained favor from investors. The total amount and quantity of global ESG investments have shown a significant growth trend.

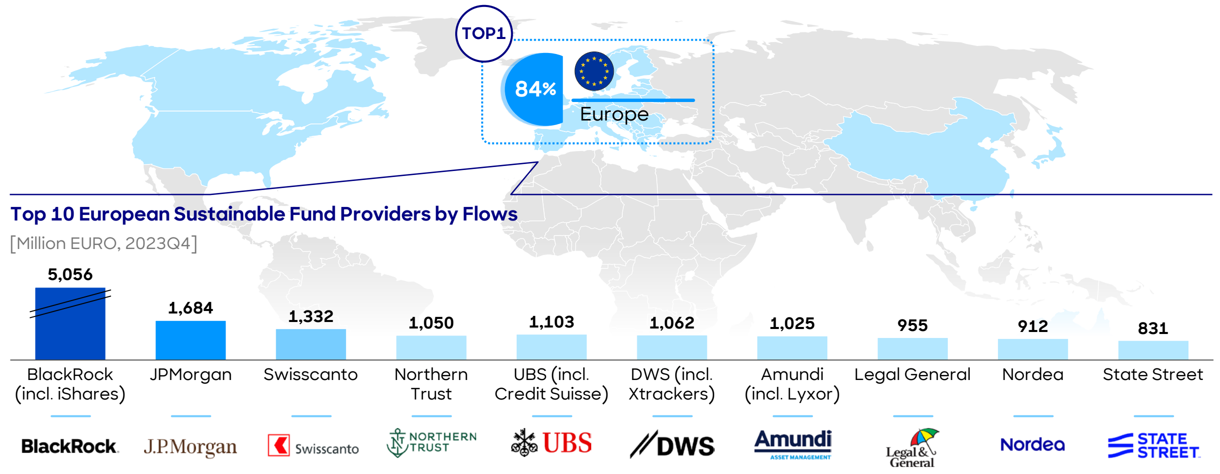
Europe leads in ESG investment volume due to a robust regulatory framework emphasizing sustainability, including over 20 ESG laws enacted in 2023 to combat greenwashing and improve disclosure.

For institutional investors, the popularity of ESG investments in Europe remains high, with sustainable fund assets far exceeding other regions, reaching 84%. Leading investors, such as Blackrock, have significant investment scales.

For individual investors, green-related financial products are also favored. Europe has issued a large number of green bonds, which account for 45% of the global green bond market in 2023. → 04、05

04 Capital: The total amount and quantity of global ESG investments has shown a significant growth trend

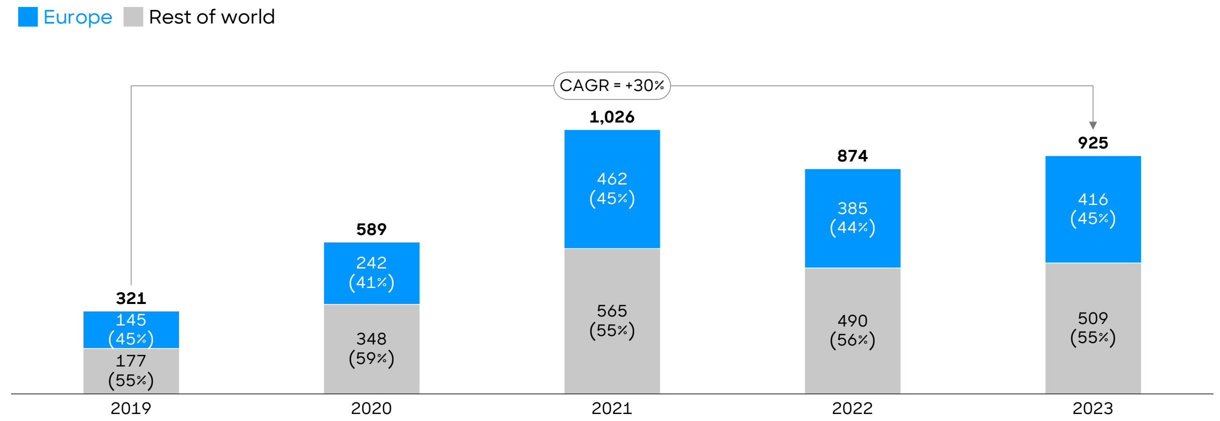
Snapshot of sustainable fund asset by region[%, 2023Q3]



Source: MorningStar, desktop research; Roland Berger

05 Capital: GSSSB[1)] bonds issuance size by region

[bn EURO, 2019-2023]



1) GSSSB--Green, social, sustainability, and sustainability-linked bonds.
Source: Environmental Finance Bond Database, S&P Global Ratings; Roland Berger

The carbon emissions from the freight logistics industry account for 23% of global emissions, making the industry with the highest carbon emissions in developed countries like the UK and France. Net-zero development is imperative for the future.

The net-zero transformation of major freight logistics presents a dual driving force: top-down policy push from the government and investors in the short term, and bottom-up market pull from customer demand in the long term. This trend has led industry giants to embark on net-zero transformations one after another, making it a focal point of competition in the new era of freight logistics. → 06

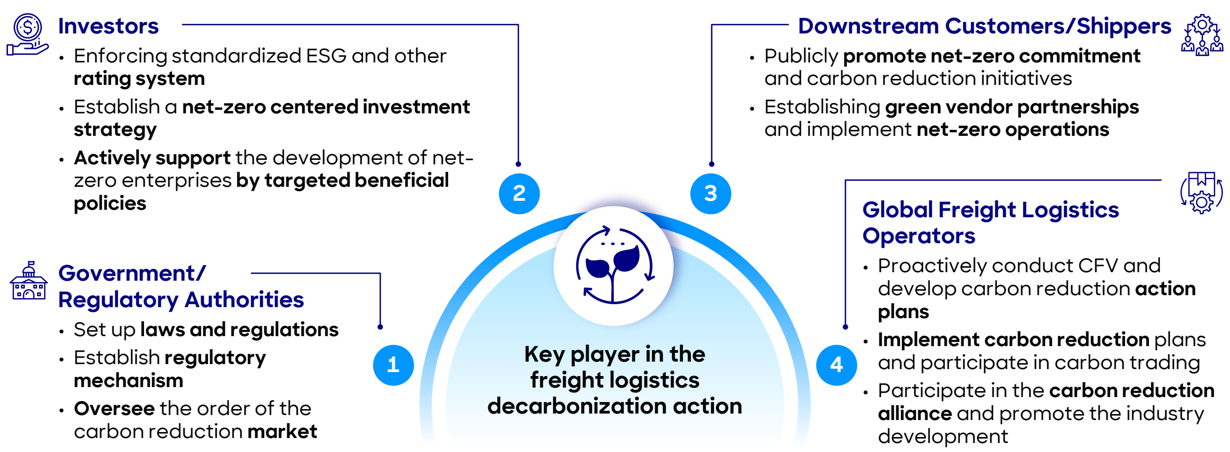
Government/Regulatory Authorities

Government/regulatory authorities need to assume the roles of platform builders, rule makers of the ecosystem, and guides of market behavior. Under the EU ETS carbon trading system, the aviation industry was prioritized in the second phase, while the maritime sector will be included in the fourth phase (2024). → 07

Investors

Green and net-zero developments have become a major trend in the freight logistics industry, and the opportunities arising from its green transformation are drawing significant attention from capital

06 Decarbonization in Freight Logistics Industry: Freight logistics companies' net-zero transition exhibits a dual momentum - top-down policy "push" from government and bottom-up market "pull" from customer demand



Source: desktop research; Roland Berger

07 Government/Regulatory Authorities: EU ETS is the most mature carbon trading market in the world, now aviation and maritime transport have been included

European Carbon Trading Development Path

	Phase I	Phase II (Aviation)	Phase III	Phase IV (Maritime)
Period	2005 - 2007	2008 - 2012	2013 - 2020	2021 - 2028
Related Industry	• Electrical power, cement, iron and steel, glass, paper, ceramic, etc.	• Add **aviation** (flights within the European Economic Area and departing flights to Switzerland and UK)	• Add **petrochemical, aluminum**	• **Add maritime transport** • **Plans to include 20% of emissions from the maritime sector from 2023 onwards, with full inclusion by 2026** 1)
Quota Distribution Rule	• **95%** allocation without any compensation	• **95%** allocation without any compensation	• **>50%** allocation, allocated through auctions	• **Maritime 100% of emissions within EU ports, 50% for voyages starting or ending outside of the EU** • Free quota gradually reduced from **30% after 2026** to **0% in 2030**
Compulsory Condition	• **Mandatory participation for companies with >25,000 tons** of carbon dioxide in covered industries, with companies with smaller emissions taxed according to the carbon-carbon regime of the country in which they are located and not included in the mandatory carbon trading market			

1) The EU plans to set 2023-2025 as the transition period, starting from 2023, shipowners must pay emission allowances equivalent to 20% of their authorized emissions, and thereafter the payment ratio will be increased annually to achieve 100% by 2026

Source: desktop research; Roland Berger

markets. Logistics real estate funds, green transition funds, infrastructure funds, and others are actively seeking potential investment targets related to green and net-zero initiatives within the freight logistics sector.

Taking logistics real estate funds as an example, these funds are actively incorporating the evaluation of target companies' performance in green and net-zero initiatives, making it an important consideration in their investment decisions.

GRESB is an independent organization providing validated ESG performance data and peer benchmarks for investors and managers to improve business intelligence, industry engagement and decision-making. In 2023, 2,084 real estate investment portfolios, 172 infrastructure funds, and 687 infrastructure assets participated in the rating. Gross Asset Value (GAV) reached $8.8 trillion.

Freight logistics real estate funds participating in GRESB ratings represent the importance of freight logistics real estate in ESG performance. Leading freight logistics real estate funds such as GLP are actively participating in GRESB rating.

Globally, GLP has 18 funds participating in GRESB assessment, covering the Asian, European, and American markets. The assets under these assessed funds account for 55% of GLP's global asset management scale and 47% of the property's building area. → 08

Downstream Customers/Shippers

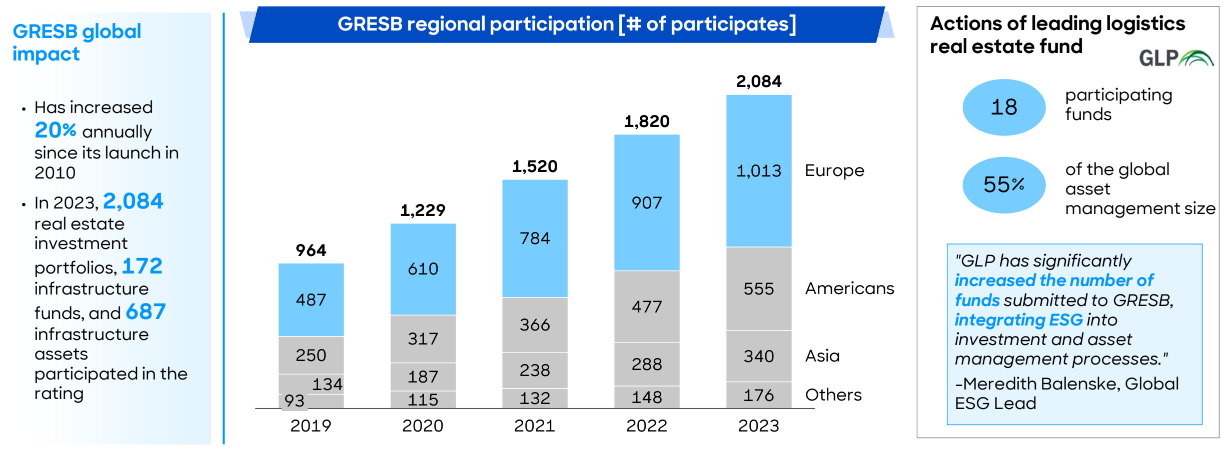
Customers need to disclose carbon footprint reports and are more inclined to use and require freight logistics service companies to provide green products and solutions. Some major shippers (such as P&G, Unilever, Amazon, etc.) are promising to become carbon neutral by 2050 and are expecting net-zero logistics. Also, in 2021, some of the world's largest cargo shippers launched “Cargo Owners for Zero Emission Vessels” (coZEV). → 09

Global Freight Logistics Operators

Under the dual forces of the "push" from policy and investors, as well as the "pull" from end-consumer demand, global freight logistics operators have made commitments to carbon neutrality one after another.

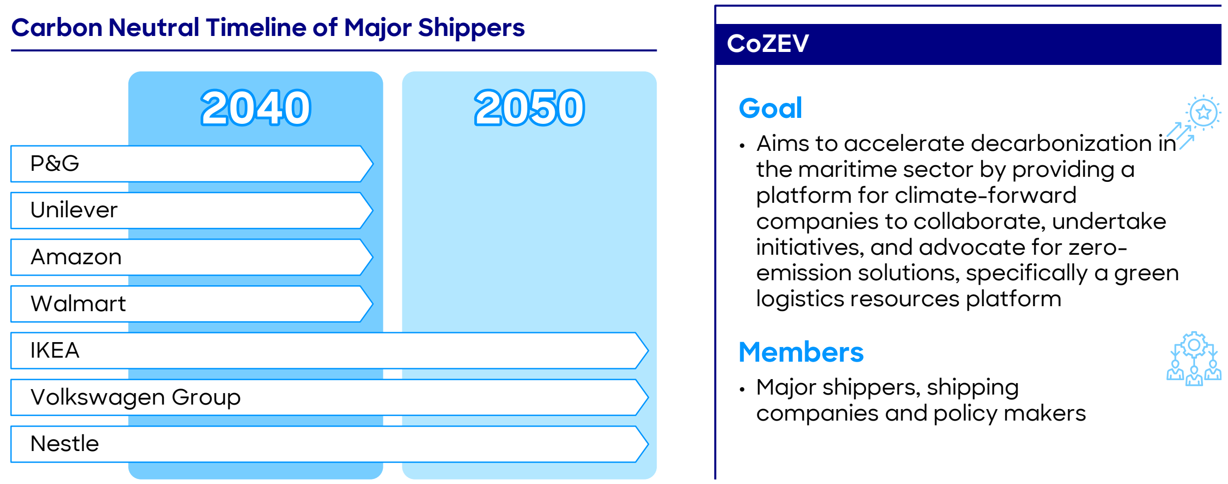
Freight logistics operators are direct emitters of carbon emissions, and therefore, they are among the main entities responsible for achieving carbon reduction targets. In recent years, many leading

08 Investors: Some logistics real estate funds may refer to GRESB ratings to assess the green performance of logistics real estate projects



Source: GRESB 2023 Real Estate Assessment Results, desktop research; Roland Berger

09 Downstream Customers/Shippers: Major shippers are promising to become carbon neutral by 2050 and are expecting net-zero logistics



Source: desktop research; Roland Berger

companies in the industry have actively proposed Carbon Neutral Commitment targets in response to customer and regulatory requirements.

Moreover, the plans of these companies are accelerating. For example, Maersk announced its new decarbonization targets in 2022, aiming to achieve net-zero greenhouse gas emissions for all operations by 2040, which is ten years ahead of its initial commitment to achieve this goal by 2050. → 10

In the many aspects of the entire value chain of freight logistics, one aspect that determines the pace of transformation is the attractiveness of decarbonization, while the other aspect is the feasibility of decarbonization. Among these, the highly standardized seaport scenario has a very high feasibility foundation and is expected to be one of the first areas to undergo net-zero transformation. → 11

10 Global Freight Logistics Operators: Freight logistics operators have demonstrated resolutions to carbon reduction (including carbon neutral commitments)

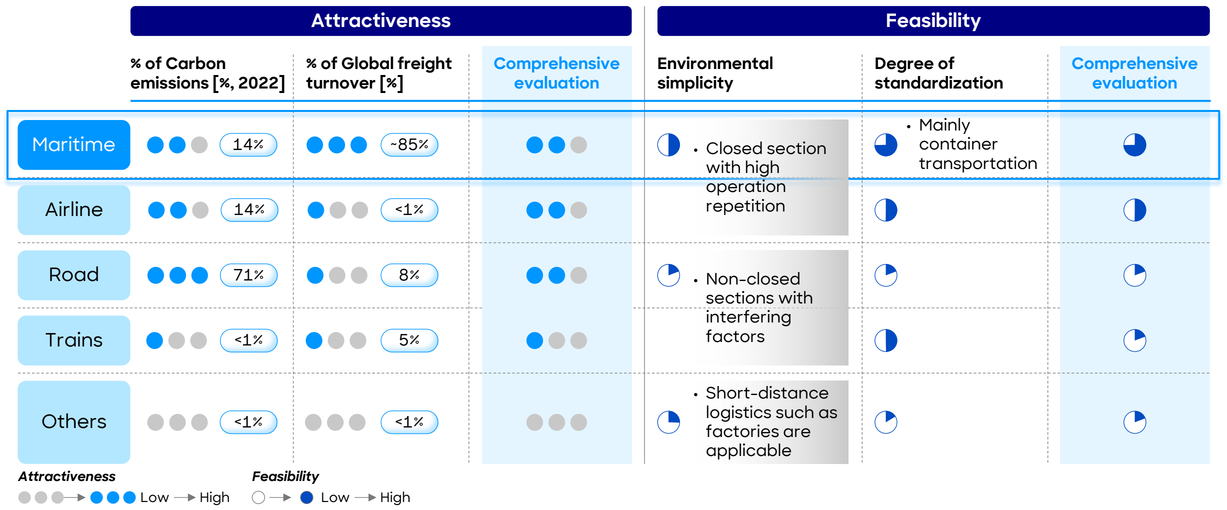
Case study of maritime-related company with the largest turnover

Terminal Operators		Hybrids 1)	Carriers	
Bolloré Ports	ICTSI	China Cosco Shipping	Evergreen	NYK Line
China Merchants Ports	PSA International	CMA CGM	HMM	Wan Hai
DP World	SAAM Puertos	Terminal Investment Limited	MOL	Yang Ming
Eurogate	SSA Marine	APM Terminals	MSC	Ocean Network Express
HHLA	Yildirim group			
Hutchison Ports	Tianjin Port Group			

1) incl. terminal operation business and carrier business
Source: desktop research; Roland Berger

11 Among logistics value chain, the highly standardized maritime sector is expected to be one of the first areas to undergo a decarbonization transformation

Comparison analysis of the carbon reduction potential in major logistics segments



Source: Roland Berger

Attractiveness: Evaluate the potential for carbon emissions reduction of different freight logistics transportation methods by comparing the proportion of carbon dioxide emissions and the proportion of large freight logistics cargo turnover.

