SFO°C
Solutions for Our Climate

PACIFIC ENVIRONMENT

Korea's Green Shipping Pathways:

The Korean Shipping Landscape and Policy Recommendations for Ocean-Climate Leadership in Shipping

Korea's Green Shipping Pathways:

The Korean Shipping Landscape and Policy Recommendations for Ocean-Climate Leadership in Shipping

Author: John Yum (SFOC)

Acknowledgments:

Madeline Rose, Grace Healy, Antonio Santos Teresa Bui, and Hyunju Kang (Pacific Environment)

Esther Heo, Kate Kalinova, Daseul Kim and Hayoung Seo (SFOC)

Design IR plus Tel. 82.557.9592

Should you have any inquiries, please contact us at solutions@forourclimate.org

Executive Summary

Shipping is the bloodline of South Korea's economy, with 99.7% of South Korea's imports and exports transported by ships. Globally, South Korea is a leading nation in both shipping and shipbuilding, ranking 7th for the number of vessels owned, 4th based on traffic at container ports, and 1st based on construction of ships.

Due to the enormous volume of cargo carried by vessels, greenhouse gas (GHG) emissions from the shipping sector are significant. As 99.7% of Korea's trade is dependent on shipping, GHG emissions from the shipping sector will be much higher than current figures if GHG emissions of Korea's share of international shipping is included. In the case of international shipping's GHG emissions, the government and related industries are aiming to be aligned with IMO's target of 50% GHG emission reduction by 2050. However, if Korea fails to move beyond its current 50% GHG reduction targets for the shipping sector, it potentially risks losing its dominance in the shipping and shipbuilding industries.

Solutions for our Climate and Pacific Environment have prepared this report to provide an overview of the current landscape of Korea's shipping sector, including the key players involved, a better understanding of the current GHG emissions of the Korean shipping industry, as well as policy recommendations to help Korea its leadership position in the shipping industry.

The Korean government is making some initial steps made to reduce GHG emissions from the shipping sector. Recently, at the 27th Conference of the Parties of the United Nations Framework Convention on Climate Change (COP27), Korea agreed to work with the United States on feasibility study for Busan and Seattle/Tacoma ports' green corridor. However, we believe the following recommendations would accelerate Korea's efforts to achieve zero emissions.

Some key policy recommendations are:

(1) implement its first green corridor and expand green corridors to other ports and countries;
(2) accelerate and increase investments in green fuels such as green hydrogen and green ammonia;
(3) commit to not finance any new fossil ships, which includes both heavy fuel oil and LNG fueled ships; and
(4) build a coalition with various stakeholders, including but not limited to, the government, shipping companies, shipbuilding companies, port authorities, research institutes, classification societies, labor unions, residents living nearby the companies and ports, and civil societies to voice their concerns and to understand the general direction of achieving zero emission by 2050.

SFO°C
Solutions for Our Climate

ABOUT SFOC:

Solutions for Our Climate (SFOC) is a nonprofit organization established in 2016 for more effective climate action and energy transition based in Seoul, South Korea. SFOC is led by legal, economic, financial and environmental experts with experience in energy and climate policy and works closely with domestic and international players.

PACIFIC ENVIRONMENT

ABOUT PACIFIC ENVIRONMENT:

Pacific Environment is a global organization dedicated to protecting communities and wildlife of the Pacific Rim. Founded in 1987, Pacific Environment supports community leaders to fight climate change, protect the oceans, build just societies, and move away from fossil fuels toward a green economy. With three decades of achievement, Pacific Environment collaborates extensively with grassroots partners across the U.S. West Coast and Alaska, China, Vietnam, South Korea, and other Pacific Rim countries.

Contents

1. Introduction

Shipping is the bloodline of South Korea's economy, with 99.7% of South Korea's imports and exports transported by ships (Y. Yoon, 2009). Globally, South Korea (from hereon, Korea) is a leading nation in both shipping and shipbuilding, ranking 7th for the number of vessels owned, 4th based on traffic at container ports, and 1st based on construction of ships (UNCTD, 2021b; World Bank, n.d. -a; Y. Yoon, 2009).

Figure 1 Korea's Presence in the Global Maritime Industry

Due to the enormous volume of cargo carried by vessels, greenhouse gas (GHG) emissions from the shipping sector are significant. According to the International Maritime Organization (IMO), GHG emissions from the shipping sector make up 3% of the world's entire GHG emissions. If shipping was a country, it would be the 6th largest emitting country (Schlanger, 2018). This signifies the importance and urgency of the shipping industry's decarbonization. Some scientists project that GHG emissions from shipping will skyrocket to 17% by 2050 (Cames et al., 2015).

In 2020, Korea declared its intent to achieve carbon neutrality by 2050. In the case of shipping, Korea's announced carbon neutrality ambitions that only cover domestic shipping — shipping within its borders. In the case of international shipping's GHG emissions, the government and related industries are aiming to be aligned with IMO's target of 50% GHG emission reduction by 2050.

With the declaration of carbon neutrality by 2050, the Ministry of Oceans and Fisheries, the ministry that oversees the shipping industry, released a decarbonization roadmap for domestic shipping and fisheries. In response to this roadmap, Korean shipyards are also developing alternative fuels. The government plans to develop ships with low CO2 emissions and alternative fuels for eco-friendly ships. Unfortunately, the roadmap does not specify how Korea will work with other nations to reduce GHG emissions from international shipping.

If Korea fails to move beyond its current 50% GHG reduction targets for the shipping sector, it risks losing its dominance in the shipping and shipbuilding industries.

In the cases of other countries, the US and the EU have continuously called for the IMO to revise its current target of a 50% reduction by 2050. Independent from the IMO's goals, the EU plans to achieve net zero by 2050 by reducing 55% of GHG emissions by 2030, compared to 1990 levels. Meanwhile, the United States has committed to working with countries to adopt a goal of achieving zero emissions from international shipping no later than 2050 (The White House, 2021). In addition, the United States has proposed establishing green shipping corridors with ports internationally as a targeted emissions reduction strategy. Green corridors refer to specific shipping routes where ships would use low or zero emission fuels and ports will utilize GHG reduction technologies. On November 7, 2022, at the World Leaders Summit of Conference of the Parties of the United Nations Framework Convention on Climate Change (COP 27), Korea announced that it will cooperate with the United States to explore creation of a green shipping corridor between major cargo ports in Korea and the United States (US Department of State, 2022).

By declaring zero emissions in shipping by 2050 or even earlier, including both domestic and international shipping GHG emissions, Korea would send a strong message to other countries that it can and will maintain its current lead position in the shipping and the shipbuilding sectors. Korea is well primed to be a leader in the shipping industry because of its current position in shipping, shipbuilding and port industries, and it can leverage it's such role to lead the maritime clean energy technology transition, create new jobs, and reduce pollution in Korean port communities.

Pacific Environment (PE) and Solutions for Our Climate (SFOC) have jointly prepared this report for both international and domestic public policy and industry experts, academics and civil society organizations to provide an overview of the current landscape of Korea's shipping sector, including the key players involved, a better understanding of the current GHG emissions of the Korean shipping industry, as well as policy recommendations to help Korea achieve carbon neutrality in the shipping industry by 2050.

2. The Shipping Industry

2.1 Global

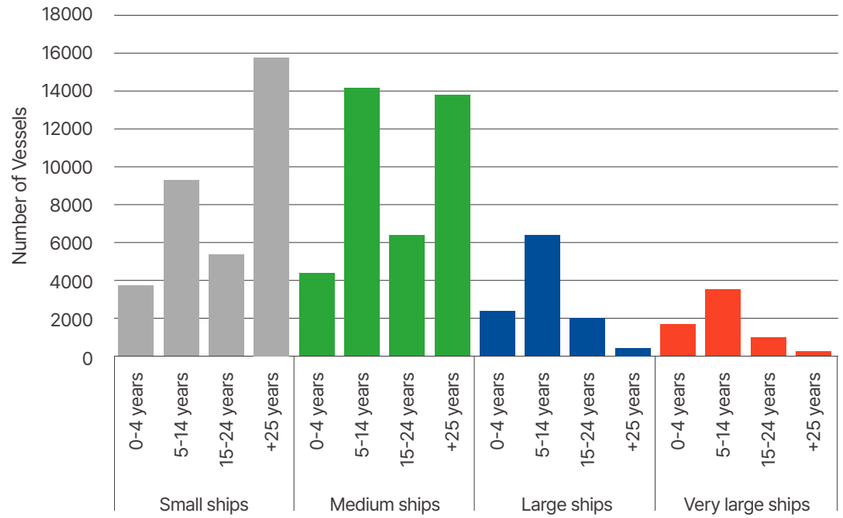
Shipping is the bloodline of global trade. Over 80% of the international cargo is transported by sea (UNCTD, 2021a). There are nearly 60,000 ships in international waters. Large and very large ships, which are ships that are larger than 25,000 gross tonnages (GT: measuring unit for ship) are only 20% of the world fleet but are responsible for 82% of the fleet's gross tonnage (Equasis, 2020). Container ships (cargo ships that transport standardized containers), tankers (ships that transport liquids or gases) and bulk carriers (ships that carry dry goods such as grains, coal, ore, steel coils, and cement), together make up the most of large and very large vessels, and they are responsible for more than 85% of shipping trade and 70% of the shipping industry's fuel consumption (Gray et al., 2021). Most of the large and very large ships are relatively new, with most of them being between 5 to 14 years old (Gray et al., 2021).

Table 1 Global Number of Ships and Types of Ships (Reproduced from H. Y. Yun et al., 2021)

Type of Vessels	Number of Vessels	Proportion to Total Vessels
Tanker	15,946	27.26%
Bulker	12,667	21.66%
Gas Carrier	2,222	3.80%
Container ship	5,572	9.53%
Multipurpose	3,169	5.42%
General Cargo	15,860	27.11%
Reefer	1,459	2.49%
RO-RO	834	1.43%
PCC	763	1.30%
	58,492	100%

Clarckson Research-Shipping Intelligence Network

Figure 2 Global by ship size and age (Reproduced from Gray et al., 2021)



As of January 2020, China has the greatest number of vessels, with 6,869 ships, but Greece has the most based on deadweight tonnage (DWT; measure of how much weight a ship can carry) basis, with 363,854DWT. Based on DWT, Greece, Japan, China, Singapore, and Hong Kong are countries with the most vessels registered in its country and flag of convenience (ships that are not registered in the vessel owner's country) combined (Korea Shipowners' Association, 2021).

Box 1 Types of Key Vessels manufactured by Hyundai Heavy Industries (Reproduced from Hyundai Heavy Industries Group, 2022)

[Tanker]

HHI is leading the tanker market with its streamlined eco-friendly designs specifically in VLCC (Very Large Crude Carrier) segment ever since its first delivery in 1974.
HHI is striving to take yet another leap in developing greener and more fuel-efficient technology for tankers for the future as well as designing new systems for next generation smart ships.

- Product Range: VLCC / Suezmax T/K / Aframax T/K & P/C / Shuttle Tanker

[Container ship]

HHI has delivered almost 600 container ships and boasts the world's largest performance record in this particular product segment.
HHI can construct as many as 20units of over 14,000 TEU Container ship (Ultra Large Container Ship) per year.

- Product Range: 19,200 TEU / 14,800 TEU / 11,100 TEU / 9,000 TEU

[LNG Carrier]

HHI is the only shipyard capable of constructing LNG (Liquefied Natural Gas) carriers of both Membrane type and Moss type Cargo Containment System, which contains liquefied natural gas at a temperature of -163°C. In addition, HHI can accommodate various kinds of propulsion systems, such as ME-GI, XDF as well as TFDE, Steam Turbine.

[LPG Carrier]

HHI dominates the VLGC market by its technical superiority and high quality. In consequence, HHI is maintaining 40% market share of VLGC orderbook and 45% market share of VLGC fleet.

