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Report

Achieving Net Zero in International Shipping through Korea-US-Japan Green Shipping Corridor

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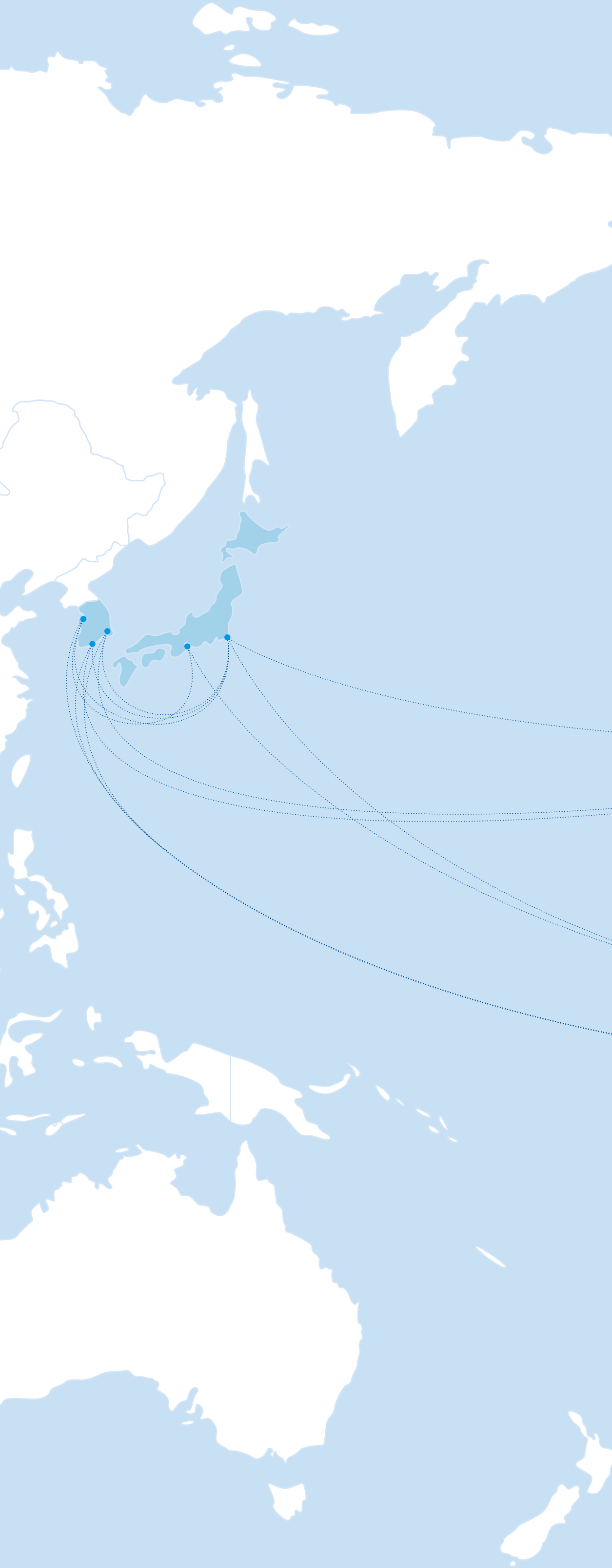
Executive Summary

With the advent of the climate crisis, the International Maritime Organization and developed countries are implementing trade policies, regulations, and carbon taxes in earnest to reduce greenhouse gas (GHG) emissions from the shipping sector. As South Korea tries to cope with the upcoming regulation for GHG emissions from ships, it is crucial to form green shipping corridor that could accelerate the green transition of ports and deployment of green fuels. In particular, the establishment of green shipping corridors between the three countries of South Korea, the United States, and Japan, which have a significant amount of mutual maritime traffic, is an opportunity for South Korea to not only actively reduce GHG emissions from international shipping, but also to consolidate the position as the key player in the future shipping industry.

Currently, there is international consensus that green shipping corridors include port decarbonization and transition to low- and zero-carbon fuels, but there are a range of perspectives on mitigation approaches and regulations. Green shipping corridor in this report is about the fundamental reductions leading to zero emissions, rather than offsetting mechanisms and shifting away from the existing fossil fuel-based structure and analyzes the effects of building the corridor based on this perspective.

We evaluated the anticipated impact of several proposed Korea-United States-Japan green shipping corridors involving ports of Busan (KRPUS), Incheon (KRINC), and Gwangyang (KRKAN) — South Korea's three major container ports. Each of the three South Korean ports will have the most significant environmental impact if connected to ports of Tokyo (JPTYO)/Yokohama (JPYOK) in Japan and ports of Los Angeles (USLAX)/Long Beach (USLGB) in the United States. If container ships that travel KRPUS – JPTYO/ JPYOK and KRPUS – USLAX/USLGB are converted to zero emission ships, we can expect significant reduction in global carbon dioxide emissions, approximately 20.7 million tCO_2 and 20.6 million tCO_2, respectively. Accordingly, reducing GHG emissions in the global maritime shipping will require coordinated multilateral commitments and actions.



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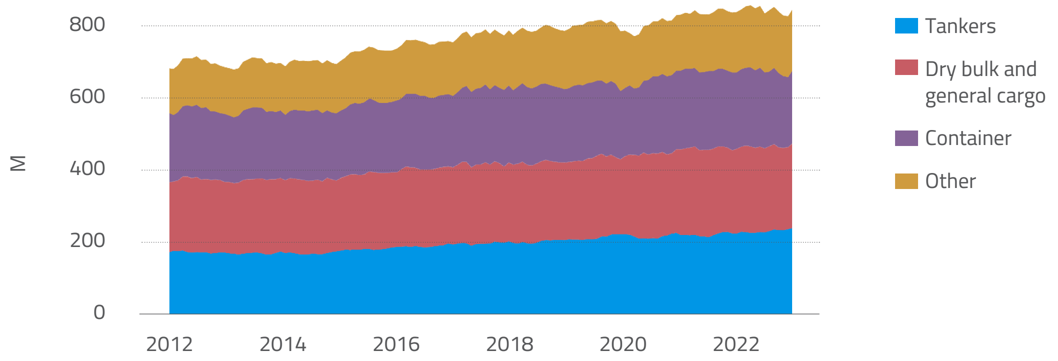
1. Background

Global maritime shipping contributes approximately three percent to worldwide greenhouse gas emissions (GHG), marking a 20-percent rise in the last decade. Without significant efforts for reduction, these emissions are expected to surge to 130 percent, compared to 2008 by 2050 (UNCTAD, 2023). South Korea is also a significant player in this industry and contributor to the global shipping emissions. South Korea owns the world's eighth-largest merchant fleet, and it saw an approximately 15-percent rise in emissions from 2012 to 2022 (UNCTAD, 2023).

[Figure 1] Carbon Dioxide Emissions by Main Vessel Types, tons, 2012-2023



Note: The group 'other' includes vehicles and roll-on/roll-off ships, passenger ships, offshore ships and service and miscellaneous ships.
Source: UNCTAD(2023), Review of Maritime Transport (2023)

[Figure 2] Carbon Dioxide Emissions by Top 10 Countries, 2012-2022

	Country	2012	2022
1	China	43,493,613	102,317,721
2	Japan	99,628,524	101,254,900
3	Greece	69,330,862	95,968,419
4	United States of America	43,859,245	45,656,717
5	China, Hong Kong SAR	18,822,466	39,060,933
6	Germany	86,588,074	37,040,384
7	Singapore	19,806,355	32,522,147
8	Korea, Republic of	24,324,282	28,736,060
9	Denmark	23,473,417	28,007,662
10	Norway	25,748,700	26,496,768

Note: Carbon dioxide emissions from vessels' main and auxiliary engines, calculated based on bunker fuel from the Automatic Identification System
Source: UNCTAD based on data provided by Marine Benchmark, June 2023.

In a landmark announcement on July 7, 2023, of the 80th Marine Environment Protection Committee (MEPC 80), the International Maritime Organization (IMO) committed to a net-zero target for international shipping by 2050. This decision overhauled the IMO's 2018 strategy, which had proposed a 50-percent reduction by 2050 from 2008 levels. With the revised plan, the IMO announced *indicative checkpoints*, aiming at a reduction of 20 percent, and striving for 30 percent by 2030 and a reduction of 70 percent and striving for 80 percent by 2040 in GHG emissions (IMO, 2023).

Due to the nature of shipping, decarbonization of international shipping not only hinges on the IMO's interventions but robust global cooperation is necessary. Europe and the United States (US) are tightening GHG regulations in maritime shipping. The European Commission, for instance, introduced the *FuelEU Maritime* initiative in July 2021. This regulation, dedicated to curbing GHGs from maritime transport, will take effect in 2025. The new legislation ambitiously aims for a reduction of two percent by 2025, 20 percent by 2035, and 80 percent by 2050, relative to 2020 emission levels. Furthermore, starting in 2030, a new mandate will require container and passenger ships to utilize alternative marine power (also known as on-shore power) systems, which are shore-based power supply systems.

In the US, two bills, the *Clean Shipping Act and the International Maritime Pollution Accountability Act* were proposed in May 2023 to curb the GHG emissions in shipping. The first bill will mandate the US Environmental Protection Agency to enforce ship fuel regulations targeting net-zero emissions by 2040, with reduction milestones of 20 percent by 2027, 45 percent by 2030, and 80 percent by 2035, relative to 2024 levels. The second bill proposes imposition of a pollution fee of US$150 per metric ton of carbon on foreign ships exceeding tonnage of 10,000 metric tons.

In February 2023, South Korea proactively declared to meet net zero by 2050 in international shipping. *Strategy for International Shipping Decarbonization* was announced aiming at alignment with global carbon neutrality goals to remain competitive in maritime shipping (Kim, 2023). The Ministry of Oceans and Fisheries (MOF) unveiled a strategy to transform ships owned by national carriers into eco-friendly fuel vessels[1]. This move was aimed at facilitating the country's compliance with anticipated IMO revised GHG Strategy and fortifying the Korean shipping industry's competitiveness in 2050. It involved the conversion of 867 ocean-going ships of 5,000 metric tons or more (which are subject to international regulation by the IMO) into sustainable fuel ships when they are too old to function as originally intended and need to be replaced. Furthermore, in order to meet EU's application of EU Emission Trading System to the ships that are subject to EU MRV (Regulation (EU) 2015/757), the MOF also announced plan to first convert 60 percent of the country's regular shipping fleets operating in Europe and the Americas into eco-friendly vessels by 2030. This project is part of an initiative that encompasses the green transformation of a total of 118 ships.

Due to South Korea's reliance on maritime industry for 99.5% of its trade and the need to comply with other region's GHG reduction measures, it must proactively reduce GHG emissions of its shipping fleet. In this

1 The Act on *Promotion of Development and Distribution of Environment-Friendly Ships* (hereinafter the "*Eco-Friendly Ship Act*") encompasses the use of LNG, a type of fossil fuel, in the definition of "eco-friendly." However, IMO, in its 2023 Strategy on Reduction of GHG Emissions from Ships, indicates the difficulties in attaining carbon neutrality while using fossil fuels (IMO, 2023).

endeavor, green shipping corridors are seen as one important breakthrough solution. In such aspect, MOF has declared its intention to foster green shipping corridors. Beginning in 2025, national ships will commence operations along the Korea-US corridor, with plans to extend these green shipping corridors to cover Europe, Asia, and Australia starting in 2030. However, at the 28th Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) in December 2023, Korea and US announced that they will operate a trial green shipping corridor around 2028 (Lim, 2023).