- Although the maritime industry's contribution to carbon emissions in the logistics sector is not significant, as the largest mode of global freight transportation, its carbon emissions could reach up to 17% by 2050 if no emission reduction measures are taken.
- Moreover, seaports, as critical logistics nodes, also bear the responsibility of environmental governance. Ship and seaport-related activities inevitably cause air and water pollution, which is harming the health of low-income and marginalized communities living near seaports. Seaport decarbonization projects can not only free up land resources for urban development and restore the natural environment but also accelerate the market promotion of zero-emission technologies, thereby injecting new momentum into economic development.

Feasibility: Technology has become the core enabler of carbon reduction, and the speed of carbon reduction implementation in different logistics scenarios depends on the complexity of operational processes and the degree of standardization. Specifically, the lower the complexity of the scenario and the higher the level of standardization, the faster the implementation progress will be. Among different freight logistics scenarios, the highly repetitive and highly standardized work processes in the maritime make it the most feasible scenario for implementing carbon reduction initiatives.

Simultaneously, decarbonizing freight logistics nodes is an imperative that cannot be overlooked.

- A Crucial Consideration: While the focus on carbon reduction during transportation, such as vessel shipping, is commendable, the carbon footprint of freight logistics nodes like seaports should not be overlooked. Seaports are significant contributors to global carbon emissions, with their operations, infrastructure, and supporting activities generating considerable volumes of greenhouse gases. Addressing carbon reduction in seaports is essential to achieve comprehensive sustainability in the transportation sector and to mitigate the overall environmental impact of global trade and freight logistics.
- With High Feasibility: Seaport operation often involves highly standardized freight logistics, and the vehicle routes are almost repetitive, which provides excellent conditions for the implementation of new technology.

Chapter 2

Seaport as Pioneer: Implementation path for decarbonization transformation of seaports

Seaport Decarbonization Methodology: "LEAD" the green wave, bring the "DEEP" impact

Decarbonization requires comprehensive evaluation and consideration for any company. Similarly, for maritime companies and seaport operators, the transformation to decarbonization is not an isolated decision but follows the "LEAD" principle. → 12

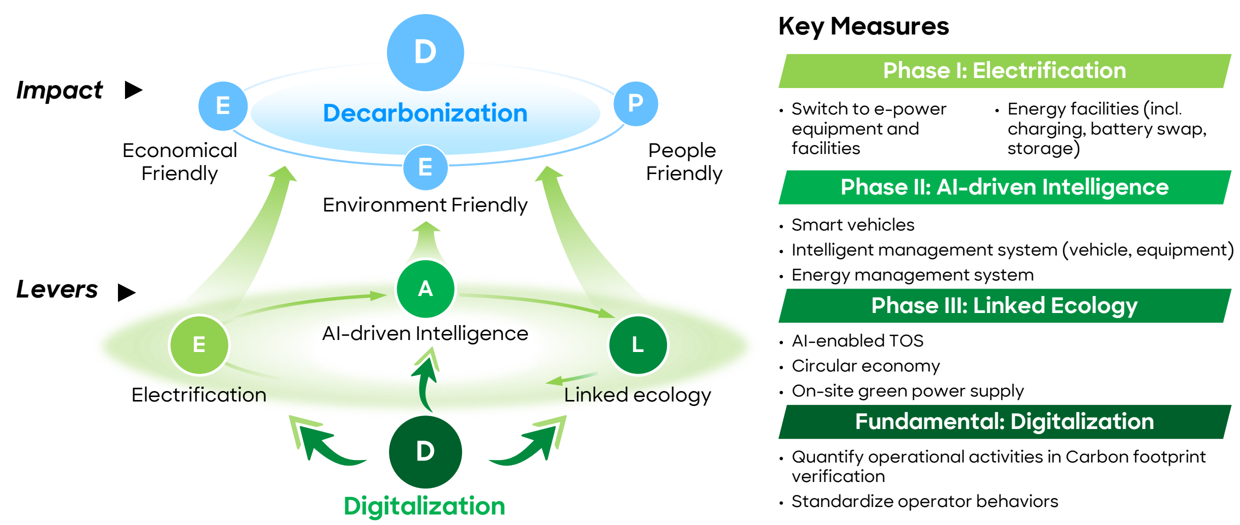
Seaport carbonization mainly focuses on three key aspects: the electrification transformation of equipment, the optimization of intelligence equipment and systems, and the improvement of overall seaport operations. These aspects form the basis for different carbon reduction methods required in different stages of seaport differentiation:

Levers: Decarbonization is a systematic project. For seaport operators, achieving the ultimate goal requires adopting various means in phases, including the three aspects of "LEA".

Phase I – Electrification: Equipment Energy Transformation

Electrification is the starting point of the entire carbon reduction process. In addition to enabling the switch of power systems, electrification also allows for more precise control and more accurate

12 Seaport Decarbonization Methodology: "LEAD" the green wave, bring the "DEEP" impact



Source: Roland Berger

energy monitoring and analysis, serving as the foundation for overall decarbonization process.

By converting traditional fuel-powered equipment into electric equipment, the carbon emissions of seaports can be significantly reduced. The electrification transformation can be applied to various equipment, including cranes, yard equipment, and transportation vehicles. This transformation not only reduces carbon emissions but also improves the efficiency and sustainability of the equipment.

Seaport can also benefit from energy facilities (e.g., charging, battery swap and energy storage). On one side, these facilities can provide a continuous and uninterrupted energy supply for electric vehicles, thereby supporting the normal operation of electric vehicles. Conversely, energy facilities allow seaports to store energy during off-peak, low-cost periods and discharge it during peak, high-cost periods. This can significantly reduce a seaport's overall energy costs.

Phase II - AI-driven Intelligence: Intelligentization of Equipment and Systems

Intelligence is the key pathway for seaports to achieve carbon reduction. Intelligence not only enhances the energy efficiency performance of existing facilities, but after completing localized intelligent upgrades, it also lays the foundation for future interconnection and unified scheduling among different management subsystems.

Seaports can utilize intelligence technologies to improve the operational performance of on-site equipment. For trucks, for example, through artificial driving assistance systems and on-site cameras, real-time monitoring of road conditions can predict congestion in advance, thereby reducing unnecessary braking and idling to lower energy consumption losses.

Concurrently, seaports can adopt advanced energy management systems to intelligently monitor and optimize the scheduling of various energy-consuming equipment, improving energy utilization efficiency. Through big data analysis and artificial intelligence algorithms, the system can sense the operating status of energy-consuming equipment in real-time, and based on the seaport's production and operation plans, precisely control the equipment by referring to energy consumption models to minimize energy waste and improve energy utilization.

Phase III - Linked Ecology: Interconnected Networks for Information, Energy, and Material Cycles

“Linked ecology” is the culminating step in the seaport decarbonization process. After localized intelligent upgrades, "Linked ecology" enables the realization of overall decarbonization and operational optimization for the seaport.

Seaports can utilize AI-empowered TOS systems to achieve intelligent scheduling and optimized layout across the board. Also, by collecting various production data, analyzing carbon emission hotspots in the cargo flow process, and feeding the analysis results back to the TOS system, cargo handling and storage links can be further optimized to reduce emissions.

Simultaneously, seaports can vigorously implement a circular economy model, recycling and reusing seaport infrastructure materials, containers, batteries, etc., to extend their service life and reduce the consumption of new materials.

Additionally, establishing an on-site green electricity power station can be a game-changer for seaports that have already invested in energy storage capabilities. By tapping into the power of the sun, wind, or even tidal energy, these seaports can significantly reduce their reliance on grid electricity, which is often subject to price fluctuations and potential disruptions. This not only translates to lower energy costs but also enhances the resilience of seaport operations, ensuring a reliable and uninterrupted flow of goods and services.

Fundamental: Digitalization is the foundational capability for leveraging these levers.

Digitalization is a prerequisite for enabling decarbonization levers, helping to quantify net-zero processes and standardize operational behaviors. Therefore, the net-zero transformation of seaports also relies on digital technologies such as artificial intelligence, the Internet of Things, big data analytics and so on.

Impact: Although carbon reduction is the core goal for seaports, while achieving this, seaports can also obtain derived value in three aspects - economically friendly, people-friendly, and environment friendly, ultimately realizing the overall "DEEP" effect. → 13

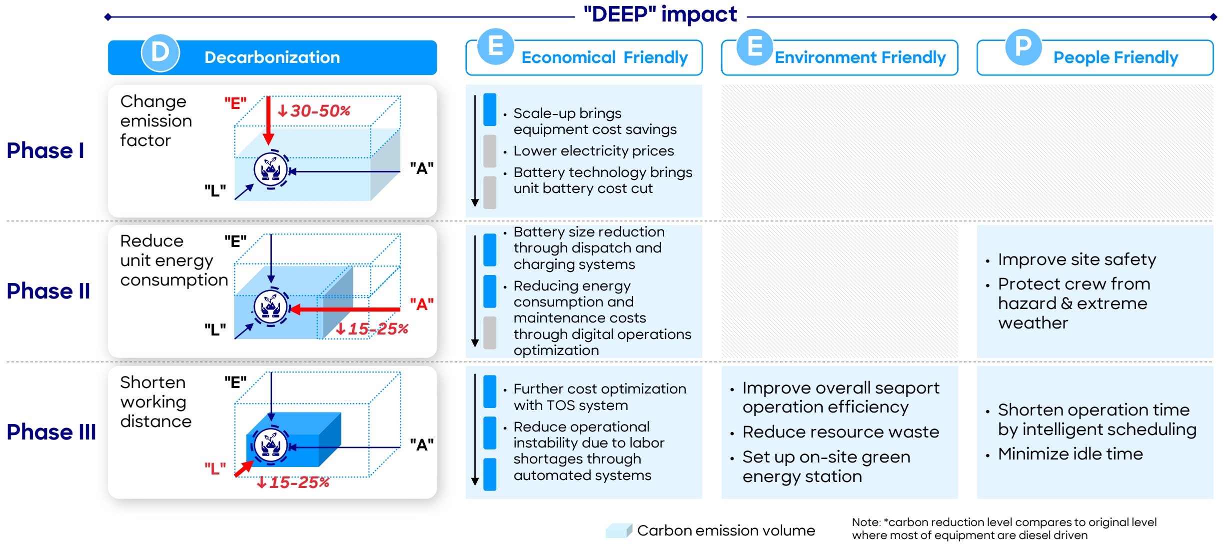
Decarbonization: The three major levers of "Electrification", "AI-driven intelligence", and "Linked ecology" will respectively influence different variable factors in the carbon emission calculation formula, thereby achieving emission reduction benefits to varying degrees. Specifically, electrification mainly reduces carbon emissions from the source by replacing traditional fossil fuel-powered systems and lowering the emission factor value. Intelligence reduces congestion and idling, lowering energy consumption and indirectly reducing carbon emissions. Connectivity promotes efficient overall seaport operations, reducing activity data (such as mileage driven).

Economical Friendly: Global non-renewable energy price volatility exerts economic strain on energy consumers. Seaports, as energy-intensive entities, must transform towards stable, renewable energy options, with electrification being a key solution. Also, optimizing seaport operations through technological means can improve production efficiency and achieve economic benefits. For example, by applying vehicle monitoring systems and driving behavior analysis algorithms, vehicle driving behavior can be optimized, reducing unnecessary acceleration and deceleration, thereby lowering fuel consumption, and effectively saving energy costs.

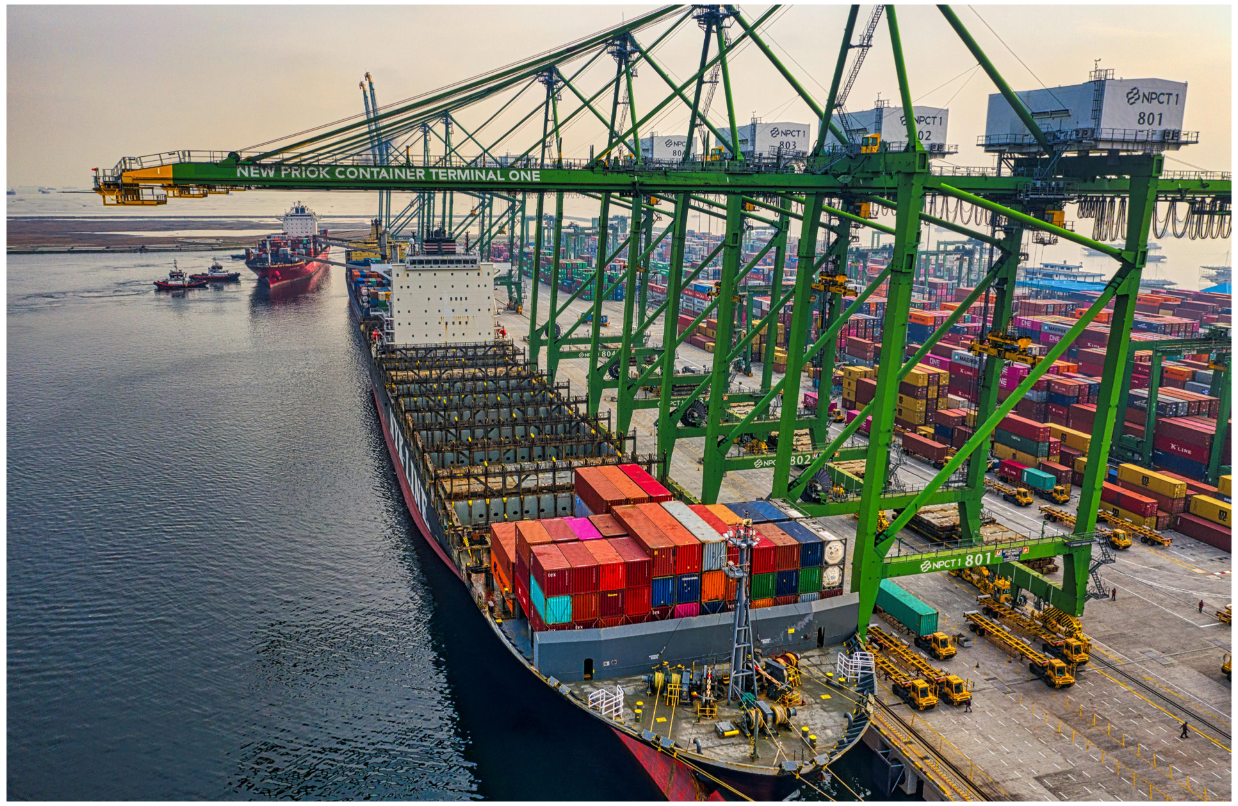
Environment Friendly: Linking various production factors within seaport, and utilizing digital means to achieve overall optimized scheduling, can significantly improve the overall operational efficiency of the seaport ecosystem. Also, seaports can vigorously implement a circular economy model, recycling and reusing infrastructure materials, containers, batteries, and other items to extend their service life and reduce consumption of new materials, further promoting the environment friendly development of seaports.

People Friendly: Intelligent technologies can enable seaport workers to withdraw from arduous and extreme working environments. For example, through intelligent vehicles, site-wide safety monitoring systems, and remote-control technologies, non-compliant driving behaviors can be reduced, thereby improving work safety.

13 "LEAD" benefit seaport with carbon emission reduction and other value-added impact



Source: Roland Berger



Phase I - Electrification → 14

Primarily focusing on seaport equipment and facility upgrades, by transforming the energy utilization method of equipment from diesel-driven to electric-driven.

Reduce emission factor by shifting diesel to electric. Electric equipment does not directly produce exhaust emissions during operation, while fuel-powered equipment emits greenhouse gases such as CO2. Therefore, the carbon emission factor of electric equipment is zero during the usage phase, which is lower than that of fuel-powered equipment.

Among the various operational equipment at seaports, the electrification of horizontal container handling equipment (CHE) is the most feasible priority entry point.

- The electrification retrofit of vertical CHE at seaports faces significant technical and implementation challenges. In comparison, the retrofit of horizontal CHE is more feasible. Vertical equipment such as cranes requires high-power support, placing a heavy burden on batteries and charging infrastructure. Seaport operators are concerned that electric cranes may struggle to match the performance of their diesel counterparts. Additionally, once vertical CHE is installed, retrofitting would involve large-scale renovations across the entire seaport, making the retrofit process extremely difficult and costly. Currently, the level of electrification for yard cranes and quay cranes at China seaports is relatively high. However, at European seaports, the proportion of traditional diesel-powered equipment remains high, and the electrification retrofit lags.

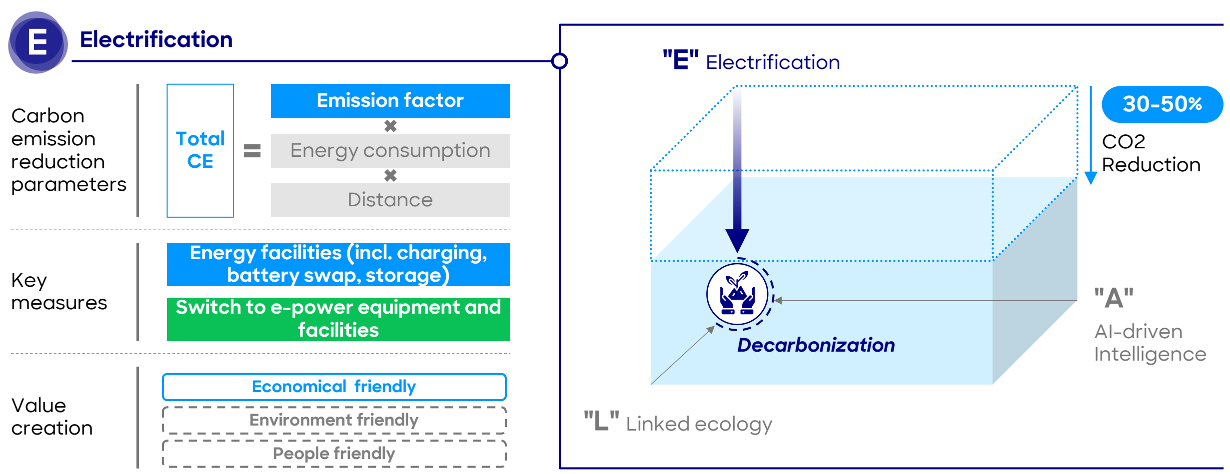
- In contrast, the electrification retrofit of horizontal CHE like trucks is more technically feasible and easier to implement, making it a pioneering force in the decarbonization process of seaports. → 15

Key Measures:

- **Switch to E-power Equipment and Facilities:** Shifting from diesel-powered to electric-powered equipment represents direct carbon emission reduction in the short term.