HHI's constant innovation resulted in the application of the world's first flame-retarding insulation developed in cooperation with insulation system manufacturers to 84,000 cmb LPG carrier's cargo tank

-Product Range: 84K m^3 LPGC / 79.3K m^3 LPGC / 60K m^3 LPGC

Table 2 Top Shipping Countries (Reproduced from Korea Shipowners' Association, 2021)

[as of January 2020]

Country		Vessels			Ship Capacity (1,000 DWT)		
		National Flag Carrier	Flag of Convenience Carrier	Total	National Flag Carrier	Flag of Convenience Carrier	Total
1	Greece	671	3,977	4,648	60,827	303,027	363,854
2	Japan	909	3,001	3,910	36,805	196,330	233,135
3	China	4,569	2,300	6,869	99,484	128,893	228,377
4	Singapore	1,493	1,368	2,861	74,754	62,546	137,230
5	Hong Kong	883	807	1,690	72,505	28,452	100,957
6	Germany	205	2,299	2,504	8,341	81,062	89,403
7	Korea	778	837	1,615	14,403	66,180	80,583
8	Norway	383	1,660	2,043	1,885	62,051	63,936
9	Bermuda	13	529	542	325	60,089	60,414
10	United States	799	1,131	1,930	10,238	46,979	57,217
11	United Kingdom	317	1,027	1,344	6,836	46,355	53,191
12	Taiwan	140	850	990	6,636	44,255	50,891
13	Monaco	-	473	473	-	43,832	43,832
14	Denmark	25	921	946	31	42,683	41,714
15	Belgium	113	188	301	10,040	20,658	30,698
16	Turkey	449	1,079	1,528	6,657	21,433	28,090
17	Switzerland	26	401	427	1,113	25,365	26,479
18	India	859	183	1,042	16,800	9,035	25,836
19	Indonesia	2,132	76	2,208	22,301	1,604	23,906
20	Russia	1,403	339	1,742	8,293	14,812	23,106
Subtotal of 20 countries		16,167	23,446	39,613	458,274	1,305,641	1,763,849
Global total		23,375	29,586	52,961	576,941	1,471,035	2,047,975

UNCTAD, Review of Maritime Transport 2020
※1,000G/T or larger vessels

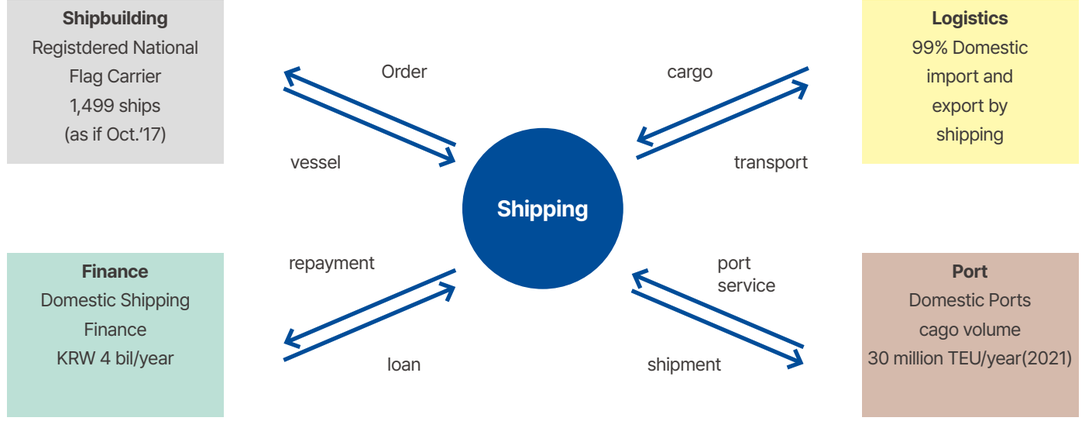
2.2 Korea

The export-oriented policies of South Korea are one of the most important factors in contributing to its economic success. According to the World Trade Organization, the country is the world's 7th largest exporter of goods, while being the 9th largest importer. In 2021, trade represented almost 80% of Korea's GDP (World Bank, n.d. -b). Some of Korea's top export items include integrated circuits (US$127 billion), cars (US$46 billion), refined petroleum (US$38 billion), ships and offshore platform and parts (US$22.9 billion), and motor vehicles parts and accessories (US$22.7 billion) (Statistics KOREA, 2022).

Given this high volume of cross-border trade and dependence on the maritime trade routes, shipping is the bedrock of Korea's economy – with 99.7% of its cargo being dependent on shipping for export and imports. South Korea has the world's 7th largest shipping fleet capacity and hosts the world's 6th largest port, located in the city of Busan, which is the 2nd largest metropolitan area following Seoul. Furthermore, HMM, the largest shipping company in Korea, ranks as the 8th largest shipping company in the world. Additionally, according to the Korean government, the shipping industry is responsible for providing 24,000 jobs, earns US$19 billion worth of foreign currency and has a revenue of 36 trillion Korean Won (approximately US$36 billion; exchange rate of US$1 : 1,000 Korean Won) (MOF & MTIE, 2022). Furthermore, together with the shipbuilding industry, it has a combined revenue of 77 trillion Korean Won (approximately US$77 billion) (MOF & MTIE, 2022).

The Korean government plays a key role in pushing Korea to be one of the top shipping countries in the world. For example, the government provides shipping companies with loans of around 4 trillion Korean Won per year (US$4 billion). It also arranges for sale and lease-back of used ships to help support the industry.

Figure 3 Ecosystem of Korea's Shipping Industry (Ministry of Oceans and Fisheries, 2018, 2022)



Since the bankruptcy of Hanjin Shipping, the then oldest and largest Korean shipping company and 7th largest shipping company in the world, in 2017, the government has fostered an environment for both Korea's shipping and shipbuilding to closely work together. As a result, 82% of orders (208 ships out of 274 ships) by Korean shipping companies were to Korean shipbuilders from 2018 to 2021 (MOF & MTIE, 2022).

Due to the shipping sector's interlinkages with the global supply chain of major industries, the decarbonization of this sector will significantly impact not only Korea's national economy, but also the scope 3 emissions of multinational corporations (US EPA, 2022).[1]

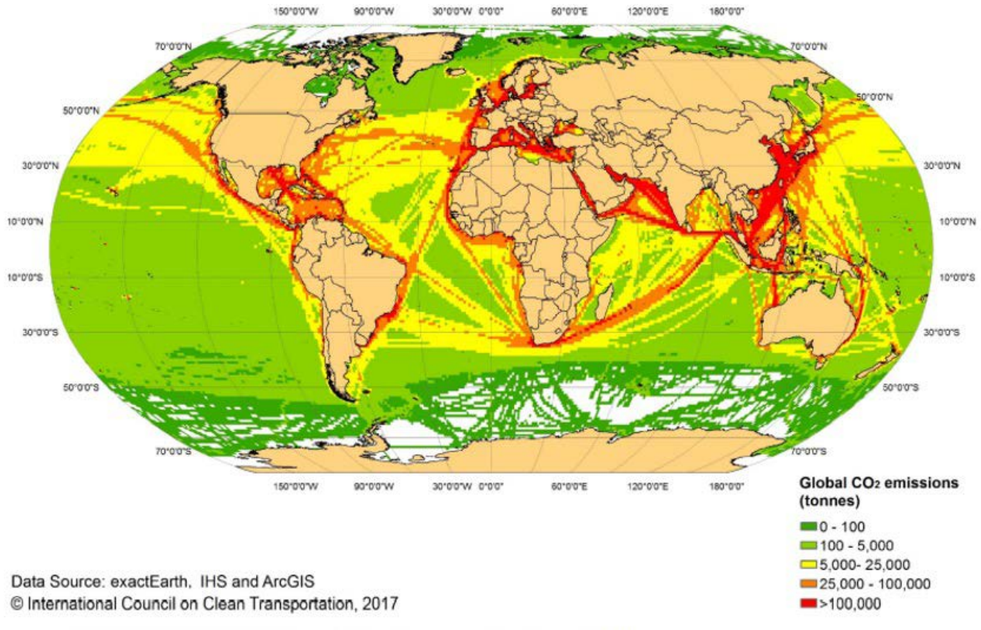
[1] According to US Environmental Protection Agency, Scope 3 emissions are *"the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly impacts in its value chain. Scope 3 emissions include all sources not within an organization's scope 1 and 2 boundary. The scope 3 emissions for one organization are the scope 1 and 2 emissions of another organization. Scope 3 emissions, also referred to as value chain emissions, often represent the majority of an organization's total GHG emissions."*

3. GHG Emissions in Shipping Industry

3.1 Global

With the adoption of the Paris Agreement in 2015, the global community agreed to limit global temperature rise to 1.5°C, compared to pre-industrial levels. This means that many industry sectors have to achieve zero emissions by 2050. Yet, the current IMO reduction targets of reducing GHG emissions from shipping to 50% compared to 2008 levels falls short of achieving carbon neutrality in the shipping industry and is not aligned with Paris Agreement goals.

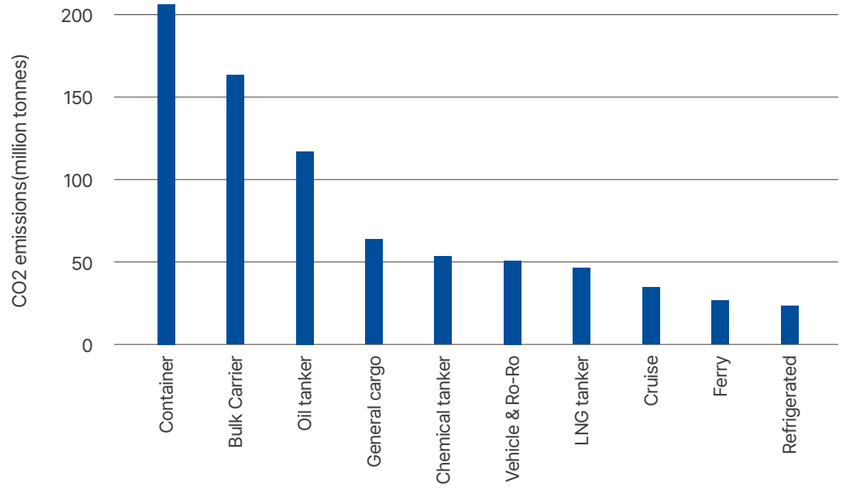
Figure 4 Shipping routes and Distribution of Shipping CO2 emissions (Reproduced from Olmer et al., 2017)



The top 5 shipping routes are: Asia-US, Asia-Europe, Europe-United Kingdom, United States-Canada, and intra-Asia, and CO2 emissions correlate with such routes (Wood, 2022).

According to the IMO, container shipping, bulk carriers and oil tankers are the dominant source of international shipping's GHG emissions. Combined with chemical tankers, general cargo ships and liquefied gas tankers, they constitute 86.5% of international shipping's total emissions (IMO, 2021).

Figure 5 CO2 emissions from international shipping by ship type (Reproduced from Gray et al., 2021)



While building and operating a vessel are both very GHG intensive, when applying the life cycle analysis to evaluate the environmental impacts of ships, most of ship's CO2 emissions arise from the operation of the ship (Quang et al., 2021).

Figure 6 Lifecycle of a ship (Revised from Quang et al., 2021)

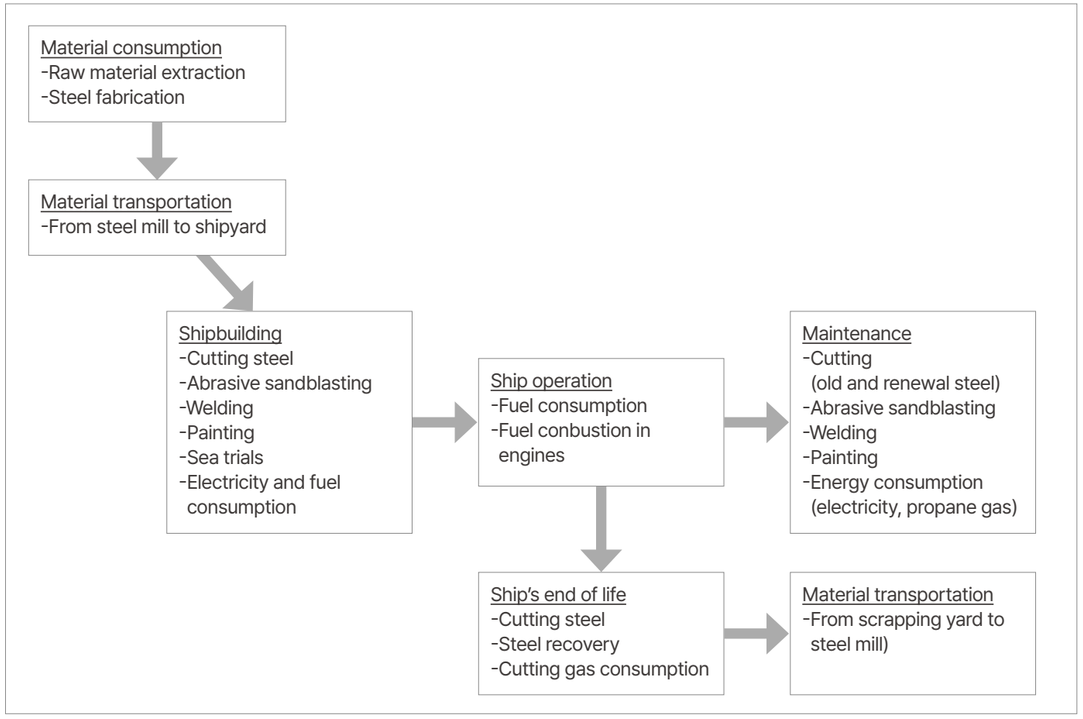


Table 3 GHG emissions arising from Shipbuilding to Shipping (Reproduced from Quang et al., 2021)

	CO2	CO	NOX	N2O	SOX
Material	1.8%	29.3%	0.1%	1.2%	0.0%
Shipbuilding	0.1%	0.2%	0.0%	0.0%	0.0%
Ship operation	99.1%	93.7%	99..9%	99.6%	100.0%
Maintenance	0.0%	0.0%	0.0%	0.0%	0.0%
End of life	-1.1%	-23.3%	-0.1%	-0.9%	0.0%
Transportation	0.1%	0.2%	0.1%	0.0%	0.0%

In response to the severity of GHG emissions in the shipping industry, some companies are taking the initiative to accelerate decarbonization efforts within the sector. For example, Maersk and CMA, two of the top shipping companies in the world, have proactively joined global corporates from other industries in setting ambitious decarbonization targets. CMA, a French shipping company, plans to invest US$1.5 billion over the next 5 years to accelerate its ships' energy transition. However, in its plan, CMA includes liquefied natural gas (LNG) fueled ships. Unfortunately, LNG is not a solution to decarbonization (Habibic, 2022). While LNG emits 25% less carbon dioxide (CO2) than conventional marine fuels, LNG is mostly methane, a GHG that has a global warming potential of more than 80 times that of CO2 over a 20-year time period (Pavlenko et al., 2020). In the case of Maersk, it is being recognized as a leader in the shipping industry for revealing its plans to decarbonize by 2040, 10 years ahead of other competitors (Maersk, 2022). Mediterranean Shipping Company, one of the top three shipping companies, also declared carbon neutrality by 2050, but they lacked specifics on how to achieve carbon neutrality (Dempsey, 2021b).

