



Charting a Net-Zero Pathway

A Korea-Europe Green Shipping Corridor Linking
Pyeongtaek and Key European Ports



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Publication Date **April 2025**

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Executive Summary

• The Need for Establishing a South Korea–Europe Green Shipping Corridor

In alignment with the International Maritime Organization’s (IMO) 2050 net-zero target, South Korea has announced its “Greenship-K Program” to accelerate the adoption of eco-friendly vessels and set a national goal to achieve a 100% reduction in greenhouse gas (GHG) emissions from shipping by 2050. Green Shipping Corridors have emerged as a key strategy for decarbonizing the maritime sector, and structural transformation for practical implementation remains a critical challenge.

• Recommendation for a GSC for PCTCs Linking Pyeongtaek and Key European Ports

This report proposes the establishment of a Green Shipping Corridor (GSC) focused on Pure Car and Truck Carriers (PCTCs), linking Pyeongtaek Port—South Korea’s largest hub for automotive trade—with major European ports including Bremerhaven, Antwerp, Zeebrugge, and Southampton. Unlike container terminals, car terminals require minimal heavy cargo-handling infrastructure, making them more suitable for conversion to green port operations. Given the steady cargo volumes typically seen in PCTC services, the route presents high potential for sustainable, long-term operation.

• Introducing a Low-Emission Shipping Model Based on Green Methanol

As the global shipping industry accelerates its shift toward clean fuels, methanol-powered vessels are gaining traction as a viable alternative to conventional fossil fuels. The Korean government has announced plans to deploy green methanol-fueled ships on the Busan–Tacoma route starting in 2027. According to Clarkson Research, there are currently 361 methanol-powered ships in operation or on order worldwide, including 30 Roll-on, Roll-off (RoRo) or Pure Car Carrier (PCC) vessels. In this context, this report proposes the adoption of green methanol as the primary fuel for the Korea–Europe corridor, with a long-term goal to transition toward e-methanol. This shift is expected to reduce CO₂ emissions by more than 70% compared to conventional fossil fuel use.

• Proposal for a Public–Private Partnership Driven Implementation Strategy

Robust public policy support is crucial to establish a Korea–Europe Green Shipping Corridor. This includes enacting a dedicated Green Shipping Corridor Bill, creating fuel supply infrastructure, and providing expanded financial support. At the same time, active participation from key private-sector stakeholders such as shipping companies, fuel suppliers, cargo owners, and financial institutions will be indispensable. Through targeted financial incentives from the government, shipping lines can invest in eco-friendly vessels, while cargo owners can adopt transport options that utilize low-emission non-fossil fuel, helping to stabilize demand. Financial institutions can further accelerate market formation through increased investment, thereby enhancing both the feasibility and competitiveness of the green corridor.

1. Introduction: The Need for a Korea-Europe Green Shipping Corridor

Maritime shipping is responsible for roughly 3% of total global greenhouse gas (GHG) emissions. Decarbonization is emerging as a critical means of achieving the 2050 net-zero goal declared by the International Maritime Organization (IMO). Governments and major shipping companies worldwide are actively pursuing initiatives such as deploying eco-friendly vessels, shifting towards low-emission fuels, and transitioning maritime infrastructure. South Korea has announced its aspirations to fully eliminate GHG emissions from the shipping sector by 2050 through its action plans for the Greenship-K Promotion Strategy (Ministry of Ocean and Fisheries (MOF), 2024).

Within this context, the Green Shipping Corridor (GSC) initiative has gained recognition as a crucial mechanism for the sustainable transition of maritime transportation. These initiatives typically involve operating ships powered by emission-free fuels, electrifying port operations, ensuring power supply from renewable energy sources, and mandating the use of alternative maritime power (AMP) systems (SFOC, 2023).¹ They also offer a holistic solution for accelerating the adoption of environment-friendly practices throughout the entire process of ships entering and leaving ports (JANG Gyeong-seok, Dec. 2023). To date, the world has seen more than 60 green shipping corridor plans surface (Global Maritime Forum, 2024), but no single one is in action yet. The longer the route, the more challenging the practical implementation.

Against this backdrop, this report proposes the establishment of a Korea-Europe green shipping corridor centered on Pure Car and Truck Carriers (PCTCs). The corridor would connect South Korea's largest automobile trade port, Pyeongtaek, with key European ports including Bremerhaven, Antwerp, Zeebrugge, and Southampton. This model is grounded in public-private cooperation and explores the use of green methanol as a primary fuel, in alignment with industry trends toward methanol-fueled vessels and expanding bunkering infrastructure at major global ports.

¹ Alternative maritime power (AMP) refers to a system that supplies electrical power to ships at berth from the shore. While docked, vessels typically generate power by running their onboard generators, a practice that emits significant amounts of pollutants such as sulfur oxides (SOx), nitrogen oxides (NOx), and particulate matter (PM). By providing shoreside electrical power directly to ships at berth, AMP systems can reduce these emissions by at least 98 percent, greatly improving air quality in port areas.

This Korea–Europe GSC offers several strategic implications: First, it complements existing container-based GSC efforts by broadening participation to PCTCs, thereby accelerating decarbonization across a wider range of vessel types. Second, it shifts the focus from intra-European short-sea routes to transcontinental long-distance shipping, enabling larger-scale CO₂ emission reduction.

As Korea’s primary hub for automotive logistics, Pyeongtaek Port maintains stable annual cargo volumes and operates under a private-sector-driven governance structure, making it a highly suitable starting point for piloting a collaborative green shipping initiative. These characteristics provide a strong foundation for practical, scalable implementation of a public–private GSC model.

2. Research Overview and Methodology

2.1. Global Green Shipping Corridors: Status and Outlook

South Korea is exploring the feasibility of the Korea-US green shipping corridor and is planning to strengthen cooperation with Australia and Singapore in pursuit of similar initiatives (2025 Action Plans for the Greenship-K Promotion Strategy, 2025). Moreover, the country has announced a conceptual plan for a *mega green shipping corridor* that links South Korea to Singapore and Europe, thereby formalizing its commitment to decarbonizing long-distance international shipping routes (MOF). To back these aspirations, the National Assembly took a groundbreaking step in October 2024 by introducing a special bill for green shipping corridors, the first of its kind in the world. The nation has not been without a law on eco-friendly ships; it has the Act on Promotion of Development and Distribution of Environment-Friendly Ships (hereinafter the “Green Ship Act”). Nevertheless, the special act, if enacted, will go beyond the vessel-oriented support of the Green Ship Act to involve a broader range of stakeholders, such as port operators and fuel supply chains (*Headline Jeju*, 2024). The proposed act is expected to mark a pivotal turning point, injecting renewed momentum into the IMO’s decarbonization strategy and expediting South Korea’s cruise toward carbon neutrality. Green shipping corridor initiatives initially underscored cooperation between governments or between ports; however, today private-sector involvement and industrial partnerships are increasingly prevalent.

Among all officially announced green shipping corridor plans to date, only two specifically target vehicle carriers (The Zero-Emission Shipping Mission (ZESM) Green Shipping Corridor Tracker). At COP 2022, the South Korean and US governments unveiled their green shipping corridor initiative with two distinct routes: one connecting the Port of Busan, for container ships, to the Northwest Seaport Alliance (NWSA) Ports of Tacoma and Seattle in the US, and the other linking the Port of Ulsan to the same NWSA ports to serve automobile carriers.

[Figure 1] Pyeongtaek Port, a Gateway to the World



① Port of Gothenburg–North Sea Port (Sweden–Belgium)

This route represents a collaborative initiative led by the Port of Gothenburg in Sweden and North Sea Port, which straddles regions in Belgium and the Netherlands. It involves the Danish shipping and logistics company DFDS as a key partner. Spanning approximately 2,500 kilometers from north to south, this corridor connects from Norway in Northern Europe down to Spain in the southern part of the continent. In its early stages, the initiative, with the aim of establishing a fully green, zero-emission shipping route by 2027, considered a range of fuel options including methanol, advanced biofuels,² and ammonia. Later, it expanded its ambitions in alignment with DFDS's net-zero plans,³ envisioning the operation of at least two ammonia-fueled vessels along this corridor by 2030 and welcoming a new partner—the Port of Antwerp-Bruges—in 2024. Unveiled in October 2022, the initiative for this route has reached its final stage, with an implementation plan already hammered out.⁴

² Advanced biofuels are derived from non-food crops and algae.
(<https://www.sciencedirect.com/topics/engineering/advanced-biofuels-production>)

³ DFDS has announced that it will operate six low-carbon vessels by 2030.