1.1 Definition of Green Shipping Corridors

Green shipping corridors are maritime transport routes designed for zero-carbon vessels, connecting two or more ports. During the 26th COP in 2021, multiple countries[2] signed the Clydebank Declaration, pledging to establish a minimum of six carbon-free shipping corridors between two or more ports across the planet by 2025 (Jung, 2022, p.2).

In February 2022, the US launched the *Green Shipping Corridor Framework*. This initiative defines green shipping corridors as "maritime routes that showcase low- and zero-emission lifecycle fuels and technologies with the ambition to achieve zero greenhouse gas emissions across all aspects of the corridor in support of sector-wide decarbonization no later than 2050 (US DOE, 2023)".

Based on the above definitions and to accelerate shipping industry's compliance with the Paris Agreement, this report defines a green shipping corridor as follows:

> "A maritime route where ships powered by zero-carbon fuels travel between at least two ports, ensuring alignment with the Paris Agreement's 1.5℃ goal no later than 2050, and use of 100 percent renewable energy by each port for full electrification of port facilities and transportation, and mandatory use of alternative marine power. (SFOC, 2023)"

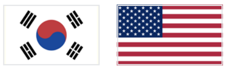
Following the Clydebank Declaration, around 20 international green shipping corridors have been declared. These routes predominantly feature eco-friendly shipping paths either from port to port or from country to country (please refer to Table 1 of the attachment for the list of international green shipping corridors).

1.2 South Korea's Green Shipping Corridors

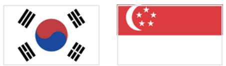
Since the MOF's announcement in February 2023, the South Korean government recently unveiled an initiative to broaden the scope of green shipping corridors. At the G20 Summit of September 2023, President Yoon Suk Yeol presented a plan for South Korea's participation in forming a global green shipping corridor framework (Sun, 2023). As it stands, the country is currently evaluating or proposed four green shipping corridor plans.

2 As of December 7, 2023, total of 24 countries: Australia, Belgium, Canada, Chile, Costa Rica, Denmark, Fiji, Finland, France, Germany, Ireland, Italy, Japan, Marshall Islands, Morocco, Netherlands, New Zealand, Norway, Palau, Singapore, Spain, Sweden, UK, US.

[Figure 3] Korea's Green Corridor Update


Korea-US Green Shipping Corridor Collaboration and Pre-Feasibility Study (Nov. 2023)
In addition to Busan and Tacoma, adding Ports of Ulsan, Masan, Seattle, and Everett


Korea-Australia Green Shipping Corridor Proposed (Sep. 2023)


Korea-Singapore Green Shipping Corridor Discussion (Nov. 2023)


Korea-United Kingdom Green Shipping Corridor Discussion (Nov. 2023)

1.3 Proposal for Korea-US-Japan Green Shipping Corridors

In the realm of global trade, the success of the country's green shipping corridors hinges on cross-border partnerships. South Korea is a prominent exporter, second only to China in its exports to the US, with Japan in fourth place. Regarding imports, the US is South Korea's second-largest supplier after China, followed by Japan in third place (KOTRA, 2023). Also, in view of the ongoing bilateral maritime dialogues—South Korea-US, US-Japan, and South Korea-Japan—merging these discussions into a trilateral effort for more comprehensive collaboration could markedly accelerate the establishment of the South Korea-US-Japan green shipping corridors[3]. If green shipping corridors can be implemented among the trade partners of Korea, direct reduction of GHG from these shipping routes and indirect reduction of GHG from other routes will come together.

In the ever-shifting dynamics of current global affairs, the fate of green shipping corridors could remain uncertain if it was solely predicated on economic considerations. The successful creation and maintenance of these routes necessitate incorporate both political determination and diplomatic cooperation among nations. Such a holistic approach is key to not only developing but also reliably sustaining these green shipping corridors.

Some have raised concerns that, since most South Korean ports are transshipment ports and if the ports start providing more expensive alternative fuels, the vessels will embark and disembark at nearby ports. However, in the mid- and long term, such concerns are outweighed by the following: first, IMO announced

3 (1) South Korea and the US have long been in periodical dialogue regarding maritime cooperation. Discussions between the MOF and the US Maritime Administration (MARAD) have been ongoing since 2014, focusing on pertinent shipping issues between the two countries. Notably, the 7th South Korea-US Maritime Collaboration Meeting in August 2023 included deliberations on the development of green shipping routes.

(2) The US and Japan have been actively discussing the development of green shipping corridors. On February 14, 2023, the California State Government and Japan's Ministry of Land, Infrastructure, Transport and Tourism formalized this initiative by signing a letter of intent, paving the way for eco-friendly maritime connections between California and Japanese ports.

(3) Despite the absence of formal discussions on green shipping corridors between South Korea and Japan, a significant step was taken in April 2023. The Korea Shipowners' Association and the Japanese Shipowners' Association entered a memorandum of understanding (MOU) to bolster cooperation and jointly advance their maritime industries. This agreement opens the door to potential future dialogues on establishing green shipping routes between the two countries.

a dual approach, combining goal-based standards (GBS) for fuels to progressively lower fuel-based GHG intensity, alongside a pricing system mechanism for reduction of GHG emissions[4], and second, in order to meet the Paris Agreement's 2050 target of limiting the temperature increase to 1.5 degrees Celsius, experts suggest that at least five percent of maritime fuel should be carbon-free by 2030 (UMAS, 2021). Accordingly, South Korea should be able to supply alternative fuel to ships in the near future, but currently, is limited in production of carbon free fuel due to a lack of renewable energy and electrolysis infrastructure. Hence, establishing a cooperative relationship with countries that are relatively rich in such resources and technologies can be expected to relieve some concerns by securing stable fuel supply.

To establish green shipping corridors among South Korea, US, and Japan, as well as considering the transshipment characteristic of the South Korean ports, incentives for low-emission and zero-emission vessels voyaging along these routes could extend their impact beyond the initially intended ship types to other classes of vessels and to adjacent ports. Such a move is poised to catalyze the integration of zero-emission vessels across additional maritime routes, promoting a wider shift towards sustainable shipping practices (Smith et al., 2021).

4 It is a system that imposes a price on GHG emissions such as a carbon levy to induce reduction by recognizing GHG emissions as a cost. The pricing mechanism in discussion are combination of the technical and economic elements.

2. Methodology

The most practical strategy for creating green shipping corridors is to focus on routes regularly traversed by liners. Liner shipping, often exemplified by container ships, involves ships operating on specific routes on regular schedules. The recurring nature of these routes necessitates zero emission fuel bunkering facilities at the ports involved to support sustainable maritime operations.

2.1 AIS Data Analysis Approach

In 1998, the Maritime Safety Committee (MSC) of the IMO adopted the finalized standards, mandating that newly built vessels with a gross tonnage exceeding 300 metric tons be equipped with the Automatic Identification System (AIS), starting in July 2002 (Kim et al., 2016, p.3). The data gathered from AIS is instrumental in analyzing ship movements, facilitating port management, and preventing collisions and other accidents (Kang et al., 2023).

AIS encompasses three primary types of information: static, voyage, and dynamic. Static data pertains to relatively constant aspects of a ship, such as its specifications. Voyage data covers detailed information sent at specific times, like the destination and estimated arrival time. Most importantly, dynamic data provides real-time updates on the vessel's current location such as latitude and longitude, as well as transmission time and operational status, forming the core of AIS functionality.

This study analyzed AIS data in collaboration with Korea Maritime Institute (KMI). Leaning on the Korea Ship Emission Estimation Approach (K-SEEA), a model for estimating ship exhaust emissions developed by Mu-hong Kang and others (2023), the analysis estimated the fuel consumption for various shipping routes.

The study (Kang et al., 2023) analyzed AIS data from 4,973 container vessels in the year 2022, examining roughly 46 million dynamic data records to estimate exhaust emissions. The average data reception interval was first found to be approximately 54 minutes, and the average value then underwent verification and calibration using actual data collected (Kang et al., 2023, p.47-50). This subsequent process found a deviation of merely about five percent from the actual data, showing so high a level of reliability as to be used for this study.

This study also leveraged AIS data to identify vessels entering various ports. In Kim et al. (2022), specific harbor limits, anchorages, and moorages for each port were set for individual ports, and vessels traversing those designated areas were tracked in reliance of AIS data, leading to the measurement of key metrics such as turnaround and mooring time and ultimately yielding insights into the service quality of each port (Kim et al., 2022, p.6). This study employs the same methodology. That is, vessels entering the key ports of South Korea, US, and Japan were identified; the K-SEEA model was applied to quantify the fuel consumption by each vessel; and the potential impact of a South Korea-US-Japan green shipping corridor was evaluated.

2.2 Recommended South Korea-US-Japan Green Shipping Corridors

In line with earlier discussions, this study identified container ships as initial choice for the South Korea-US-Japan green shipping corridors. Given their routine operation along established routes, container ships are likely to significantly amplify the effectiveness of the green shipping initiative. Conversely, bulk carriers and tankers, typically not operating on fixed schedules, are expected to contribute less to this initiative and were consequently not included in this study, but it should be subsequently evaluated to fully integrate these types of ships to the South Korea-US-Japan green shipping corridors to accelerate the decarbonization of the shipping industry.

In this report, we focused on three ports in South Korea, two in Japan, and two in the United States, choosing them for their high container traffic.