3.2 Korea

In 2019, South Korea emitted GHG equivalent to 701,370gg of CO2, with the transportation sector (including the shipping industry) representing about 14% of total national emissions. Although the Ministry of Oceans and Fisheries has said that Korea's shipping industry is responsible for less than 1% of national emissions, this does not accurately capture the entirety of the shipping industry's GHG emissions, as it omits the bulk of emissions coming from international shipping. In most countries, including Korea, international shipping and international aviation are excluded from the calculations of national GHG emissions despite international shipping being emission intensive (Greenhouse Gas Inventory & Research Center of Korea, 2021). Notably, United Kingdom recently decided to include its international shipping into its carbon budget, setting a positive precedent for the accurate measurement of the emissions coming from the shipping sector.

International shipping's GHG emission dwarfs that of domestic shipping, as it is more than 95% of entire shipping GHG emissions. One common way to measure a country's share of international shipping emissions is through international bunkering, which is maritime fuel sold by country for ships operating outside a nation's borders. Other ways to calculate international shipping emissions include bunker fuel country basis or by flag country, owner country, operator country, or manager country.

As 99.7% of Korea's trade is dependent on shipping, GHG emissions from the shipping sector will be much higher than the current figures if GHG emissions of Korea's share of international shipping is factored in (Jeong et al., 2022). As shipping faces increasing global pressure to decarbonize by 2050, it is critical to know how much of international shipping's GHG emissions is actually due to Korea's fleets, owned or controlled, in order to appropriately respond to challenges and competition from other nations. A future assessment could be made to accurately calculate Korea's share of international emissions to have an accurate understanding of the shipping sector's climate impact (Selin et al., 2021).

3.2.1. Eco-Friendly Ship Act and Greenship-K Promotion Strategy

In response to global measures to the climate crisis, the Korean government committed to becoming carbon neutral by 2050 in October 2020. In order to tackle the GHG emissions issue in the shipping industry and in response to IMO's strengthening of SOx restrictions, the government also passed the Act on Promotion of the Development and Distribution of Eco-Friendly Ships ("Eco-Friendly Ship Act") in 2018 (H.-K. Lee, 2021). The Eco-Friendly Ship Act establishes a basis for the government to push for the manufacture and distribution of eco-friendly ships that use eco-friendly fuel. However, the definition of "Eco-Friendly Ship" is broad, including scrubbers and LNG fuels, in addition to electricity, fuel cells, hybrid vessels, hydrogen, ammonia, etc. (Environmentally Friendly Shipping Act, 2018).

Furthermore, based on this Eco-Friendly Ship Act, in 2021, the Ministry of Oceans and Fisheries announced the 2030 Greenship-K Promotion Strategy, the government's plan to decarbonize the shipping industry by 2050 and its first initiative to promote eco-friendly ships (Prevljak, 2020). In July 2022, the Ministry of Oceans and Fisheries and Ministry of Trade, Industry and Energy jointly launched the Unified Business Team for Eco-friendly ship LCA Innovation Technology Development Business to invest 250 billion Korean Won (approximately US$ 250 million) from 2022 to 2031 to develop mid and large size eco-friendly ships (MOF, 2022a).

However, Korean government's goal to align with IMO's 50% reduction by 2050 may need to be revised upwards in the near future. IMO Secretary-General Kitack Lim stated in the 77th Marine Environment Protection Committee (MPEC) meeting in 2022, that 'Strengthening the ambition of the Initial IMO GHG Strategy during its revision will be crucial. Our collective actions must show our dedication to contribute towards the global issue, climate change (Tan, 2021). He further reiterated this point during the recent 2022 Korea Maritime Week, stating that IMO's position on net zero by 2050 will be disclosed sometime in July 2022. At COP27, Korea joined other nations to support carbon neutrality by 2050 in the international shipping area (Bureau of Climate, Environmental Science and Diplomacy, 2022). This would give a clear message to other countries and stakeholders that Korea plans to achieve zero emissions in shipping and will continue to be leader in shipping industry well into the future.

4. Key Players

This section provides a landscape of key players in the Korean shipping industry, diving into each key player's business overview, structure, strategic direction, competitors, and greenhouse gas emission strategies.

4.1 HMM

4.1.1 Business Overview

HMM, formerly known as Hyundai Merchant Marine, is the world's 8th largest shipping company with 814,766 twenty-foot equivalent units (TEU; TEU is often used to describe container ships' cargo capacity and ports that handle containers) and has a global market share of 3.2% (Alphaliner, 2022; HMM, 2022b). It has 102 ships, 51 owned and 51 charted, providing more than 60 service routes and connecting to more than 100 ports (HMM, 2022b, 2022a). Its revenue has been steady in the range of 5 trillion Korean Won (around US$5 billion) to 6.4 trillion Korean Won (around US$6.4 billion) from 2017 to 2020 until it more than doubled to 13.8 trillion Korean Won (US$13.8 billion) in 2021 (HMM IR, n.d.).

HMM was initially a subsidiary of Hyundai Heavy Industries, but it entered into a voluntary agreement with the creditors to restructure its financial problems after it posted an operating loss of 253.5 billion Korean Won (around US$253 million) in 2015, resulting in the government to become the largest shareholder of HMM (J. Yoon, 2016).

In 2018, HMM ordered a total of 20 container vessels from Hyundai Heavy Industries (8 vessels), Samsung Heavy Industries (5 vessels), and Daewoo Shipbuilding and Maritime Engineering (7 vessels) for a total of 3 trillion Korean Won (US$3 billion). Despite having the opportunity to order from a single shipbuilder, HMM decided to distribute the orders to the three companies to help the financially struggling shipbuilders under the government's 5-Year Shipping Rebuilding Plan (D-H. Kim, 2018).

Since 2016, when the global shipping sector was hit by the recession, the Korean government has invested more than 7.4 trillion Korean Won (US$7.4 billion) into HMM (S. Kim, 2022). As HMM gradually stabilizes and improves in profitability, the government plans to sell HMM to private companies in the near future (MOF, 2022b).

Table 4 Top 10 Carriers of the World (Reproduced from Sylvain, 2022)

	Current TEU	Current Ships	On order TEU	Market Share
MSC	4,455,950	684	1,533,898	17.3%
APM-Maersk	4,255,163	733	321,938	16.5%
CMA CGM	3,294,250	577	640,289	12.8%
COSCO	2,904,122	469	586,672	11.3%
Hapag-Lloyd	1,765,563	253	415,588	6.8%
Evergreen Line	1,554,762	202	568,296	6.0%
ONE	1,523,088	207	440,686	5.9%
HMM	814,557	74	176,488	3.2%
Yang Ming	673,329	92	35,580	2.6%
Zim	483,243	133	389,904	1.9%

Table 5 Ships owned and operated by HMM (Reproduced from HMM, 2022b)

*Chartered-in Vessels : Vessels chartered in more than 1 year

As of Jun. 30, 2022	HMM Vessels		Owned Vessels		Chartered-in Vessels*	
	Capacity	No.	Capacity	No.	Capacity	No.
Containerships	809,526 TEU	72	555,643 TEU	37	253,883 TEU	25
≥20,000 TEU	286,848 TEU	12	286,848 TEU	12	0 TEU	0
≥10,000 TEU	341,820 TEU	26	215,924 TEU	15	125,896 TEU	11
<10,000 TEU	180,858 TEU	34	52,871 TEU	10	127,987 TEU	24
Tankers	2,061,586 DWT	9	1,601,196 DWT	7	460,390 DWT	2
Crude Tankers	1,960,214 DWT	7	1,499,824 DWT	5	460,390 DWT	2
Other tankers	101,372 DWT	2	101,372 DWT	2	0 DWT	0
Dry Bulkers	1,914,700,DWT	17	302,545 DWT	3	1,612,155 DWT	14
Multi-Purpose Vessels	120,078 DWT	4	120,078 DWT	4	0 DWT	0
Total No. of Vessels	102		51		51	

4.1.2 Company Structure

HMM's major shareholders currently are (1) Korea Development Bank at 20.69%, (2) Korea Ocean Business Corporation at 19.96%, and (3) Korea Credit Guarantee Fund at 5.02%. The three shareholders are all controlled by the government; thus, making the government the largest shareholder of HMM with a total of 45.7%. Shares of HMM are traded on the Korea Exchange (KRX). In addition to ownership of HMM shares, KOSE and KDB purchased more than 2 trillion Korean Won (around US$2 billion) worth of convertible bonds and bonds with warranties from 2018 until 2020 (D.-H. Park, 2022). If KOSE and KDB exercise their rights to the bond, they will gain much larger ownership of HMM.

Table 6 HMM Major Shareholders (Reproduced from HMM, 2022b)

*As of Jun. 30, 2022

Shareholders	Number of Shares	Shareholding Ratio
Korea Developoment Bank	101,199,297	20.69%
Korea Ocean Business Corporation	97,590,859	19.96%
Korea Credit Guarantee Fund	24,527,807	5.02%
Others	265,721,533	54.34%
Total	489,039,496	100.00%

4.1.3 Notable Customers

Although HMM does not disclose data regarding its key customers, we can reasonably infer that major companies in Korea would use HMM when they export their products to China (US$131 billion), the United States (US$75 billion), Vietnam (US$48 billion), Hong Kong (US$30.9 billion), and Japan (US$25.1 billion).

The top 10 largest companies in Korea by sales are Samsung Electronics (integrated circuits and consumer electronics), Hyundai Motor Company (motor vehicles), SK hynix (integrated circuits), Kia (motor vehicles), Posco Holdings (steel), LG Display (display), LG Electronics (consumer electronics), Hyundai Mobis (motor vehicle parts and accessories), LG Chem (refined petroleum) and Hyundai Steel (steel) (KIND, 2021).[2]

However, some of HMM's customers are disclosed via public filings. In February 2021, HMM initiated a long-term transport contract with GS Caltex for 3 VLCCs (very large crude carriers) to carry 6.3 trillion Korean Won worth of crude oil for 10 years. Previously in 2018, HMM had a contract with GS Caltex to transport 1.9 trillion Korean Won worth of crude oil for 5 years (HMM, 2021).

[2] Public enterprises and non parts and material businesses were excluded.

4.1.4 Major Competitors

HMM is by far the largest shipping company in Korea. According to Alphaliner, in 2020, HMM ranked 8th with 718,967 TEU, while Korea Marine Transport (KMTC) ranked 14th with 158,828 TEU, Sinokor Merchant Marine (Sinokor) ranked 20th with 98,521 TEU, and SM Line ranked 26th with 56,970 TEU (Shipping News Net, 2021). In 2020, HMM joined the Alliance, the 3rd largest shipping alliance. The Alliance members are Hapag-Lloyd of Germany, OEN of Japan, and Yangming of Taiwan (Hellenic Shipping News Worldwide, 2020). Previously, HMM was part of 2M, which consisted of Maersk and MSC, the world's largest shipping alliance (Hellenic Shipping News Worldwide, 2020).

4.1.5 Strategic Direction

In 2022, HMM announced its latest mid-long-term plan. HMM plans to increase its shipping capacity to more than 1.2 million TEU, up from 820,000 TEU, substantially increase bulk carriers by 90% to 55 ships, and invest more than 15 trillion Korean Won (US$15 billion) from 2022 to 2026 in vessels, terminals, and logistic facilities (HMM, 2022c).

4.1.6 Greenhouse Gas Emission Reduction Strategies

HMM's GHG emissions have been increasing since 2019, from 4,237,447tCO2e to 4,911,971tCO2e in 2020, and 5,513,352tCO2e in 2021. HMM plans to reduce its business as usual (BAU) GHG emissions by 21.5% by 2030. To reduce these emissions, HMM will focus on acquiring LNG fueled ships and eco-friendly fueled vessels in order to achieve net zero by 2050 (HMM, 2022c).

In addition, in May 2021, HMM declared net zero by 2050 and 50% GHG emission reduction by 2030. In the same month, it signed a memorandum of understanding (MOU) with POSCO, Lotte Global Logistics, Lotte Fine Chemical, Korean Register, and KSOE to jointly develop green ammonia and to operate such ships delivered by Korea Shipbuilding and Offshore Engineering, the parent company of Hyundai Heavy Industries (HMM, 2022c).