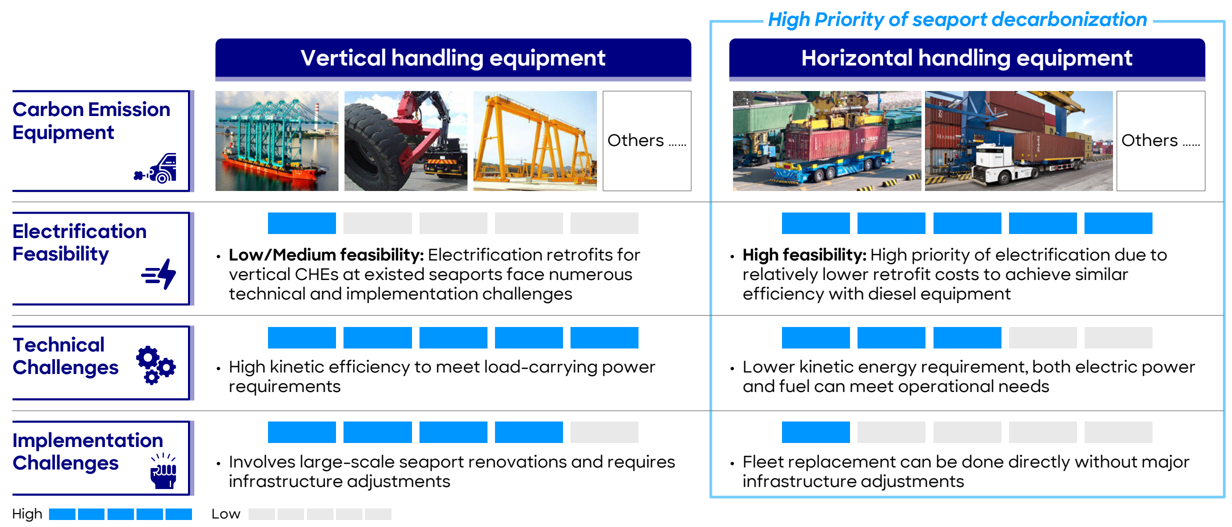
- **Establish Energy Facilities:** With the introduction of electric-powered equipment and vehicles, it is also necessary to build energy facilities, such as charging facilities, battery swap stations, and energy storage facilities. Charging facilities and battery swapping stations can provide a continuous energy supply for electric-powered equipment, ensuring their stable

14 Phase I - "E" Electrification
Transforming the energy utilization method of equipment from diesel-driven to electric-driven



Source: Roland Berger

15 Feasibility of CHE Electrification at Seaports: Horizontal container handling equipment presents the highest priority for decarbonization currently



Source: Roland Berger

operation. Also, energy storage can yield stable energy supply substantial financial benefits. By storing energy during off-peak, low-cost periods and discharging it during peak, high-cost times, seaports can significantly reduce their overall energy expenses.

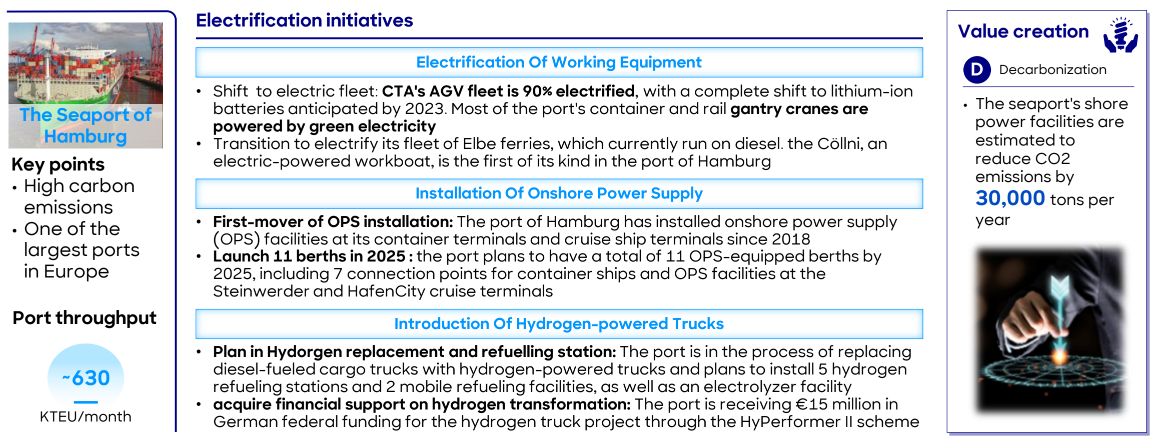
Value Creation:

- **Decarbonization:** It is anticipated that the comprehensive adoption of electrified equipment will yield a significant reduction in carbon emissions, estimated at 30-50%. This projection is predicated on the understanding that diesel's carbon emission factor is two to four times greater than that of electricity. It is recognized that this transformation towards electrification is a systematic and long-term endeavor, necessitating the formulation of tailored electrification pathways that reflect the varied operational capacities of individual enterprises.

Case Study - Seaport of Hamburg, Germany

The seaport of Hamburg embraced sustainability as a core part of its strategy, introducing electric working equipment, aiming carbon neutral by 2040. The seaport's shore power facilities are estimated to reduce CO2 emissions by 30,000 tons per year.

16 **Case Study - Seaport of Hamburg, Germany**
Embraced sustainability as a core part of its strategy, introducing electric working equipment, aiming carbon neutral by 2040

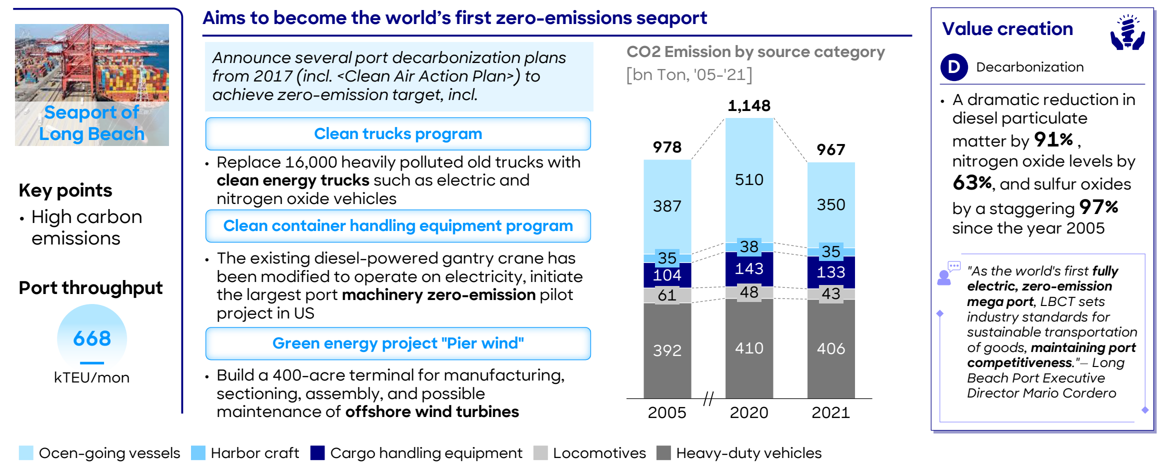


Source: Port of hamburg press, Torqeedo press; Roland Berger

Case Study - Seaport of Long Beach, US

The seaport of long beach announced several seaport decarbonization plans from 2017 (incl. <Clean Air Action Plan>) to achieve net-zero target, incl. the famous 'Clean Truck Program' to reduce total truck emissions by over 80% within 5 years.

17 **Case Study - Seaport of Long Beach, US**
Announced the famous 'Clean Truck Program' to reduce total truck emissions by over 80% within 5 years

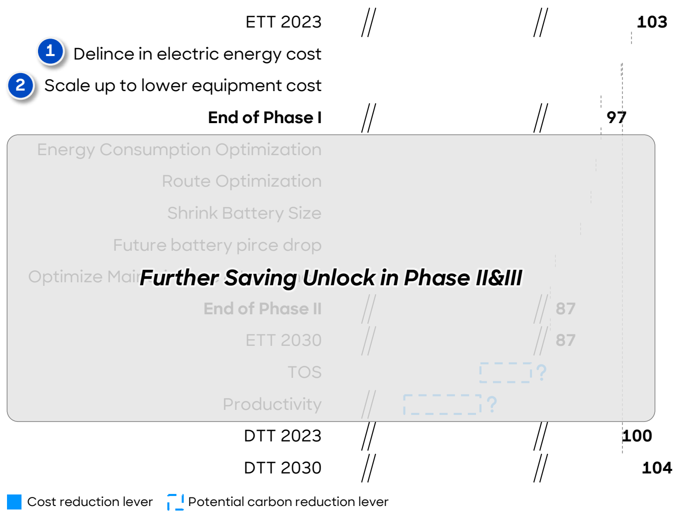


Source: Port of long beach 2022 Air Emissions Inventory; Roland Berger

- **Economical Friendly:** Seaports can reduce energy costs by using electricity to replace high-priced fuel oil. Also, as the electric truck industry chain matures and achieves economies of scale, the overall cost of electric trucks will also continue to decrease. → 18

Declining Energy Costs. It is pleased to find out the fact that electric is cheaper than diesel in most of the world. If the truck fleet shift to electric-powered, it is reasonable to expect a decrease in energy cost. As installed power capacity expands, electricity prices will decrease, further widening the price gap between electricity and fuel. Moreover, the deployment of distributed energy storage systems will further stabilize the power supply for seaports and smooth out electricity prices through "peak shaving and valley filling," thereby further reducing energy usage costs. → 19, 20

18 Economical Value Add in Phase I: Declining energy cost, coupled with economies of scale across the supply chain, leads to cost reductions



Key Saving Contributors

1 Declining Energy Costs

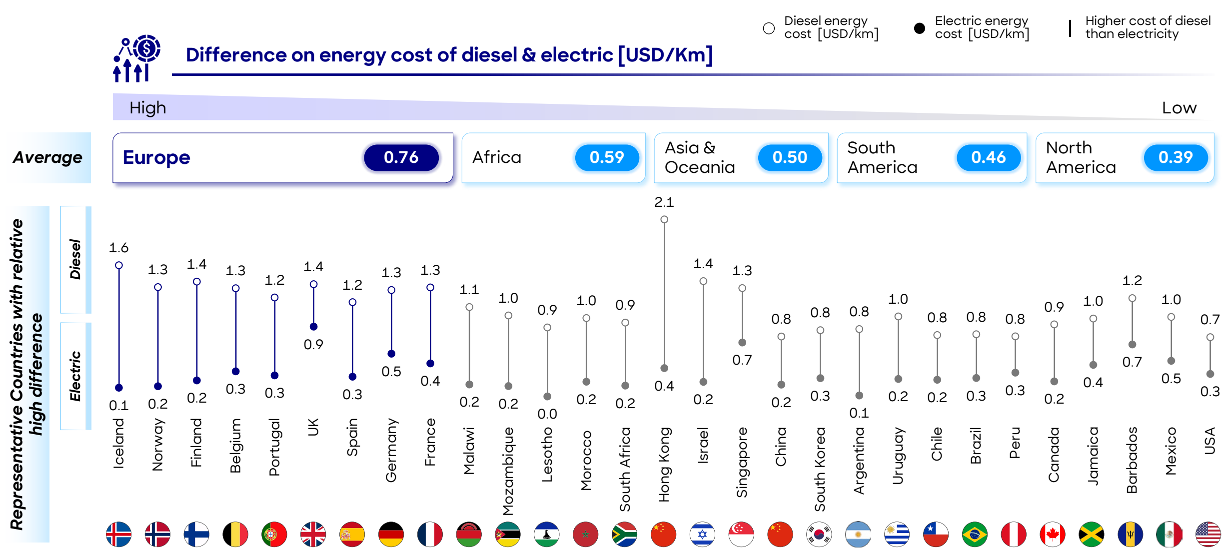
- Electricity prices are projected to decrease in the coming years, leading to a reduction in overall energy expenditures
- Implementation of energy storage, combined with TOU, will reduce electricity cost additionally

2 Economies of Scale Drive Down Equipment Costs

- Large-scale industrial production is expected to drive down the costs of various equipment, including vehicles and software, resulting in substantial cost savings

1) ETT is electric powered vehicle, DTT is diesel powered vehicle
Source: Roland Berger

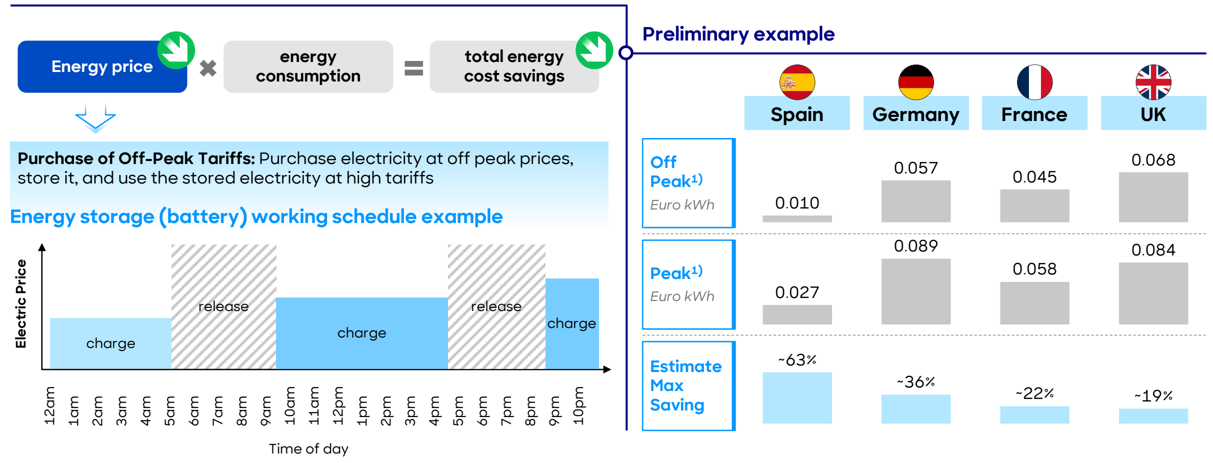
19 Declining Energy Cost: In terms of energy cost, electric is generally lower than diesel in most regions



1) Based on electricity consumption 2.04 kWh/km, diesel consumption 0.7 L/km; 2) Data sourced from 2023S2 to 2024S1
2) Time-of-use (TOU) electricity pricing refers to a billing structure where the rate paid for electricity varies based on the time of day, season, and day of the week.
Source: GlobalPetrolPrices; Roland Berger

20 Peak & off-peak electricity pricing brings further saving when equipped with sufficient energy storage

Incorporate energy storage and utilize TOU tariffs to further reduce electricity costs



1) Data from 2024.3, The price shown here is the wholesale spot price. It is not an end-user price.
Source: IEA; Roland Berger

Economies of Scale Drive Down Equipment Costs. Large-scale industrial production is expected to drive down the costs of various equipment, including vehicles and software, resulting in substantial cost savings.

Key Considerations / Potential Challenges:

- **Develop a Charging Schedule to Optimize Efficiency and Reduce Downtime:** Electric-powered trucks can run efficiently, as long as there is a well-design charging schedule and station. To ensure operation and cost efficiency, setting a time-saving charging schedule to maximize working hours and an approachable charging station to minimum charging commute is necessary.
- **Reserve Interfaces for Future Intelligence Upgrades:** When procuring electrified equipment, it is essential to reserve standardized equipment interfaces for potential future intelligence upgrades and opt for modular product designs. This forward-thinking approach allows for direct module replacement or upgrades without impacting the overall system, avoiding large-scale equipment replacements due to incompatibility during intelligence retrofits, thereby reducing substantial one-time capital expenditures (CAPEX).

Phase II - AI-driven Intelligence

→ 21

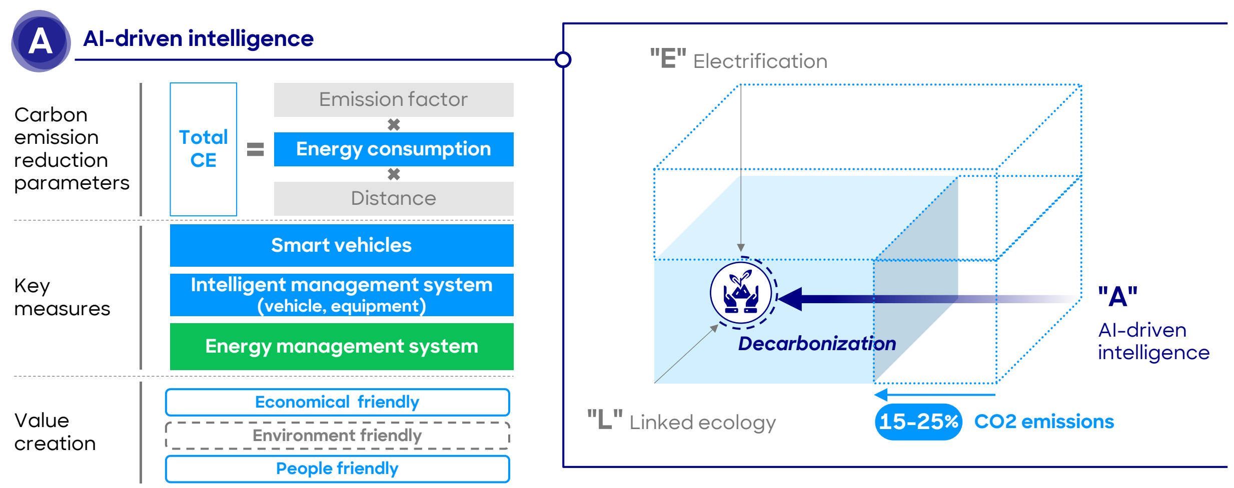
Optimize equipment performance and energy management based on intelligence technology to further reduce carbon emission and improve working environment.

Reduce Energy Consumption Per Unit. Leveraging intelligent equipment to effectively reduce energy consumption per kilometer. In addition, digitization can also assist in intelligent scheduling and optimization of equipment, enabling more efficient utilization of energy resources during operation.