⁴ The seven statuses of the development of Green Corridors (① Announcement and initial partnerships; ② Conducting pre-feasibility assessment; ③ Pre-feasibility assessment conducted; ④ Conducting feasibility assessment; ⑤ Feasibility assessment conducted; ⑥ Developing implementation plan; and ⑦ Implementation plan developed)

② FIN-EST Green Corridor (Finland-Estonia)

In October 2023, Finland and Estonia announced their vision for a green shipping corridor connecting the ports of Helsinki and Tallinn, which are about 90 kilometers apart. The initiative remains at the very first stage of the seven statuses outlined by the ZESM Green Shipping Corridor Tracker: Announcement and initial partnerships.

This initiative is being pursued by leading shipping companies such as Rederi AB Eckerö, Tallink Grupp, and Viking Line as well as by the Finnish and Estonian governments. A concrete blueprint detailing the fuels to use and operational schedules has yet to be developed. Recently, the FIN-EST green shipping initiative has officially approved 19 different projects aimed at achieving carbon neutrality ("FIN-EST Green Corridor approves 19 projects for carbon neutrality of maritime shipping," 2024). These projects include transitioning to eco-friendly fuels, decarbonizing port infrastructure, improving waste management, and leveraging digital technology to enhance fuel efficiency.

2.1.1. Why Pyeongtaek Port?

—The Role and its Significance in the Corridor

① Critical Hub for Automobile Imports and Exports

The Port of Pyeongtaek is South Korea's largest port for automobile imports and exports, handling about 95 percent of all vehicle imports nationwide. A vast majority of imported cars that are registered in Seoul, Gyeonggi-do Province, or Incheon are brought into the country through this critical logistical hub (Total Registered Motor Vehicles, 2025).

In 2024, South Korea saw 263,288 foreign automobiles newly registered. European brands commanded a colossal combined share of 74.5 percent (196,219 units). Breaking it down further, BMW (Germany) led the market with a share of 28.01 percent (73,754 units), followed by Mercedes-Benz (Germany) with 25.22 percent (66,400 units), and Tesla (USA) in third place with 11.30 percent (29,750 units). German brands dominate the top ranks, while French, British, and Italian marques also maintain an impressive market presence. These figures testify to the unmatched influence of the European carmakers, especially German brands (New Registrations of Passenger Cars, 2025).

The Port of Pyeongtaek also serves as South Korea's gateway to the world. Automobiles produced by the country's major car manufacturers—Hyundai Motor Group, Kia, and KG Mobility—are shipped to Northern and Central European markets through this automotive gateway. In 2024, the country posted KRW 94.84 trillion (USD 70.8 billion) in automobile exports, surpassing the USD 70 billion milestone for a second consecutive year and hitting a new monthly high of KRW 9.12 trillion (USD 6.8 billion) in April. Of the exports, eco-friendly vehicles amounted to KRW 3.8 trillion (USD 2.29 billion), reflecting sustained growth driven by rising demand for electric vehicles (EVs) and hybrid vehicles as well as by accelerating exports of sports utility vehicles (SUVs) (Automobile Division, Director General for Manufacturing Industry, Office of Industrial Policy, Ministry of Trade, Industry and Energy(MOTIE), 2024).

② Private-Led Management

Unlike South Korea's four major ports—Busan, Ulsan, Incheon, and Gwangyang—which are developed and operated under the leadership of the central government (specifically, the MOF) and their respective port authorities, the Port of Pyeongtaek operates under an unusual governance structure. Gyeonggi-do Province and Pyeongtaek City spearhead its development and management, with heavy involvement from private enterprises. While the four major ports are each managed by their dedicated port authorities, Pyeongtaek Port is overseen by the Pyeongtaek Regional Office of Oceans and Fisheries, a branch of the MOF (KIM Jong-hun et al. 2022, p.3). In addition, the development of hinterland complexes and key components of the infrastructure at Pyeongtaek Port has been advanced through initiatives funded by private capital (Port Investment Cooperation Division, 2021).

This governance structure has proven beneficial for the port's growth as an automobile gateway. The private-sector logistics infrastructure, including the dedicated terminals for automobile imports and exports and pre-delivery inspection (PDI) centers, has continuously expanded. The port's geographic proximity to the manufacturing plants of the country's three major automakers—Hyundai, Kia, and KG Mobility—situated in Asan, Hwaseong, and Pyeongtaek has further encouraged active private-sector involvement. Moreover, the port serves as a critical global logistical nexus for leading shipping lines, including EUKOR Car Carriers, Hyundai Glovis, and Wallenius Wilhelmsen.

Among the terminals at the Port of Pyeongtaek, those dedicated to automobile handling rarely rely on large-scale unloading equipment, and their facilities are relatively easy to renovate. This flexibility facilitates the adoption of new equipment for alternative fuels and supports the port's potential as a model harbor in the establishment of a green shipping corridor.

③ Lack of Discourse on Green Shipping Corridors

Despite its pivotal role in South Korea's automotive trade, the Port of Pyeongtaek has been largely absent from national and international discussions on green shipping corridors. In contrast, the Port of Ulsan—ranked first in liquid cargo handling and second in automobile imports and exports—is currently undergoing a government-led feasibility study for a Korea-U.S. green corridor initiative. Moreover, the port of Pyeongtaek is not a signatory to the Memorandum of Understanding (MOU) for Promoting Mutual Cooperation Among the Four Major Port Authorities, which was established by Busan Port Authority (BPA), Incheon Port Authority (IPA), Ulsan Port Authority (UPA), and Yeosu-Gwangyang Port Authority (YGPA). This MOU outlines joint efforts toward eco-friendly port transitions, information sharing, policy coordination, ESG initiatives, port redevelopment, overseas market engagement, and cooperative business opportunities (Incheon Port Authority, 2022).

For Pyeongtaek Port to ensure its long-term sustainability as a critical automobile gateway, it must align with global and domestic decarbonization momentum. Establishing a green shipping corridor would not only reinforce its strategic position but also demonstrate its commitment to the maritime industry's low-carbon future.

2.1.2. Criteria for Selecting Key European Ports

Most scheduled shipping services connecting Europe and East Asia routinely call at ports within the following three strategically vital European regions in terms of logistics, trade, and market accessibility (Theo Notteboom 2015):

- **Rhine-Scheldt Delta:** Rotterdam, Antwerp, and Zeebrugge
- **North German Multi-Port Gateway:** Hamburg, Bremerhaven, and Wilhelmshaven
- **Southeast Coast of the UK:** Felixstowe, Southampton, and London Gateway

These regions are home to Europe's leading container ports, functioning as critical hubs for global trade. They also experience the highest concentration of container ship traffic, vessels that are among the largest contributors to GHG emissions in the maritime sector. These regions also feature some of the fastest throughput growth rates globally. Given these characteristics, they are identified as priority candidates for the establishment of green shipping corridors.

Ro-Ro vessels departing from the Port of Pyeongtaek and calling at European ports primarily voyage along routes that cross the aforementioned regions. The European ports of call for some major shipping lines are shown in the following table:

[Table 1] European ports of call for vessels departing from Pyeongtaek Port

Shipping Lines	Ports of call	
•EUKOR Car Carriers •Hyundai Glovis •Wallenius Wilhelmsen Ocean •The Nippon Yusen Kabushiki Kaisha •Mitsui O.S.K. Lines	•Livorno, Italy •Tarragona, Spain •Rotterdam, Netherlands •Zeebrugge, Belgium •Setúbal, Portugal •Southampton, UK	•Fos, France •Koper, Slovenia •Bremerhaven, Germany •Antwerp, Belgium •Immingham, UK •Tilbury, UK

Source: Gyeonggi Pyeongtaek Port Corporation

These routes are well-qualified as priority candidates for green shipping corridor initiatives, as they closely align with major container ship lanes, resulting in high logistics density and substantial CO₂ emissions.