4.2 Korea Shipbuilding and Offshore Engineering

4.2.1 Business Overview

Korea is the no. 1 shipbuilding country in the world, followed closely by China (Yonhap, 2022). And Korea Shipbuilding and Offshore Engineering (KSOE) plays a big part in the shipbuilding market. KSOE is the holding company of Hyundai Heavy Industries (HHI), Hyundai Mipo Dockyard (HMD), and Hyundai Samho Heavy Industries (HSHI), Hyundai group's three shipbuilding companies. It is by far the biggest shipbuilding group in Korea. KSOE's primary businesses are shipbuilding, offshore and industrial plants, engine and machinery, and solar energy (KSEO, 2022a). HHI and HSHI focus on building large vessels while HMD focuses on building mid-sized vessels (J. Nam, 2021).

Among the KSOE companies, HHI is the biggest shipbuilding company and has delivered more than 2,300 vessels to 324 shipowners (Hyndai Heavy Industries Group, 2022). It has manufactured various types of ships such as container ships, VLCCs, LNG carriers, and LPG carriers.

In 2021, HHI signed a contract to deliver 8 methanol-fueled container ships to Maersk, the world's no. 1 shipping company. It will be the first large vessel in the world to be equipped with a methanol engine (KSEO, 2022a). As of October 2022, Maersk ordered a total of 19 methanol-fueled ships from HHI (Ryu, 2022). In addition, KSOE announced that it had contracted to build 4 LNG-fueled container ships (Choi, 2022).

Table 7 KSOE's shipbuilding orders (Reproduced from KSOE, 2022)

(Unit:USD 100 million)

Classification Shio Type		2019		2020		2021	
		No of ships	Amount	No of ships	Amount	No of ships	Amount
Shipbuilding	LNGC	24	123.9	21	97.9	29	201.5
	LPGC	19		16		49	
	Container ship	22		5		72	
	Tanker	73		70		53	
	Others	8		3		13	
Naval & Special ship		1	6.2	1	3.8	3	10.4
Offshore engineering	Manufacturing equipment	-	0.5	-	2.6	3	17.9
Plant		-	1.7	-	0.5	-	0.3
Engine & Machinery		-	14.2	-	9.0	-	20.7
Total		147	146.5	116	113.8	222	250.8

*Combined no. of orders recelved by HHI, HMD, HSHI(based on the consolldation of shipbuilding subsidiaries)

However, even though HHI has continued to receive orders for vessels, like other Korean shipbuilders, HHI has reported losses for many years. This industry-wide decline is primarily due to the increase in steel and other materials prices, and the low purchase price of the ships (Shipping News Net, 2022). In particular, the shipbuilding industry is highly affected by the increase in steel price (S.-H. Kim, 2022). It is also notable that the Korean steel and shipbuilding industries are closely intertwined. In 2019, the three largest customers of the Korean steel industry were construction (30.6%), automotive (27.7%), and shipbuilding (19.7%), where Korea and China would often rank 1st and 2nd in the world respectably. Since 2010, the construction and automotive industries have driven demand for steel products, while, in contrast, the shipbuilding portion has declined by about 5.2% on account of a decade-long slump in the global shipbuilding industry (J. Kim & Kim, 2021).

4.2.2 Company Structure

KSOE's majority shareholder is HD Hyundai, formerly known as Hyundai Heavy Industries Holdings, which is the holding company with about 35% of shares in KSOE (Ahn, 2022; KSOE, 2022b). In turn, KSOE has 78% shares of HHI, 80% of HSHI, and 42.4% of HMD. Except for HSHI, which is an unlisted company, HD Hyundai, KSOE, HHI and HMD are listed in the KOSPI Market.

4.2.3 Major Competitors

The main domestic competitors of Hyundai Heavy Industries are Samsung Heavy Industries (SHI) and Daewoo Shipbuilding and Marine Engineering (DSME). In 2019, HHI announced plans to acquire 55.7% shares of Daewoo Shipbuilding from KDB for about 2 trillion Korean Won (around US$2 billion) (Yoo, 2022). However, the EU rejected the HHI-DSME merger in January 2022 on an anti-trust basis. Recently, it was reported that Hanhwa Group has expressed interest in purchasing shares of DSME from the Korea Development Bank, which is controlled by the Korean government (S.-Y. Jung, 2022).

As of July 2022, SHI, HHI, DSME, and HSHI are ranked 1, 2, 3, and 4 respectively in the world based on order backlog (Oh, 2022). Korean shipbuilders in the aggregate narrowly beat Chinese shipbuilders by 2% (Oh, 2022). Outside Korea, China State Shipbuilding Corporation, China Shipbuilding Industry Corporation, and Imabari Shipbuilding (Japan) are key competitors (Chung & Lim, 2022).

4.2.4 Strategic Direction

HHI has disclosed its plans to achieve revenue of 21 trillion Korean Won (US$21 billion) and an operating income of 10% by 2030 (Y.-S. Lee, 2022). In order to achieve this goal, HHI plans to invest 6 trillion Korean Won (US$6 billion) into developing smart shipyards, hydrogen carriers, and fully autonomous ships (Y.-S. Lee, 2022).

4.2.5 Greenhouse Gas Emission Reduction Strategies

KSOE reported 6,963tCO2e for its 2020 GHG emissions. Because KSOE is not a shipbuilding company, its GHG emissions are much lower than its subsidiaries. By contrast, HHI reported that its GHG emissions have been increasing since 2018, with 485,537tCO2e in 2018, 509,780tCO2e in 2019, and 523,352tCO2e in 2020 (KSOE, 2022).

According to KSOE, its strategy to reduce GHG emissions is by developing and manufacturing low-carbon and zero-carbon ships (KSOE, 2022). It is currently developing LNG dual-fuel ships, ammonia-fueled ships, hydrogen ships, CO2 carriers, and electric propulsion ships (KSOE, 2022). KSOE expects to develop ammonia-fueled ships by 2025 to2027, while hydrogen, fuel cell, and electric propulsion ships are expected to be developed by 2028 to 2030.

KSOE is yet to declare a net zero by 2050 target. However, in April 2021, it joined other shipbuilders in committing to work towards achieving net zero by 2050 by joining the 'Shipbuilding Carbon Neutrality Committee (Mandra, 2021).

In November 2021, HHI, KSOE, and ABD agreed to jointly develop a technical guidance for green hydrogen production from offshore platforms, where the companies aim to utilize seawater electrolysis to generate hydrogen. Furthermore, the three companies plan to develop a CO2 injection platform for offshore storage, which would be designed to store 400,000 tons of captured and liquefied CO2. Both projects are targeted to be usable from 2025 (Battersby, 2021).

Table 8 HHI, SHI, DSME's eco-friendly Ships R&D status (Reproduced from D.-J. Kim, 2022)

Shipyard	Development status
KSOE	- First in the world to build methanol duel fueled engine vessels and developing ammonia and hydrogen fuel propelled ships - Acquired basic certification from Korea's Register for conceptual design for ammonia fuel supply system in December 2021, goal is to commercialize by 2024 - announced "Hydrogen Dream 2030 Roadmap" to develop hydrogen value chain and to develop hydrogen fueled vessels
SHI	- Acquired basic certification from Lloyd's Register and DNV for basic design for ammonia ready VLCC and ammonia fueled 110,000 metric ton tanker - To develop and have detail design of ammonia fuel supply system, and commercialize by 2024
DSME	- Acquired basic certification from Lloyd's Register for ammonia ready LNG dual fuel propulsion engine container ship and VLCC; goal is to commercialize by 2025 - Currently designing ammonia bunkering vessel

4.3 Busan Port Authority (BPA)

4.3.1 Business Overview

Busan Port, located in the southeastern tip of Korea, is the largest port in Korea, with 21 million TEU of cargo (77% of the country's cargo container volume handled). It is the world's 7th largest port, based on container cargo, and the 3rd largest, based on transshipment after Singapore (Busan Port Authority, 2022). At the Busan port, 60% of Korean goods are exported and 96% of transshipment goods are handled. The transshipment cargo is primarily headed to China, Japan and the United States (G.-C. Nam, 2021).

Busan Port Authority (BPA) develops and operates Busan port facilities, port redevelopment, and other businesses delegated by the government to make Busan port competitive as Northeast Asia's key hub port (BPA, 2022b).

4.3.2 Company Structure

BPA was established in 2004 in accordance with the Port Authority Act of 2003 and is owned and operated by the government (BPA, 2022). The Ministry of Economy and Finance has 87.31% shares and the Korea Ocean Business Corporation has 12.69%. BPA is not a listed company.

4.3.3 Major Competitors

Busan port is by far the largest port in Korea. The next biggest Korean ports are Gwangyang (located in the middle south of Korea), Ulsan (located in east Korea), Incheon (located near Seoul), Pyeongtaek-Dangjin (located near west Korea) by TEU. Busan processed 77% of containers coming in and going out of Korea.

Figure 7 Top 10 Korean ports (Cargo by Ports; mof.go.kr 2021)

(unit:1,000 tons, %)

4.3.4 Strategic Direction

BPA has recently announced its 2030 vision. It aims to strengthen its world's 3rd largest transshipment rank by having 60% of cargoes be transshipped and, by developing port related-business, achieve 7.7 billion Korean Won worth of impact on the local economy (G.-M. Yim, 2015).

4.3.5 Greenhouse Gas Emission Reduction Strategies

Busan Port has reported that its GHG emissions for the past 4 years were steadily decreasing: 658tCO2eq in 2018, 529 tCO2eq in 2019, 472tCO2eq in 2020, and 436tCO2eq in 2021 (BPA, 2022a). It was further reported that vessels are responsible for 59% of Busan port's total GHG emissions, unloading equipment was responsible for 39% and vehicles were responsible for 2% (BPA, 2022a). For air pollutants, more than 45,000 ships enter and leave the port annually, and this is responsible for 94.79% of Busan port's air pollution (ME, 2021). Meanwhile, according to the government's report, Busan Port's SO2 and NO2 concentration is higher than that of Busan city (MOF, 2021a).

In April 2022, Busan Port announced plans to establish the 2050 Comprehensive Plan for Carbon Neutrality of Busan Port (Ship Technology, 2022). Some of BPA's plans are to have solar power generation facilities in Woongdong Distripark, and use seawater for heating, ventilation, and air conditioning system (Ship Technology, 2022).

To achieve the targets outlined in the "Busan Port Green Port Roadmap", Busan Port Authority aims to switch from gasoline-based rubber tire gantry cranes to electric E-RTGC/cable reels to save fuel costs and reduce CO2 emissions. According to BPA, they electrified over 100 cranes and committed to zero-emission ferries and harbor craft, that will be operational in 2023. Busan Port has also implemented eco-friendly incentives, the use of hybrid and electric vehicles, and the installation of alternative marine power (AMP) (Shin & Kim, 2020).

In March 2022, BPA announced plans to increase the number of AMP to reduce air pollutants from ships by waiving port dues if such ships use AMP installed at Busan North port (H. Park, 2022). Since 2019, Busan Port has installed 20 AMP facilities; however, few ships have used these AMP facilities. This underutilization is likely due to the use of AMP not being mandatory and more expensive than using a ship's fuel. Furthermore, the government's support for refitting ships with AMP equipment is not sufficient (H. Park, 2022).

The Korean government plans to build AMP facilities in 248 berths by 2030 in the following key ports: Busan Port (62 facilities), Incheon Port (27), Gwangyang (22), Pyeongtak -Dangjin (24), Ulsan (24), and Pohang (28). The government plans to invest 699 billion Korean Won (US$699) into developing this AMP infrastructure, with port authorities investing an additional 231 billion Korean Won (US$231 million) (Ryo, 2019).

4.4 The Korean Government

4.4.1 Overview

For South Korea, effectively an island given the inaccessibility of land routes, shipping is a crucial industry as Korea is 99% dependent on its export and import by sea. The Korean government, through various government organizations, has been providing support to the shipping industry in various ways, such as loans, sales and lease back, guarantees, etc. When Hanjin shipping, then Korea's largest shipping company went bankrupt in 2017, Korea's shipping plummeted to 10th from 5th, and the shipping industry lost at least 10 trillion Korean won (around US$10 billion) (Korea Policy Briefing, 2021). The government took action to support the shipping industry by revealing a 5-Year Shipping Rebuilding Plan to revive the shipping industry in 2018. It established the Korea Ocean Business Corporation (KOBC) to invest and provide loans to the domestic shipping industry. Through the support of KOBC, 20 very large container ships (VLCS) were ordered by HMM at 3.15 trillion Korean Won (around US$3.15 billion). The Korean shipping industry is now recovering to the pre-Hanjin bankruptcy level (Korea Policy Briefing, 2021).