Key Measures:

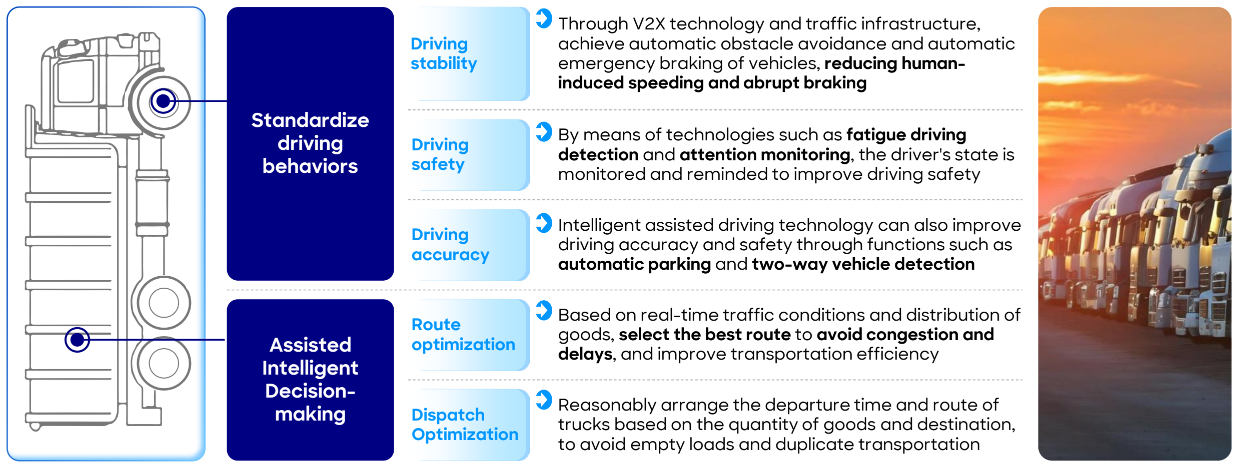
- Smart vehicles: The application and iteration of intelligent driving/autonomous driving technology can help both manual and autonomous vehicles continuously optimize driving behavior. Also, it enables better coordination between vehicles and the production and management systems of operators, thereby reducing the unit energy consumption in the logistics and production process.
- Intelligent management system (vehicle, equipment): Intelligent management systems bring tremendous value to carbon reduction and operational efficiency improvement in seaports by orchestrating and optimizing the operations of vehicles and equipment within the seaport area. Leveraging artificial intelligence and Internet of Things technologies, the system can monitor and dispatch seaport vehicles such as trucks and cranes in real-time, plan optimized routes, and avoid unnecessary idling and waste, thereby reducing energy consumption and carbon emissions. → 22
  - Standardize driving behaviors: Improve driving stability: By enabling interaction between smart vehicles and roadside equipment (e.g., cameras and other V2X sensing devices) and achieving coordination with fleet management system, vehicles can gain a beyond-line-of-sight perspective. This helps vehicles avoid congestion and emergencies in advance, reducing the wear and tear from sudden braking. Also, by means of technologies such as fatigue driving detection and attention monitoring, the driver's state is monitored and reminded to improve driving safety. Intelligent assisted driving technology can also improve driving accuracy and safety through functions such as automatic parking and two-way vehicle detection.

21 Phase II - "A" AI-driven Intelligence
Further reduce carbon emission and improve working environment based on intelligence technology



Source: Roland Berger

22 Optimize Operator Behaviors: Avoid energy waste during operation via human assistance system, e.g., driver assistance system



Source: Roland Berger

◇ Assisted Intelligent decision-making: Route optimization: Based on real-time traffic conditions and distribution of goods, select the best route to avoid congestion and delays, and improve transportation efficiency. Dispatch Optimization: Reasonably arrange the departure time and route of trucks based on the quantity of goods and destination, to avoid empty loads and duplicate transportation.

- **Energy Management System:** Energy Management System (EMS) enables seaport operator to manage and keep an eye on electric utilities and electricity-using appliances. Seaport operator may minimize consumption and utility expenses while maximizing usefulness and comfort by using the EMS, which provides insight into energy utilization. Adopt overall energy management system based on digitalization infrastructure, aimed at elevating their energy efficiency. → 23

◇ **Energy Consumption Management:** Energy management can be carried out at three levels: individual devices, overall equipment, and different energy sources. In terms of individual devices, take trucks as an example, the use of Breaking Energy Recovery System can effectively capture and store the kinetic energy generated during each braking event for future use, thereby reducing energy consumption. In terms of overall equipment, take a fleet of vehicles as an example, the unified planning and scheduling provided by the Fleet Management System (FMS) can achieve smooth and steady driving, reducing energy waste caused by sudden braking and acceleration. Additionally, various energy sources such as electricity, wind power, and solar power in the seaport also need to be monitored to provide reference for energy distribution.

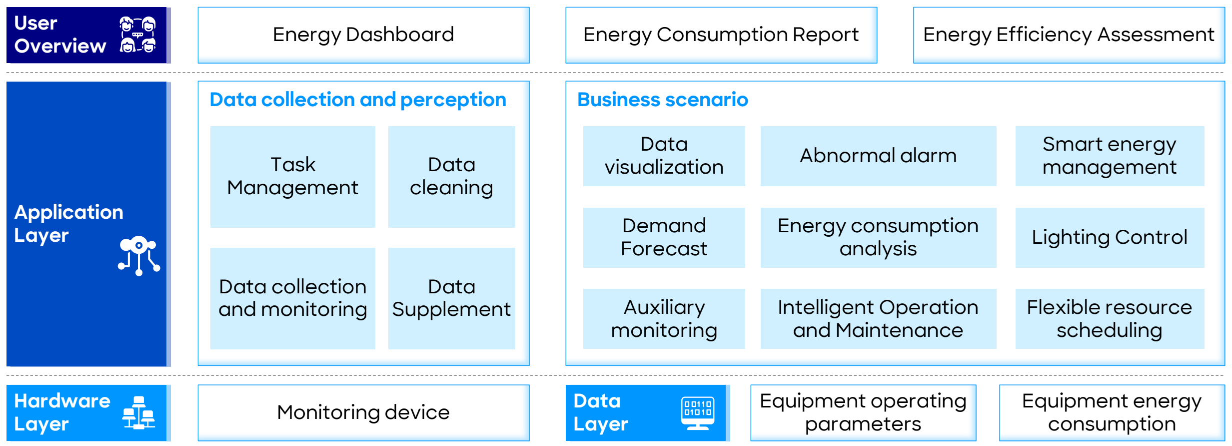
◇ **Energy Supply Management:** Systematically monitor, control, and optimize energy consumption to save energy usage and reduce energy costs. Utilize the Internet of Things, advanced connectivity, and big data to better manage facilities through energy data analysis and help address challenges in energy consumption and energy management. For example, develop financial forecasts for the deployment of renewable energy services and make other improvements in the coming years to reduce clean energy consumption and lower energy costs.

◇ **Flexible Energy Dispatch:** Reducing energy consumption by adjusting energy supply during peak demand periods through intelligent means.

Value Creation:

- **Decarbonization:** Reduce energy consumption per unit by optimizing equipment operation and standardize operator behaviors, leveraging intelligence technology and systematic energy consumption data collection. For example, after using the artificial driving assistance system, the energy consumption per kilometer of electric trucks can be reduced by 15-25%.

23 Optimize Energy Consumption: Minimize waste and boost utilization via systematic energy management technology

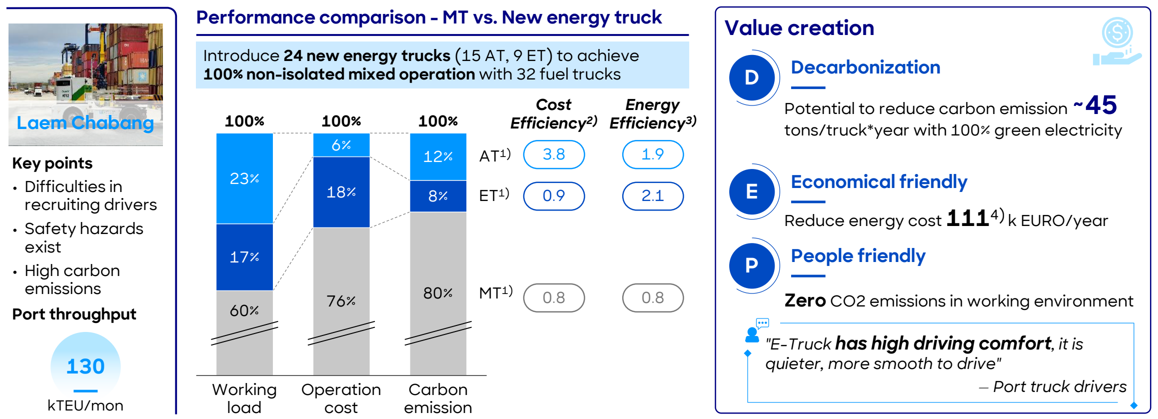


Source: Roland Berger

Case Study - Seaport of Laem Chabang, Thailand

As cargo volume have risen, Seaport of Laem Chabang have recently faced difficulties in hiring sufficient workers, while the working environment for employees poses potential safety risks. Therefore, Seaport of Laem Chabang has introduced mixed cross-operation of electric vehicles and diesel vehicles, helping save energy costs and optimizing driver driving experience.

24 **Case Study - Seaport of Laem Chabang, Thailand**
Mixed operation of electric vehicles and diesel vehicles, helping save energy costs and optimizing driver driving experience



1) MT = Diesel truck with drivers, ET= Electric truck with drivers, AT= Autonomous electric truck without drivers; 2) Cost efficiency = workload / operation cost; 3) workload / CO2 emission; 4) Euro to RMB exchange rate = 7.66 (2023 averaged rate);
Source: Roland Berger

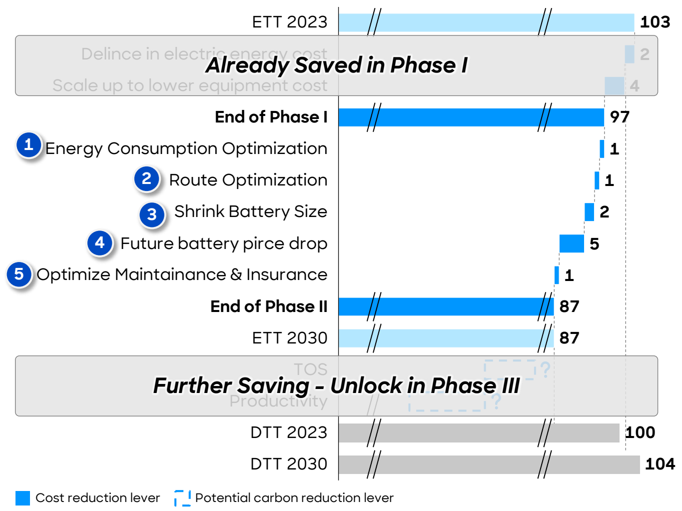
- **Economical Friendly:** As the industry evolves, the phase II advancements in battery, fleet management, and driving optimization will pave the way for a more cost-effective and sustainable transportation future.

Improvements in battery technology will lead to declining unit costs, making EVs more affordable for consumers. Implementing Fleet Management System (FMS) and charging optimization will allow the use of smaller batteries to meet operational needs. The continuous optimization of driving strategies and behaviors of intelligent vehicles will minimize wear, tear, and accident rates, creating a safer and smoother working environment.

Advanced technologies can further reduce EV energy consumption through better driving assistance and route optimization algorithms in FMS. → 25

- People friendly: Provide a safe and comfortable working environment for port workers to ensure well-being and productivity.
  - Safe working environment: Help workers stay away from dangerous work environment. In the operation process of shore cranes and yard cranes, the workers are freed from long-term high-altitude operations. In the freight logistics process, avoids blind spots in the field of vision, regulates driver behavior, and reduces the possibility of collisions.
  - Comfortable working environment: Workers are transferred from the harsh outdoor working environment to the terminal control room. Make the operations simpler by simplifying interfaces and processes, reducing steps and complexity, and enabling staff to complete tasks more easily. This helps alleviate the burden on staff and improves work efficiency.

25 **Economical Value Add in Phase II: Multiple combined factors drive cost reductions, including energy consumption optimization and others**



Key Saving Contributors

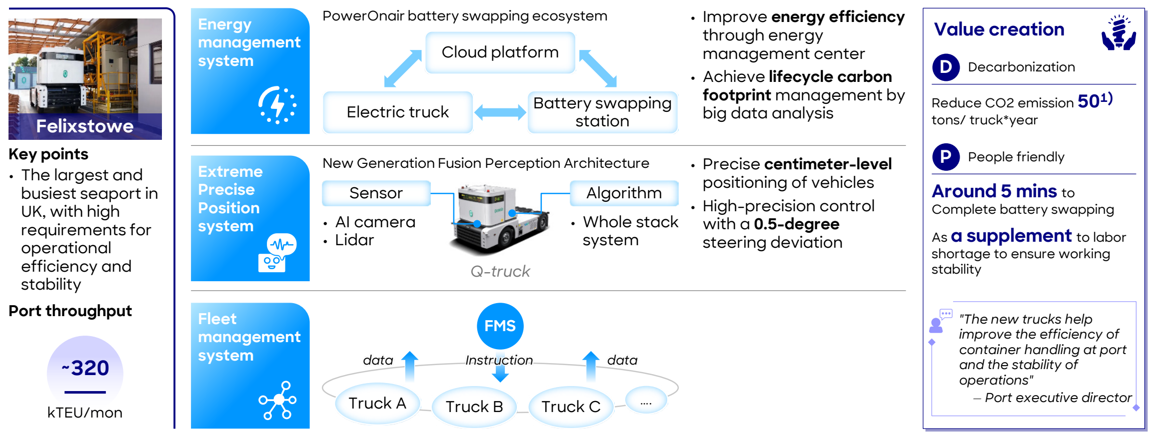
1. **Energy Consumption Optimization**
   - With driving assistance, high energy-consuming behaviors like sudden braking can be reduced, thereby lowering the energy consumption rate of electric vehicles
2. **Route Optimization**
   - FMS can reorganize and shorten working routes with algorithms, minimizing empty runs and circuitous routes
3. **Smaller Battery Size**
   - Through collaborative design of battery sizes and charging facilities, smaller batteries can meet the same operational requirements
4. **Battery Price Drop**
   - Advancements in battery technology will lead to a decline in unit battery costs, while optimized battery usage habits will allow for procurement of cost-effective batteries
5. **Optimized Maintenance and Insurance**
   - Operational and driving optimization strategies will help minimize wear and tear and accident rates, thereby reducing routine maintenance and insurance expenses

1) ETT is electric powered vehicle, DTT is diesel powered vehicle
Source: Roland Berger

Case Study - Seaport of Felixstowe, United Kingdom

Seaport of Felixstowe is the largest and busiest seaport in UK, with high requirements for operational efficiency and stability. Now the seaport has achieved CO2 emission reduction and optimized driving experience based on integrated intelligent management system for truck, fleets, and energy.

26 **Case Study – Seaport of Felixstowe, United Kingdom**
Achieve CO2 emission reduction based on integrated intelligent management system for truck, fleets, and energy



1) based on scenario with 100% green electricity supply
Source: Desktop research; Roland Berger

Key Considerations / Potential Challenges:

- **Make a Forward-looking Planning:** Systematic design and planning are required for hardware deployment (such as IOT terminals like sensors), underlying data collection (data standardization and cleaning), and infrastructure construction (networking, matching power resources, etc.).

- **Reserve Interfaces for Connections Between Different Systems:** The seamless integration of AI into existing freight logistics systems can be complex. Significant challenges include compatibility issues, data interoperability, and the need for synchronization between AI platforms and legacy systems. Employing standardized data formats, using middleware solutions, and conducting thorough system audits facilitate smoother integration.

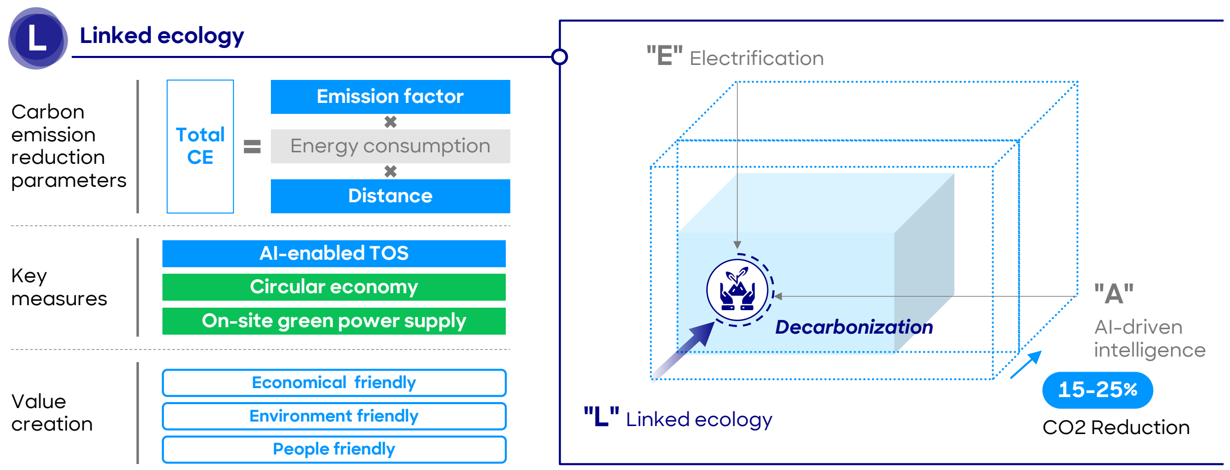
- **Prepare for Future Device Upgrades:** Accommodation AI solutions for growing freight logistics demands can be challenging. As freight logistics operations expand, AI systems must scale accordingly without compromising performance. Employing modular and flexible AI architectures, anticipating future growth needs, and investing in scalable infrastructure are key strategies to address scalability concerns.

Phase III – Linked Ecology → 27

Linking Network: Constructing an Interconnected Ecosystem for Enhanced Efficiency and Sustainability by integrating dispersed systems, devices, energy, information, and materials within the terminal.

Realize Operation Efficiency Excellence. By integrating various elements of the seaport together through the TOS system for unified planning, efficiency can be improved, and carbon emissions can be reduced by 15-25%. For example, for trucks, the placement of containers can be adjusted according to the actual

27 **Phase III – "L" Linked Ecology**
Constructing an interconnected ecosystem for enhanced efficiency and sustainability by integrating dispersed systems, devices, energy, information, and materials within the terminal



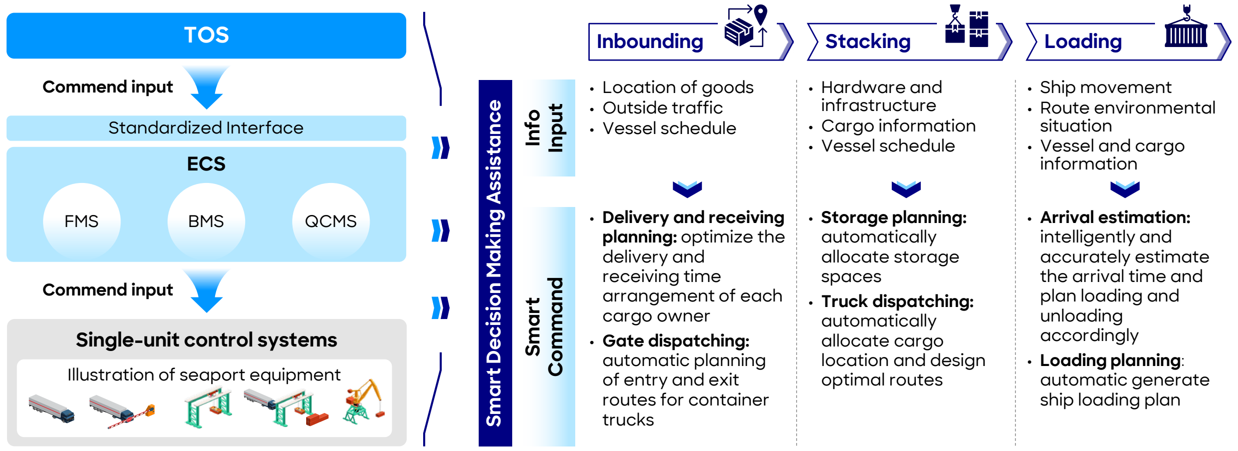
Source: Roland Berger

situation of the port, thereby shortening the route of truck transportation, and reducing the carbon emissions generated by each shipment.