Among these, this report identifies a set of European ports that not only represent a balanced cross-section of the continent's automotive logistics hubs but are also directly connected to the Port of Pyeongtaek through existing maritime routes. From the Rhine-Scheldt Delta region, this report focuses on Antwerp and

Zeebrugge; notably, Zeebrugge recently surpassed Antwerp in deep-sea Ro-Ro vessel calls ("Zeebrugge overtakes Antwerp for deepsea Ro-Ro," 2024). From the North German Multi-Port Gateway and the Southeast Coast of the UK, this report chooses the Port of Bremerhaven, a central gateway for automotive logistics, and the Port of Southampton, which maintains a high share of vehicle transport (Marcus Williams, 2023), respectively. Although the Ports of Antwerp and Zeebrugge in Belgium were officially merged into the Port of Antwerp-Bruges in 2022, this report treats them as distinct ports of call within the corridor design. This distinction reflects the geographically separate locations of the two ports and the unique strategic roles each plays in Europe's maritime and automotive logistics networks.

2.1.3. ESG Demands of Global Automotive Supply Chains

Regulations on CO₂ emissions are toughening across the globe, and the EU, the US, and other major countries are taking measures such as imposing carbon border tax and even stricter environmental standards. Carmakers, as a result, are coming under increasing pressure to manage not only their direct emissions (Scope 1),⁵ generated during vehicle operation, but also their indirect emissions (Scope 3), arising throughout the supply chain, including the manufacture of vehicle frames and parts as well as the transportation of finished vehicles.

Noteworthy, as mandatory climate-related disclosures are increasingly becoming the norm, companies must assume greater responsibility for reducing CO₂ emissions throughout their value chains. The Scope 3 disclosure requirements in major countries are as follows:.

- **EU⁶:** Mandatory reporting of Scope 3 GHG emissions starting in 2025, in accordance with the Corporate Sustainability Reporting Directive (CSRD), applies not only to large EU-based companies but also for non-EU companies with significant EU operations, i.e. if they generate a net turnover of more than €150 million in the EU and have at least one subsidiary or branch in the EU exceeding specific size thresholds.
- **UK⁷:** In 2022, the UK adopted the UK Green Taxonomy and the standards set by the International Sustainability Standards Board (ISSB). UK-listed and UK-registered companies are now required to disclose material Scope 3 emissions.
- **South Korea:** There are currently no mandatory requirements for Scope 3 emissions reduction, but companies operating overseas, along with their suppliers and contractors, need to make prepare to comply with regulations imposed by the EU and other jurisdictions.

The automobile industry is a cornerstone of South Korea’s economy. Being one of the nation’s top ten export sectors, the industry has placed second or third in total export value over the past three years (Share of Top Ten Export Items in Total Export Value Over Time, 2025). However, the automobile industry inevitably produces significant CO₂ emissions

5	Direct Emissions	Scope 1	GHG emissions occurring directly from sources owned or controlled by the reporting company
	Indirect Emissions	Scope 2	GHG emissions resulting from the generation of purchased electricity, steam, heating, and cooling consumed by the reporting company
		Scope 3	GHG emissions occurring from sources not owned or controlled by the reporting company but generated as an indirect result of the reporting company’s activity throughout its value chain

(A Guide to Measuring Scope 3 GHG Emissions for Working-Level People, 2023, p.12)

6 DIRECTIVE (EU) 2022/2464 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL 2022

7 Navigating mandatory Scope 3 emissions reporting in the EU, US, and beyond 2024

across all stages of its lifecycle – from production to logistics and beyond. This is largely due to the automotive industry’s exceptionally multilayered and complex supply chains, which are far more intricate than those of most other sectors. A typical vehicle production value chain involves up to 729 primary component suppliers. As a result, the automotive sector is the country’s second-largest GHG emitter, following the food industry. Notably, its Scope 3 emissions—those arising from indirect activities such as raw material procurement, product use, and transport—are on average 4.6 times higher than the combined total of its Scope 1 and Scope 2 emissions (GWON Eun-jung, 2023). A significant portion of these emissions occurs during the vehicle use phase (up to 80%) and the procurement of raw material and component make up a significant share.

In this context, improving performance across environmental, social, and governance (ESG) criteria throughout the entire automotive supply chain is no longer just a matter of regulatory compliance. It has become a strategic imperative – a key driver of competitiveness in global markets—prompting automakers to accelerate their decarbonization efforts and emissions reduction strategies.⁸

According to recent editions of the *Auto Supply Chain Leaderboard* by Lead the Charge, which evaluates the ESG performance across global automotive supply chains, many European automakers occupy top ranks in terms of the “sustainable supply chain” scores. However, U.S. manufacturers scored higher on average in the latest assessments. According to the third edition of the annual report, published in February 2025, Hyundai Motor ranked tenth among 18 manufacturers, inching up by one rank from the previous year, and Kia advanced from 14th to 12th place (Hyundai Motor & Kia Rank 10th and 12th Respectively on Climate & Human Rights Scorecard ... “To Better Compete, Decarbonize Hyundai Steel,” 2025).

The MOTIE and the MOF are collaborating with the automobile and maritime shipping industries in an attempt to maximize the international competitiveness of South Korea’s car exports.⁹ In this context, Green shipping corridor initiatives are highly

⁸ As the need to mandate and standardize ESG information disclosure continues to grow, different sets of corporate sustainability reporting standards are increasingly converging around three major frameworks: 1) the EU EFRAG’s European Sustainability Reporting Standards (ESRS); 2) the US Securities and Exchange Commission (SEC)’s climate-related disclosure requirements; and 3) ISSB disclosure standards under the IFRS Foundation. Of course, discrepancies do exist across these frameworks: while the ESRS mandates that companies calculate and disclose Scope 3 emissions based on a materiality assessment, the ISSB explicitly allows companies to include Scope 3 emissions in their total GHG emissions calculation. (*A Guide to Calculating Scope 3 Emissions for the Secondary Battery Industry*. 2024, p.8)

⁹ An MOU was executed to pave the way for more reliable and efficient long-term support for export logistics by addressing shortages of ships and containers and by expanding technical cooperation, among other measures (Automobile & Shipping Industries Actively Cooperate on Car Export Logistics, 2023).

likely to play an integral role in boosting this competitiveness as a pivotal component in decarbonizing the auto export supply chain.

Among the various segments of transportation, pure car and truck carriers (PCTCs) represent a critical lever for reducing Scope 3 emissions in the automotive sector. While PCTCs account for a relatively small share of the shipping industry's overall GHG emissions, they are particularly significant due to their operation on regular liner routes, similar to container vessels. Prominent shipping lines operating through the Port of Pyeongtaek have therefore established their own net-zero goals and are implementing decarbonization strategies to tackle Scope 3 emissions. Listed below are the target years for net-zero achievements among major Ro-Ro shipping companies:

- **Hyundai Glovis:** 2045¹⁰
- **Wallenius Wilhelmsen (WW) and EUKOR Car Carriers:** 2040¹¹
- **The Nippon Yusen Kabushiki Kaisha (NYK):** 2050¹²
- **Mitsui O.S.K. Lines (MOL):** 2050¹³

By proactively setting these targets, these companies are laying the groundwork for private-sector-led green corridor initiatives, underscoring the shipping sector's vital role in advancing low-carbon automotive logistics on a global scale.

2.2. Data Analysis Methodology

This study analyzed Automatic Identification System (AIS) data to assess carbon emissions along PCTC routes connecting the Port of Pyeongtaek with leading European ports—Bremerhaven, Antwerp, Zeebrugge, and Southampton—from 2021 to 2023.

In 2002, it became mandatory for newly commissioned vessels over 300 gross tonnages (GT) to be equipped with AIS receivers. The system enables real-time tracking and analysis of vessel movements, aiming particularly to help manage port traffic and prevent collisions and other types of incidents (KIM Byeong-Ok et al. Marh 2016).

¹⁰ NET ZERO Special Report, 2023

¹¹ Fueling a decarbonized future: the new energies taking us towards net-zero 2040, 2024

¹² NYK Group Environmental Vision and Policy, 2023

¹³ Aiming at Net Zero GHG Emissions by 2050 - Introducing "MOL Group Environmental Vision 2.1" 2021

Widely recognized and adopted by both the International Maritime Organization (IMO) and the European Commission (EC), the AIS platform allows for monitoring and verifying vessel entries into canals, countries, ports, terminals, anchorages, and other key maritime zones.¹⁴

AIS data are collected in varying time units and cycles, from minutes to hours, depending on the transmission mode and location. These data comprise the following main information (SFOC 2024, p10):

- **Static information:** Information that hardly changes, such as the dimensions of the ship
- **Voyage-related information:** Information related to the ship's voyage, such as the destination and data transmitted at specific points in time, including the expected time of arrival
- **Dynamic information:** Real-time positional data, including its current latitude and longitude, transmission time, and operational status.