4.4.2 Structure

Ministry of Oceans and Fisheries

The Ministry of Oceans and Fisheries oversees the shipping industry. Its budget for the fiscal year 2022 is 6.3 trillion Korean Won (around US$6.3 billion) (J.-H. Jung, 2021). As mentioned above, together with the Ministry of Trade, Industry and Energy, the Ministry of Oceans and Fisheries has announced plans to develop eco-friendly ships by investing more than 250 billion Korean Won (around US$250 million) over 10 years from 2022 to 2031 (Suh, 2021). The investment will be provided to companies, universities, and research institutions to research such ships (Suh, 2021). Such an amount is slightly more than 10% of the annual budget allocated to shipping by the Ministry of Oceans & Fisheries (2 trillion Korean Won (around US$2 billion)). In order to accelerate decarbonization, the government will need to expand the shipping budget itself and the R&D budget.

Korea Ocean Business Corporation

The Korea Ocean Business Corporation (KOBC) was established in July 2018 after Hanjin Shipping, then the largest Korean shipping company went bankrupt. Its goals are to enhance the competitiveness of Korea's maritime transport industry by providing the shipping companies' ships and liquidity safety (KOBC, 2022). Its key areas are (1) investment support - investment on ships and terminals, acquisition, management and sale of ships, and purchase and brokerage of bonds and stocks; and (2) guarantee service - investment guarantee on ships and/or terminals (KOBC, 2022). KOBC was established by combining Korea Maritime Guarantee Insurance, which was established to provide subordinated financing, and Korea Ship & Offshore, established to purchase ships from shipping companies and lend the vessel back to the shipping company (also referred to as tonnage bank) (Jun et al., 2019). The Ministry of Oceans and Fisheries, along with the Ministry of Economy and Finance, is the majority shareholder of KOBC with 53.57%.

KOBC, since its incorporation, has provided 7.2 trillion Korean Won (around US$7.2 billion) to 101 shipping companies as of June 2022 to support the acquisition of competitive vessels and stabilization of shipping companies' business (S.-S. Kim, 2022).

When HMM ordered 20 container ships from HHI, SHI and DSME, Korea Development Bank, Korea Ocean Business Corporation, Korea Eximbank, Korea Trade Insurance Corporation, and Korea Asset Management Corporation jointly provided 3.15 trillion Korean Won (around US$3.15 billion) (H.-M. Kim, 2018). However, KOBC's support to HMM has been decreasing: 1.69 trillion Korean Won (around US$1.69 billion) in 2019, 1.1 trillion Korean Won (around US$1.1 billion) in 2020, and only 800 million Korean Won (around US$800,000) in 2021 (M. Kim, 2022).

In addition, KOBC has provided guarantees to Korean shipping companies to install scrubbers to comply with IMO's regulations (Moon, 2019).

Table 9 KOBC financial support from July 2018 to October 2021

	Support of acquisition of assets					Support for business stability		Total
	Ship funding	Eco-friendly equipment	Scrap ship subsidy	Container box	Logistics	S&LB	Capital	
Amount (100 million Korean	24,647	4,882	620	6,127	699	4,676	22,968	64,700

4.4.3 Other Key Government Organizations

Korea Development Bank

Since the 1970s, Korea Development Bank (KDB) has provided financing for shipping companies and continues to provide loans and acquisition of shares of such companies. KDB is the largest shareholder of HMM (20.69%) and DSME (28.2%) (J.-H. Park, 2022).

Export Import Bank of Korea

Export Import Bank of Korea (KEXIM) provides loans and guarantees to Korean and foreign shipping companies for their purchase of vessels, refinancing, and working capital (Korea Eximbank, 2022). In addition, KEXIM provides financing to Korean shipbuilders.

Korea Asset Management Corporation

Korea Asset Management Corporation (KAMCO) provided shipping funds by sale and leaseback arrangement after the financial crisis of 2008, and, from 2009 to 2011, it purchased 33 ships from 7 shipping companies and leased back the ships to them (Jun et al., 2019). In addition, in 2015, KAMCO created KAMCO Shipping Fund to provide support to the shipping industry (KAMCO, 2022).

KOBC works closely with KDB, KEXIM, and KEMCO to provide financial support to the shipping industry. In June 2021, they initiated an MOU to provide support for the construction of vessels (KOBC, 2022). Under the support program, the organizations will provide US$1.5 billion to shipping companies, with plans to expand to US$3 billion (KOBC, 2022).

Accordingly, KOBC, KDB, KEXIM, and KEMCO jointly provided US$78 million for a domestic shipping company's order of 5 very large LPG carriers for US$390 million in May 2022 (Suk, 2022).

Figure 8 Role of KOBC, KDB, KEXIM, KAMCO and K-Sure (Reproduced from Jun et al., 2019)

	Subordinated Loan (including equity investment)	Senior Loan (including guarantee)	Ship Bond (including guarantee)
Korean vessels	▲●□◈	▲△●□◈	▲
Foreign vessels	▲●	▲△●	▲△

KEXIM / Korea Trade Insurance Corporation / KDB / KAMCO / KOBC

4.4.4 Strategic Direction

With the success of the 5-year rebuilding plan, the government revealed the 2nd step of the plan, the "Shipping Industry Leading Country Strategy." The plan is to achieve the following by 2030: revenue of at least (1) 70 trillion Korean Won (around US$70 billion) from the shipping industry, (2) 1.5 million TEU for container ships, and (3) 1.4 billion DWT ships (Korea Policy Briefing, 2021).

Further, the government plans to support the commercialization of zero-carbon vessels by 2050 and build LNG bunkering ships and bunkering terminals. In addition, the government plans to increase the national eco-friendly ship fleet by up to 528 vessels (Korea Policy Briefing, 2021).

4.4.5 Greenhouse Gas Emission Reduction Strategies

In conjunction with the Korean government's declaration of net zero by 2050, in December 2021, the Ministry of Oceans and Fisheries announced the Oceans and Fisheries 2050 Carbon Neutrality Roadmap (MOF, 2021b). For shipping, it plans to reduce 70% by 2050: 3,07,000 tons, based on 2018 emissions of 1,019,000 tons (MOF, 2021b). Since the figures do not reflect Korea's share of international shipping, the emissions are lower than those of fisheries, which were 3,042,000 tons as of 2018. For the shipping sector, the Ministry of Oceans and Fisheries plans to switch existing fuel to low-emission and zero-emissions ships. To achieve this, the Ministry of Oceans and Fisheries will increase its efforts to utilize LNG and other low-emission fuels, while commercializing zero-emission ships by 2030. It plans to induce private companies to switch to eco-friendly ships by switching government-operated vessels first and support the construction of eco-friendly ships (MOF, 2021b).

The Ministry of Oceans and Fisheries is also providing support to Korean shipping companies by providing 10% of installation costs to limit engine power to satisfy IMO's GHG restrictions which will be in effect from January 2023 (B.-J. Yim, 2022).

Table 10 Ministry of Oceans and Fisheries plan for decarbonization by 2050

(unit:10,000 tons)

	2018 Emission	Target Emission for 2050	Reduction Rate
Total	406.1	42.2	90%
Shipping	101.9	30.7	70%
Fisheries, Fishing village	304.2	11.5	96%

With the support of the government, HMM ordered 20 very large container ships with hybrid-ready scrubbers (12 23,000 TEU container ships and 8 15,000 TEU container ships). In 2018, HMM installed scrubbers in two 11,000 TEU container ships and five very large oil tankers as well (Shin & Kim, 2020). However, KMTC has not installed scrubbers as it has small mid-sized container ships that only operate along the intra-Asia routes and used Very Low Sulphur Fuel Oil (VLSFO) instead. However, KMTC plans to install scrubbers on the existing 5,000 TEU container ships and install scrubbers on four 1,8000 TEU ships (Shin & Kim, 2020). Sinokor Merchant Marine has not decided to install scrubbers on all of its existing ships. However, it plans to install scrubbers on 14 newly ordered ships (Shin & Kim, 2020). Panocean plans to install open-loop scrubbers in 15 existing ships and 11 newly ordered ships. If the new ships are factored in, Panocean will have 38% of its entire fleet with scrubbers installed (Shin & Kim, 2020).

The Korean shipping landscape shows that the government has a key role to play in supporting small and mid-sized shipping companies to own and operate zero-emission ships.

Box 2 Alternative Fuels

Alternative fuels are key to reducing significant GHG emissions from ships because they have the most potential to reduce such emissions.

Currently, almost 95% of the ships (102,960 ships) in the world use diesel engines as their main propulsion (Arief & Fathalah, 2022). Only 5.6% of the ships (5,753 ships) use LNG as fuel, installed scrubbers, or have other non-diesel engines. Among the 5.6%, the majority of vessels installed scrubbers (78%), while 16% use LNG as fuel and only 6% use alternative fuels (Relevant Ministries, 2020).

In Korea, only 3.4% out of 10,038 ships use LNG as fuel, installed scrubbers, or have other non-diesel engines. Among the 3.4%, most vessels installed scrubbers (93%), while 6% use LNG as fuels and 1% use electricity as propulsion (Relevant Ministries, 2020).

With the shipping industry being pressured to decarbonize, the shipping industry is focusing on LNG as a transition fuel. According to Clarksons Research Service, there were 1,050 ships in the world that can use liquefied natural gas (LNG) as fuel and more than 700 LNG-fueled ships contracted and to be delivered (Comer et al., 2022). Korea is no exception as the government views LNG-fueled ships as an interim solution. Since 2016, Ulsan port has been preparing to be Asia's 2nd port to provide LNG bunkering (LNG World News Staff, 2016; Shin & Kim, 2020).

Compared to diesel and heavy fuel oil (MDO and HFO), LNG substantially reduces air pollutants such as SOx, NOx, and PM10. However, LNG does not substantially reduce GHG emissions, as the actual benefit is only about 8-20% due to methane slip (Wang & Wright, 2021). Methane slip refers to a situation where gaseous methane escapes into the air (MAN, 2022). Methane is much more potent than CO2, as it has a greenhouse effect of 28 times as strong as the same amount of CO2 over a 100-year period (MAN, 2022).

However, for the shipping industry to align with the Paris Agreement, shipping needs to move away from fossil fuels, including LNG (Fricaudet et al., 2021). According to one recent study, if the LNG-fueled ships cannot switch to alternative fuels, such ships could lose all their value of US$890 billion in 2030, based on stranded assets/value to LNG fueled ships recently ordered and the LNG-fueled ships to be ordered (MAN, 2022). Also, if the LNG infrastructure is already in place, there will be less incentive for the shipping industry to switch to zero-emission fuels due to the significant amount invested in those facilities (Barry et al., 2021). For example, building and operating LNG infrastructure at Busan port would cost around US$12 ~ 14 billion (N. K. Park & Park, 2019). Considering that the economic life of a ship is generally 20 to 30 years before being retired, if we use LNG, a fossil gas, we will be locked in for many years (IMO, 2016).

Among many alternative fuels to fossil fuels, green hydrogen and green ammonia are the most promising alternative fuels. Green hydrogen has zero emissions if produced with renewable energy. However, it has lower energy density than fuel oil, has challenges in storage, and needs to be liquified at an extremely low temperature of –253C (Ash & Scarbrough, 2019). Further, hydrogen requires heavy tanks that take up space, which makes it unattractive for large cargo ships (Dempsey, 2021a).

In the case of green ammonia, although it is easier to transport and store, it has a high toxicity level, therefore requiring additional safety protocols (Barry et al., 2021). However, according to the Hydrogen Council and McKinsey & Company, among various fuels including LNG, green ammonia was expected to be most inexpensive in the long term for container ships (E.-M. Kim, 2022).

When compared between ammonia and hydrogen, ammonia is safer with lower cost and storage but has higher well-to-wake emissions than hydrogen (Inal et al., 2022).

Other alternative fuels such as biofuels and methanol are not zero-emissions fuels, so they are not viable solutions in the long term unless they are produced from green sources and, in the long term, green methanol will be more expensive than ammonia (Barry et al., 2021; Gielen et al., 2021).

Table 11 Fuels We Recommend (Revised from Barry et al., 2021)

FUEL	PROS	CONS
Battery	Ideal for short-range ships like ferries, tugboats. Could be used for auxiliary power and hybrid propulsion for ocean-going vessels.	Not yet powerful enough to totally power large ships that cross oceans. Lithium-ion batteries pose safety risks.
Green Hydrogen	Zero emissions when produced with renewable sources. Can be produced by electrolyzing water. When hydrogen is used, the by-product is water.	Lower energy density than fuel oil. Storage challenges. Liquefies at extremely low temperatures. Flammable.
Solar	Free and renewable. Suitable as a source for on board electricity for auxiliary power	most likely will need to be combined with other fuel sources
Hydrogen or ammonia fuel cells	Like a battery, but never needs to be charged as long as there's a fuel source. Highly scalable. Can run on hydrogen or ammonia.	Low-density, compared to fossil fuels. Still more expensive than fossil fuels.
Wind	Unlimited, free, and renewable. Many wind-propulsion options available to fit ship owner needs.	Most likely will need to be combined with other fuel sources.
Green Ammonia	A "carrier" for hydrogen. Can power internal combustion engine or fuel cell or be transformed into hydrogen.	Toxic, will require additional safety and spill avoidance protocols. *more testing is needed to mitigate safety for oceans and marine wildlife and policy measures will need to be put in place to ensure zero air pollution emissions from this zero-carbon fuel source.