Key Measures:

- **AI-enabled TOS Collaborating Key Elements in Seaport:** Link the core elements of systems, employees, and infrastructure layout on the seaport, and unify management through an intelligent platform to improve the overall operational efficiency of the seaport. Through the intelligent platform, seaport managers can remotely monitor and manage various operational activities of the seaport, including the work status of employees, the operation of equipment, and the use of energy. This allows for more efficient resource scheduling, faster cargo handling, reduced energy waste, and lower operating costs.
  - **AI-optimized TOS:** For traditional TOS, approximately 30% of planning work relies on manual settings. Additionally, at the scheduling level, container operation instructions flow unidirectionally from the planning module to the scheduling modules of various equipment management systems (such as Fleet Management System). With the introduction of a new AI-optimized TOS architecture, algorithms and strategies can significantly reduce the need for manual intervention, enabling automatic planning, intelligent vessel stowage, and smart yard allocation. At the scheduling level, an integrated scheduling module can be formed at the TOS level, allowing for dynamic interaction between scheduling and planning. This not only facilitates closer coordination between the TOS and execution equipment such as quay cranes, yard cranes, and vehicles, enabling real-time feedback, but also optimizes work plans, container slot arrangement, and operation routes, improving overall loading and unloading efficiency, reducing unit energy consumption, and achieving lean operations.
  - **AI-enabled Employee Management System:** Use intelligent systems to achieve more dynamic and comprehensive optimization of labor allocation, centrally manage the labor requirements for each task, and prevent excessive rotation of personnel. At the same time, centrally monitor overtime situations to balance the costs of subcontractors and new workers.
  - **Infrastructure (e.g., container, renewable energy) Layout Optimization:** Optimize the placement of containers and flip them in advance. Establish a container space resource allocation and transportation decision-making system, from quay cranes and yards to horizontal transportation. Through artificial intelligence algorithms, achieve optimal management of complex freight logistics of multiple varieties, small spacing, and irregular concentrated container goods. Optimize the arrangement of different import and export container storage sections to improve the utilization efficiency of container space. → 28

28 **AI-enabled TOS Collaborating Key Elements in Seaport:** Connect various management subsystems to TOS and realize unified management through TOS to improve the overall operational efficiency of seaport



Source: Roland Berger

Looking ahead, the future TOS holds even greater promise. As the TOS continues to evolve, it will support real-time data interaction with the ECS, enabling dynamic planning based on real-time inputs.

- **Real-time Data Interaction:** The next-generation TOS will support robust and bidirectional data flows with the ECS. This will allow for the continuous exchange of real-time information, including vessel arrival and departure times, container and cargo details, equipment status and location, and environmental conditions (weather, traffic, etc.). By ingesting this real-time data, the TOS can maintain a comprehensive and up-to-the-minute understanding of the seaport's operations.
- **Dynamic Planning & Optimization:** TOS will be able to perform advanced

analytics and predictive modeling. This will enable the system to dynamically adjust plans and schedules based on changing conditions, such as rerouting vehicles and equipment to account for unexpected delays or disruptions, reallocating labor, and storage resources to adapt to fluctuations in cargo volumes and optimizing vessel berthing and unloading sequences to maximize throughput.

The integration of real-time data interaction and dynamic planning is expected to further improve the seaport's operational efficiency including reduced downtime and bottlenecks, optimized resource utilization (equipment, labor, storage), improved responsiveness to changing conditions, enhanced visibility, and control over the entire seaport ecosystem. By seamlessly linking people, equipment, and infrastructure, the TOS has unlocked a new era of intelligent seaport management, setting the stage for a future where efficiency, safety, and optimization are the cornerstones of success. → 29

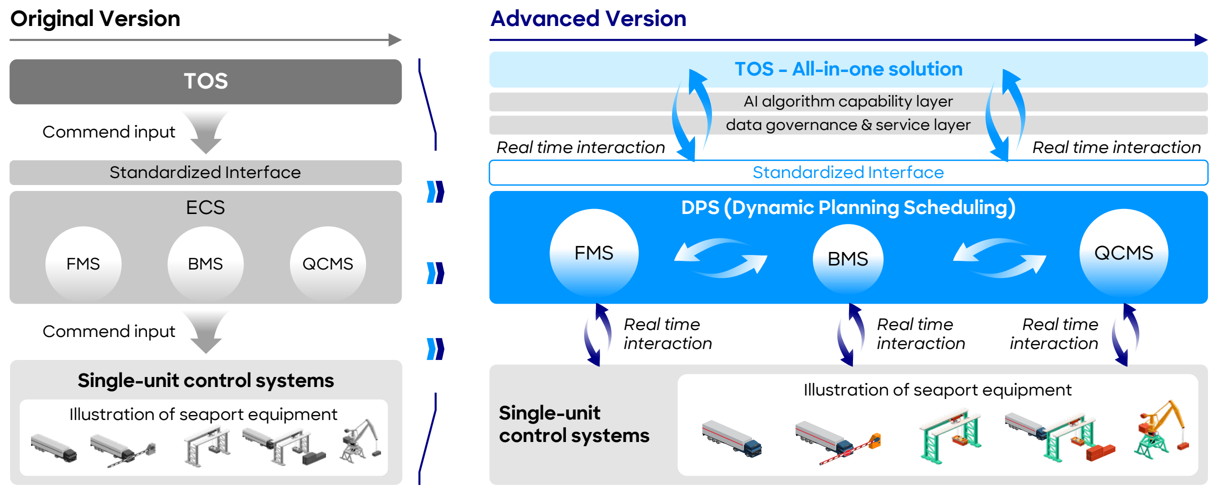
- **Circular Economy:** Develop circular supply chains at seaports and promote the utilization of recycled resources. This includes recycling and reusing old containers, batteries, materials, machinery, and other items. → 30

  - **Seaport Material/ Machinery Recycling (e.g., packaging materials):** Seaports have many materials and machinery that can achieve circularity through maintenance, reuse, remanufacturing, and recycling. Maintenance is a basic form of circularity, allowing recurrent use and extended life cycles. Secondly, as fixed assets, some seaport assets can be leased and reused by another operator after a concession ends, enabling circularity. Thirdly, upgrading existing seaport equipment to change its function or operational characteristics is a form of remanufacturing and circularity. Additionally, end-of-life seaport equipment can also be recycled.

  - **Container Recycling:** Container shipping is designed as a recycling system, representing specialized circularity. Reusable containers are constantly repositioned by carriers owning or leasing fleets. Container leasing companies also allocate assets to maximize returns. Containers are interchangeable transport units traded on markets. To remain usable, they require cleaning, maintenance, and repair. After their 15-year lifespan, containers can be recycled for components or repurposed (e.g., storage, offices).

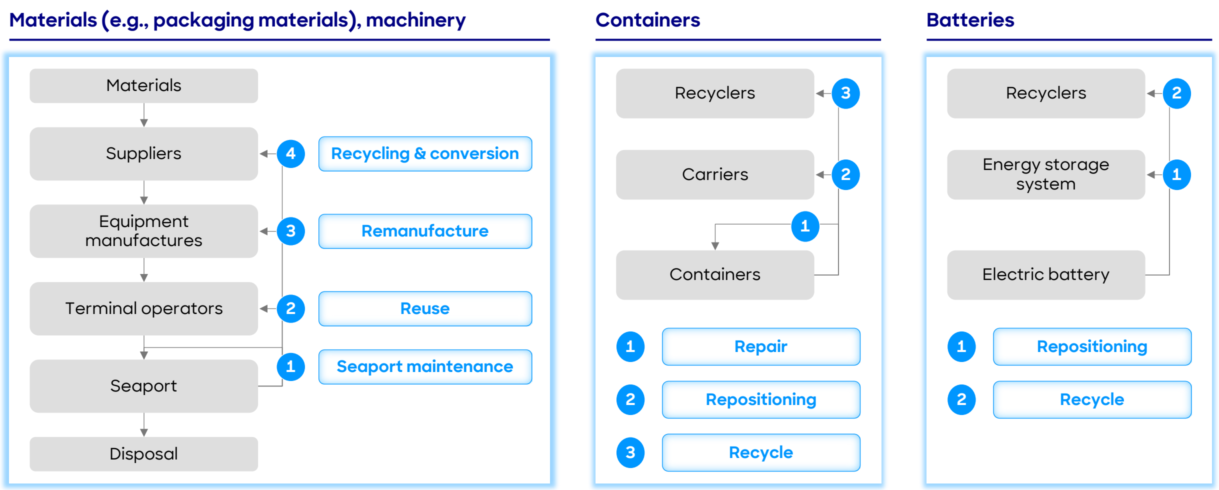
  - **Battery Recycling:** Electric vehicle battery recycling or reuse depends on their condition, remaining capacity, and demand for secondary applications. Metals can be extracted

29 **Advanced TOS:** Through intelligent algorithms and supporting equipment, TOS enables real-time data transmission to further optimize seaport operations



Source: Roland Berger

30 **Circular Economy:** Build seaport CE mechanisms, including maintenance, reuse, upgrading and recycling, achieving seaport "zero waste" target



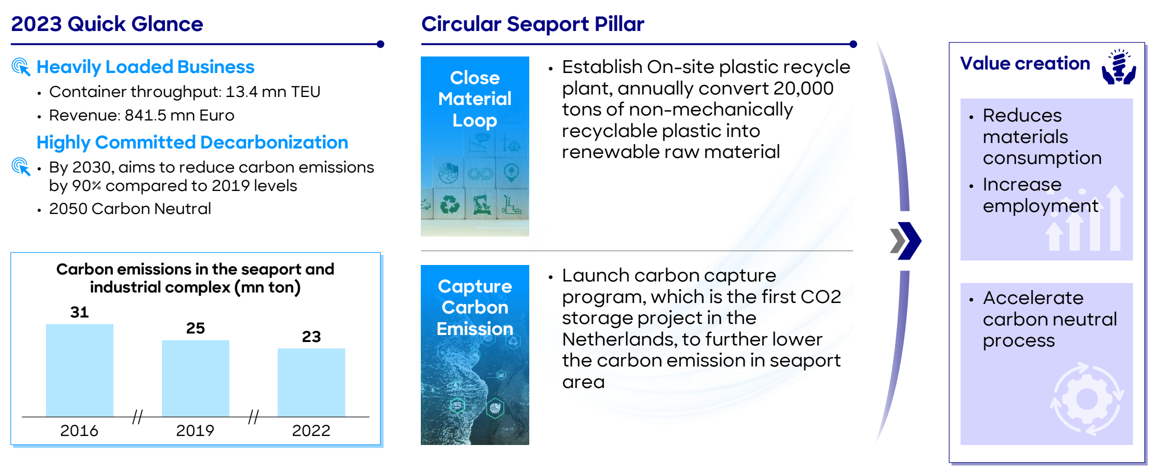
Source: desktop research; Roland Berger

from crushed batteries using hydrometallurgy or pyrometallurgy. Recycling recovers limited resources, reduces mining impacts, and minimizes new raw material needs. Batteries with sufficient capacity and health can be refurbished for stationary energy storage backup. Under normal circumstances, the batteries replaced from electric vehicles still retain about 80% of their original capacity, offering potential for recycling and reuse.

Case Study - Seaport of Rotterdam, Netherland

As one of the European Union's most crucial seaports, the Seaport of Rotterdam has set targets to reduce its carbon emissions by 75% from 2019 levels by 2025 and 90% by 2030, with the ultimate goal of achieving full carbon neutrality. Seaport of Rotterdam leveraged circular seaport pillar such as close material loop and capture carbon emission to reduce materials consumption and accelerate carbon neutral process. To accelerate its carbon neutral process, the Seaport of Rotterdam has leveraged its circular seaport pillars, such as closing material loops (initiated in 2018) to reduce material consumption and implementing carbon capture systems (pilot launched in 2020) to mitigate emissions from its operations.

31 Case Study - Seaport of Rotterdam, Netherland
Leading the advancement of the seaport's circular economy by effectively closing the material loop

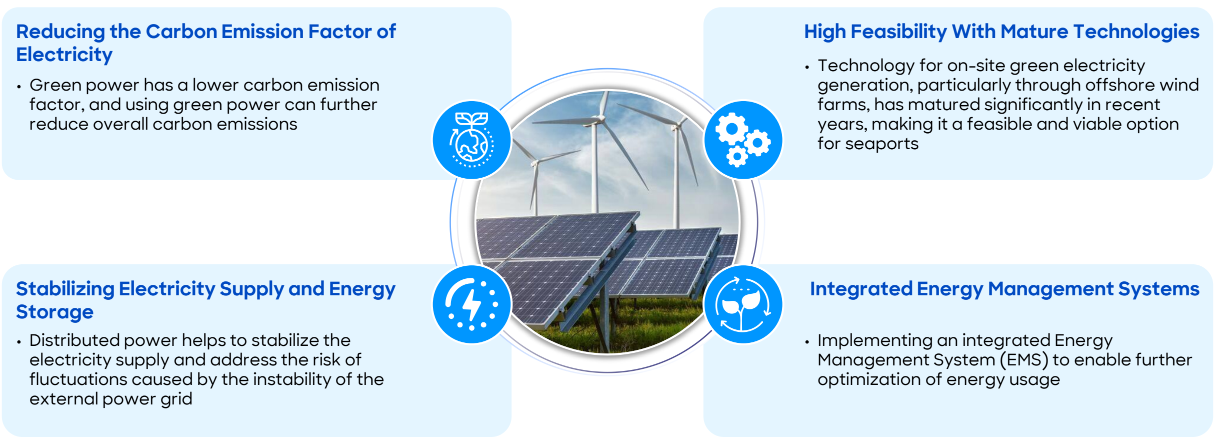


Source: Annual Report 2023 - Port of Rotterdam Authority; Roland Berger

- **On-site Green Electricity Power Supply:** Through the deployment of on-site green electricity, the carbon intensity of energy usage can be further reduced, and the risks associated with instability from the external power grid can be eliminated, providing a continuous and stable electricity supply for seaport operations.
  - **Reducing the Carbon Emission Factor of Electricity:** A common challenge in many regions is that the electricity grid still relies heavily on thermal power generation, resulting in a high carbon emission factor. By establishing renewable energy power plants within the seaport, the carbon intensity of the electricity used can be further reduced, leading to real and measurable carbon reductions.
  - **Stabilizing Electricity Supply and Energy Storage:** Seaports require a reliable and stable electricity supply to support their operations. Distributed power plants within the seaport can help stabilize the electricity supply and address the risk of fluctuations caused by the instability of the external power grid. Additionally, integrating energy storage and switching capabilities can help manage the intermittency of renewable energy sources, ensuring a consistent and reliable power supply.
  - **High Feasibility with Mature Technologies:** Moreover, the technology for on-site green electricity generation, particularly through offshore wind farms, has matured significantly in recent years, making it a feasible and viable option for seaports. By establishing on-site green power stations, seaports can also sell excess electricity to the grid, achieving energy recovery and utilization.
  - **Integrated Energy Management Systems:** Beyond the power generation aspect, seaports can also consider implementing an integrated Energy Management System (EMS) that integrates the power generation, distribution, and consumption within the seaport. This can enable further optimization of energy usage, leading to additional energy savings and carbon reductions. → 32

32 **On-site Green Power Supply:** Establishment of distributed green power plants helps seaports to further reduce carbon emissions while optimizing operations

Major benefits of setting up on-site green electricity station



Source: desktop research; Roland Berger

Value Creation:

The synergistic approach, reinforced by strategic external carbon offsetting investments, positions the terminal to potentially realize zero carbon emissions under the most favorable circumstances.

- **Decarbonization:** Thanks to the on-site green energy supply, the seaport can further reduce carbon emission and able to reach net-zero in best case scenario. Moreover, using artificial intelligence algorithms, the layout of seaport infrastructure can be optimized to achieve more efficient operations. By analyzing large amounts of data, the algorithm can determine the optimal location and layout of facilities to minimize vehicle travel distance and energy waste. In addition, artificial intelligence algorithms can also optimize vehicle routes to ensure that vehicles reach their destinations in the shortest possible route, further reducing vehicle travel distance and energy consumption.

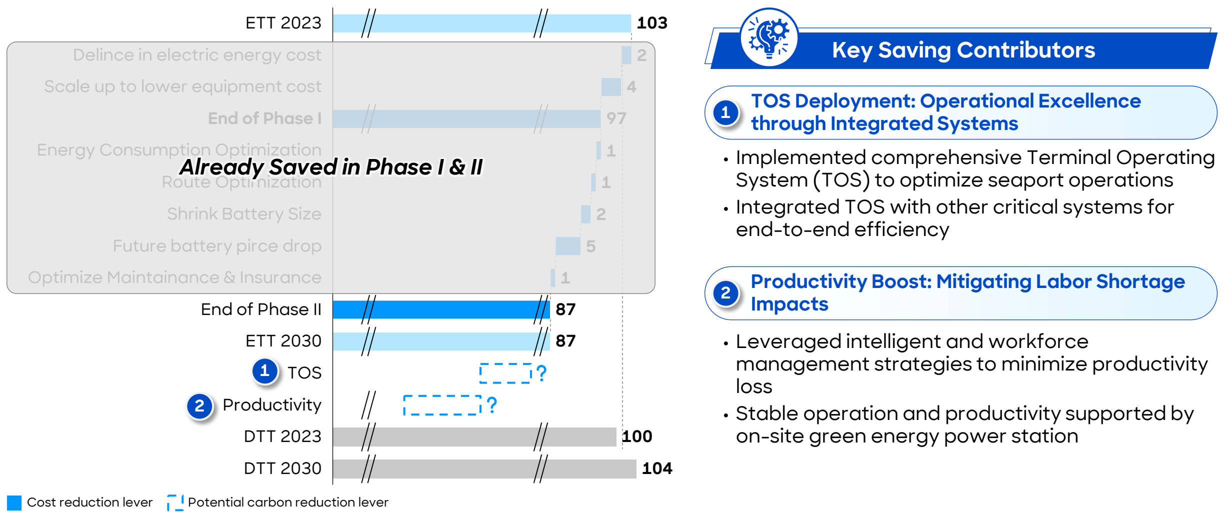
- **Economical Friendly:** The TCO reduction in Phase III comes from optimizing the overall scheduling of the seaport through the TOS system and feeding basic data back to the TOS system to coordinate ship plans and seaport operations.