This report utilizes AIS-based datasets from Marine Benchmark to analyze the PCTC routes directly connecting Pyeongtaek Port with major European ports. Comparative analyses are conducted for two directions—from Pyeongtaek to Europe and vice versa—over the three years of 2021, 2022, and 2023, focusing on port-to-port voyage distances and vessel information and other key indicators. The report also explores route-specific operational patterns between ports (e.g., Pyeongtaek-Bremerhaven).

This report employs the FuelEU Maritime¹⁵ standards because any South Korea-Europe green shipping corridor, if established, will inevitably be directly influenced by the EU's regulatory framework. The analysis uses data from the past three years to capture the latest trends and shifts in operational patterns post-COVID-19.

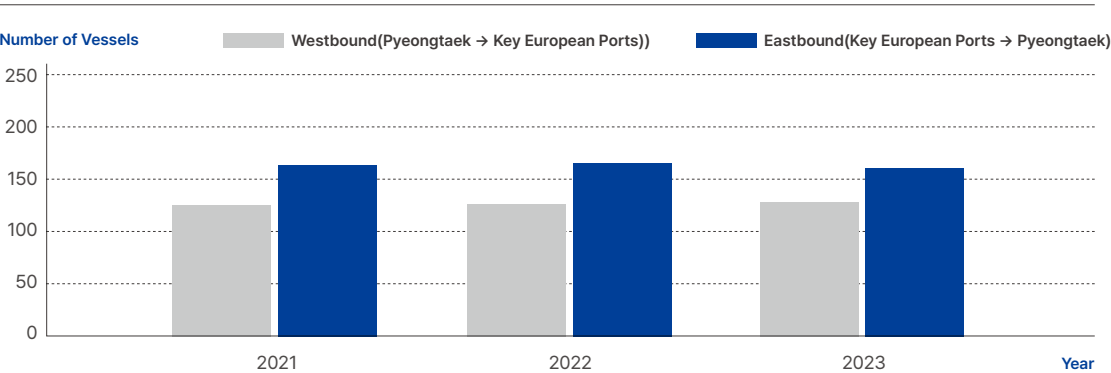
¹⁴ The IMO used the system during the latest MEPC 82 session for its Comprehensive Impact Assessment of member states; while the EC applied the system to evaluate the expansion of the EU Emissions Trading System (EU ETS) to include a wider range of vessel sizes.

¹⁵ In an effort to reduce GHG emissions, the European Commission (EC) announced a comprehensive package of legislative proposals and policy initiatives in July 2021, named "EU Fit for 55." A key component of this package, FuelEU Maritime, targets international shipping. This legislative proposal aims to promote the use of low-carbon fuels by vessels operating in and calling at ports within the EU and the European Economic Area (EEA) and applies a Well-to-Wake (WTW) approach to account for greenhouse gas emissions from fuel use. Unlike Tank-to-Wake (TTW) emissions, which count only emissions from fuel combustion onboard a vessel or vehicle, Well-to-Tank (WTT) emissions encompass emissions from fuel extraction, production, refining, transportation, and distribution, but not from combustion.

3. Expected Reductions in CO₂ Emissions

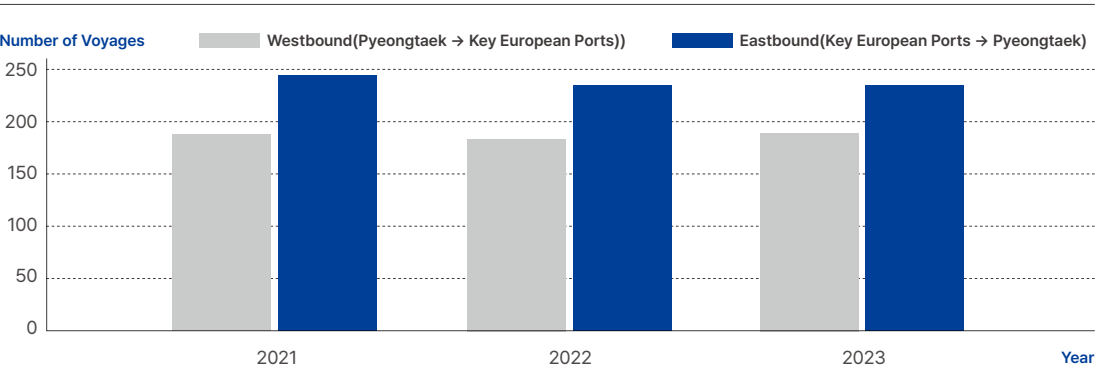
3.1. Automotive Shipping Trends: Export and Import Corridors

[Graph 1] Number of Vessels by Route (2021-2023)



An analysis of PCTC operations between Pyeongtaek Port and major European ports over the three-year period from 2021 to 2023 shows a stable and slightly increasing trend, with an annual average of approximately 286 voyages. On the westbound route (Pyeongtaek → Europe), outbound voyages increased steadily from 124 in 2021 to 125 in 2022 and 127 in 2023. On the eastbound route (Europe → Pyeongtaek), the number of inbound voyages remained stable at 162 in 2021, 164 in 2022, and 159 in 2023.

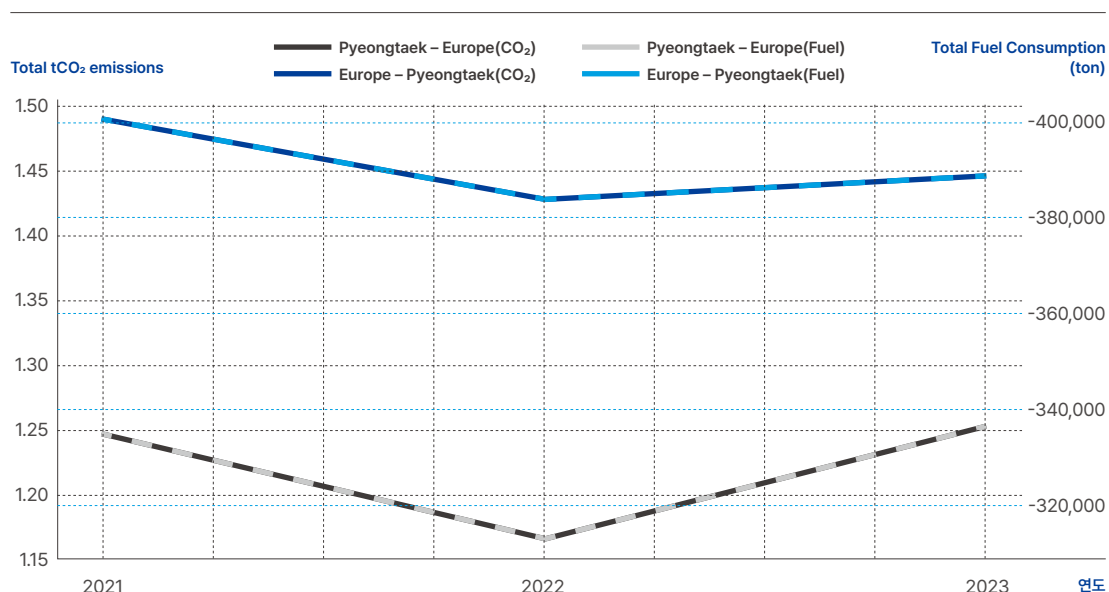
[Graph 2] Number of Voyages by Route (2021-2023)



Adding voyage counts to the vessel numbers provides a clearer picture of overall operational patterns. The annual number of voyages on the westbound export routes remained within a narrow range—188 in 2021, 183 in 2022, and 190 in 2023—maintaining a stable average of 187 voyages annually. The eastbound import routes recorded consistently higher voyage counts, with 245 voyages in 2021, 237 in 2022, and 235 in 2023, leading to an average of 239 voyages per year.