Table 12 Suitable Short Term Bridge Fuels

FUEL	PROS	CONS
E-Methanol	Can be used conventional fuel storage and bunkering with just a few modifications. Has low flammability and high environmental safety -methanol spills in the ocean dissolve within 24 to 48 hours with virtually no negative environmental impacts.	Not 100% zero-emissions

Table 13 Fuels Not Recommended (Reproduced from Barry et al., 2021).

FUEL	CONS
LNG	Not zero-emission and often worse on a well-to-wake basis than conventional fuels. Methane, its main ingredient, is 87 times more potent a greenhouse gas than CO2, and marine engines leak large amounts of unburned methane.
Biofuels	Not zero-emission and often worse on a well-to-wake basis than conventional fuels unless made from waste or nonfood crops. Could result in deforestation and other environmental damage to grow feedstock.
Nuclear	Significant environmental, health and security risks.

5. Policy Recommendations

In October 2020, the South Korean government pledged to achieve carbon neutrality by 2050. However, international shipping's GHG emissions figures are excluded from the total. If the figure is included, in 2019, the annual volume of GHG emissions from the South Korean shipping industry would amount to about 27,392.32Gg, which is 3.9% of the total GHG emissions of Korea (701,370.42Gg). Even though GHG emissions from international bunkering cannot be included entirely into Korea's carbon budget as it includes international bunkering for non-Korean vessels, it will more than likely be higher than the current figures. Thus, Korea's shipping cannot achieve zero emissions with the continued exclusion of international shipping GHG emissions. Furthermore, the Ministry of Oceans and Fisheries announced in December 2021 that it will achieve net zero by 2050. For domestic shipping, the Ministry announced a target reduction of at least 70% compared to 2018 by 2050. However, there must be consideration of international shipping as well, which is significantly higher in emissions than domestic shipping, yet is currently excluded from the target.

For the Korean government to achieve zero emissions by 2050, in both international and domestic shipping, while maintaining the global competitiveness of the Korean shipping industry, it is critical to support the shipping industry in accelerating its decarbonization efforts. In order to facilitate this acceleration, the government must play a key role in urging shipping and port authorities to execute the following:

1. Declaration of Domestic and International Shipping as Zero GHGs by 2050 or earlier

Analysis indicates that there needs to be a fixed date for zero emissions for the global shipping industry. According to the ICCT, it should not be later than 2050 and ideally close to 2040 in order to be compliant to the Paris Agreement 1.5C (Comer, 2021). If Korea, one of the leading shipping nations in the world, can declare its commitment to zero GHG emissions by no later than 2050, and ideally 2040, for international shipping, it will maintain its position as a global climate leader and can send a strong message to other nations that it can and will maintain its competitiveness in the shipping sector. This declaration for both domestic and international shipping must be done preferably no later than July 2023, when IMO submits its second strategy for GHG emissions from shipping. Recently at COP27, the Korean government declared it will support the goal of phasing out GHG from international shipping to net zero no later than 2050 (Bureau of Climate, Environmental Science and Diplomacy, 2022). While this was a significant step, a stronger message by the Korean government to declare zero emissions for both domestic and international shipping no later than 2050 would be more effective.

In addition to the declaration of zero emission no later than 2050, declaration of interim reduction targets for years 2025, 2030, 2035, and 2040 are also important. Furthermore, if Korea does not start reducing its GHG emissions as soon as possible, there will be greater pressure due to rapid emissions reductions in the future. It is clear that the Korean government will need to continue to monitor international shipping GHG emissions data on a periodical basis and, eventually, revise the commitment year from 2050 to an earlier point of time.

As part of the declaration, the government should include CO2 emissions of Korea's share of international shipping into Korea's total GHG emissions. This will create incentives for Korea's stakeholders to aggressively reduce the emissions.

a. Other Suggested Specific Declarations

Once the declaration of domestic and international shipping as absolute zero GHG by 2050 or earlier is announced, the Korean government can declare these specific declarations:

(i) Setting zero-emissions "At Berth" Policy by 2030: Korean government should pass a new policy requiring that every vessel coming into regulated Korean waters or Korean Ports to use AMP while they are at port to reduce harmful emissions and accelerate shipping's clean energy transition as soon as possible. This policy is already in place in countries such as California, United States, where research has shown the policy was effective in helping to save hundreds of lives, prevent millions of cases of cancer and save over US$2.31 billion in public health benefits, and send market signals to shipping companies to invest in zero-emission solutions (California Air Resources Board, 2022a). California's At Berth Regulation is currently seen as the leading standard for shore power policy, which could make it a valuable case for Korea to adapt and adopt locally.

(ii) Setting zero-emissions ferry and commercial harbor craft standards by 2030/2035: To accelerate the zero emission vessel market and help familiarize electric and green hydrogen-based technologies to ports and shipbuilding companies, Korea should require that ferries and other commercial harbor crafts such as tugboats, and other harbor vessels transition to 100% electric propulsion or other zero-emission options. These vessels tend to be smaller vessels than ocean going vessels within more limited range, and therefore easier to transition to zero emissions. Electrifying the ferry fleet is also a way to build public and international support for the maritime energy transition. For example, a commitment to 100% zero emission ferries in Busan in time for the 2030 World Expo would showcase Korea's climate leadership commitment.

California's Harbor Craft Regulation, which was passed in March 2022, sets the first zero emission marine standard for ferries in the United States, and it is the first of its kind for emission standard requirements for commercial passenger fishing vessels, pilot vessels, tank barges over 400 feet, workboats and research vessels. The amendments will begin phasing starting from 2023 and continuing through to the end of 2032. Californian regulators estimate the policy will save 531 lives statewide and yield $5.25 billion in public health benefits for Californians (California Air Resources Board, 2022b).

2. Green Shipping Corridors

In order to achieve net zero by 2050, United States has proposed green corridors as a key policy lever to accelerate shipping decarbonization. The Department of State of the United States has defined green corridors as "maritime routes that showcase low-emission 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 (Office of the Spokesperson, 2022).

Given that the IMO's GHG reduction target by 2050 is insufficient and will not move the shipping industry to achieve net zero at its current state, the first step for the Korean government to achieve zero emissions by 2050, is to join international treaties and declarations, such as Clydebank Declaration (DfT, 2022). Furthermore, given that international shipping requires international cooperation among nations, green shipping corridors between two countries are one prime example of such cooperation.

A. Clydebank Declaration

In addition to the US-proposed green corridors, in November 2021, the United States, United Kingdom and 22 other countries signed the Clydebank Declaration to address the GHG emissions arising from international shipping. Under the Clydebank Declaration, signatories agreed to establish at least 6 green corridors and further expand such green corridors by 2030 (DfT, 2022). One way to expand the number of green corridors is to have more countries join the Clydebank Declaration. For Korea to commit to zero emissions by 2050 for the shipping industry, strengthening international cooperation frameworks is essential, and joining the Clydebank Declaration provides a logical first step in achieving this goal. Furthermore, in order to maintain Korea's competitive edge in maritime trade, cooperation with Clydebank Declaration signatories is essential.

B. Specific Green Corridors

These are green corridors that are agreed into by two or more nations.

1. Los Angeles/Long Beach-Shanghai green corridor: These cities have agreed to develop specific green corridor plans by the end of this year (Sporrer, 2022). Shanghai is the world's largest port in the world while Los Angeles port is the largest port in the United States. The two ports combined add up to more than 50 million TEU.

2. Singapore-Rotterdam: This green corridor is the longest green corridor (Schuler, 2022). Singapore is the 2nd largest port and Rotterdam is 10th largest port in the world. The two ports combined add up to more than 50 million TEU.

3. Other notable green corridors:
   A. Montreal and Antwerp ports (Gedeon, 2022)
   B. Green shipping corridor in Chile (Mærsk Mc-Kinney Møller Center, 2022a)
   C. European Green Corridors Network (announced on March 30, 2022) (Mærsk Mc-Kinney Møller Center, 2022b)
   D. Nordic Region Green Shipping Corridors (announced on May 3, 2022) (Carstad & Eriksen, 2022)
   E. Rotterdam-Gothenburg (announced on October 14, 2022) (Port of Rotterdam, 2022)

C. Opportunities for Korea

Busan-Seattle/Tacoma green corridor: The US government recently proposed this specific route as a potential green corridor to the Korean government. And during COP27, Korea announced that it will explore the feasibility of creating a green corridor with United States, in particular, green corridor between Busan port and Seattle/Tacoma ports (Bureau of Climate, Environmental Science and Diplomacy, 2022).

Busan is world's 7th largest port and 2nd largest transshipment port, while the Seattle/Tacoma port is the largest port in northwest of the United States. The two ports combined will have more than 20 million TEU of cargo. Given that Asia-North America shipping routes are one of the busiest routes, Busan-Seattle/Tacoma corridor would be a good complementary corridor to the Los Angeles – Shanghai green corridor.

3. Accelerate investment into green fuel R&D

In order to achieve zero emissions by 2050, public and private investments in green fuel R&D must be increased. Currently, alternative fuels with promising zero carbon emissions are green hydrogen and green ammonia. However, they are expected to be commercialized at the earliest in 2030. The government must accelerate this process so that green fueled ships will be available prior to 2030.

4. Non-commitment to public financing of new fossil fuel ships (including LNG fueled ships) and LNG bunkering

While accelerating green fuel R&D, it is important for the government to also make a commitment to not finance any new fossil ships, which includes both heavy fuel oil and LNG fueled ships, before 2030. Generally, life expectancy of ships is around 25 years, so any new orders for LNG fueled ships after 2025 will hinder the shipping industry in achieving zero emissions by 2050 (The Editorial Team, 2020).

5. Coalition among various stakeholders

Finally, to solidify the cooperation among the government, shipping companies, shipbuilding companies, port authorities, research institutes, classification societies, labor unions, residents living nearby the companies and ports, and civil societies, the government should host a periodic forum for the various stakeholders to voice their concerns and to understand the general direction of achieving zero emission by 2050 for the shipping industry.

6. Other Recommendations

Other countries have started to introduce legislation to reduce carbon emissions from shipping. For example, the European Union (EU), under the Fit for 55 legislative package (FIT 55), has decided to aggressively reduce CO2 emissions, with the goal of 55% GHG emissions reduction by 2030 (compared to 1990 levels). The EU's FuelEU Maritime proposed regulation, included as part of the Fit for 55 package, will impose lifecycle GHG requirements on the fuel used onboard ships calling on ports in an EU Member State. The regulation will also require container and passenger vessels to connect to shore power (or use zero-emission technologies that achieve emission reductions that are equivalent to using shore power) from 2030. The regulation is expected to be finalized in early 2023 (Legislative Observatory, 2021). In addition, under Fit for 55, international shipping will be folded into EU Emission Trading System (EU ETS), starting in 2023 (Psaraftis, 2021). The inclusion of shipping involves CO2 emissions arising from intra-EU trips, 50% of CO2 emissions arising between non-EU and EU ports, and all at-berth EU ports CO2 emissions (Fit for 55 – New EU GHG Regulations for Ships Coming Soon, 2021; Psaraftis, 2021).

In addition, the ETS includes CO2, methane and nitrous oxide. This can help dissuade the use of LNG as a shipping fuel.

Similarly, the Korean government has been using the Emissions Trading Scheme (K-ETS) to regulate industrial GHG emissions since 2015 (H.-K. Lee, 2021). About 75% of total GHG emissions come from the companies and other entities that participate in the K-ETS. The government allocates emissions permits based on the carbon intensity benchmarks of key production processes. However, shipping is currently not part of the K-ETS framework (H.-K. Lee, 2021). For Korea to maintain its leadership in the shipping industry, implementing aggressive policies modeled after the EU's policy framework may be helpful for staying ahead of the competition.

6. Conclusion

Green shipping is clearly emerging as the next frontier of decarbonization. Reflecting these global trends in shipping decarbonization, it is clear that Korea should – and is well positioned to - accelerate its decarbonization efforts to maintain a competitive edge in the industry and join other leading nations that are setting ambitious zero emission goals.

Given the significance of both shipping and shipbuilding industries for Korea, it is vital for the government and industry to urgently come together to address the climate and transition risks of delayed decarbonization and develop proactive strategies to achieve 2025, 2030, 2040 and 2050 decarbonization targets in order to respond to escalating costs and pressure under strengthened US and EU environmental regulations. Furthermore, in a global context, if Korea is successful in its transition to a zero emission system, it can serve as a model to other countries to follow Korea's lead in the transition of the shipping sector.