  - **Shorten Working Distance Through TOS.** Specifically, the seaport can integrate container location information and vehicle travel data to optimize container storage layout, making vehicle working distances as short as possible, thereby reducing fuel consumption and emissions. Additionally, the connectivity of TOS and other related systems would further elevate the operation efficiency.

  - **Also, Improve Productivity.** Through data analysis, reduce the time workers wait for quay crane operations, improve loading and unloading efficiency, achieve seamless link between ship berthing and departure plans and seaport operations, reduce ship waiting time, and lower fuel consumption. Moreover, leveraging automotive function would greatly mitigate the operation instability brought by labor shortage. → 33

- **People Friendly:** By deploying an integrated intelligent seaport management system, it can intelligently integrate data such as vessel arrival times and cargo characteristics, and formulate optimized plans for operations like unloading, marshaling, and storage in advance. Operators only need to issue commands through the

33 **Economical Value Add in Phase III:** Through TOS deployment and productivity enhancements, there exists significant potential for reducing TCO in the future



1) ETT is electric powered vehicle, DTT is diesel powered vehicle
Source: Roland Berger

system interface, and the intelligent equipment can autonomously complete the tasks, significantly reducing manual preparation and repetitive labor. The system also incorporates human-machine interaction capabilities, allowing it to adjust operational processes according to employee habits, enhancing the work experience.

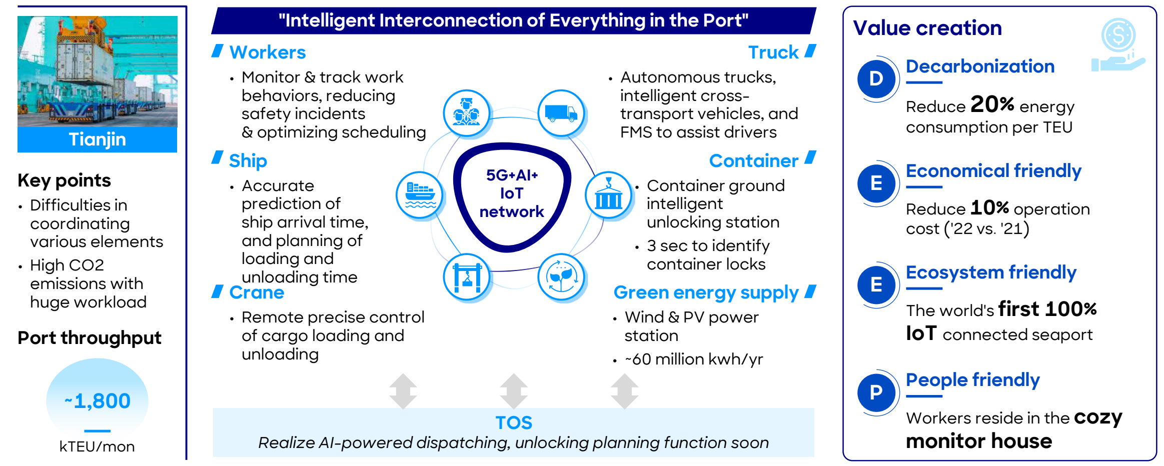
- **Environment Friendly:** Link various core elements of the seaport, including employees, systems, energy infrastructure, etc., and unify the scheduling of all systems within the seaport. This shift allows for a transformation from optimizing individual operations to optimizing overall operations. By linking employees, it is possible to achieve more efficient employee shift management and job coordination. Linking systems enables intelligent management and optimized usage, leading to improved operational efficiency and reduced failure rates. Linking energy infrastructure allows for effective utilization and conservation of energy, thereby reducing operational costs. Unifying the scheduling of all systems within the seaport enables collaborative and optimized operations, resulting in improved overall operational efficiency.

Case Study - Seaport of Tianjin, China

The Seaport of Tianjin has undergone a remarkable digital transformation, leveraging advanced technologies to become a leading efficient, sustainable, and worker-friendly seaport. At the heart of this transformation is the development of an "intelligent seaport brain" - a cloud-based management system that integrates all key seaport operations, from cranes and trucks to ships and cargo.

34 Case Study - Seaport of Tianjin, China

Intelligent interconnected all elements in seaport to achieve "DEEP" impact



Source: Port of long beach 2022 Air Emissions Inventory; Roland Berger

A critical component of this intelligent system is Tianjin Seaport's advanced Terminal Operating System (TOS), which serves as the fundamental foundation for the seaport's digitalization. The TOS integrates all seaport activities, using real-time data analysis and optimization algorithms to automate processes or loading, unloading, and equipment management, and will unlocking auto-planning function soon.

This automation has been particularly impressive, with Tianjin deploying a large fleet of driverless IGVs for container transportation. This has boosted efficiency, allowing the smart terminal to move more containers per hour than traditional terminals, while also enhancing safety and working conditions for operators. Seaport

workers now monitor and control equipment remotely from comfortable control rooms.

Sustainability has also been a key priority, with Tianjin Seaport transitioning to 100% renewable energy from on-site solar and wind sources. This has reduced the seaport's overall energy consumption and carbon footprint, while ensuring stable supply of green energy.

Key Considerations / Potential Challenges:

- **Adopt E2E Solution:** Achieving the goals of global carbon reduction and operational improvement in seaports is a complex process that cannot be achieved solely through the upgrade of individual devices and system construction. In order to successfully achieve this goal, it is necessary to comprehensively consider the actual pain points and have a deep understanding of the business and adopt an end-to-end integrated solution from the early planning and design, flexible deployment of products to the final operation and maintenance.
- **Optimize Data Recognition Technology:** The overall operation optimization of seaports requires the adoption of a more advanced bottom-up information identification solution to achieve full coverage and high accuracy of bottom-up information input. Advanced technology and systems are needed to collect, analyze, and utilize bottom-up information, including the use of sensors, monitoring devices, and data analysis tools, as well as the establishment of a comprehensive information management system and decision support system.
- **Collaborate with External Professional Suppliers:** Seaports need to seek more professional service providers from outside to provide technical and services. The seaports have multiple systems that need to be connected, and professional partners can help the seaports establish strong compatibility transmission standards to ensure smooth communication and data exchange between the systems. At the same time, as the amount of data increases, the seaport's demand for computing power will become more prominent, requiring external partners' computing power support.

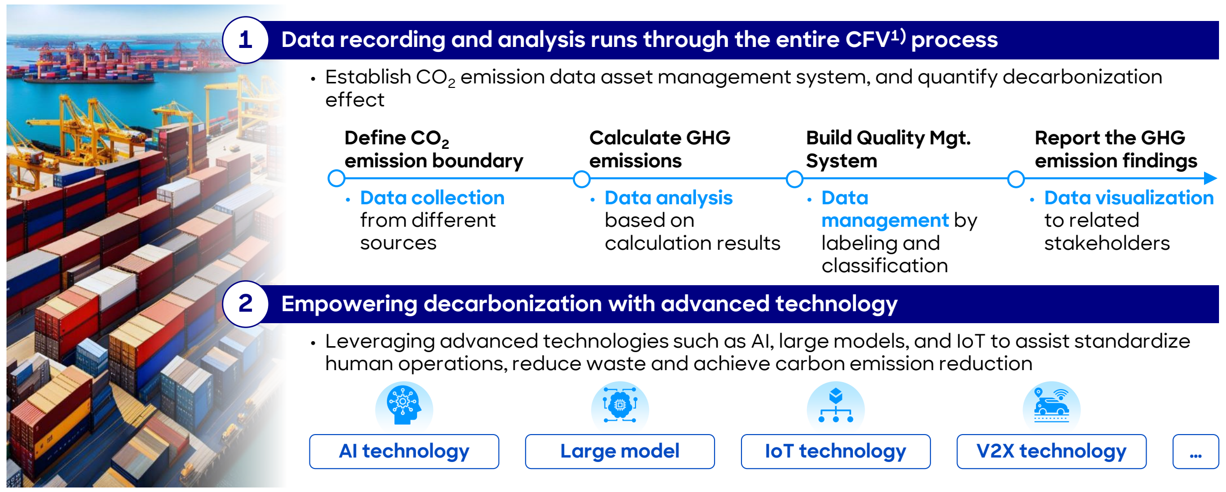
Fundamental Lever - Digitalization

Digitalization is One of the Fundamentals of Decarbonization Levers. Digitalization helps to quantify decarbonization process and standardize operations.

- **Quantify Operational Activities in Carbon Footprint Verification:** Data plays a crucial role throughout the entire process of carbon footprint assessment, quantifying all operational activities. It permeates every stage, from data collection, organization, and analysis, to interpreting results and making decisions. The accuracy and comprehensiveness of data directly impact the outcomes of carbon footprint assessments and subsequent decarbonization efforts. Therefore, ensuring the reliability and timeliness of data and employing scientifically effective data management methods are paramount for achieving accurate carbon footprint assessments and targeted emission reduction measures.
- **Standardize Operator Behaviors:** Using data allows for the standardization of operations for seaport workers. For instance, monitoring and managing the driving behavior of truck drivers. By collecting and analyzing data on driver behavior, such as driving speed, acceleration, braking, etc., seaport management can develop standardized driving behavior guidelines and training programs. Such measures not only enhance the safety of truck drivers and reduce accident risks but also optimize internal freight logistics processes within the seaport, improving overall operational efficiency. Through digital standardized operations, seaports can achieve more efficient, safe, and sustainable operations.

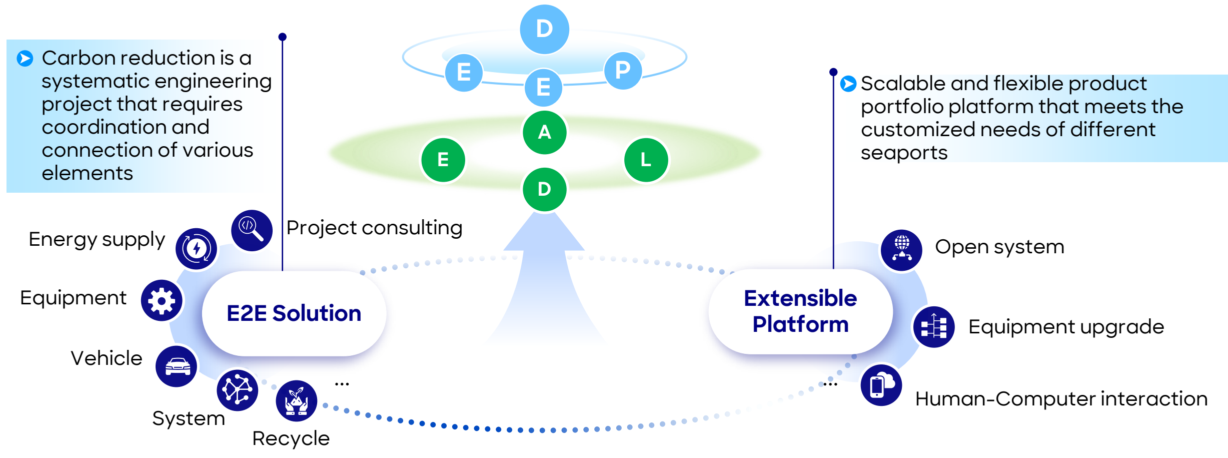
Also, the decarbonization transformation of seaports relies on cutting-edge technologies, such as artificial intelligence, the Internet of Things, and big data analytics. AI technology can enable intelligent energy management systems to monitor seaport energy consumption in real-time and optimize adjustments based on data analysis results, thereby reducing carbon emissions. Moreover, AI technology can enhance the efficiency and accuracy of seaport freight logistics by predicting demand and optimizing fleet scheduling to reduce empty voyages and waiting times, thus lowering energy consumption and emissions. Additionally, AI technology can optimize the operation and maintenance of seaport equipment, increasing equipment utilization rates and reducing energy waste and carbon emissions. → 35

35 **Digitalization:** The necessary path for decarbonization by quantifying decarbonization process and standardizing operations



1) Carbon Footprint Verification
Source: Roland Berger

36 **How to Boost the Decarbonization Process:** E2E solution and extensible platform are the key accelerators to achieve "DEEP" impact



Source: Roland Berger

How to boost the decarbonization process? 2 key accelerators

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To attain the strategic goal of carbon emission reduction, seaport operators are encouraged to cultivate 2 core competencies that are critical to this objective.

Extensible Platform: During the decarbonization process, continuous upgrades and iterations are required. Therefore, a modular and flexible structure is needed to accommodate future modular iterations, allowing for localized equipment upgrades. An effective extensible platform features the capability of flexible human & machine interactability, adaptable machine scalability and open-sourced system compatibility.

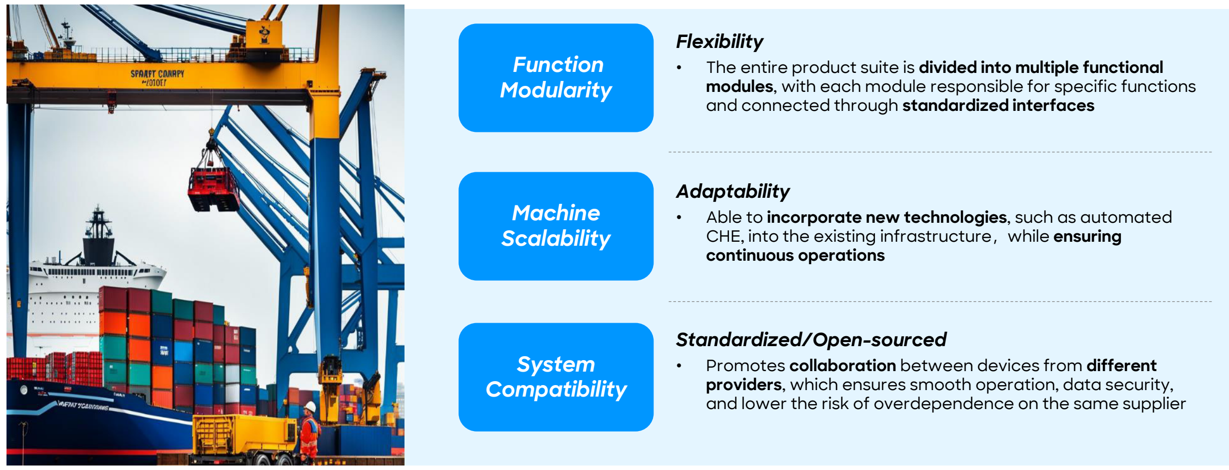
E2E Solution: The "end-to-end solution" for seaport decarbonization refers to a comprehensive solution that takes a holistic approach to reducing carbon emissions from various aspects of seaport operations to achieve sustainable development. This solution covers the full life cycle services for seaport decarbonization, from consulting and planning for transformation and upgrading, financial support for certain products, to delivery of all necessary products, operation and maintenance services, advanced operational empowerment (providing optimization suggestions based on equipment performance), functional expansion and upgrading, as well as recycling and reuse (such as battery recycling), providing a one-stop solution.

Extensible Platform

Modularity, scalability, and an open architecture are key characteristics needed to build an extensible product platform that can sustain continuous iteration and adapt to future upgrades.

- **Flexible Function Modularity:** Adopting a loosely coupled design, the entire product suite is divided into multiple functional modules, with each module responsible for specific functions and connected through standardized interfaces. Therefore, based on actual needs, different functional modules can be freely combined.
- **Advanced Machine Scalability:** At the heart of the platform is a robust infrastructure that prides itself on its agile machine scalability, integrating the latest technological advancements, such as intelligent CHEs, into the seaport's existing ecosystem without disrupting ongoing operations. This

37 **Extensible Platform:** An effective extensible platform features the capability of human & machine interactability, machine scalability and system compatibility



Source: Roland Berger

allows for a smooth evolution of the operational processes and keeps the seaport at the forefront of industry innovation.

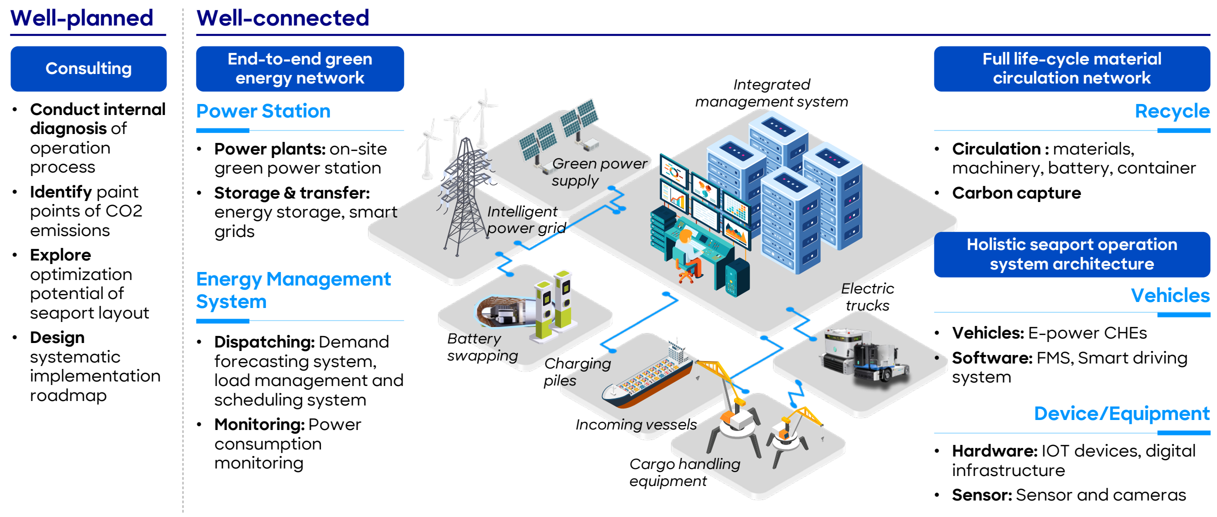
- **Seamless System Compatibility:** An extensible platform should also allow flawless interoperability among various systems and devices, regardless of the provider. By fostering compatibility across different technological solutions, the platform ensures cohesive and uninterrupted seaport operations. The importance of this cannot be overstated, as it underpins data security and mitigates the risk associated with over-reliance on a single supplier. This strategic vendor diversification empowers seaport administrations to maintain autonomy and resilience in their critical operations infrastructure.