Overall, voyage volumes remained consistent in 2023, or increased slightly compared to previous years. This indicates a stable flow of automotive cargo between Pyeongtaek and Europe, with gradual growth potential. However, the year-to-year variation in westbound exports signals some volatility in outbound demand, which could reflect broader shifts in European market dynamics or supply chain strategies among Korean automakers.

[Graph 3] Total CO₂ Emissions and Fuel Used (2021-2023)



Changes in voyage traffic are directly linked to fuel consumption and carbon dioxide (CO₂) emissions. The higher the voyage counts, the greater the fuel consumption and associated CO₂ emissions. This underscores the importance of factoring in cargo volume characteristics when devising an emissions reduction strategy for a green shipping corridor.

In 2021, the eastbound import routes emitted approximately 1,489,915 metric tons of CO₂, about 19.5 percent higher than the 1,246,708 metric tons emitted by the westbound export routes. Emissions edged down on both routes in the following year, only to rebound in 2023, reaching 1,253,166 metric tons for exports and 1,447,594 metric tons for imports.

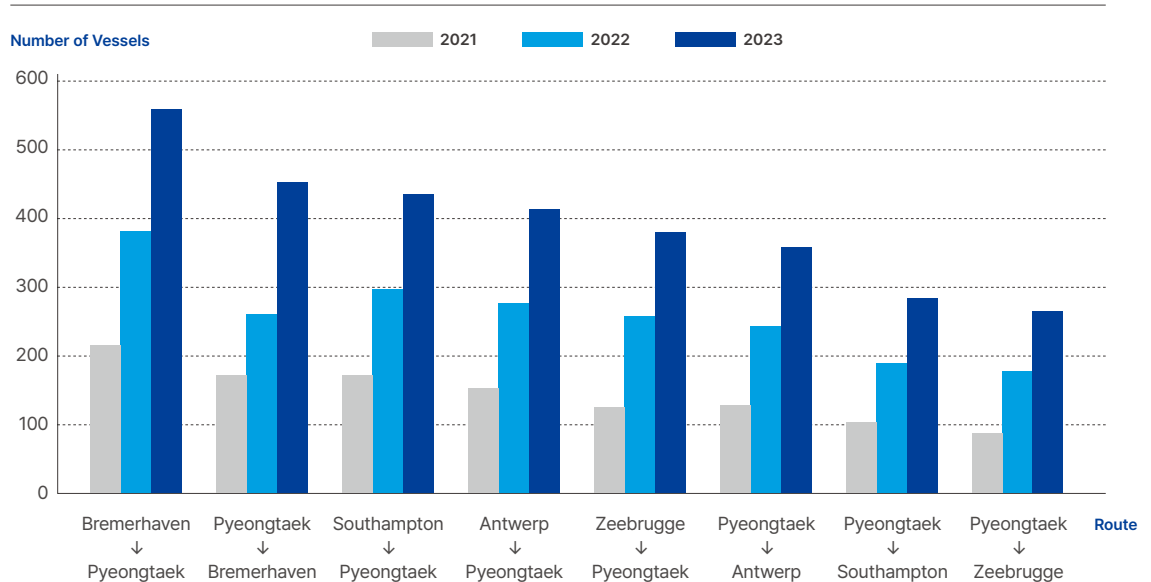
[Table 2] Total CO₂ Emissions from Export and Import Routes

Total CO₂ Emissions (tCO₂)

Route	Year	Total CO ₂ Emissions
Export (Pyeongtaek → Key European Ports)	2021	1,246,708.419
	2022	1,165,679.315
	2023	1,253,166.123
Eastbound (Key European Ports → Pyeongtaek)	2021	1,489,915.159
	2022	1,428,304.284
	2023	1,447,594.472

3.2. CO₂ Emissions on Pyeongtaek – Europe Shipping Routes

[Graph 4] Number of Voyages by Port-to-Port Route (2021-2023)



This report assesses the potential carbon reduction benefits of establishing a future green shipping corridor based on an analysis of PCTC operations and CO₂ emissions between Pyeongtaek Port and major European ports over the three-year period from 2021 to 2023.

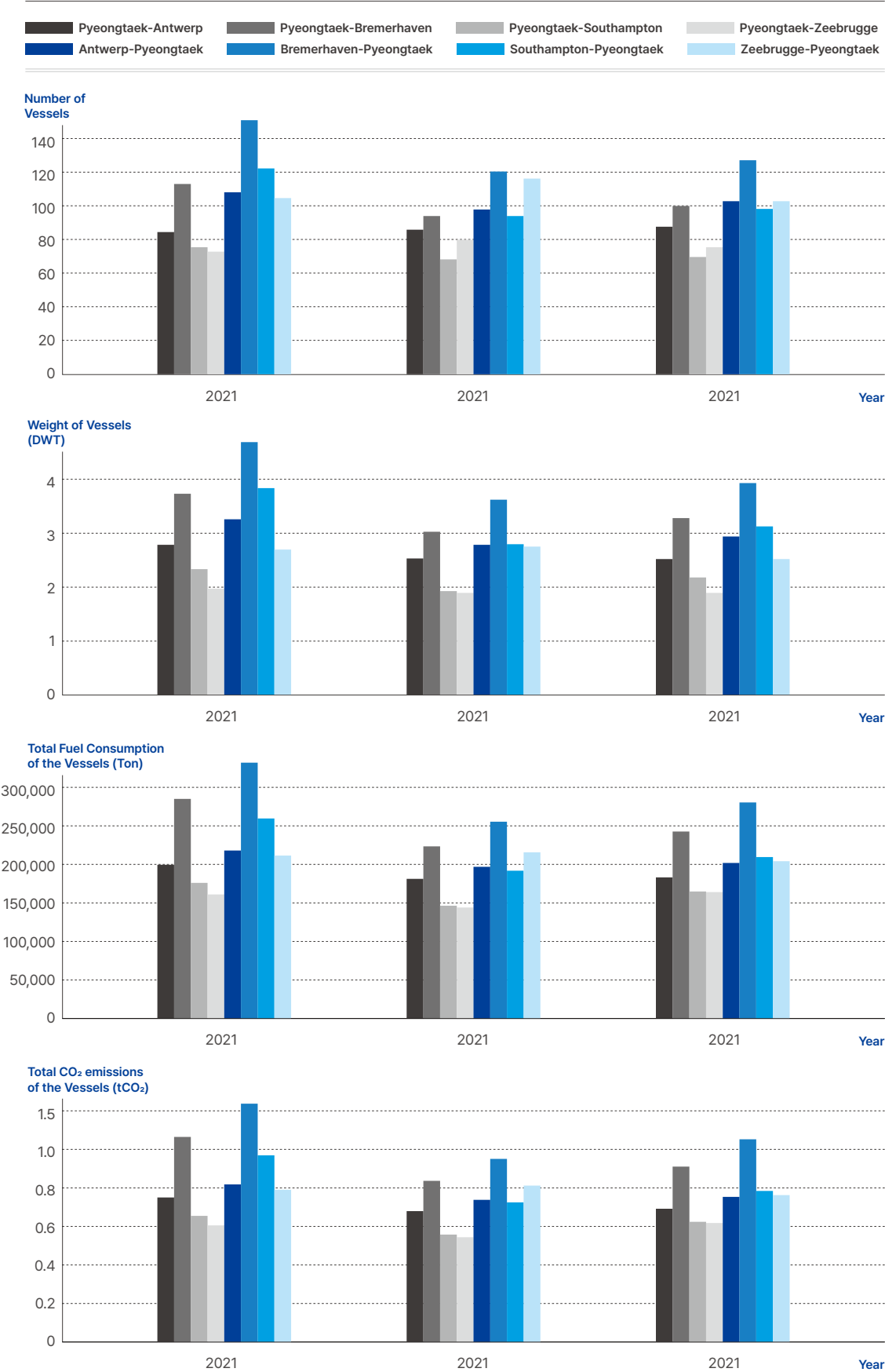
The findings show that the route connecting Pyeongtaek and Bremerhaven recorded the highest voyage frequency, highlighting it as a top-priority target for emission reduction strategies. A total of 1,006 direct voyages were made along this corridor, including 557 import voyages and 449 export voyages, underscoring Bremerhaven’s role as the busiest automobile cargo gateway among all the routes analyzed.