<References>

Korean References

Act on the Development and Promotion of Environmentally Friendly Vessels (Environmentally Friendly Shipping Act), Pub. L. No. 16167 (2018). https://law.go.kr/%EB%B2%95%EB%A0%B9/%ED%99%98%EA%B2%BD%EC%B9%9C%ED%99%94%EC%A0%81%EC%84%A0%EB%B0%95%EC%9D%98%EA%B0%9C%EB%B0%9C%EB%B0%8F%EB%B3%B4%EA%B8%89%EC%B4%89%EC%A7%84%EC%97%90%EA%B4%80%ED%95%9C%EB%B2%95%EB%A5%A0

Ahn, T. (2022, February 25). Hyundai Heavy Industries Holdings will change its name to 'HD Hyundai'. The Hankyoreh. https://www.hani.co.kr/arti/economy/economy_general/1032422.html

Bureau of Climate, Environmental Science and Diplomacy. (2022, November 8). Ambassador for Climate and Environment Na Kyung-won attended the 27th General Assembly of the Parties to the United Nations Framework Convention on Climate Change. Ministry of Foreign Affairs. https://www.mofa.go.kr/www/brd/m_4080/view.do?seq=372977&page=1

Busan Port Authority (BPA). (2022a). 2021 Busan Port Authority Sustainability Report. https://busanpa.com/_Ebook/20220530/index.jsp

Busan Port Authority (BPA). (2022b). Busan Port Authority. Busan Port Authority (BPA). https://www.busanpa.com/eng/Contents.do?mCode=MN0006

Choi, S.-Y. (2022, September 19). Korea Shipbuilding & Marine Engineering Co., Ltd. won orders for 8 ships, including LNG propulsion ships, for 525 billion won. Asia Economy. https://n.news.naver.com/mnews/article/277/0005149260?sid=101

Chung, J.-H., & Lim, J.-W. (2022, July 7). Korean shipbuilders rank No. 1 in orders booked in first half. Korea JoongAng Daily. https://koreajoongangdaily.joins.com/2022/07/07/business/industry/Korea-ships-shipbuilders/20220707190926533.html

Greenhouse Gas Inventory & Research Center of Korea. (2021). 2021 National Greenhouse Gas Inventory Report of Korea." Ministry of Environment's National GHG Management System. https://www.keep.go.kr/portal/144?action=read&action-value=911b270fc724ba60a269aee45ad73cc6

HMM. (2021). HMM Business Report 2021. https://www.hmm21.com/cms/company/irk/irachive/data/__icsFiles/afieldfile/2022/03/31/HMM_BIZREPORT_46TH.pdf

HMM. (2022a). 1H 2022 Earnings Release. https://www.hmm21.com/cms/company/ire/irachive/earning/__icsFiles/afieldfile/2022/08/24/FY2022_1H_HMM_EARNINGS_RELEASE_EN_04.pdf

HMM. (2022b). HMM Corporate Profile. HMM. http://hmmbrochure.com/shipping#s02

HMM. (2022c, July 14). HMM Announces Strategy for Future Growth "Invest 15 trillion won by 26." HMM. https://www.hmm21.com/cms/company/korn/introduce/prcenter/news/1211258_7823.jsp

HMM IR. (n.d.). Statement of Comprehensive Income. HMM IR. Retrieved November 11, 2022, from https://www.hmm21.com/cms/company/ire/financial/income/index.jsp

Hyundai Heavy Industries Group. (2022). HHI Shipbuilding Group. http://english.hhi.co.kr/biz/ship_over

Jeong, S.-B., Kwon, J., Kim, S.-E., & Park, D.-U. (2022). Korea's Ocean Economy 2022. Korea Maritime Institute.

Jun, H.-J., Yoon, H.-S., & Yoon, J.-Y. (2019). A Study on Ways to Enhance Maritime Finance Capabilities Through a Comparison of Overseas Cases. Korea Maritime Institute.

Jung, J.-H. (2021, December 3). Ministry of Oceans and Fisheries budget of 6.4171 trillion won in 2022 is confirmed. Ministry of Oceans and Fisheries (MOF). https://www.mof.go.kr/article/view.do?menuKey=971&boardKey=10&articleKey=43942

Jung, S.-Y. (2022, September 26). DSME to Be Sold to Hanwha Group for KRW2tn. Business Korea. http://www.businesskorea.co.kr/news/articleView.html?idxno=101034

KAMCO. (2022). KAMCO Shipping Fund (structure). Korea Asset Management Corporation (KAMCO). https://www.kamco.or.kr/eng/contents.do?mId=0203020000

Kim, D.-J. (2022). Effects of Alternative Fuel Diffusion on the Shipping Industry. Korea Development Bank, 3(796), 29–52.

Kim, D-H. (2018, June 4). Hyundai Merchant Marine Co., Ltd. placed an equal order for 3 trillion won worth of "three shipbuilders"...Why? Newsis. https://newsis.com/view/?id=NISX20180604_0000326694&cID=13001&pID=13000

Kim, E.-M. (2022). Current status and implications of greenhouse gas reduction in the global transportation sector: Focusing on the shipping sector. Korea Institute for International Economic Policy. https://www.kiep.go.kr/gallery.es?mid=a10102040000&bid=0005&list_no=9998&act=view

Kim, H.-M. (2018, September 30). Hyundai Merchant Marine's order for 20 ships was 3 trillion won in construction funds...Korea Development Bank, Korea Maritime Corporation, Mercury, Mubo, and KAMCO. Chosun Biz. https://biz.chosun.com/site/data/html_dir/2018/09/29/2018092900654.html

Kim, J., & Kim, G. (2021). The South Korean Steel Industry and Carbon Neutrality: Responses, Issues, and Policy Recommendations. Solutions for Our Climate (SFOC). https://forourclimate.org/sub/data/view.htmlidx61

Kim, M. (2022, May 31). Korea Maritime Promotion Agency "We saved HMM, so we will provide intensive support for small and medium-sized shipping companies." The JoongAng. https://www.joongang.co.kr/article/25075575#home

Kim, S. (2022, August 26). HMM, who became a swan in "The Ugly Duckling"? Nocut News. https://www.nocutnews.co.kr/news/5807657

Kim, S.-H. (2022, February 25). The price of coal, shipbuilding, and steel industries has tripled in a year. Aju Economy. https://www.ajunews.com/view/20220224152634379

Kim, S.-S. (2022, July 22). Announcement of the four major development directions of finance, policy, information, and ESG...Declared "KOBC 2030 VISION." The JoongAng. https://www.joongang.co.kr/article/25088821#home

Korea Eximbank. (2022). Maritime Financing. Korea Eximbank (The Export-Import Bank of Korea). https://www.koreaexim.go.kr/he/HPHEIR005M01#tab3

Korea Investor's Network for Disclosure System (KIND). (2021). Korean Corporate Statistics. Korea Exchange (KRX). https://kind.krx.co.kr/compfinance/financialinfo.do?method=loadInitPage&searchgubun=order

Korea Ocean Business Corporation (KOBC). (2022). Korea Ocean Business Corporation Profile. Korea Ocean Business Corporation. https://www.kobc.or.kr/ebz/kor/contents.do?mId=0101010000

Korea Policy Briefing. (2021, December 23). Shipping Reconstruction. Korea Policy Briefing. https://www.korea.kr/special/policyCurationView.do?newsId=148897203

Korea Shipowners' Association. (2021). 2021 Shipowners Statistics. https://www.oneksa.kr:4431/statistics/ect.php?ptype=view&idx=18156&page=1&code=ect

Korea Shipbuilding & Offshore Engineering (KSOE). (2022a). KSOE Integrated Report 2021. Korea Shipbuilding & Offshore Engineering (KSOE). http://www.ksoe.co.kr/getFile?B_SEQ=24&MENU_SEQ=1&AT_SEQ=2

Korea Shipbuilding & Offshore Engineering (KSOE). (2022b). Governance Structure of Korea Shipbuilding & Offshore Engineering. Korea Shipbuilding & Offshore Engineering (KSOE). http://www.ksoe.co.kr/ir02_06

Lee, H.-K. (2021). A Study on Legal Issues dealing with Carbon Dioxide Emissions from Maritime Transport. The Journal of Korea Maritime Law Association, 43(2), 51–95.

Lee, Y.-S. (2022, April 7). Hyundai will increase sales 2.5 times by 2030. Maeil Economy. https://www.mk.co.kr/news/business/10283417

Ministry of Environment (ME). (2021, August 6). Busan Port Corporation will reduce port ultrafine dust (PM2.5) by 70% by 2025, creating clear air quality. Ministry of Environment (ME). https://www.blueskyday.kr/bbs/board.php?bo_table=report&wr_id=270

Ministry of Oceans and Fisheries (MOF). (2018). Shipping Reconstruction Five-Year Plan (2018-2022). https://eiec.kdi.re.kr/policy/materialView.do?num=179519

Ministry of Oceans and Fisheries (MOF). (2021a). The first comprehensive plan to improve air quality such as port areas (2021-2025). https://www.mof.go.kr/article/view.do?menuKey=851&boardKey=22&articleKey=37207

Ministry of Oceans and Fisheries (MOF). (2021b, December 16). Maritime and fisheries push for "minus" beyond carbon neutrality...2050 Emissions - 3.24 million tonnes. Korea Policy Briefing. https://www.korea.kr/news/top50View.do?newsId=148896922

Ministry of Oceans and Fisheries (MOF). (2022a, July 15). The integrated project group for innovative technology development of eco-friendly ships has been launched...a lead in carbon-free technology. Korea Policy Briefing. https://www.korea.kr/news/policyNewsView.do?newsId=148903582

Ministry of Oceans and Fisheries (MOF). (2022b, August 10). Pre-Briefing of the Ministry of Oceans and Fisheries' Business Report. Korea Policy Briefing. https://www.korea.kr/news/policyNewsView.do?newsId=156520708

Ministry of Oceans and Fisheries (MOF), & Ministry of Trade, Industry and Energy (MTIE). (2022). 5th edition of the Shipping Industry White Paper. https://www.mof.go.kr/upload/whitebook/44384/book.pdf

Moon, M.-H. (2019, February 12). Ministry of Oceans and Fisheries gives financial support to install eco-friendly facilities for ships. Ministry of Oceans and Fisheries (MOF). https://www.mof.go.kr/article/view.do?articleKey=24776&boardKey=10&menuKey=376&currentPageNo=1

Nam, G.-C. (2021, June 3). Transshipment port, meaning and value of transshipment cargo. Busan Ilbo. https://www.busan.com/view/busan/view.php?code=2021060116413249667

Nam, J. (2021, December 26). The three Joseon companies have differentiated business directions. Global Economic. https://news.g-enews.com/article/Industry/2021/12/20211226010856907 5ce58317c16_1?md=20211226092733_U

Oh, S.-M. (2022, July 6). South Korea's shipbuilding industry ranks first in the world in the first half of 2022. MT News. http://www.mtnews.net/m/view.php?idx=13960

Park, D.-H. (2022, August 11). The key is to dispose of 2.680 trillion won worth of permanent bonds held by the Korea Development Bank and the Korea Maritime Promotion Agency. Maeil Economy. https://www.mk.co.kr/news/economy/10419927

Park, H. (2022, November 11). Busan Port Corporation strengthens support for ships using land power supply facilities at Busan Port. ENews Today. https://www.enewstoday.co.kr/news/articleView.html?idxno=1556148

Park, J.-H. (2022, September 26). KDB has priority over acquiring Daewoo Shipbuilding to Hanwha Group. Article 2 Testimony "Stalking hose" method. YonHap Infomax. https://news.einfomax.co.kr/news/articleView.html?idxno=4234982

Park, N. K., & Park, S. K. (2019). A Study on the Estimation of Facilities in LNG Bunkering Terminal by Simulation—Busan Port Case. Journal of Marine Science and Engineering, 7(10), 354. https://doi.org/10.3390/JMSE7100354

Relevant Ministries. (2020). 2030 Greenship-K Promotion Strategy: 1st Basic Plan for the Development and Distribution of Eco-Friendly Ships ('21~'30). https://policy.nl.go.kr/search/searchDetail.do?rec_key=SH2_PLC20200258887

Ryo, J.-H. (2019, December 5). The Ministry of Oceans and Fisheries plans to build land power supply facilities (AMPs) on 248 ships by 2030. Monthly Maritime Korea. http://www.monthlymaritimekorea.com/news/articleView.html?idxno=25500

Ryu, Tae-woong. (2022, October 5). Hyundai Heavy Industries Group supplies six methanol-powered super-large container ships to Musk. ETNEWS. https://www.etnews.com/20221005000228

Shin, H.-S., & Kim, D.-Y. (2020). A Study on the Countermeasures of Shipping Companies According to MRV and DCS. Korea International Trade Research Institute, 16(5), 485–500. https://doi.org/10.16980/JITC.16.5.202010.485

Shipping News Net. (2021, January 9). The first ranking of the new year, HMM 8th, Goryeo Woon 14th, and Janggeum Merchant Marine 20th, remain unchanged. Shipping News Net. https://www.shippingnewsnet.com/news/articleView.html?idxno=40521

Shipping News Net. (2022, August 27). What is the possibility and timing of Hyundai Heavy Industries Group's improvement in the shipbuilding sector? Shipping News Net. https://www.shippingnewsnet.com/news/articleView.html?idxno=49231

Statistics KOREA. (2022, October 19). Top 10 Import and Export Items. Korea Customs Service. https://www.index.go.kr/potal/main/EachDtlPageDetail.do?idx_cd=2455&param=013

Suh, J.-M. (2021, June 29). Carbon neutral on the sea, Korea's eco-friendly ship (Greenship-K) is being developed. Ministry of Oceans and Fisheries (MOF). https://www.mof.go.kr/article/view.do?menuKey=971&boardKey=10&articleKey=39272