→ 37

E2E Solution

The development status of each seaport varies, and the demands and pace for decarbonization and intelligentization differ. Customized consulting and implementation solutions are needed to help seaports establish the most suitable upgrade plans. Adopt an integrated and customized solution with early planning and coordination of various elements within seaport.

38 **E2E Solution:** Adopt an integrated and customized solution with early planning and coordination of various elements within seaport



Source: Roland Berger

- Well-planned: The decarbonization transformation of seaports is a complex process that requires forward-looking planning. From consulting and planning, financial support, product delivery, post-sales maintenance, operational empowerment, and functional expansion and upgrades to material recycling, every step requires systematic planning to achieve overall optimization and upgrades. For example, to shorten the distance traveled by trucks, adjustments to the positioning and layout of containers are necessary, and such designs should be planned at the early stages of the project.

- Well-connected: At the same time, seaport operators also need to consider the synergy among various elements within the seaport. Therefore, it is necessary to build an end-to-end green energy network, a holistic seaport operation system architecture, and a full life-cycle material circulation network. These include machinery, truck transportation, energy facilities, and software systems, among others. It is essential for these elements to work together in harmony to ensure the efficiency and sustainability of the entire seaport operation. → 38

Chapter 3

Replication and Variation: Extend beyond the seaport to other freight logistics scenarios

Revisiting the freight logistics industry reveals that it involves multiple logistics nodes, such as seaports, air cargo terminals, railway ports, land ports, and manufacturing hubs, as well as road freight between different freight logistics nodes.

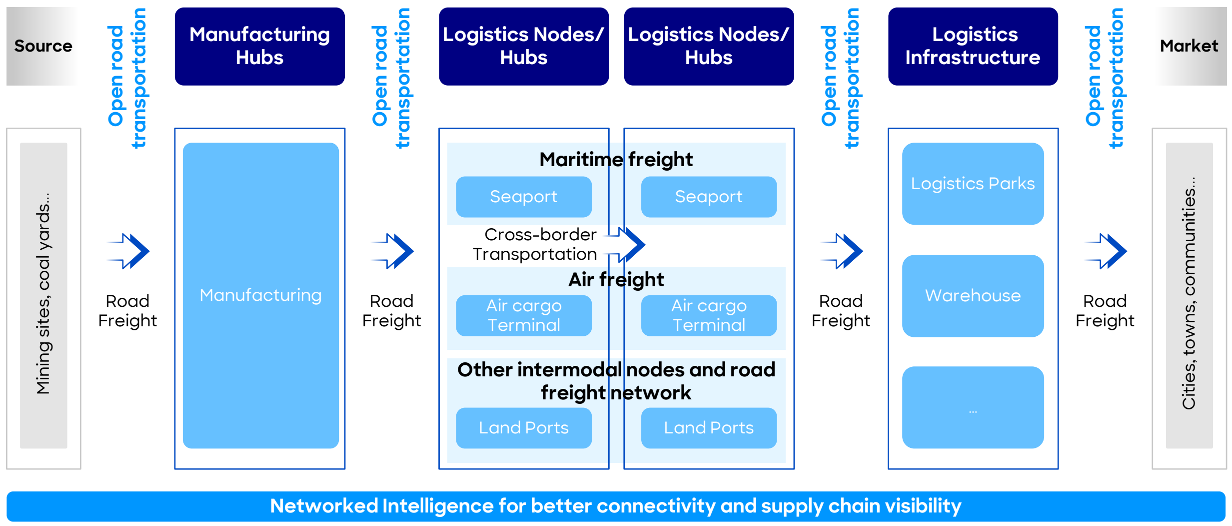
For these different scenarios, the "LEAD" decarbonization methodology can be adjusted and rhymed, with tailored measures taken based on their respective characteristics and requirements, to deliver "DEEP" impact and jointly promoting the green and net-zero development of overall freight logistics industry.

Extending to Other Freight Logistics Nodes/ Hubs (e.g., air cargo terminals). Seaports, air cargo terminal, railway port, and land ports all serve as key freight logistics nodes, sharing similar operational processes and logic. This similarity presents a significant opportunity for a seamless transition towards green carbon reduction strategies. Among them, air cargo terminals are important representatives for replicating seaport carbon reduction methodologies. Air cargo terminals and seaports occupy similar hub node positions in the freight logistics chain, both being important places for cargo distribution and handling.

Extending to Manufacturing Hubs (e.g., OEMs). Manufacturing hub logistics plays a crucial role in the green decarbonization of the overall freight logistics system, as it directly impacts overall logistics efficiency and serves as the link between manufacturing and logistics.

Extending to Other Intermodal Nodes and Road Freight Network. Compared to the enclosed logistics node environment, logistics network faces a more open and dynamic condition environment, posing greater challenges for digital transformation. Take road freight as an example, as the connecting link between nodes, road freight needs to further promote the overall green and net-zero transformation by integrating transportation capacity and data for better connectivity and supply chain visibility. → 39

39 **Comprehensive Freight Logistics Decarbonization:** Build an integrated multi-scenario green freight logistics model with a networked intelligence platform



Source: Roland Berger

Air cargo terminal – Decarbonization by forming an integrated ground logistics network

The global climate change crisis is intensifying, and the aviation industry, as a major emission source, is facing immense pressure to reduce carbon emissions. In 2022, the International Civil Aviation Organization (ICAO) adopted a new long-term global aspirational goal for international aviation to achieve net-zero by 2050.

As one of the core businesses of the aviation industry, the air cargo logistics needs to undergo a structural upgrade to meet the goal.

As critical supporting link in air cargo logistics, the air cargo ground logistics should involve structural upgrades and transformations with the participation of multiple stakeholders, including airlines, airports, air cargo terminals and so on.

The decarbonization of air cargo ground logistics can learn from the methodologies used by the seaport industry in carbon emission reduction, but still faces some unique challenges and conditions.

- **Achieve decarbonization with safety as a prerequisite.** Due to the high safety requirements of airports, strict safety operating rules have been established. In the process of air cargo logistics decarbonization, the prerequisite for business upgrades and transformations is to ensure that operations and safety are not compromised.

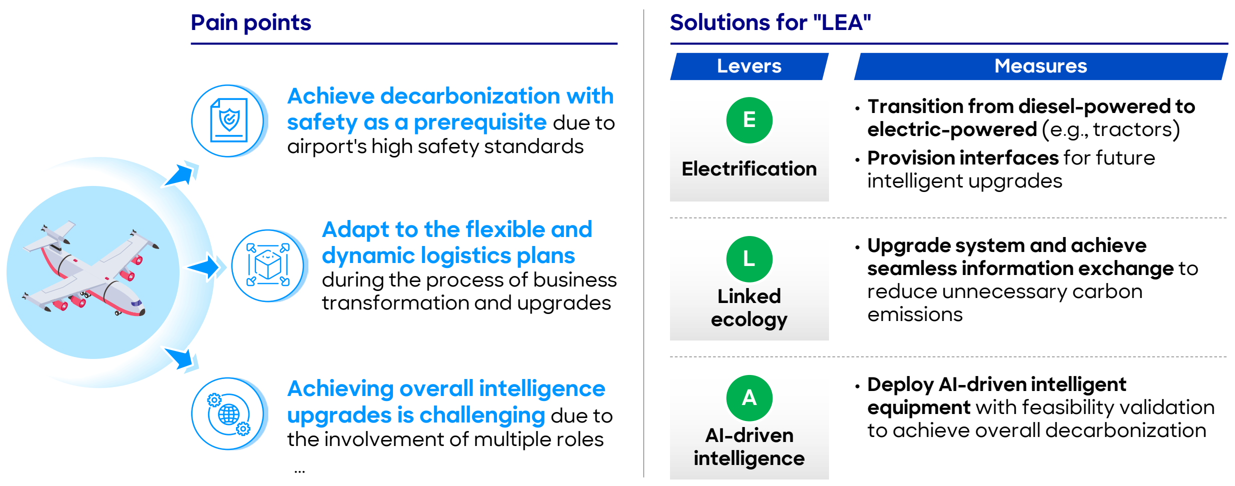
- **Adapt to the flexible and dynamic logistics plans.** The characteristic of air cargo logistics is flexible scheduling and dispatching of operations. In traditional methods, workers rely on pagers, phones, and other means to communicate schedule changes. Therefore, there is a demand for adaptability and flexibility in dispatching plans for new ground service vehicles and equipment.

- **Achieving overall intelligence upgrades is challenging due to the involvement of multiple roles.** Air cargo logistics involves multiple roles, the intelligentization of individual processes in air cargo logistics is difficult to implement independently. It requires coordinated upgrades to the workflow and information flow through a systematic roadmap for comprehensive intelligentization upgrades. → 40

While the seaport "LEAD" decarbonization methodology can be applied to air cargo logistics, the approach to upgrading air cargo operations will differ from seaports.

Compared to seaports, air cargo terminals involve numerous entities. Establishing connections between these entities and ensuring smooth and intelligent operations have been prioritized. Therefore, "Linked ecology" needs to be prioritized before deployment of intelligent

40 **Decarbonization in Air Cargo Ground Logistics:** Decarbonization by forming an integrated ground logistics network



Source: Roland Berger

equipment. Air cargo terminals will first plan and optimize system processes, with upfront design for each step to absolutely avoid risks. Any potential collision hazards posed by intelligent devices, especially in the airside areas critical to aircraft and personnel safety, cannot be overlooked.

Therefore, the decarbonization approach for air cargo logistics is as follows:

- **Electrification from Traditional Diesel:** Transition from diesel-powered to electric-powered air cargo logistics transportation equipment, such as tractors. Also, provision interfaces for future intelligent upgrades to enable seamless integration with lower capital expenditure.
- **Upgrade System and Achieve Seamless Information Exchange:** With systems connected, facilitate seamless information exchange across operations and integrate business upgrades at the process level to mitigate unnecessary carbon emissions.
- **Deploy AI-driven Intelligent Equipment:** After conducting initial adjustments and feasibility validation based on the requirements of the air cargo terminal, deploy intelligent equipment. This will facilitate holistic green upgrades and enable sustainable, low-emission air cargo logistics.

Therefore, when upgrading various aspects of air cargo logistics, it is necessary to consider the overall roadmap in advance. For instance, during the initial electrification phase, provisions should be made for the integration of electrical equipment and systems in the next phases, enabling continuous modular upgrades and laying the foundation for intelligent enhancements.

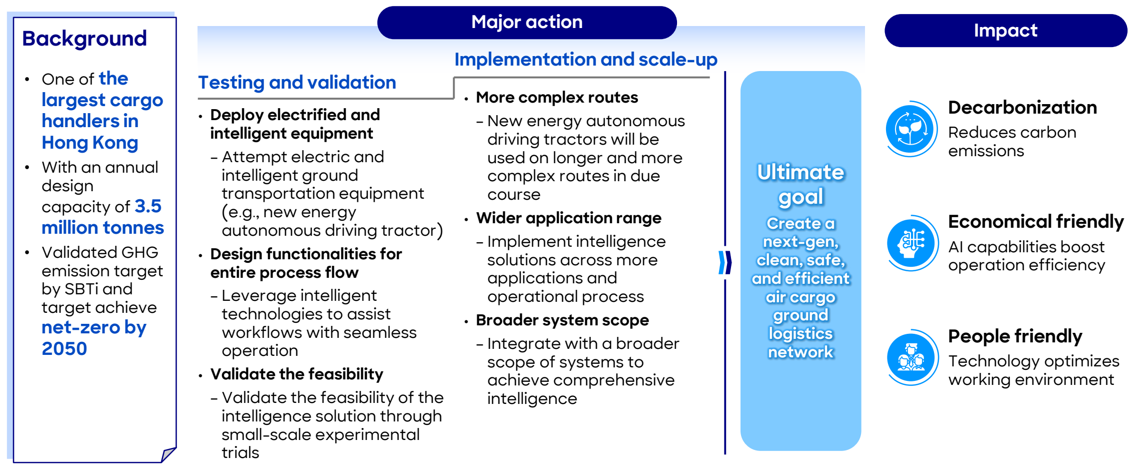
Case Study – An Air Cargo Terminal Operator in Hong Kong

The leading air cargo terminal will collaborate with Westwell to introduce the next-generation new energy autonomous cargo tractor. This solution consists of two key steps:

Step 1: Testing and Validation. Transition from traditional fuel-powered vehicles to electric vehicles, incorporating autonomous driving technologies and other intelligent technologies across processes to achieve electrification and automation upgrades in air cargo logistics ground transportation, validating the feasibility of this upgrade approach.

Step 2: Implementation and Scale-up. Relying on this feasibility validation, proceed with a more comprehensive deployment of intelligent solutions in the future (e.g., more complex routes). Through this approach, achieve the ultimate goal of greening air cargo logistics ground transportation operations.

41 **Case Study – An Air Cargo Terminal Operator in Hong Kong**
Introduce intelligent transportation solution in air cargo logistics



Source: Roland Berger

Manufacturing hub – Synergize inbound manufacturing hub logistics with production pace

Manufacturing hub plays a crucial role in the green decarbonization of the overall logistics system, as it directly impacts the overall logistics efficiency and serves as the link between manufacturing and logistics.

The decarbonization of manufacturing hub logistics is similar to that of seaports, but particularly, from the perspective of specific scenarios, for industries that require precise coordination between manufacturing hub logistics and production cadence, such as automotive manufacturing and electronics manufacturing, the degree of difficulty in system integration and coordination is greater due to the numerous production processes and complex supply chains involved. These industries necessitate systematic decarbonization solution planning and design.

In the process of replicating the "LEAD" carbon reduction methodology from seaports, manufacturing hub logistics decarbonization shares some similarities with seaport carbon reduction, such as the need for electrification retrofits of fuel-powered vehicles. However, manufacturing hub logistics also faces unique challenges, the most significant of which is the lack of an FMS relying primarily on manual dispatching and complexity for supply chain coordination.

- **Fleet dispatching relying primarily on manual operations, lacking intelligent systems.** Compared to seaport, manufacturing hubs lack an overall dispatching management system, resulting in a relatively low level of digitalization in factories. This has led to vehicle management primarily relying on manual dispatching, making intelligent upgrades more challenging and urgent. Reliance on manual vehicle dispatching leads to low efficiency and generates unnecessary carbon emissions.

- **Achieve synergy between systems and equipment to precisely match production rhythms across subsystems.** Traditional manufacturing hub logistics suffers from the "silo effect," where systems lack interconnectivity and information sharing. To avoid this silo phenomenon, data integration across upstream and downstream stages of the industrial chain is necessary. Simultaneously, the production mode emphasizes speed and flexibility to cater to diverse, small batch demands. This necessitates close integration and a high degree of coordination between logistics and production systems. The logistics supply of components and raw materials must be precisely synchronized with the production cadence, ensuring accurate positioning and timely delivery.

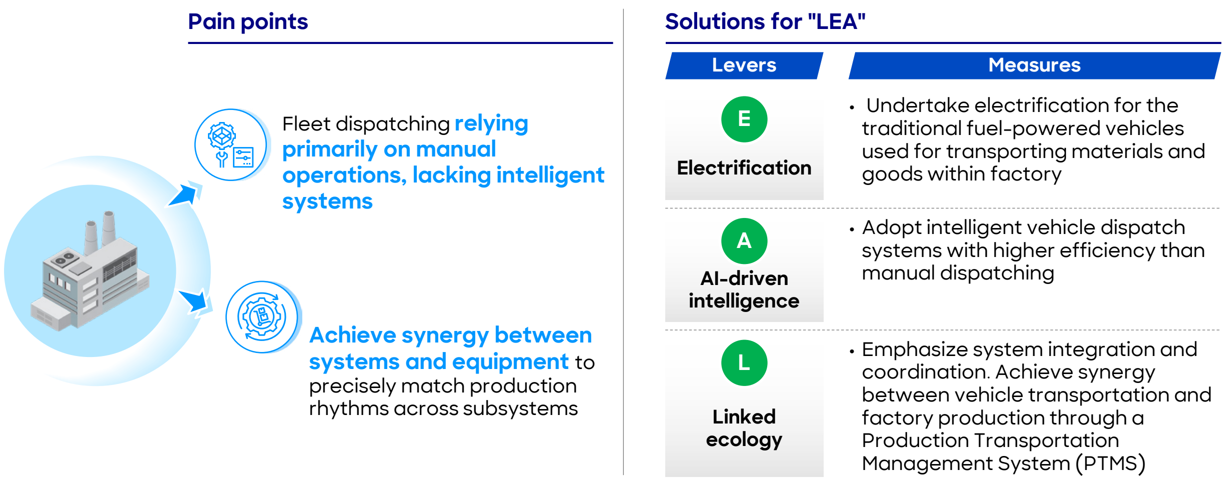
Accordingly, replicating the "LEAD" emission reduction methodology from seaports to manufacturing hub logistics requires adopting corresponding emission reduction measures based on the differences in manufacturing hubs. Among these measures, achieving system integration and coordination through the "Linked ecology" aspect is the most crucial. → 42

- **Electrification from Traditional Diesel:** Undertake electrification for the traditional fuel-powered vehicles used for transporting materials and goods within the manufacturing hub.

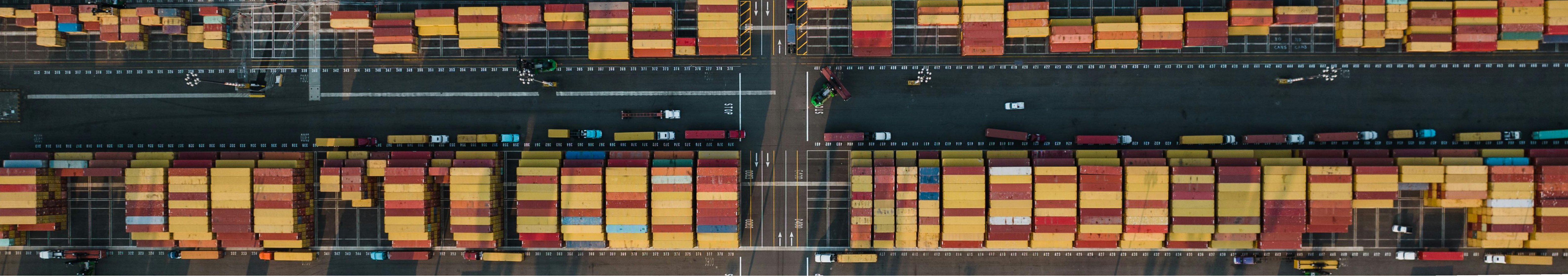
- **Adopt Intelligent Fleet Management Systems:** Compared to traditional manual dispatching in manufacturing hub logistics, an FMS can leverage big data analytics and AI algorithms to enable intelligent vehicle dispatching and efficient operations. FMS can minimize unnecessary transportation mileage and energy consumption, thereby significantly reducing carbon emissions.