[Table 3] Number of Voyages

Year	Bremerhaven → Pyeongtaek	Pyeongtaek → Bremerhaven
2021	214	168
2022	166	135
2023	177	146
Total	557	449

Eastbound import routes from major European ports to Pyeongtaek are also conspicuous, including Southampton to Pyeongtaek (433 voyages), Antwerp to Pyeongtaek (412 voyages), and Zeebrugge to Pyeongtaek (377 voyages).

[Graph 5] Key Information on Shipping Routes between Pyeongtaek Port and Major European Ports



Due to the frequency of voyages, the Bremerhaven–Pyeongtaek route recorded the highest CO₂ emissions among the analyzed routes. On the export leg (Pyeongtaek → Bremerhaven), annual average emissions reached approximately 930,000 tons of CO₂, while the import leg (Bremerhaven → Pyeongtaek) emitted around 1.08 million tons annually. Combined, this route alone accounts for over 2 million tons of CO₂ emissions per year.

Overall, CO₂ emissions on import routes are around 15 to 20 percent higher than those from export routes. This discrepancy may be attributed to vessel loading conditions, sailing environments, and average speeds. Therefore, strategies to improve fuel efficiency and adopt slow steaming should be prioritized before implementing a green shipping corridor on inbound routes.

[Table 4] Well-to-Well (WTW) CO₂ Emissions by Port-to-Port Route

Export Route CO ₂ Emissions (in metric tons)		2021	2022	2023
Pyeongtaek ↓ Key European Ports	Bremerhaven	1,059,786	832,949	907,462
	Antwerp	746,550	674,308	684,690
	Southampton	652,113	546,131	615,837
	Zeebrugge	598,955	540,494	614,134
Import Route CO ₂ Emissions (in metric tons)		2021	2022	2023
Key European Ports ↓ Pyeongtaek	Bremerhaven	1,230,342	949,805	1,049,379
	Antwerp	812,201	733,497	749,637
	Southampton	964,407	718,316	782,575
	Zeebrugge	785,135	805,839	762,553

The CO₂ emissions analyzed in this study are based entirely on operations using conventional fossil fuels, primarily heavy fuel oil (HFO). If low-emission non-fossil fuel such as green methanol was introduced on these routes, a greenhouse gas (GHG) reduction of approximately 70% could be achieved on a well-to-wake basis (EU, 2023). For instance, if e-methanol were fully adopted on the Bremerhaven–Pyeongtaek route, it is projected that approximately 1.4 million tons of CO₂ emissions—70% of the current 2 million tons annually—could be reduced.

This illustrates that even a single route has the potential to reduce GHG emissions by several million tons per year, strongly reinforcing the need to prioritize this route for green shipping corridor implementation and fuel transition.

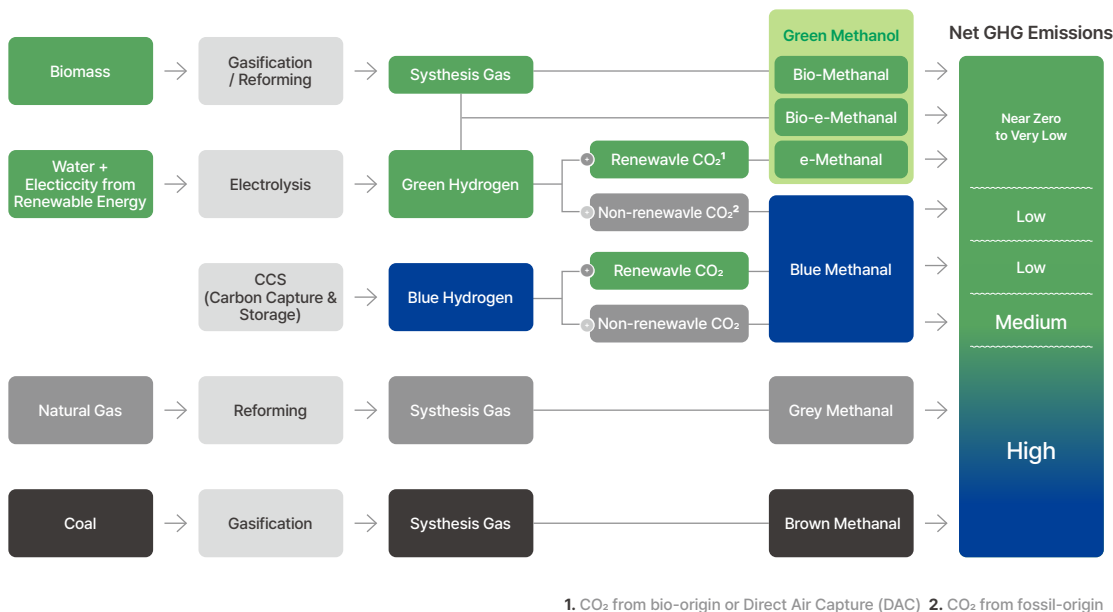
4. Recommendations for a South Korea-Europe Green Shipping Corridor

4.1. Adoption of Green Methanol as the Primary Alternative Fuel

An analysis of plausible 2050 carbon neutrality pathways for South Korea's shipping industry suggests that the more ambitious the greenhouse gas reduction targets requires faster departure from LNG—a fossil fuel—towards low/zero emission non-fossil fuels—such as methanol, hydrogen, and ammonia (SFOC, 2024, p.16). Among these, methanol is currently the most widely considered alternative fuel in the development of global green shipping corridors (2025 Action Plans for the Greenship-K Promotion Strategy, 2025, p.6).

[Figure 2] Color Codes of Methanol by Production Method

Professor Youngsub Lim, Naval Architecture and Ocean Engineering, Seoul National University



Source: Korean Register (2023), reorganized by SFOC

The carbon intensity of methanol varies widely depending on how it is produced. Brown and gray methanol, derived from fossil fuels, emit more greenhouse gases than conventional marine fuels, with a carbon intensity of 100.4 g CO₂eq/MJ. In stark contrast, green methanol generates nearly zero carbon emissions. This environment-friendly methanol is further classified into two types, as shown below (Youngsub Lim, 2023, p.13):

- **Bio-methanol:** Produced from biomass, which absorbs carbon dioxide during its growth
- **E-methanol:** Synthesized by combining green hydrogen, generated via water electrolysis powered by renewable energy, with carbon dioxide sourced either through direct air capture (DAC) or from biogenic origins

Green methanol not only poses lower environmental risks than fossil fuels such as liquefied natural gas (LNG). It also offers practical advantages as a promising transitional fuel. Being in liquid form, it allows for the use of existing fuel storage facilities and bunkering systems with minimal modifications. In addition, the commercial availability of methanol engines makes its immediate adoption feasible.

A policy foundation is gradually taking shape in South Korea as well for the adoption of green methanol. In 2023, the Port of Ulsan successfully carried out ship-to-ship (STS) methanol bunkering for a 16,200 TEU methanol dual-fuel container carrier—the world's first of this kind on such a scale (World's First STS Methanol Bunkering for Ultra-Large Container Carrier at Ulsan Port, 2023). Building on this milestone, the South Korean government plans to introduce green methanol on the Busan-Tacoma Green Shipping Corridor, which will see pilot operations starting in 2027 (Challenges to Tackle for the Busan-Tacoma Green Corridor, 2024).

Amid this flux of change, this report recommends the adoption of green methanol as the primary fuel for the Pyeongtaek-Europe green shipping corridor discussed herein.

4.1.1. Current Status and Outlook of Green Methanol

Globally, the number of methanol-powered vessel orders is rapidly increasing, with a total of 361 ships ordered to date. While fully cellular container (FCC) ships account for the largest share, adoption is expanding across a broader range of vessel types, including PCTCs. In 2023, South Korea's largest container shipping company, HMM, placed orders for nine methanol-fueled container ships and announced plans to deploy some of them on the Korea-U.S. green shipping corridor (HMM to Launch Nine Methanol-Fueled Container Carriers, 2023). Meanwhile, global PCTC operator Wallenius Wilhelmsen (WW) has ordered 14 Shaper Class methanol dual-fuel vessels, which are scheduled to be gradually deployed from the second half of 2026 through 2028(2024–a hectic, humbling and headstrong year, 2025).