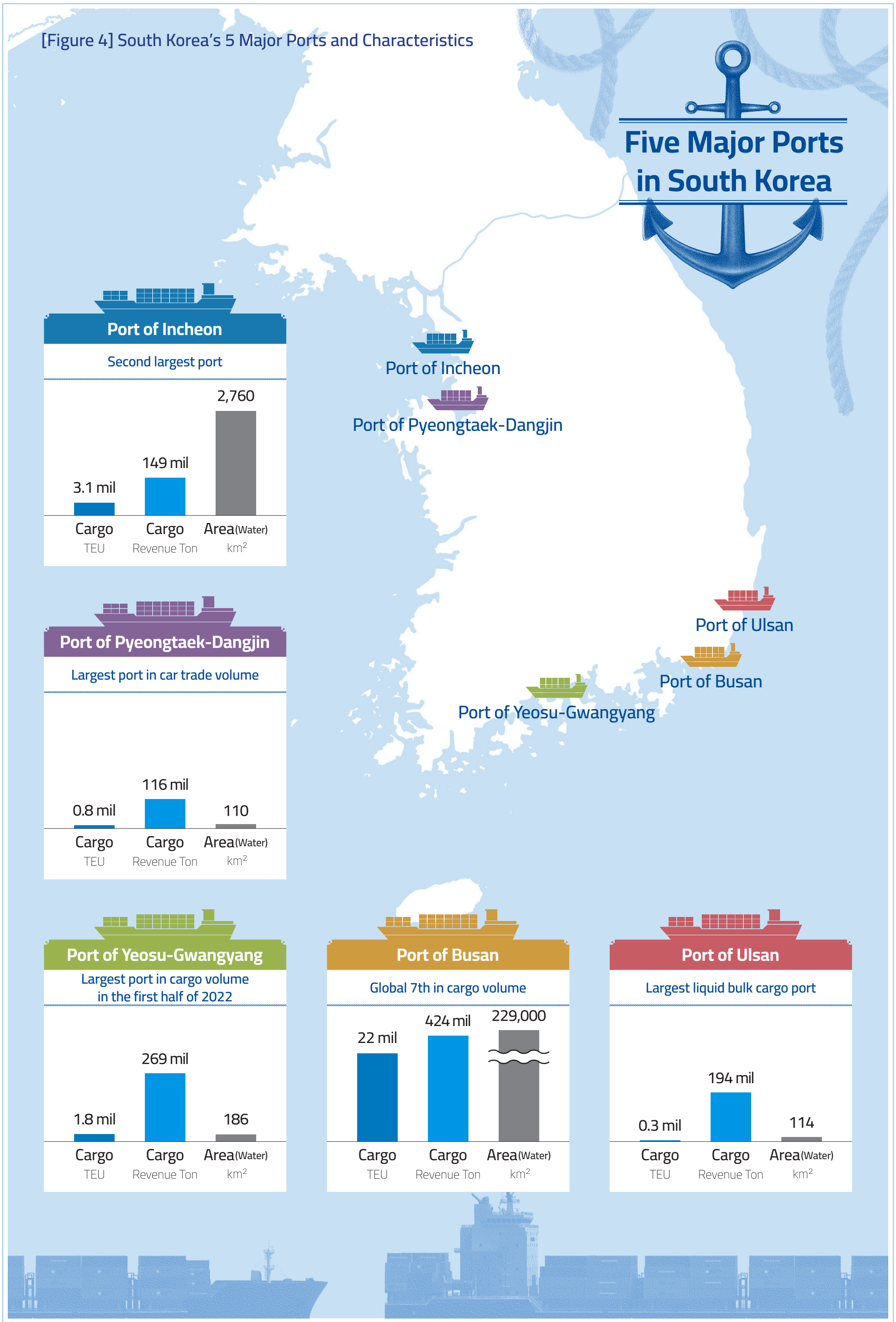
For South Korea, the ports of Busan, Gwangyang, and Incheon were selected due to their high container traffic. These ports, governed by their respective port authorities and actively supported by their local governments in increasing cargo capacity, can be anticipated to readily cooperate in the event of their invitation into the green shipping route initiative.

In Japan, the selection of ports was based on 2022 container traffic, with Tokyo Port (4.4 million TEU), Yokohama Port (2.6 million TEU), and Nagoya Port (2.5 million TEU) leading the list. Given the proximity and shared maritime routes of ports of Tokyo and Yokohama, they were treated as a single port in this report.

In the United States, the Long Beach and the port of New York/New Jersey were chosen as key maritime hubs. As of 2022, they were the top two US ports, processing 19 million and 9.5 million TEUs respectively, serving as the primary gateways for the west and east coasts of the country.

Ships transiting all these ports number between from three to 53 vessels. Although this seems modest against the global tally of around 5,000 container ships, it marks a pivotal beginning for the South Korea-US-Japan green shipping corridor initiative. In the context of the trilateral trade dynamics, introducing low-emission or zero-emission fuel vessels on these routes promises a more substantial reduction in GHG emissions.

[Figure 4] South Korea's 5 Major Ports and Characteristics

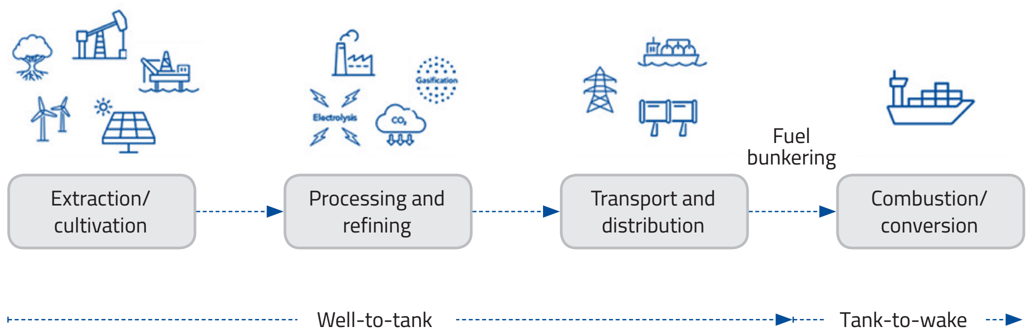


3. Analysis of Green Shipping Corridor based on CO_2 Emissions

This chapter introduces the comprehensive analysis regarding carbon dioxide emissions from key domestic ports such as ports of Busan, Incheon, and Gwangyang based on Kang et al. (2023) and explores the potential of South Korea-US-Japan green shipping corridors using these ports as the starting point and destination for each voyage. Initially, we estimated the fuel consumption and carbon dioxide emissions within each of the South Korean ports. Then, we identified vessels heading to major international ports, including ports of Tokyo and Yokohama, and Port of Nagoya in Japan, and ports of LA /Long Beach and port of New York/ New Jersey in the US, to estimate the carbon dioxide emissions from their traveling the international seas. This method provided a proactive understanding of the potential environmental impact of green shipping corridors under consideration.

However, additional calibration became necessary due to the limited availability of ship data. As previously mentioned, the primary types of data that the AIS encompasses include dynamic data (which tracks vessel positions) and static data (which comprises relatively constant information such as vessel specifications). Within the static dataset lies essential information for estimating fuel consumption, such as consumption rates at specific speeds. This study, however, faced challenge due to a lack of static data for some vessels. They appear in the dynamic dataset but are missing in the static dataset. To address this issue, we applied fuel consumption and carbon dioxide emission factors based on the proportional representation in the dynamic dataset[5]. This study adopts the tank-to-wake approach.

[Figure 5] GHG WELL-TO-WAKE AND TANK–TO-WAKE



Source: IMO, Guidelines on life cycle GHG intensity of marine fuels (LCA Guidelines)

5 For instance, when dealing with 101 vessels in the dynamic dataset and 99 vessels in the static dataset, we applied an adjustment by multiplying the fuel consumption by a factor of 101/99.

3.1 Busan

3.1.1 Carbon Dioxide Emissions in Busan Port Area

Emission assessment is focused on estimating carbon dioxide emissions within the Busan Port area. The area includes New Port of Busan (including Gadeokdo Island), and North Port of Busan near Gwangalli. Within this port area, container ships consumed roughly 179,702 metric tons of fuel in 2022, emitting approximately 568,657 tCO_2.

Bulk carriers emitted 12,392 tCO_2 by consuming 3,909 metric tons of fuel and tanker ships, which released 43,639 tCO_2 using 13,766 metric tons of fuel. It underscores Busan Port's immense carbon dioxide emissions originating from container ships, primarily due to their dominant presence in the cargo sector. Therefore, effective emission reduction strategies for container ships are imperative.

3.1.2 Busan Port's Container Vessel Carbon Dioxide Footprint

1,649 container ships entered and departed from Busan Port, totaling 12,816 as of 2022. On average, these vessels were of 3,652 TEU, with the majority falling within the 8,000 to 12,000 TEU range. During their global operations, these ships consumed an estimated 28 million metric tons of fuel, leading to emissions of approximately 90 million tCO_2.

3.1.3 Recommended Green Shipping Corridors from Busan Port

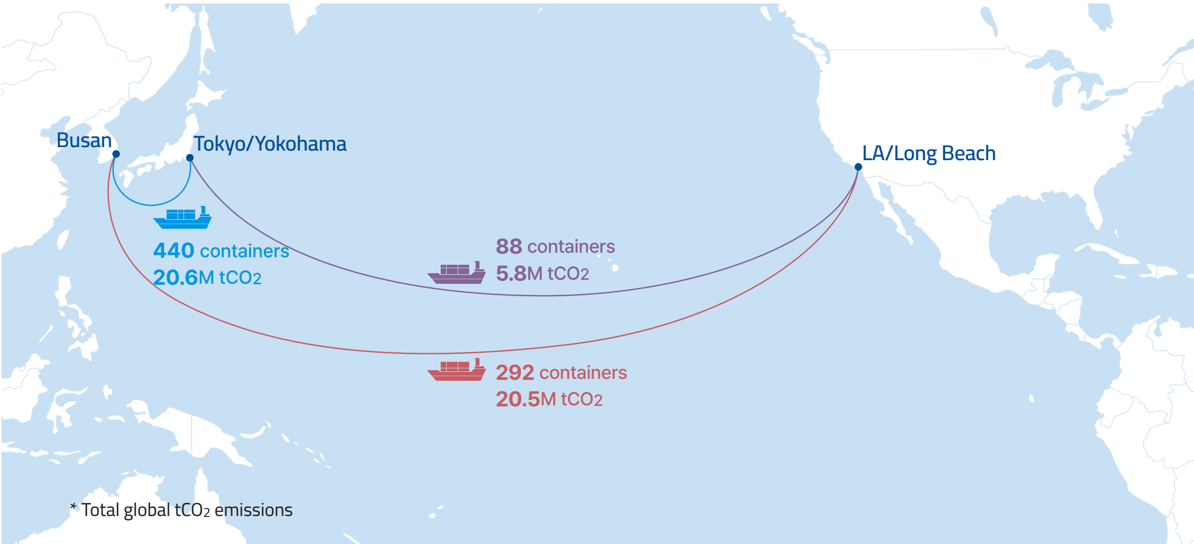
In the context of Busan Port, two alternative shipping routes connecting to Japan and the US are recommended. Among these, the route traversing from Tokyo/Yokohama Port to LA/Long Beach Port stands out by far in carbon dioxide emissions, with 47 vessels actively servicing this path (1st Recommended Corridor). Following closely is the route from Tokyo/Yokohama Port to New York/New Jersey Port, hosting 22 vessels (2nd Recommended Corridor).

1st Recommended Corridor: Busan–Tokyo/Yokohama–LA/Long Beach

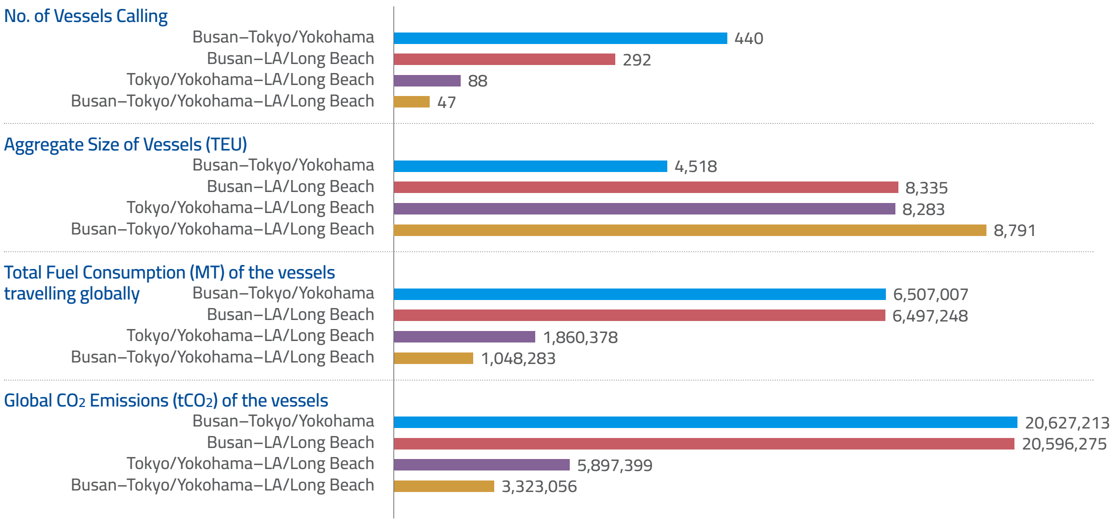
First, we examined ships calling at ports in Korea, Japan, and the US. Our findings reveal that a total of 47 ships making calls at Busan Port, Tokyo/Yokohama Port, and LA/Long Beach Port. These vessels consumed around 1.05 million metric tons of fuel while operating globally in 2022, resulting in emissions of approximately 3.32 million tCO_2, as seen in the table below.