- **Emphasize System Integration and Coordination:** Given the critical importance of coordination and synergy among various manufacturing systems, achieving "Linked ecology" is the most crucial lever for manufacturing hub logistics decarbonization. A key factor is leveraging integrated

42 **Decarbonization in Manufacturing Hubs:** Synergize inbound manufacturing hub logistics with production pace



Source: Roland Berger



Plan Transport Management System (PTMS) to connect vehicle transportation with factory production. On one hand, it manages the gate, dock, and FMS (Fleet Management System). On the other hand, it connects with the MES (Manufacturing Execution System) and WMS (Warehouse Management System), facilitating the exchange of information between the production and logistics processes. Through data interaction and intelligent algorithms with these systems, the PTMS provides optimized transportation solutions for the entire supply chain, enabling efficient coordination between logistics transportation, and manufacturing operations.

Therefore, manufacturing hub logistics intelligence solution not only directly reduces carbon emissions, but also, through efficient system coordination, the transportation of production materials becomes smoother, enhancing the efficiency of production cadence. This, in turn, lowers the carbon emission intensity of the production stage, ultimately achieving overall green operations for the entire hub.

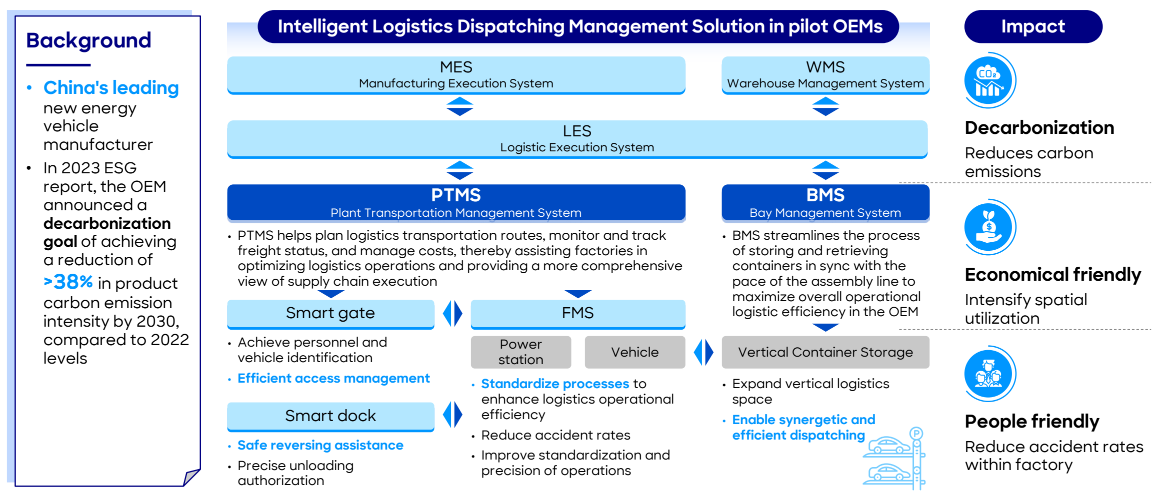
- In manufacturing hub scenarios, the intelligent scheduling system outperforms previous manual scheduling.
  - Enhances transportation efficiency in the logistics transportation process within the scenario, thereby contributing to overall efficiency improvements.
  - Reduces carbon emissions in the logistics transportation process (due to the intelligent scheduling system's superiority over previous manual scheduling, improving efficiency and eliminating unnecessary emissions caused by unclear routes), thereby achieving overall carbon reduction in the factory scenario and contributing to the global green and net-zero goals.
- In manufacturing hub scenarios, the integration of the logistics transportation process with the production side enables overall operational efficiency improvements.

Case Study - A Leading Domestic New Energy Vehicle Manufacturer

To achieve the decarbonization goal, the leading new energy vehicle manufacturer is leveraging technological innovations to reduce carbon emissions and enhance energy efficiency across its production processes and supply chain.

In this case, the solution was fully integrated into the vehicle manufacturer's production system and precisely synchronized with the production cadence. While reducing carbon emissions, it achieved coordinated collaboration between logistics dispatching management and the production system.

43 Case Study - A Leading Domestic New Energy Vehicle Manufacturer
Develop overall intelligent solution in sync with existent manufacturing systems



Source: Port of long beach 2022 Air Emissions Inventory; Roland Berger

Road freight - Networked intelligence for better connectivity and supply chain visibility

The transportation sector is a major contributor to greenhouse gas emissions, with road freight being a significant source. Globally, the road transport and freight sectors account for the largest share of carbon dioxide emissions within the logistics industry.

Road freight transportation plays a pivotal role in connecting various logistics nodes. In addition to decarbonizing its own operations, provided that decarbonization and intelligence are sufficiently implemented at each logistics node scenario, road freight will also integrate the transportation capacity and data across the entire logistics chain, enabling an end-to-end decarbonization transformation for the supply chain.

Also, as an open scenario, leveraging digital means to achieve decarbonization for road freight poses greater challenges compared to logistics nodes such as seaports. The road freight scenario is complex and dynamic, involving factors such as varying routes, changing transportation environments, multiple stakeholders, and infrastructure constraints.

Therefore, in the process of replicating the "LEAD" carbon reduction methodology from seaports, road freight decarbonization shares some similarities but also faces more unique challenges and opportunities.

- **Data is invisible, leading to a high degree of data loss and significant lag.** Road freight transportation currently suffers from a lack of effective data tracking methods. Communication between drivers and operators' experiences delays, making it impossible to obtain a complete tracking chain. Consequently, data queries are untimely and plagued by missing information. Also, the invisibility of road freight data is reflected in the lag experienced by shippers and freight forwarders in obtaining information about vehicles, goods, and containers during the transportation process.

- **Difficulty in efficiently matching transportation capacity achieving higher economic benefits.** As an open scenario, road freight is greatly impacted by fluctuations in market supply and demand, leading to occurrences of insufficient transportation capacity and unstable freight rates. Therefore, for players with their own transportation capacity need to consider how to maximize efficiency within a certain range of manpower while still being able to provide high-compliance and time-efficient transportation services to upstream and downstream parties in case of emergencies or exceptional circumstances.

- **Relying primarily on manual decision-making, supply chain planning decisions are slow.** Traditional road freight supply chain planning heavily relies on human experience and judgment, making it difficult to achieve precise planning and forecasting. Digital supply chain solutions are needed to ensure efficiency.

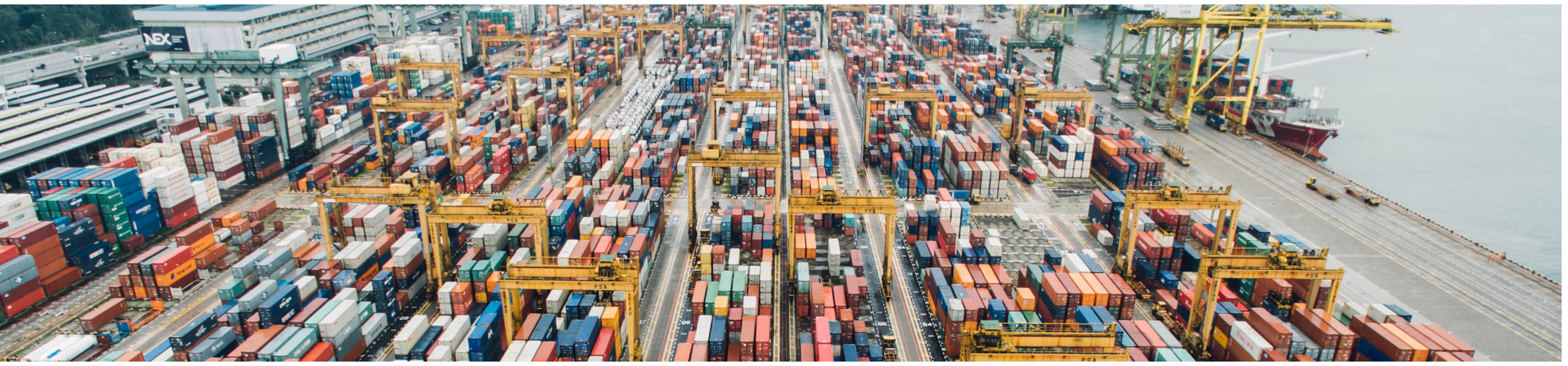
Therefore, when replicating the "LEAD" to road freight, corresponding emission reduction measures must be adopted based on the characteristics of road freight as an open scenario. → 44

- **Electrification with Optimal Battery Size or Charging Facilities to Ease Range Anxiety:** The battery range becomes a critical challenge due to the demand for long-haul transportation. One approach is to optimize battery size matching to increase the range per charge; another approach is to deploy rapid recharging facilities, such as battery swapping stations, allowing trucks to quickly swap battery packs within a short time, thereby extending the overall range.

- **Leveraging IOT Technologies, Deploying Hardware and FMS for Better Management and Monitoring:** The scheduling and management of road freight vehicles need a comprehensive solution as a foundation, including hardware terminals mounted on vehicles and cargo for data collection, a vehicle

44 Decarbonization In Road Freight: Networked intelligence for better connectivity and supply chain visibility

Source: Roland Berger

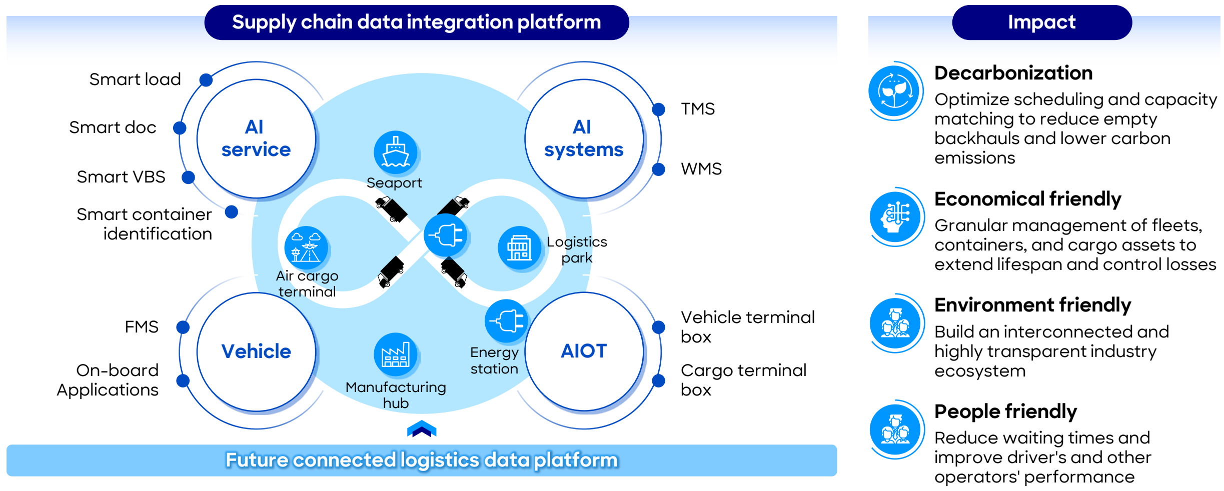


management system, and intelligent user terminals with mobile and PC access. The deployment of this solution enables better management and monitoring of fleet performance, smart tracking of freight status, and better management of logistic assets.

- **Establish a Supply Chain Data Sharing Platform with More Stakeholders Joining the Ecosystem, Enabling Efficient Matching of Vehicles and Freight, and Controllable Supply Chain Forecasting:** To achieve connectivity across different logistics scenarios at various nodes in the road freight sector and to efficiently integrate logistics, energy, and trade operations, a digital logistics data platform needs to be established.
  - Integrate core systems and data: Integrate core systems within seaport, online freight platforms, and intelligent user interfaces into the unified data platform, enabling data interoperability and business collaboration.
  - Integrate data from upstream and downstream processes: Interface with upstream suppliers, downstream customers, and other supply chain stakeholders to achieve seamless integration of order, transportation, warehousing, and delivery information flows, improving supply chain transparency and collaboration efficiency.
  - By establishing a logistics data platform in the road freight sector, efficient vehicle-cargo matching, more controllable supply chain predictions (e.g., estimated time of arrival), and overall supply chain planning and scheduling can be achieved.

Therefore, by promoting truck electrification, intelligence systems, and establishing a supply chain data integration platform in the road freight sector, not only is decarbonization achieved in this segment, but an interconnected and highly transparent ecosystem is also built for the entire supply chain, driving the green transformation of the whole chain. → 45

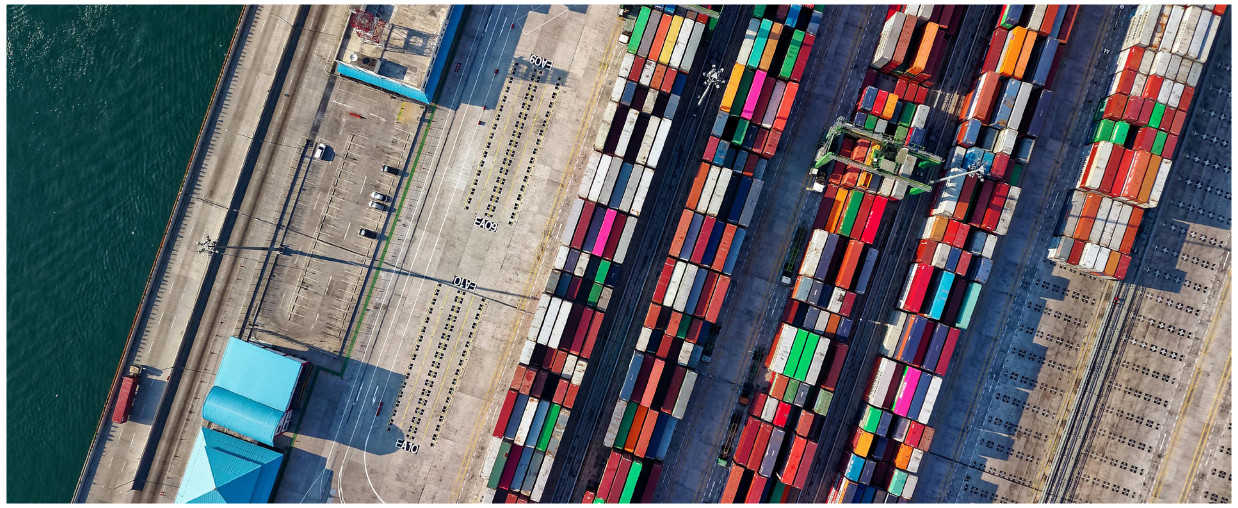
45 Solution Overview – Supply Chain Data Integration Platform
Define the future of connecting everyone and everything in the logistics industry with data



Source: Westwell; Roland Berger

Chapter 4

Call to Immediate Action: Implications for freight logistics companies



Global green and net-zero development has become an overarching trend. For the freight logistics industry, actively promoting carbon reduction transformation is not only an inevitable path to fulfilling social responsibilities but will also become another core competitiveness for future competition.

In the actual process of promoting green and net-zero transformation, digital means will help enterprises accelerate the decarbonization process, while enterprises also need to strategically plan. Therefore, enterprises need to refer to the systematic "LEAD" decarbonization methodology. This methodology takes digitalization as the foundation and through the three stages of "Electrification", "AI-driven intelligence", and "Linked ecology", it outlines a clear phased decarbonization roadmap for enterprises, guiding them to comprehensively implement technological innovation and operational optimization, thereby achieving decarbonization goals and realizing the "DEEP" values.

After successful implementation in seaports, the "LEAD" approach will be gradually replicated and promoted to other sectors. However, in the process of replication and promotion, it is necessary to carefully assess the pain points and differentiated needs of different scenarios and make targeted optimizations and adjustments to the solutions to ensure the applicability and effectiveness of the "LEAD" methodology.

"A journey of a thousand miles begins with a single step". For freight logistics enterprises, the time to embark on the decarbonization journey has arrived. By applying intelligent technologies and innovative solutions, the freight logistics industry can not only effectively reduce carbon emissions but also collectively move towards a greener, net-zero future.

About Westwell

Established in 2015, WESTWELL swiftly emerges as an industrial frontrunner by leveraging advanced AI capabilities to digitalize and decarbonize logistic industries.

Westwell develops and deploys smart NEVs (new-energy vehicles) and AI-driven intelligent industrial solutions and systems for multiple logistic scenes, including seaports, air cargo terminals, manufacturing hubs, railway logistics, cross-border transportation, road freight and supply chain platforms.

With a business footprint across 18 countries and regions, Westwell empowers clients with a diverse array of value propositions. These solutions drive heightened efficiency, improved economics, enhanced safety standards, and a steadfast commitment to fostering environmentally sustainable practices and ESG values within the logistics industry.

About Roland Berger

Roland Berger is one of the world's leading strategy consultancies with a wide-ranging service portfolio for all relevant industries and business functions. Founded in 1967, Roland Berger is headquartered in Munich. Renowned for its expertise in transformation, innovation across all industries and performance improvement, the consultancy has set itself the goal of embedding sustainability in all its projects. Roland Berger revenues stood at more than EUR one billion in 2023.

Let's talk

Our team of experts has extensive experience in implementing intelligent carbon reduction solutions for freight logistics companies worldwide. Please don't hesitate to contact us for further information and to discuss potential solutions for your organization.

WE WELCOME YOUR QUESTIONS, COMMENTS

AND SUGGESTIONS

Authors

Xing, Wang
Partner, Roland Berger China
xing.wang@rolandberger.com

Hongyuan, Hu
VP, Westwell
hongyuan.hu@westwell-lab.com

Roland Berger's **Frank Fu; Wendy Wang; Irene Duan; Janet Zhu**
Westwell's **Alvin Sun; Xingrui Zhou; Jingyi Zhao; Kanxuan He**
also contributed to this report.

Your questions, comments and suggestions are welcome!
www.rolandberger.com

Roland Berger China

Address:
Units 02B-04, 23/F, Suhe Centre, 99 Shanxi North Road,
Jing'an District, Shanghai 200085

Phone:
+86 21 5298-6677

www.rolandberger.com

Shanghai Westwell Technology Co., Ltd

Address:
Building D&E, No.155 Wuyi Road, Changning District,
Shanghai 200050

Phone:
+86 21 3335-6855

en.westwell-lab.com