It is anticipated that by 2050, methanol will represent more than 20 percent of marine fuels, with annual demand for approximately 7 million metric tons of this simplest alcohol by 2028 (Presidential Commission on 2050 Carbon Neutrality and Green Growth, May 2023). Clean methanol (hereinafter "green methanol") is emerging as an instrumental alternative fuel in South Korea's efforts to strengthen the competitiveness of its core industries. Given these prospects, securing a stable and reliable methanol supply chain has become essential.

Every year, South Korea consumes roughly 2 million metric tons of methanol, all of which is imported. The Port of Ulsan takes in 60 percent of these imports. The locations and capacities of major industrial methanol storage facilities are as follows (RYU Ji-hun, 2024):

- **Ulsan Port:** 150,000 metric tons
- **Yeosu-Gwangyang Port:** 140,000 metric tons
- **Pyeongtaek Port:** 100,000 metric tons
- **Total storage capacity:** Approx. 390,000 metric tons

In November 2023, the MOF announced its plan to establish ecofriendly marine fuel supply chains, unveiling the South Korean government's intention to build additional storage facilities for green methanol at the mutually adjacent Pyeongtaek Port and Dangjin Port (aka. Pyeongtaek-Dangjin Port) as well as to expand the green methanol bunkering system by leveraging existing storage infrastructure at major ports across the country (2025 Action Plans for the Greenship-K Promotion Strategy, 2025).

The South Korean government, envisioning carbon neutrality by 2050, aims to produce 500,000 metric tons of green methanol by 2030. Taking steps towards these goals, the government emphasizes public-private partnerships and has been pursuing a range of policies to lay the foundation for domestic green methanol production and to foster a supportive industrial ecosystem (Forging Public-Private Partnership to Promote Clean Methanol, 2023). A case in point is Taebaek City's clean energy project, aimed at constructing the country's first commercial methanol production plant. This initiative seeks to transform an abandoned mining area into a green methanol production hub, revitalizing the local economy and advancing the national energy transition.

"The Strategy to Create New Businesses Driven by Clean Methanol" announced by the South Korean government in November 2023 classifies green methanol into two types: e-methanol and bio-methanol. Bio-methanol, as promoted by the government, is derived from biomass and solid waste, among other feedstocks. The initiative includes the biogasification of organic waste and the use of waste wood and underutilized forest resources (Presidential Commission on 2050 Carbon Neutrality and Green Growth, Sept. 2023). High demand is expected for bio-methanol due to its relatively low production cost in the short term. However, ensuring sustainable production and use of bio-methanol will require vigilant management of feedstock sourcing and supply chains. For example, feedstocks such as palm oil, palm byproducts, and woody biomass raise sustainability concerns because their continued use, if not properly managed, can lead to serious land-use changes and deforestation. Use of waste cooking oil (WCO), which is generally regarded as a more sustainable feedstock for biofuel production, requires rigorous verification procedures including due diligence.

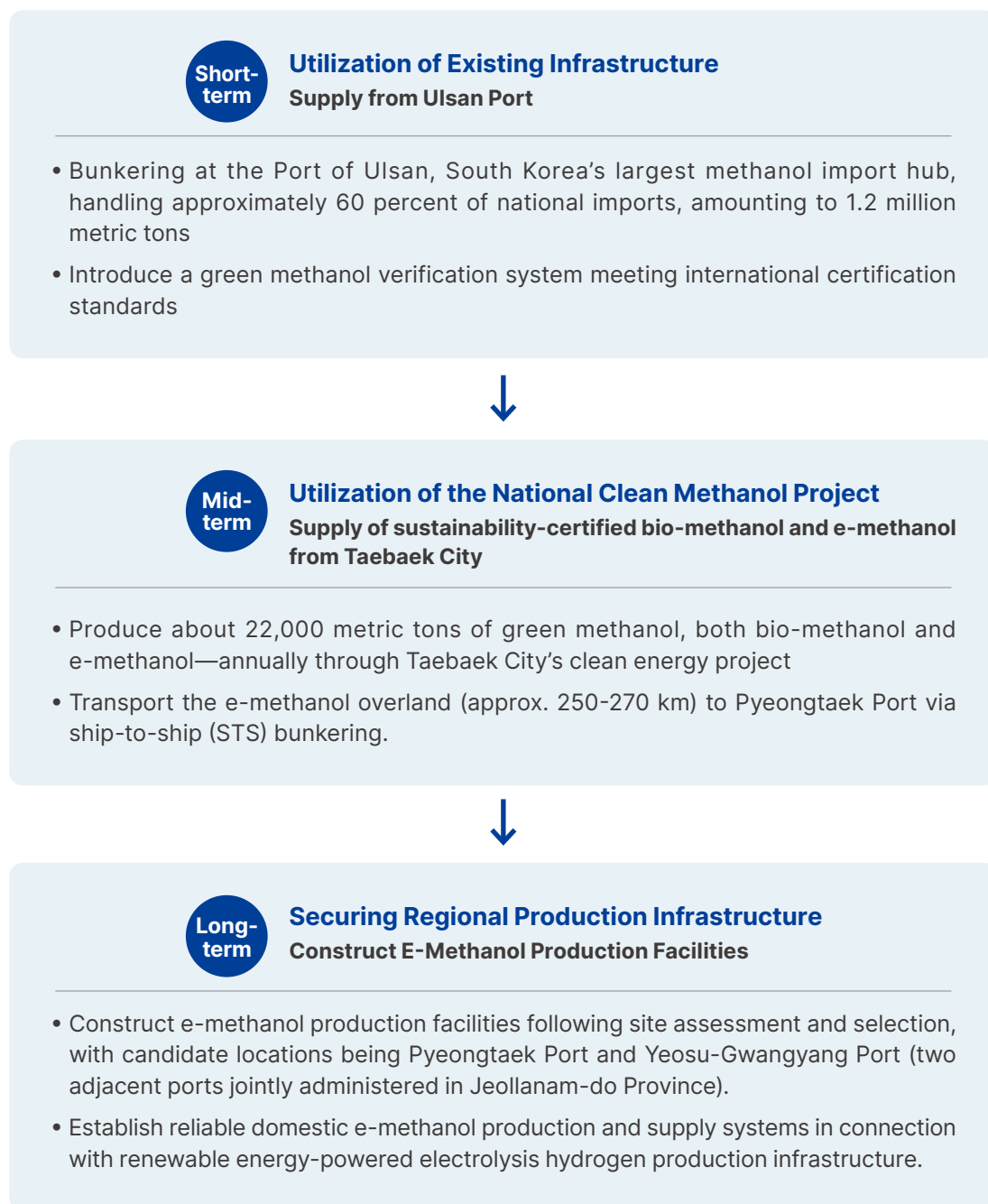
On the other hand, e-methanol—synthesized by combining renewable energy-based green hydrogen and carbon dioxide captured from non-fossil sources—emits virtually no carbon and is thus considered a promising alternative fuel. The towering hurdle of its high production cost is likely to be overcome by technological advances and the scaling up of production, leading to increased price competitiveness over time. Therefore, it is essential to employ a dual strategy across the time horizon: relying on bio-methanol to meet immediate needs while laying the groundwork for a smooth transition to e-methanol by developing domestic production capabilities and building reliable supply chains for the more distant future.

Major overseas ports are also expanding their eco-friendly fuel infrastructure. The

Port of Singapore—a significant stopover for ships—and the Port of Rotterdam—a major European maritime gateway—have already undertaken the development of green fuel bunkering infrastructure, positioning themselves as highly viable candidates for transshipment hubs along a Pyeongtaek-Europe green shipping corridor. Even though the Port of Rotterdam falls outside the primary scope of this study due to its lack of a direct route to Pyeongtaek, the opportunity for future collaboration remains open, especially for establishing a green bunkering network.

4.1.2. Supply Planning Guidelines

This report proposes a three-phase supply strategy—short-, mid-, and long-term—to ensure reliable green methanol supply for a Pyeongtaek-Europe green shipping corridor as follows:



4.2. Policy Support for Public-Private Partnership

The Sweden-Belgium Green Shipping Corridor Project, originally intended to link Sweden's Port of Gothenburg and Belgium's North Sea Port, vividly illustrates the practical challenges that green shipping corridor initiatives encounter. This project, geared at Ro-Ro ambition, was initially launched through collaboration between the port authorities and the shipping company DFDS, but it remained stalled for a while due to significant cost disparities between green and conventional fuels, unstable fuel supply chains, and insufficient government financial support.