Breaking down the numbers further, 440 traversed the Busan–Tokyo/Yokohama route; 292 ships voyaged along the Busan–LA/Long Beach route; and 88 ships traveled between Tokyo/Yokohama Port and LA/Long Beach Port, respectively emitting approximately 20.6 million tCO_2, 20.6 million tCO_2, and 5.9 million tCO_2 globally.

[Figure 6] Busan–Tokyo/Yokohama–LA/Long Beach Recommended Green Shipping Corridor



[Table 1] Busan–Tokyo/Yokohama–LA/Long Beach Recommended Green Shipping Corridor Key Information (MT = Metric Ton)

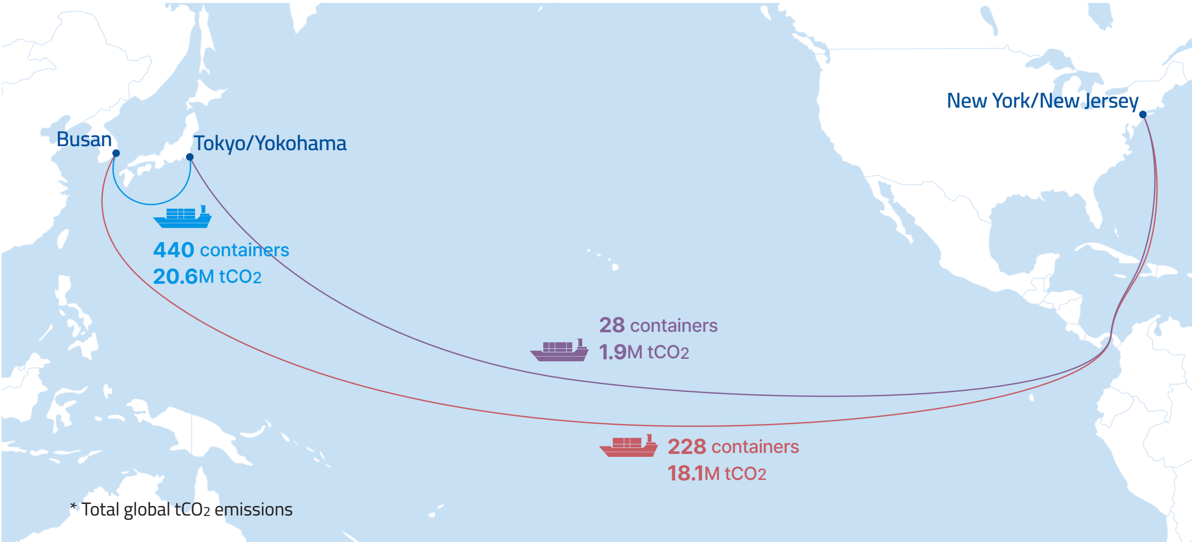


2nd Recommended Corridor: Busan–Tokyo/Yokohama–New York/New Jersey

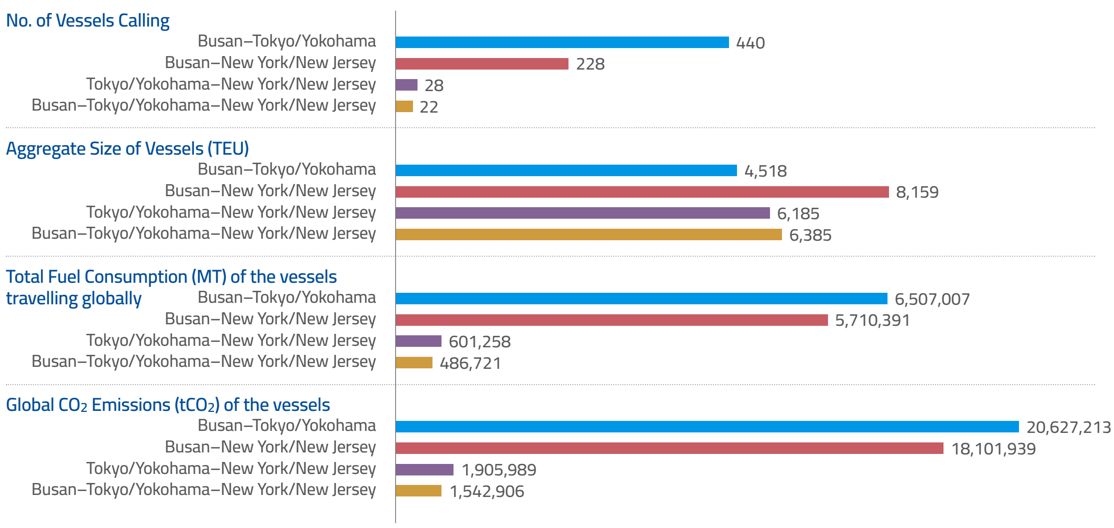
According to our findings, 22 ships simultaneously calling at all the three ports of Busan Port, Tokyo/ Yokohama Port, and New York/New Jersey Port globally consumed approximately 490,000 metric tons of fuel in 2022 and emitting approximately 1.54 million tCO_2, as indicated in the table below.

A closer look reveals that 440 ships sailed along the Busan–Tokyo/Yokohama route; 228 ships journeyed between Busan Port and New York/New Jersey Port; and 28 ships traversed along the Tokyo/Yokohama–New York/New Jersey route. The global CO_2 emissions from those voyages were estimated at approximately 20.62 million tCO_2, 18.1 million tCO_2, and 1.91 million tCO_2, respectively.

[Figure 7] Busan–Tokyo/Yokohama–New York/New Jersey Recommended Green Shipping Corridor



[Table 2] Busan–Tokyo/Yokohama–New York/New Jersey Recommended Green Shipping Corridor Key Information (MT = Metric Ton)



3.2 Incheon

3.2.1 Carbon Dioxide Emissions in Incheon Port Area

We estimated the carbon dioxide emissions generated within the Incheon Port area, which included Yeongjongdo Island, Byeondo Island, and Gubongdo Island. Within this area, container ships emitted 54,017tCO_2, followed by bulk carriers (21,561tCO_2) and tanker ships (25,967tCO_2). It is worth noting that container ships were the primary culprit, particularly with the recently opened Incheon New Port, which contributed the most CO_2 emissions.

3.2.2 Incheon Port's Container Vessel Carbon Dioxide Footprint

Incheon Port recorded the entry and exit of 339 container ships, with a total of 2,430 port calls. These ships, on average, were of 1,774 TEU; none exceeded 12,000 TEU. In their global operations, these vessels consumed an estimated 2.85 million metric tons of fuel, leading to emissions of approximately 9.04 million tCO_2.

3.2.3 Recommended Green Shipping Corridors from Incheon Port

This study presents two alternative shipping routes from Incheon Port to Japan and/or to the US. The route via Tokyo/Yokohama to LA/Long Beach in the US is identified as the most trafficked, with 14 vessels operating, thus producing the highest carbon dioxide emissions. Following are the Tokyo/Yokohama to New York/New Jersey and Nagoya to New York/New Jersey routes, each serviced by four vessels.

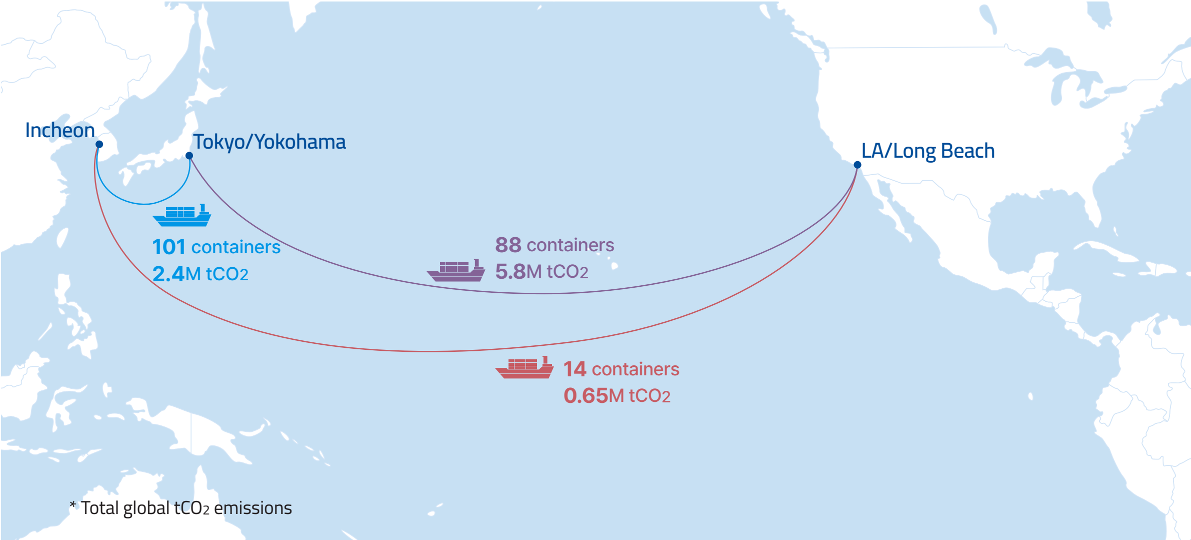
Echoing the approach employed for Busan Port, this study estimated the vessel count, fuel consumption, and carbon dioxide emissions for the primary and secondary alternatives. These alternatives encompass varying port connections: each route linking one port per country across the three countries or connective pairs of countries (Korea-US, Korea-Japan, and US-Japan). For the second recommended corridor, we examined the Incheon–Nagoya–New York/New Jersey route, rather than Incheon-Tokyo/Yokohama-New York/New Jersey to analyze diverse routes appropriate for Korea-US-Japan green shipping corridors.

1st Recommended Corridor: Incheon–Tokyo/Yokohama–LA/Long Beach

Attention was first given to a total of 14 vessels that call in all the three countries of South Korea, Japan, and the US. Specifically, they call at all the three ports of Incheon, Tokyo/Yokohama, and LA/Long Beach. Vessels, crisscrossing the vast oceans, consumed approximately 210,000 metric tons of fuel in 2022, leading to the emission of roughly 660,000 as seen in the table below.

Delving into the specifics, there were 101 ships operating between Incheon and Tokyo/Yokohama ports, 14 between Incheon and LA/Long Beach ports, and 88 between Tokyo/Yokohama and LA/Long Beach ports, emitting an estimated 2.45 million, 660,000 and 5.9 million tCO_2 of carbon dioxide globally. Noteworthy is that all 14 container ships on the Incheon to LA/Long Beach route consistently transit through Tokyo/Yokohama Port.

[Figure 8] Incheon–Tokyo/Yokohama–LA/Long Beach Recommended Green Shipping Corridor



[Table 3] Incheon–Tokyo/Yokohama–LA/Long Beach Recommended Green Shipping Corridor Key Information (MT = Metric Ton)

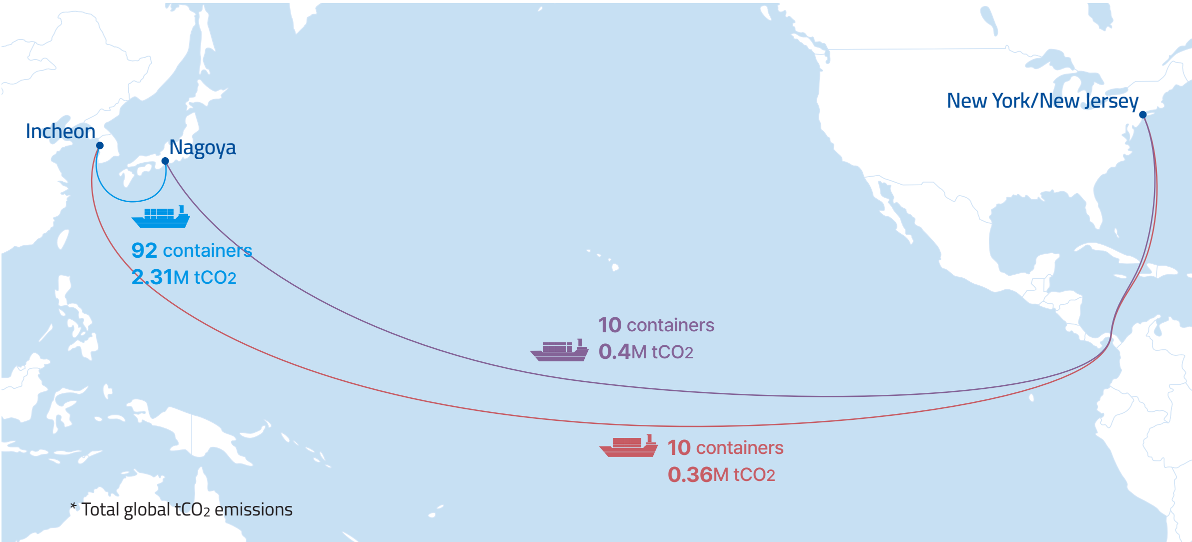
No. of Vessels Calling	Incheon–Tokyo/Yokohama	101
	Incheon–LA/Long Beach	14
	Tokyo/Yokohama–LA/Long Beach	88
	Incheon–Tokyo/Yokohama–LA/Long Beach	14
Aggregate Size of Vessels (TEU)	Incheon–Tokyo/Yokohama	1,757
	Incheon–LA/Long Beach	5,575
	Tokyo/Yokohama–LA/Long Beach	8,283
	Incheon–Tokyo/Yokohama–LA/Long Beach	5,575
Total Fuel Consumption (MT) of the vessels travelling globally	Incheon–Tokyo/Yokohama	773,621
	Incheon–LA/Long Beach	207,254
	Tokyo/Yokohama–LA/Long Beach	1,860,378
	Incheon–Tokyo/Yokohama–LA/Long Beach	207,254
Global CO_2 Emissions (tCO_2) of the vessels	Incheon–Tokyo/Yokohama	2,452,379
	Incheon–LA/Long Beach	656,994
	Tokyo/Yokohama–LA/Long Beach	5,897,399
	Incheon–Tokyo/Yokohama–LA/Long Beach	656,994

2nd Recommended Corridor: Incheon–Nagoya–New York/New Jersey

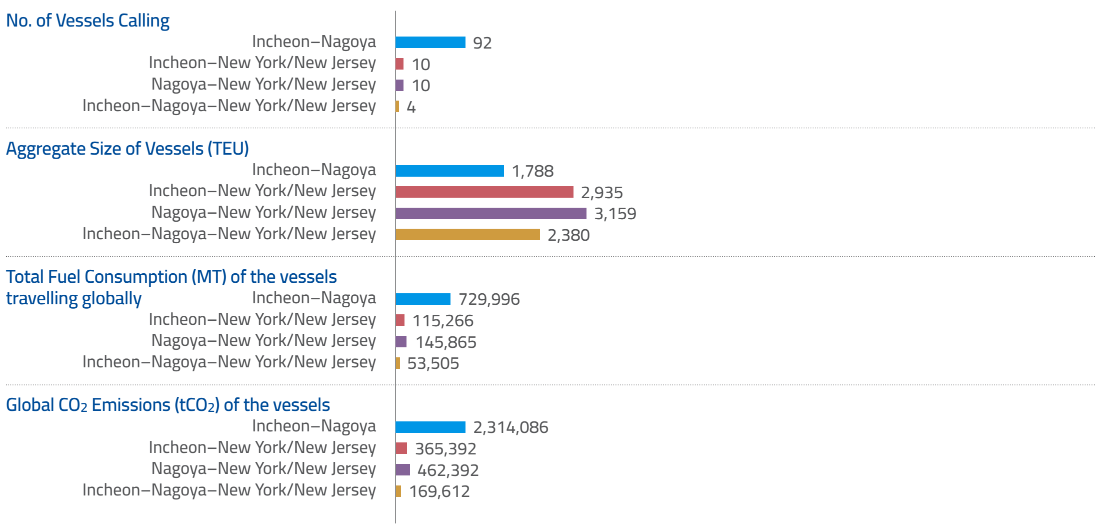
We examined four ships simultaneously servicing the ports of Incheon, Nagoya, and New York/New Jersey. In 2022, these vessels on global voyages used about 50,000 metric tons of fuel, resulting in emissions of approximately 170,000 tCO_2, as the table below shows.

A detailed look reveals that 92 ships sailed between Incheon and Nagoya ports, while ten ships navigated the Incheon–New York/New Jersey route and another ten ships serviced the Nagoya–New York/New Jersey route. The CO_2 emissions for these individual routes were calculated at 2.31 million, 0.37 million and 0.46 million tCO_2 globally.

[Figure 9] Incheon–Nagoya–New York/New Jersey Recommended Green Shipping Corridor



[Table 4] Incheon–Nagoya–New York/New Jersey Recommended Green Shipping Corridor Key Information (MT = Metric Ton)



3.3 Gwangyang

3.3.1 Carbon Dioxide Emissions in Gwangyang Port Area

Last but not least, this report estimated carbon emissions within the Gwangyang Port area. We set an area covering the whole of Gwangyang Bay as the Gwangyang Port Area, which includes the docks within the Yeosu National Industrial Complex (also known as Yeosu Petrochemical Complex) and those within the Gwangyang steel facilities. This study has found that in 2022 within the boundaries of the port area, container ships emitted 68,899 tCO_2, bulk carriers 42,410tCO_2, and tankers, primarily frequenting to service the Yeosu Petrochemical Complex, 83,547 tCO_2. Notably, tankers were the largest contributors to the port's carbon footprint, a reflection of the high level of their activity within the vicinity.

3.3.2 Gwangyang Port's Container Vessel Carbon Dioxide Footprint

In 2022, Gwangyang Port served as a pivotal hub for 464 container ships, cumulatively accounting for 3,061 port calls. These vessels, predominantly within the 1,000 to 2,000 TEU category, had an average size of 2,452 TEU. Navigating across the globe, these ships consumed around 5.36 million metric tons of fuel, generating emissions of 17 million tCO_2.

3.3.3 Recommended Green Shipping Corridors from Gwangyang Port

This study presents four alternative routes linking Gwangyang Port to Japan and/or to the US. Of the two routes, the Tokyo/Yokohama to LA/Long Beach route was the most serviced, with 53 vessels in operation, marking it as the heaviest carbon emitter. The Tokyo/Yokohama to New York/New Jersey route follows, with five vessels in service.

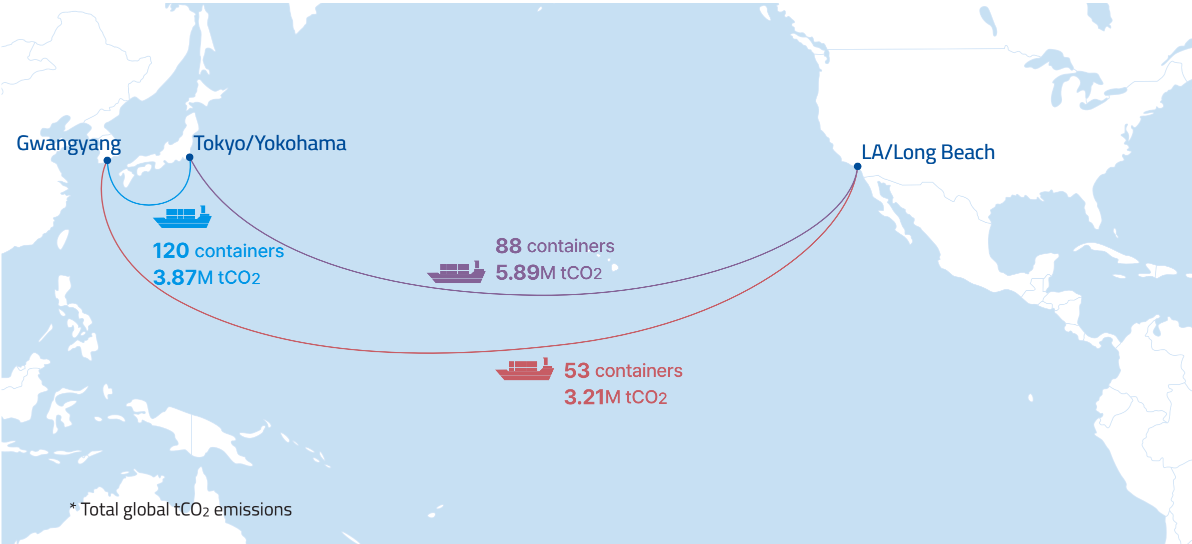
With focus on the Gwangyang–Tokyo/Yokohama–LA/Long Beach route (1st Recommended Corridor) and the Gwangyang–Tokyo/Yokohama–New York/New Jersey route (2nd Recommended Corridor), this study estimated the vessel count, fuel consumption, and carbon dioxide emissions for each route linking one port per country across the three countries, as well as across each pair of two countries among them—Korea-US, Korea-Japan, and US-Japan.

1st Recommended Corridor: Gwangyang–Tokyo/Yokohama–LA/Long Beach

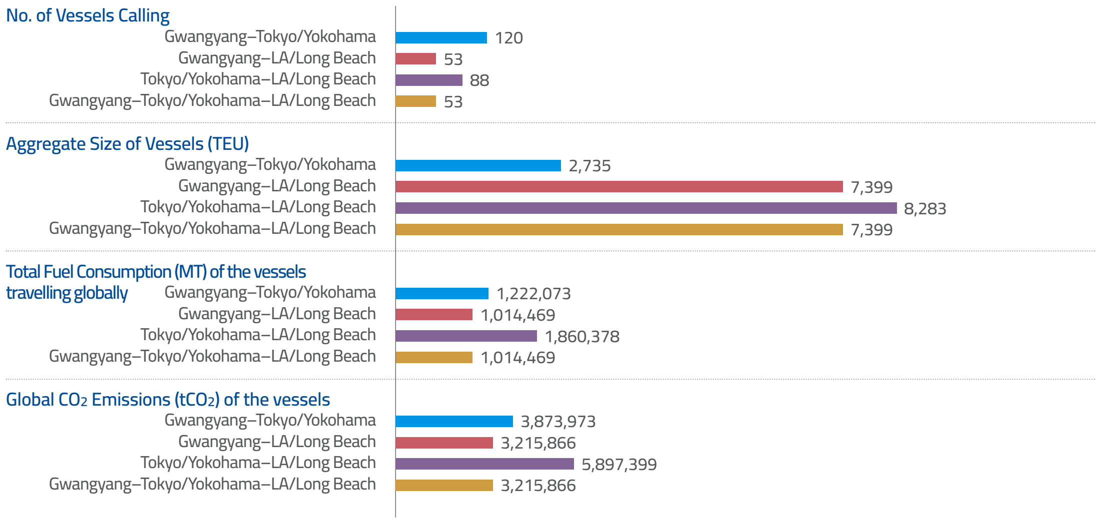
In 2022, the Gwangyang–Tokyo/Yokohama–LA/Long Beach corridor was marked by 53 vessels traversing all these ports. These ships, engaged in global operations, consumed approximately 1.01 million metric tons of fuel, resulting in emissions of 3.22 million tCO_2, as indicated in the table below.