Moreover, according to Clarksons, LNG dual-fuel ships accounted for 70 percent of the 810 eco-friendly vessels on order globally in 2024, while the share of methanol dual-fuel ships remained at a mere 14 percent (KIM Hyeong-gyu, 2025). This disheartening disparity reflects the high market entry barriers fortified by the continued low economic affordability of non-fossil fuel-driven vessels—a telling indicator of how critical early market formation is to practical pursuit of green shipping corridors.

It is more costly to adopt and operate eco-friendly fuels than their conventional fossil-derived counterparts, and this lack of economic viability makes it difficult to expect voluntary investment from the private sector without the backing of government subsidies, tax incentives, and infrastructure support. Transitioning to alternative fuels cannot take place overnight; it is a long-term endeavor. It must be underpinned by proactive and consistent policy support—the kind of policy support that goes beyond mere financial assistance but serves as a strategic catalyst for facilitating market formation and activating the broader industrial ecosystem.

The fragility of this landscape prompted South Korean lawmakers to introduce a groundbreaking bill for the world's first special legislation on green shipping corridors in October 2024 (Assemblyman MOON Dae-lim and 14 others, 2024). The bill aims to establish a legal foundation for the domestic shipping industry to make an eco-friendly transition and strengthen its global competitiveness, based on three key pillars: ① **green vessel transition**,¹⁶ ② **eco-friendly port infrastructure**,¹⁷ and ③ **reliable fuel supply**.

¹⁶ Article 2 (Definitions) The following terms as used in this Act shall be defined as below: 1. The term "Green Ships" shall refer to those ships that are defined in Article 2, Subparagraph 3 of the Act on the Promotion of Development and Distribution of Environment-Friendly Ships, are powered by carbon-free fuels, and are designated by Presidential Decree.

¹⁷ An "ecofriendly port" refers to a port where facilities are powered by renewable energy, that is equipped with bunkering infrastructure to supply ecofriendly fuels to green vessels calling thereat, and that meets other criteria specified by Presidential Decree.

If the bill is enacted later this year (2025) and enforced in 2026, fuel transition investments will be blessed with full-scale support such as subsidies, financial assistance, and tax breaks. These measures will likely bolster public-private collaboration and further build momentum to pursue pertinent projects, potentially accelerating the implementation of green shipping corridors. The enforcement of the special act is expected to directly benefit Korean and foreign vessels running on eco-friendly fuels through fuel subsidies and other forms of support, making the 2027-2028 window an optimal period for launching a Pyeongtaek-Europe green shipping corridor on a pilot basis. By riding on the currents of fuel transition in the global shipping market and capitalizing on the current policy momentum, South Korea could position itself as a frontrunner in the development of green shipping corridors.

4.2.1. Key Stakeholders in Corridor Development

The enforcement of the special act on green shipping corridors alone will not automatically invigorate the market. It may create institutional vehicles—such as fuel subsidies and support for green shipbuilding—but these mechanisms will not yield substantive change unless the private sector takes the lead and commits to meaningful investment. Under a well-defined cooperation framework, roles must be systematically assigned among key stakeholders—including shipping lines, fuel suppliers, financial institutions, and cargo owners.

To take a comprehensive approach across the entire maritime ecosystem, the roles of key stakeholders can be organized around four strategic pillars: ① Policy, ② Technology, ③ Operations, and ④ Finance.

It is essential to establish a well-defined collaboration framework in which the public and private sectors clearly understand their respective roles and work together in an integrated, coordinated manner. This structure should interlink the key elements of agreements, investment, and operation, encompassing the four building blocks of a generic maritime value chain: cargo, ships, ports, and fuel (UMAS, May 2025). To that end, the roles of the primary actors may be organized around the aforementioned four strategic pillars as below:

[Figure 3] Stakeholder Collaboration Framework for the Green Shipping Corridor



The Global Ro-Ro Community (GRC) illustrates how private sector-driven collaboration can function effectively. Launched as a cooperative platform among major PCTC/Ro-Ro deep-sea operators and classification societies under the leadership of the Smart Freight Centre (SFC), GRC aims to facilitate the decarbonization of Ro-Ro vessels and establish global standards for GHG emissions accounting for such vessels. GRC provides guidelines on GHG emissions measurement in an effort to catalyze cooperation between shipping companies and cargo owners, thereby strengthening private-led collaboration and fostering trust-based, sustainable partnerships. The initiative brings together not only Ro-Ro shipping companies, but also cargo owners (original equipment manufacturers, or OEMs) and verification bodies, serving as a model for broader private-sector participation. This approach suggests the potential to build an open, scalable ecosystem where transition to eco-friendly vessels and fuels is not limited to a handful of companies, but open to broader industry participation.

When policy support meets with private-sector leadership, technology development and commercialization accelerate, and a more open, collaborative ecosystem begins to take shape—creating an environment where more companies can participate over time. In the early stages, the proactive role of shipping companies matters, but over the long run, the participation of cargo owners and the creation of demand become important in achieving market stability and sustainability. Only when cargo owners are willing to pay for eco-friendly shipping can green shipping corridors be firmly established as a substantive pathway for transition.

4.2.2. Implementation Roadmap for Green Shipping Corridor

For a green shipping corridor to materialize, it must first be conceived with clear, phased objectives and targets, alongside actionable implementation strategies. This report proposes the following model roadmap—beginning with the deployment of green methanol-propelled vessels and progressing towards increasing fleets of zero-carbon ships beyond 2030:

Short Term

(2025~2030): Introduction of Green Methanol-Fueled Vessels

Timeline	Key Milestone
D + 6 to 9 months	• Discussion among stakeholders (shipping lines, ports, fuel suppliers, cargo owners, etc.)
D + 12 months	• Execute an MOU and form a consultation body • Discuss shipping schedules and the scope of port participation
D + 18 months	• Negotiate vessel deployment scale, port call frequencies, fuel demand, and pricing terms
D + 24 to 30 months	• Launch voyage of green methanol-powered vessels

→ **Contribute to compliance with the IMO 2030 target**
(30 percent reduction in CO₂ emissions)

Longer Term

(2030~2040): Expansion of Low- and Zero-Emission Non-Fossil Fuel Vessels & Market Ecosystem Development

Strengthen policy implementation capacity led by the government

- More investment in port infrastructure
- Institutionalization of fuel subsidies and financial support

Stabilize fuel supply chains

- Expansion of domestic production capabilities
- Linking of bunkering infrastructure with major overseas ports of call (e.g., Singapore, Rotterdam)

→ **Operation of more zero-emission non-fossil fuel vessels and achievement of the IMO 2040 target**
(80 percent reduction in CO₂ emissions)

5. Conclusion

In this report, we analyzed the necessity and feasibility of establishing a green shipping corridor between Pyeongtaek Port and major European ports and proposed implementation timeline, on the assumption of adopting green methanol and robust public-private cooperation. A green shipping corridor focused on PCTCs can offer a practical solution by broadening the current container ship-focused discourse and spurring the eco-friendly transition across a wider range of vessel types.

As key strategies, we underscored the introduction of a green methanol-driven, low-emission non-fossil fuel operational model and the establishment of reliable fuel supply chains. We also emphasized the need for strong policy support, increased financial investment, and reinforced public-private cooperation to ensure the successful implementation of these strategies.

The conditions for the successful operation of a green shipping corridor include the creation of a sustainable maritime ecosystem built on seamless collaboration among shipping companies, cargo owners, ports, and fuel suppliers. The government must take the lead in shaping the market at the early stages by offering financial and regulatory incentives, while the private sector needs to drive substantive transition through technological investment and demand generation.

A Pyeongtaek-Europe green shipping corridor will open a new strategic window of opportunity for enhancing the sustainability of South Korea's automobile industry and, more broadly, serve as a springboard for the nation to take a leading role in transitioning and decarbonizing the global maritime industry. These aspirations may turn out to be well within reach if the government and the industry work in close coordination and secure strong implementation capacity with full-throttle operations targeted for launch between 2027 and 2028.

Future green shipping corridor initiatives must evolve beyond a sole focus on CO₂ emissions reduction to consider safety and a just transition. These additional efforts will require a sustainable implementation framework that provides education and training programs, while also strengthening institutional and regulatory foundations.

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