A breakdown of the maritime traffic shows 120 vessels on the Gwangyang–Tokyo/Yokohama route, 53 on the Gwangyang–LA/Long Beach route, and 88 on Tokyo/Yokohama–LA/Long Beach route. The global carbon emissions for these routes were 3.87 million, 3.22 million, and 5.90 million tCO_2 respectively. Notably, every vessel voyaging along the Gwangyang–LA/Long Beach route called at Tokyo/Yokohama Port.

[Figure 10] Gwangyang–Tokyo/Yokohama–LA/Long Beach Recommended Green Shipping Corridor



[Table 5] Gwangyang–Tokyo/Yokohama–LA/Long Beach Recommended Green Shipping Corridor Key Information (MT = Metric Ton)

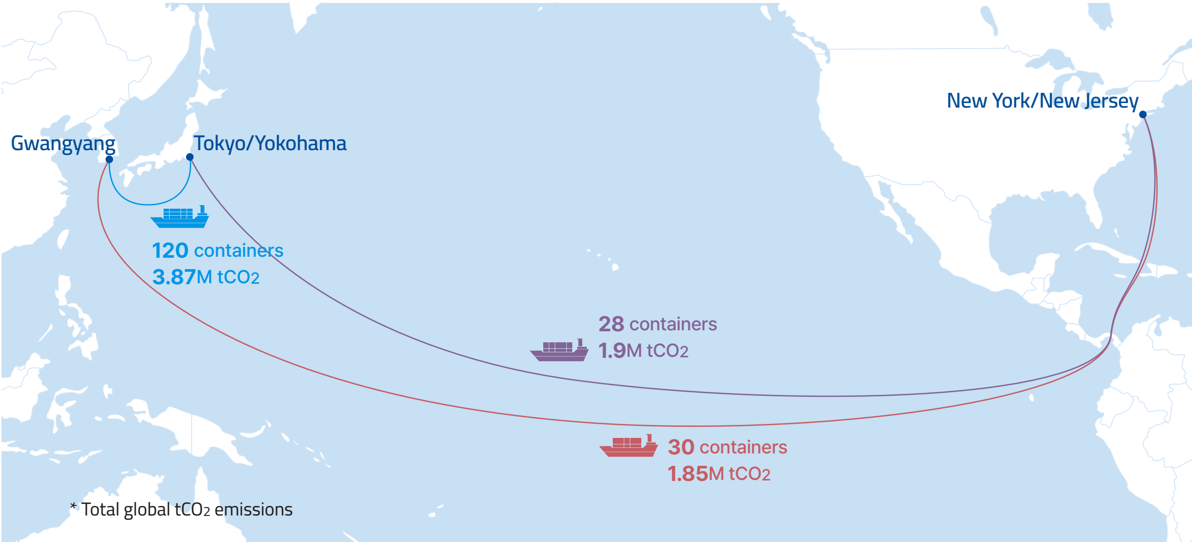


2nd Recommended Corridor: Gwangyang–Tokyo/Yokohama–New York/New Jersey

Next, the focus of our study to the route connecting Gwangyang Port, Tokyo/Yokohama Port, and New York/New Jersey Port, which saw simultaneous calls from five vessels in 2022. These vessels, traversing international waters, used about 100,000 metric tons of fuel, leading to emissions of 320,000 tCO_2 as outlined in the table below.

Delving deeper, the Gwangyang–Tokyo/Yokohama route was serviced by 120 ships, Gwangyang–New York/New Jersey 30 ships, and Tokyo/Yokohama–New York/New Jersey 28 ships. Global carbon dioxide emissions for these routes of an estimated at 3.87 million, 1.85 million, and 1.91 million tCO_2, respectively.

[Figure 11] Gwangyang–Tokyo/Yokohama–New York/New Jersey Recommended Green Shipping Corridor



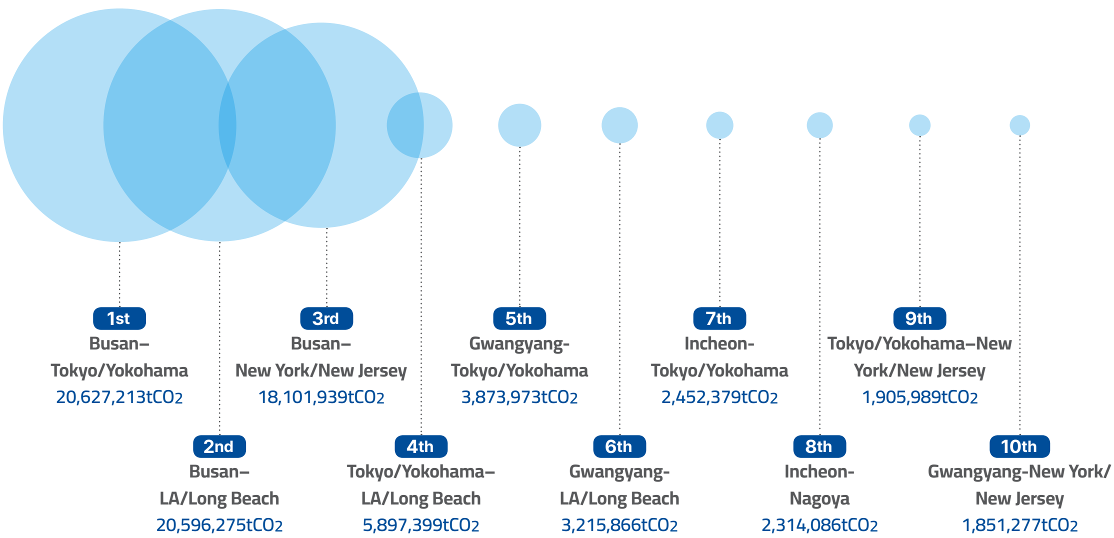
[Table 6] Gwangyang–Tokyo/Yokohama–New York/New Jersey Recommended Green Shipping Corridor Key Information (MT = Metric Ton)

No. of Vessels Calling	Gwangyang–Tokyo/Yokohama	120
	Gwangyang–New York/New Jersey	30
	Tokyo/Yokohama–New York/New Jersey	28
	Gwangyang–Tokyo/Yokohama–New York/New Jersey	5
Aggregate Size of Vessels (TEU)	Gwangyang–Tokyo/Yokohama	2,735
	Gwangyang–New York/New Jersey	6,251
	Tokyo/Yokohama–New York/New Jersey	6,185
	Gwangyang–Tokyo/Yokohama–New York/New Jersey	5,418
Total Fuel Consumption (MT) of the vessels travelling globally	Gwangyang–Tokyo/Yokohama	1,222,073
	Gwangyang–New York/New Jersey	583,999
	Tokyo/Yokohama–New York/New Jersey	601,258
	Gwangyang–Tokyo/Yokohama–New York/New Jersey	100,995
Global CO_2 Emissions (tCO_2) of the vessels	Gwangyang–Tokyo/Yokohama	3,873,973
	Gwangyang–New York/New Jersey	1,851,277
	Tokyo/Yokohama–New York/New Jersey	1,905,989
	Gwangyang–Tokyo/Yokohama–New York/New Jersey	320,155

3.4 Recommendation

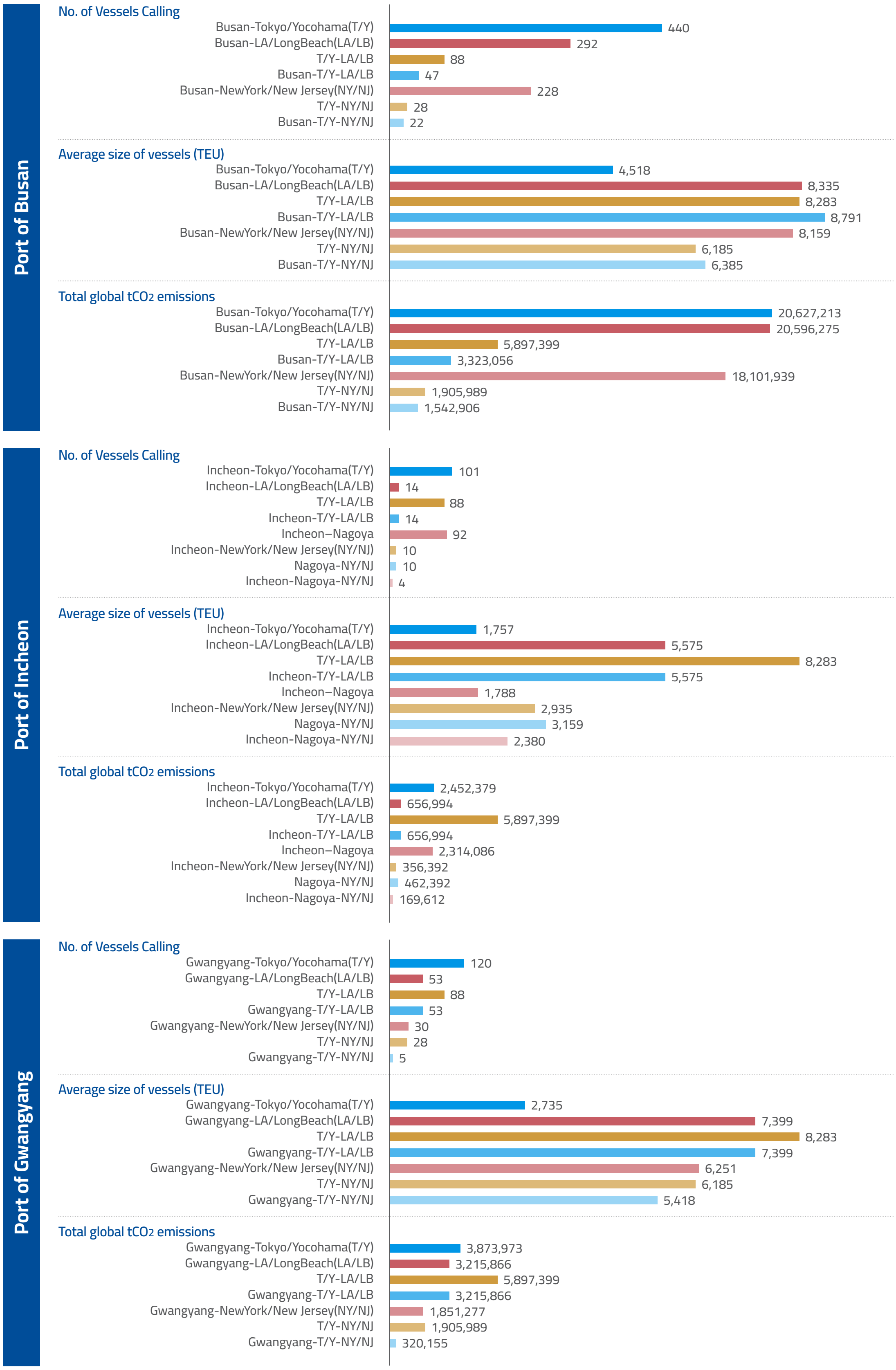
If Korea-US-Japan green corridor becomes operational, the container ships will not only travel these shipping routes but will be travelling globally and can significantly impact other shipping routes and ports in reducing GHG emissions. It becomes evident that converting ships on the individual routes connecting two of the three countries of Korea, the US, and Japan (i.e., Korea-US, US-Japan, and Korea-Japan routes) into low-carbon or zero-carbon alternatives promises much greater environmental benefits. Therefore, this report advocates for the prioritization of the following routes as green shipping corridors, with a special emphasis on starting with routes involving Port of Busan and those involving Port of Gwangyang, given their potential for the highest impact. However, if three countries need to have trial for specific green shipping corridor, it would be ideal to start with one port from each country, such as Busan-Yokohama/Tokyo-LA/Long Beach.

Figure 12. Korea-US-Japan Recommended Green Shipping Corridors



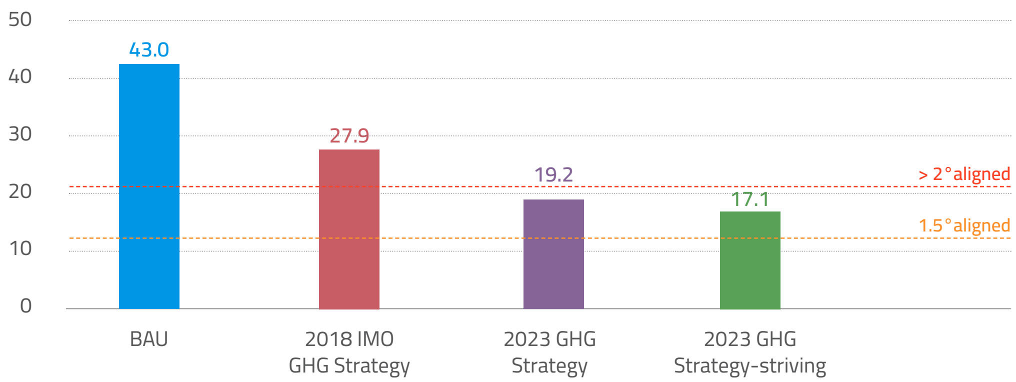
* Total global tCO_2 emissions

[Table 7] Data on Recommended Green Shipping Corridors



According to ICCT, IMO's 2023 GHG strategy may not be sufficient in aligning international shipping's GHG emissions to the Paris Agreement. Thus, for Korea-US-Japan green shipping corridor to be integral part of meeting the Paris Agreement goals, the terms and conditions for a tripartite partnership must have specific and clear milestones that all three countries can achieve at the same time.

[Figure 13] Cumulative emissions 2020-2050 WTW Gt CO2e



Source: ICCT, 2023

Thus, it is essential for the three countries to reflect the following recommended terms and conditions in the initiative:

1. Recognition among the signatories of the need for close and robust cooperation for the decarbonization of international shipping
2. Commitment by each country (or its respective ports) to transition its port and transportation facilities to 100 percent renewable energy by 2030
3. By 2030, greater investment in green fuels (e.g., green hydrogen and green ammonia) and no new investment in LNG bunkering facilities
4. By 2030, mandatory use of alternative marine power (AMP) systems by vessels of each country (or vessels calling at its respective ports)
5. By 2040, mandatory use of zero-emission fuels by vessels that call the specified ports of each country
6. Presentation of roadmaps respectively targeting the years of 2027, 2030, 2040, and 2050 aiming for 100 percent zero emission ports and shipping routes
7. Enter into separate agreements on green fuel technology transfer and/or green fuel supply

4. Conclusion

In effort to develop green shipping corridors, diverse stakeholders including the South Korean government, ports, and shipping companies have distinct roles. For example, the National Port Master Plan will need to be modified to accelerate the transformation of ports to green ports and spur the shipping companies to quickly integrate low- or zero-emission vessels into their fleets. Changes to the relevant laws and regulations aimed at boosting the green shipping corridor initiative will help ensure the maritime sector's achievement of carbon neutrality by 2040, thereby meeting the Paris Agreement's target of capping the global temperature rise at 1.5 degrees Celsius.

The purpose of green shipping corridors, which this report addresses, transcends the mere reduction of GHG emissions from the maritime sector. Their fundamental aim is to increase the sustainability of the shipping industry and its interconnected fields. Presently, the sustainability discourse in the shipping sector is narrowly focused on green shipping corridors and port decarbonization, yet there is an emerging need to broaden and deepen this discourse to encompass specific sustainability issues throughout the supply chains of the shipping industry and its related sectors.

Particularly, the adoption of alternative fuels and the development of port infrastructure have been highlighted as primary instruments in the quest for carbon neutrality in shipping, but attention should be paid to the transformations in working environments that those strategies will lead to. This critical juncture of industrial transformation not only involves governments, shipping companies, and financial institutions as primary stakeholders but workers and local communities are also key stakeholders. Future discussions will hopefully explore ways to minimize the societal impacts of the transition, as well as to safeguard secure, safe, and healthy working conditions to ensure labor rights of the workers and local communities.

Appendix

[Appendix Table 1] List of International Green Shipping Corridors

International Green Shipping Corridors	Date of Announcement
Rotterdam (Netherlands) – Singapore (Singapore)	August 2022
LA (USA) – Long Beach (USA) – Singapore (Singapore)	April 2023
Halifax (Canada) – Hamburg (Germany)	September 2022
Dover (UK) – Calais/Dunkirk (France)	March 2023
Tokyo (Japan) –Yokohama (Japan) – LA (USA)	March 2023
Yokohama (Japan) – Oakland (USA)	October 2023
LA (USA) - Nagoya (Japan)	June 2023
Antwerp (Belgium) – Montreal (Canada)	November 2021
Gothenburg (Sweden) – Rotterdam (Netherlands)	October 2022
Shanghai (China) – LA (USA)	February 2022
Guangzhou (China) – LA (USA)	October 2023
Ports Gdynia (Poland) – Hamburg (Germany) –Roenne (Denmark) – Rotterdam (Netherlands)	March 2022
Seattle (USA) – Vancouver (Canada) – Alaska (USA) – British Columbia (Canada) – Washington (USA)	May 2022
Stockholm (Sweden) – Turku (Finland)	September 2022
Helsinki (Finland) – Tallinn (Estonia)	October 2023
Rotterdam (Netherlands) – Oslo (Norway)	October 2023

Container Ships Fuel Consumption and CO_2 Emissions Information by Ports

[Appendix Table 2-1] Busan Port Container Ships Fuel Consumption and CO_2 Emissions Information (MT = Metric Ton)

	0-1000 TEU	1000-2000	2000-3000	3000-5000	5000-8000	8000-12000	12000-14500	14500-20000	20000-	Sum
No. of Vessels Entering and Departing (dynamic AIS data)	101	366	170	193	211	338	132	89	49	**1,649**
No. of Vessels Entering and Departing (static AIS data)	99	365	168	192	211	337	129	89	49	**1,639**
No. of Port Calls	3,323	4,304	1,251	838	902	1,361	465	248	124	**12,816**
Aggregate Size of Vessels Entering and Departing (TEU)	2,504,617	5,729,897	3,218,519	3,619,207	5,547,210	13,058,849	6,213,420	4,083,578	2,834,800	**46,810,097**
Average Size of Vessels Entering and Departing (TEU)	754	1,331	2,573	4,319	6,150	9,595	13,362	16,466	22,861	**3,652**
Fuel Consumption of Worldwide Transit of the Vessels (MT)	456,433	2,467,942	1,695,935	2,906,400	3,948,891	8,680,023	2,944,603	2,831,001	1,244,491	**27,175,719**
Fuel Consumption for Worldwide Mooring of the Vessels (MT)	11,564	69,651	52,594	64,782	100,092	272,905	115,743	87,107	64,634	**839,073**
Fuel Consumption for Worldwide Anchoring of the Vessels (MT)	6,173	35,052	25,856	44,452	57,100	117,316	56,259	26,537	24,579	**393,321**
Worldwide Total Fuel Consumption of the Vessels (MT)	474,170	2,572,644	1,774,385	3,015,635	4,106,083	9,070,243	3,116,605	2,944,645	1,333,703	**28,408,113**
Worldwide CO_2 Emissions of the Vessels (tCO_2)	1,503,118	8,155,283	5,624,799	9,559,562	13,016,283	28,752,671	9,879,637	9,334,525	4,227,840	**90,053,718**

[Appendix Table 2-2] Incheon Port Container Ships Fuel Consumption and CO_2 Emissions Information (MT = Metric Ton)

	0-1000 TEU	1000-2000	2000-3000	3000-5000	5000-8000	8000-12000	Sum
No. of Vessels Entering and Departing (dynamic AIS data)	26	178	87	27	15	6	**339**
No. of Vessels Entering and Departing (static AIS data)	26	177	85	27	15	6	**336**
No. of Port Calls	594	1,308	345	73	75	35	**2,430**
Aggregate Size of Vessels Entering and Departing (TEU)	467,440	1,843,827	894,313	314,428	433,309	357,655	**4,310,972**
Average Size of Vessels Entering and Departing (TEU)	787	1,410	2,592	4,307	5,777	10,219	**1,774**
Fuel Consumption of Worldwide Transit of the Vessels (MT)	118,492	1,223,827	796,230	332,111	162,513	91,643	**2,724,816**
Fuel Consumption for Worldwide Mooring of the Vessels (MT)	2,548	33,949	28,389	9,381	5,512	5,251	**85,031**
Fuel Consumption for Worldwide Anchoring of the Vessels (MT)	1,446	17,708	13,912	5,646	2,234	412	**41,358**
Worldwide Total Fuel Consumption of the Vessels (MT)	122,486	1,275,485	838,530	347,139	170,260	97,305	**2,851,205**
Worldwide CO_2 Emissions of the Vessels (tCO_2)	388,280	4,043,287	2,658,141	1,100,429	539,724	308,458	**9,038,320**

[Appendix Table 2-3] Gwangyang Port Container Ships Fuel Consumption and CO_2 Emissions Information (MT = Metric Ton)

	0-1000 TEU	1000-2000	2000-3000	3000-5000	5000-8000	8000-12000	12000-14500	14500-20000	20000-	Sum
No. of Vessels Entering and Departing (dynamic AIS data)	39	193	56	64	41	47	9	12	3	**464**
No. of Vessels Entering and Departing (static AIS data)	39	193	56	64	41	47	9	12	3	**464**
No. of Port Calls	544	1,759	256	183	135	129	8	39	8	**3,061**
Aggregate Size of Vessels Entering and Departing (TEU)	463,533	2,481,148	664,311	783,737	841,844	1,273,469	121,428	711,732	164,544	**7,505,746**
Average Size of Vessels Entering and Departing (TEU)	852	1,411	2,595	4,283	6,236	9,872	13,492	18,250	20,568	**2,452**
Fuel Consumption of Worldwide Transit of the Vessels (MT)	189,808	1,249,639	532,107	813,798	650,831	1,052,316	216,108	377,271	38,622	**5,120,500**
Fuel Consumption for Worldwide Mooring of the Vessels (MT)	4,792	36,012	18,403	24,024	20,038	41,022	7,553	8,645	986	**161,476**
Fuel Consumption for Worldwide Anchoring of the Vessels (MT)	2,176	18,263	8,962	15,132	10,252	19,600	2,433	4,052	310	**81,181**
Worldwide Total Fuel Consumption of the Vessels (MT)	196,776	1,303,914	559,473	852,955	681,121	1,112,938	226,094	389,967	39,918	**5,363,156**
Worldwide CO_2 Emissions of the Vessels (tCO_2)	623,780	4,133,407	1,773,529	2,703,867	2,159,153	3,528,014	716,719	1,236,197	126,539	**17,001,206**

Expanded Information for Recommended Green Shipping Corridors

[Appendix Table 3-1] Port of Busan based Recommended Green Shipping Corridor #1 (MT = Metric Ton)

	Busan–Tokyo/Yokohama	Busan–LA/Long Beach	Tokyo/Yokohama–LA/Long Beach	Busan–Tokyo/Yokohama–LA/Long Beach
No. of Vessels Calling	440	292	88	47
Aggregate Size of Vessels (TEU)	4,518	8,335	8,283	8,791
Fuel Consumption of Worldwide Transit of the Vessels (MT)	6,250,125	6,241,084	1,796,221	1,009,259
Fuel Consumption for Worldwide Mooring of the Vessels (MT)	182,061	180,365	47,674	29,085
Fuel Consumption for Worldwide Anchoring of the Vessels (MT)	74,821	75,799	16,483	9,938
Worldwide Total Fuel Consumption of the Vessels (MT)	6,507,007	6,497,248	1,860,378	1,048,283
Worldwide CO_2 Emissions of the Vessels (tCO_2)	20,627,213	20,596,275	5,897,399	3,323,056

[Appendix Table 3-2] Port of Busan based Recommended Green Shipping Corridor #2 (MT = Metric Ton)

	Busan–Tokyo/Yokohama	Busan–New York/New Jersey	Tokyo/Yokohama–New York/New Jersey	Busan–Tokyo/Yokohama–New York/New Jersey
No. of Vessels Calling	440	228	28	22
Aggregate Size of Vessels (TEU)	4,518	8,159	6,185	6,385
Fuel Consumption of Worldwide Transit of the Vessels (MT)	6,250,125	5,487,499	577,841	466,452
Fuel Consumption for Worldwide Mooring of the Vessels (MT)	182,061	128,085	13,783	12,006
Fuel Consumption for Worldwide Anchoring of the Vessels (MT)	74,821	94,807	9,635	8,263
Worldwide Total Fuel Consumption of the Vessels (MT)	6,507,007	5,710,391	601,258	486,721
Worldwide CO_2 Emissions of the Vessels (tCO_2)	20,627,213	18,101,939	1,905,989	1,542,906

[Appendix Table 3-3] Port of Incheon based Recommended Green Shipping Corridor #1 (MT = Metric Ton)

	Incheon-Tokyo/Yokohama	Incheon-LA/Long Beach	Tokyo/Yokohama–LA/Long Beach	Incheon-Tokyo/Yokohama–LA/Long Beach
No. of Vessels Calling	101	14	88	14
Aggregate Size of Vessels (TEU)	1,757	5,575	8,283	5,575
Fuel Consumption of Worldwide Transit of the Vessels (MT)	742,221	200,449	1,796,221	200,449
Fuel Consumption for Worldwide Mooring of the Vessels (MT)	21,339	5,914	47,674	5,914
Fuel Consumption for Worldwide Anchoring of the Vessels (MT)	10,061	891	16,483	891
Worldwide Total Fuel Consumption of the Vessels (MT)	773,621	207,254	1,860,378	207,254
Worldwide CO_2 Emissions of the Vessels (tCO_2)	2,452,379	656,994	5,897,399	656,994

[Appendix Table 3-4] Port of Incheon based Recommended Green Shipping Corridor #2 (MT = Metric Ton)

	Incheon-Nagoya	Incheon-New York/New Jersey	Nagoya-New York/New Jersey	Incheon-Nagoya-New York/New Jersey
No. of Vessels Calling	92	10	10	4
Aggregate Size of Vessels (TEU)	1,788	2,935	3,159	2,380
Fuel Consumption of Worldwide Transit of the Vessels (MT)	700,988	111,846	140,057	52,107
Fuel Consumption for Worldwide Mooring of the Vessels (MT)	19,749	2,300	3,704	1,037
Fuel Consumption for Worldwide Anchoring of the Vessels (MT)	9,258	1,120	2,104	361
Worldwide Total Fuel Consumption of the Vessels (MT)	729,996	115,266	145,865	53,505
Worldwide CO_2 Emissions of the Vessels (tCO_2)	2,314,086	365,392	462,392	169,612

[Appendix Table 3-5] Port of Gwangyang based Recommended Green Shipping Corridor #1 (MT = Metric Ton)

	Gwangyang-Tokyo/Yokohama	Gwangyang-LA/Long Beach	Tokyo/Yokohama–LA/Long Beach	Gwangyang-Tokyo/Yokohama–LA/Long Beach
No. of Vessels Calling	120	53	88	53
Aggregate Size of Vessels (TEU)	2,735	7,399	8,283	7,399
Fuel Consumption of Worldwide Transit of the Vessels (MT)	1,166,794	972,164	1,796,221	972,164
Fuel Consumption for Worldwide Mooring of the Vessels (MT)	36,545	29,093	47,674	29,093
Fuel Consumption for Worldwide Anchoring of the Vessels (MT)	18,734	13,212	16,483	13,212
Worldwide Total Fuel Consumption of the Vessels (MT)	1,222,073	1,014,469	1,860,378	1,014,469
Worldwide CO_2 Emissions of the Vessels (tCO_2)	3,873,973	3,215,866	5,897,399	3,215,866

[Appendix Table 3-6] Port of Gwangyang based Recommended Green Shipping Corridor #2 (MT = Metric Ton)

	Gwangyang-Tokyo/Yokohama	Gwangyang-New York/New Jersey	Tokyo/Yokohama-New York/New Jersey	Gwangyang-Tokyo/Yokohama-New York/New Jersey
No. of Vessels Calling	120	30	28	5
Aggregate Size of Vessels (TEU)	2,735	6,251	6,185	5,418
Fuel Consumption of Worldwide Transit of the Vessels (MT)	1,166,794	559,051	577,841	96,207
Fuel Consumption for Worldwide Mooring of the Vessels (MT)	36,545	14,910	13,783	2,491
Fuel Consumption for Worldwide Anchoring of the Vessels (MT)	18,734	10,038	9,635	2,297
Worldwide Total Fuel Consumption of the Vessels (MT)	1,222,073	583,999	601,258	100,995
Worldwide CO_2 Emissions of the Vessels (tCO_2)	3,873,973	1,851,277	1,905,989	320,155

References

- Byungjun Lim. (2023, December). Ambassador Hong-sik Cho announces plan to build green shipping lanes at the 28th Conference of the Parties to the UNFCCC. MOF. https://www.mof.go.kr/doc/ko/selectDoc.do?docSeq=54171&searchDeptName=&menuSeq=971&searchEndDate=2023-12-31&searchEtc1=&searchEtc2=&searchEtc3=&searchEtc4=&searchEtc5=&currentPageNo=1&searchSelect=title&searchStartDate=2023-12-01&recordCountPerPage=&bbsSeq=10&searchValue=
- Comer, Bryan & Carvalho, Francielle. (2023, July 7). IMO's newly revised GHG Strategy: What it means for Shipping and the Paris Agreement. ICCT. https://theicct.org/marine-imo-updated-ghg-strategy-jul23/
- IMO. (2023). *2023 IMO Strategy on Reduction of GHG Emissions from Ships*. https://www.imo.org/en/OurWork/Environment/Pages/2023-IMO-Strategy-on-Reduction-of-GHG-Emissions-from-Ships.aspx
- Jaeho Jung. (2022, August). *IMO International Maritime Policy Trends (Vol. 61)*. KMI.
- Kang et al. (2023). *AIS-based global ship emissions analysis study (II) - Focusing on major Korean ports*. KMI.
- Kim et al. (2016, September). *Study on improvement plan to improve the reception rate of automatic ship identification system*. MOF.
- Kim et al. (2022). Study on Comparing the Performance of Fully Automated Container Terminals during the COVID-19 Pandemic. *Sustainability*. 14(9415). pp. 1-13.
- KOTRA. (2023, September). *South Korea Trade Status*. https://www.kotra.or.kr/bigdata/visualization/korea#search/ALL/ALL/2023/9/imp
- Kyung-cheol Sun. (2023, September). Economic Diplomacy' Focus of ASEAN-G20 Tour...Efforts to Expand New Markets, Trade and Supply Chains. *South Korea Policy Briefing*. https://www.korea.kr/news/policyNewsView.do?newsId=148920002&pWise=sub&pWiseSub=J1
- Sejun Kim. (2023, February). Korea's shipping industry to lead carbon-free transportation at sea. *MOF*. https://www.mof.go.kr/doc/ko/selectDoc.do?docSeq=49155&searchDeptName=&menuSeq=971&searchEndDate=2023-02-14&searchEtc1=&searchEtc2=&searchEtc3=&searchEtc4=&searchEtc5=&currentPageNo=1&searchSelect=title&searchStartDate=2023-02-14&recordCountPerPage=&bbsSeq=10&searchValue=
- SK E&S. (2023, May). *Hydrogen production, storage, and distribution: The core of the hydrogen economy value chain*. https://media.skens.com/4921
- Smith, T., et al.. (2021). *A Strategy for the Transition to Zero-Emission Shipping. – An analysis of transition pathways, scenarios, and levers for change*. Getting to Zero Coalition.
- Solutions for Our Climate (SFOC). (2023, September). *Industry Trends Brief No.3 - Port Decarbonization: Focusing on South Korean Five Major Ports*. https://forourclimate.org/en/sub/data/industry-trends-brief-no.3-port-decarbonization-focusing-on-south-korean-five-major-ports
- UMAS. (2021). *Five Percent Zero Emission Fuels by 2030 Needed for Paris Aligned Shipping Decarbonization*. https://www.u-mas.co.uk/five-percent-zero-emission-fuels-by-2030-needed-for-paris-aligned-shipping-decarbonization/
- UNCTAD. (2023, September 27). *Review of Maritime Transport 2023: Towards a green and just transition*. https://unctad.org/publication/review-maritime-transport-2023
- US Department of Energy. (2023, August 7). *Interagency Collaboration Releases Request for Information on the Establishment of Green Shipping Corridors between the U.S. and the UK*. https://www.energy.gov/eere/bioenergy/articles/interagency-collaboration-releases-request-information-establishment-green

- US Department of State. (2022, April 12). *Green Shipping Corridors Framework*. https://www.state.gov/green-shipping-corridors-framework/
- US Senator for California, Alex Padilla. (2023, June 8). *Padilla, Whitehouse Introduce Bills to Reduce Ocean Shipping Emissions*. https://www.padilla.senate.gov/newsroom/press-releases/padilla-whitehouse-introduce-bills-to-reduce-ocean-shipping-emissions/

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