Suk, H.-G. (2022, May 13). Four policy financial institutions, including the Korea Development Bank and the Korea Maritime Promotion Corporation, provide financial support for new orders for national shipping companies. Korea Logistics News. https://www.klnews.co.kr/news/articleView.html?idxno=304534

Yim, B.-J. (2022, April 7). Offshore men, reduce greenhouse gases, get support. Ministry of Oceans and Fisheries (MOF). https://www.mof.go.kr/article/view.do?articleKey=45569&boardKey=10&menuKey=376&currentPageNo=1

Yim, G.-M. (2015, March 12). [Public Enterprise Special - Busan Port Corporation] A new paradigm for luxury ports with "Busan Port Vision 2030." Busan Ilbo. https://www.busan.com/view/busan/view.php?code=20150313000011

Yonhap. (2022, July 6). S. Korea Recaptures No. 1 Shipbuilding Nation Status in H1. The Korea Herald. https://www.koreaherald.com/view.php?ud=20220706000321

Yoo, H. (2022, January 14). DSME in Search for New Owner as Tie-up with Hyundai Heavy Fails. https://www.koreaherald.com/view.php?ud=20220114000603

Yoon, J. (2016, March 22). Hyundai Merchant Marine Applies for Voluntary Workout Program with Creditors. Maeil Business News Korea. https://pulsenews.co.kr/view.php?no=214091&year=2016

Yoon, Y. (2009). Policy for Maritime Industry Development. In the National Assembly Secretariat. https://ltc.na.go.kr:444/flexer/index2.jsp?ftype=hwp&attachNo=429986

Yun, H. Y., Yoon, J., & Chai, S. (2021). Estimation of Incremental Costs of World Container industry in Response to IMO's Environmental Regulations. Global Financial Review, 2(2), 117–148. https://kiss.kstudy.com/thesis/thesis-view.asp?key=3931059

Yun, K.-J. (2022, March 24). Export and Cargo Volume Forecast of Korean Ports. Cello Square. https://www.cello-square.com/go-en/blog/view-136.do

Foreign References

Alphaliner. (2022, November 11). Alphaliner Top 100. Alphaliner. https://alphaliner.axsmarine.com/PublicTop100/

Arief, I. S., & Fathalah, A. (2022). Review of Alternative Energy Resource for the Future Ship Power. IOP Conference Series: Earth and Environmental Science, 972, 12073. https://doi.org/10.1088/1755-1315/972/1/012073

Ash, N., & Scarbrough, T. (2019). Sailing on Solar: Could Green Ammonia Decarbonise International Shipping? Environmental Defense Fund. https://www.edfeurope.org/news/2019/02/05/shipping-can-reduce-climate-pollution-and-draw-investment-developing-countries

Barry, J., Rose, M., & Hubbell, D. (2021). All Aboard: How the Biden-Harris Administration Can Help Ships Kick Fossil Fuels. Pacific Environment and Ocean Conservancy. https://www.pacificenvironment.org/wp-content/uploads/2021/04/All-Aboard-US-Policy-Zero-Emissions-Report_FINAL.pdf

Battersby, A. (2021, November 5). Hyundai Heavy Industries, parent KSOE and ABS team up for green hydrogen production and CCS. Upstream. https://www.upstreamonline.com/energy-transition/hyundai-heavy-industries-parent-ksoe-and-abs-team-up-for-green-hydrogen-production-and-ccs/2-1-1094034

California Air Resources Board. (2022a). Ocean-Going Vessels at Berth Regulation. State of California. https://ww2.arb.ca.gov/our-work/programs/ocean-going-vessels-berth-regulation

California Air Resources Board. (2022b, March 24). CARB passes amendments to commercial harbor craft regulation | California Air Resources Board. State of California. https://ww2.arb.ca.gov/news/carb-passes-amendments-commercial-harbor-craft-regulation

Cames, M., Graichen, J., Siemons, A., & Cook, V. (2015). Directorate General for Internal Policies Policy Department A: Economic and Scientific Policy - Emission Reduction Targets for International Aviation and Shipping Study. European Parliament. https://www.europarl.europa.eu/RegData/etudes/STUD/2015/569964/IPOL_STU(2015)569964_EN.pdf

Carstad, J., & Eriksen, H. J. (2022, March 5). Clear to Proceed - Green Shipping Corridors in the Nordic Region. Nordic Co-Operation. https://www.norden.org/en/news/clear-proceed-green-shipping-corridors-nordic-region

Comer, B. (2021, September 8). Zero-Emission Shipping and the Paris Agreement: Why the IMO Needs to Pick a Zero Date and Set Interim Targets in its Revised GHG Strategy. International Council on Clean Transportation (ICCT). https://theicct.org/zero-emission-shipping-and-the-paris-agreement-why-the-imo-needs-to-pick-a-zero-date-and-set-interim-targets-in-its-revised-ghg-strategy/

Comer, B., O'malley, J., Osipova, L., & Pavlenko, N. (2022). Comparing the Future Demand for, Supply of, and Life-Cycle Emissions from Bio, Synthetic, and Fossil LNG Marine Fuels in the European Union. The International Council on Clean Transportation (ICCT). www.theicct.org

Dempsey, H. (2021a, April 25). Shipping Looks to Hydrogen as it Seeks to Ditch Bunker Fuel. Financial Times. https://www.ft.com/content/b3cd9b09-584e-4205-8c98-2185466c9f81

Dempsey, H. (2021b, September 15). MSC commits to net zero by 2050. Financial Times. https://www.ft.com/content/91a27f7e-3d3c-4161-a5f5-a67517a64c2e

Department of Trade (DfT). (2022). COP 26: Clydebank Declaration for Green Shipping Corridors. https://www.gov.uk/government/publications/cop-26-clydebank-declaration-for-green-shipping-corridors/cop-26-clydebank-declaration-for-green-shipping-corridors

Equasis. (2020). The 2020 World Merchant Fleet Statistics. https://www.equasis.org/Fichiers/Statistique/MOA/Documents%20availables%20on%20statistics%20of%20Equasis/Equasis%20Statistics%20-%20The%20world%20fleet%202020.pdf

Fricaudet, M., Taylor, J., Smith, T., & Rehmatulla, N. (2021). Exploring Methods for Understanding Stranded Value: Case Study on LNG-Capable Ships. The Bartlett Energy Institute. https://vpoglobal.com/wp-content/uploads/2022/09/Stranded-value-case-study-on-LNG-capable-ships.pdf

Gedeon, J. (2022, April 1). First-ever North Atlantic Green Shipping Corridor prioritized by Montreal and Antwerp ports. Chamber of Marine Commerce. https://www.marinedelivers.com/2022/04/first-ever-north-atlantic-green-shipping-corridor-prioritized-by-montreal-and-antwerp-ports/

Gray, N., McDonagh, S., O'Shea, R., Smyth, B., & Murphy, J. D. (2021). Decarbonising ships, planes and trucks: An analysis of suitable low-carbon fuels for the maritime, aviation and haulage sectors. Advances in Applied Energy, 1, 100008. https://doi.org/10.1016/J.ADAPEN.2021.100008

Habibic, A. (2022, September 5). CMA CGM creates $1.5 billion fund to speed up shipping decarbonisation. Offshore Energy. https://www.offshore-energy.biz/cma-cgm-creates-1-5-billion-fund-to-speed-up-shipping-decarbonisation/

Hellenic Shipping News Worldwide. (2020, August 4). HMM Joins the Alliance. Hellenic Shipping News Worldwide. https://www.hellenicshippingnews.com/hmm-joins-the-alliance/

Inal, O. B., Zincir, B., & Deniz, C. (2022). Investigation on the Decarbonization of Shipping: An Approach to Gydrogen and Ammonia. International Journal of Hydrogen Energy, 47(45), 19888–19900. https://doi.org/10.1016/J.IJHYDENE.2022.01.189

International Maritime Organization (IMO). (2016). Studies on the Feasibility and Use of LNG as a Fuel for Shipping. International Maritime Organization (IMO). https://greenvoyage2050.imo.org/wp-content/uploads/2021/01/STUDIES-ON-THE-FEASIBILITY-AND-USE-OF-LNG-AS-A-FUEL-FOR-SHIPPING-.pdf

International Maritime Organization (IMO). (2021). Fourth Greenhouse Gas Study 2020. https://www.imo.org/en/OurWork/Environment/Pages/Fourth-IMO-Greenhouse-Gas-Study-2020.aspx

Legislative Observatory. (2021). Procedure File: 2021/0210(COD). European Parliament. https://oeil.secure.europarl.europa.eu/oeil/popups/ficheprocedure.do?lang=en&reference=2021/0210(COD)

LNG World News Staff. (2016, August 4). South Korea's Ulsan Port in LNG Bunkering Deal. Offshore Energy. https://www.offshore-energy.biz/south-koreas-ulsan-port-in-lng-bunkering-deal/

Maersk. (2022, January 12). A.P. Moller - Maersk accelerates Net Zero emission targets to 2040 and sets milestone 2030 targets. https://www.maersk.com/news/articles/2022/01/12/apmm-accelerates-net-zero-emission-targets-to-2040-and-sets-milestone-2030-targets

Mærsk Mc-Kinney Møller Center. (2022a, Summer 13). Chilean Ministries of Energy, Transport and Telecommunications, And Foreign Affairs, together with the Maersk Mc-Kinney MØLler Center for Zero Carbon Shipping Launch Joint Project to Establish Green Shipping Corridors in Chile. Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. www.zerocarbonshipping.com

Mærsk Mc-Kinney Møller Center. (2022b, March 30). The Center Launches Partnership with Progressive Ports To Establish The European Green Corridors Network . Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. https://www.zerocarbonshipping.com/news/the-center-launches-partnership-with-progressive-ports-to-establish-the-european-green-corridors-network/

MAN. (2022). Methane Slip. MAN Energy Solutions. https://www.man-es.com/discover/decarbonization-glossary---man-energy-solutions/methane-slip

Mandra, J. O. (2021, April 9). Top Dogs of South Korean Shipbuilding Industry Eye Carbon Neutrality by 2050 - Offshore Energy. Offshore Energy. https://www.offshore-energy.biz/top-dogs-of-south-korean-shipbuilding-industry-eye-carbon-neutrality-by-2050/

Office of the Spokesperson. (2022, April 12). Green Shipping Corridors Framework. United States Department of State. https://www.state.gov/green-shipping-corridors-framework/

Olmer, N., Comer, B., Roy, B., Mao, X., & Rutherford, D. (2017). Greenhouse Gas Emissions from Global Shipping, 2013-2015. The International Council on Clean Transportation. https://theicct.org/sites/default/files/publications/Global-shipping-GHG-emissions-2013-2015_ICCT-Report_17102017_vF.pdf

Pavlenko, N., Comer, B., Zhou, Y., Clark, N., & Rutherford, D. (2020). The Climate Implications of Using LNG As a Marine Fuel. The International Council on Clean Transportation. https://theicct.org/publication/the-climate-implications-of-using-lng-as-a-marine-fuel/

Port of Rotterdam. (2022, October 14). Ports of Rotterdam and Gothenburg Kick Off Green Corridor Initiative for Sustainable Shipping. Port of Rotterdam. https://www.portofrotterdam.com/en/news-and-press-releases/port-of-rotterdam-and-port-of-gothenburg-kick-off-green-corridor-initiative

Prevljak, N. H. (2020, December 24). South Korea Unveils Initiative to Promote Eco-Friendly Ship Technologies. Offshore Energy. https://www.offshore-energy.biz/south-korea-unveils-initiative-to-promote-eco-friendly-ship-technologies/

Psaraftis, H. N. (2021). Shipping Decarbonization in the Aftermath of MEPC 76. Cleaner Logistics and Supply Chain, 1, 100008. https://doi.org/10.1016/J.CLSCN.2021.100008

Quang, P. K., Dong, D. T., & Hai, P. T. T. (2021). Evaluating Environmental Impacts of an Oil Tanker Using Life Cycle Assessment Method. Institution of Mechanical Engineers, 235(3), 705–717. https://doi.org/10.1177/1475090221989195

Schlanger, Z. (2018, April 18). If shipping were a country, it would be the world's sixth-biggest greenhouse gas emitter. World Economic Forum. https://www.weforum.org/agenda/2018/04/if-shipping-were-a-country-it-would-be-the-world-s-sixth-biggest-greenhouse-gas-emitter

Schuler, M. (2022, August 2). Singapore and Rotterdam to Establish "World's Longest" Green Shipping Corridor. GCaptain. https://gcaptain.com/singapore-and-rotterdam-to-establish-worlds-longest-green-shipping-corridor/

Selin, H., Zhang, Y., Dunn, R., Selin, N. E., & Lau, A. K. H. (2021). Mitigation of CO2 Emissions from International Shipping Through National Allocation. Environmental Research Letters, 16(4), 045009. https://doi.org/10.1088/1748-9326/ABEC02

Ship Technology. (2022, April 26). Busan Port Authority Unveils 2050 Carbon Neutrality Plan. Ship Technology. https://www.ship-technology.com/news/busan-port-authority-carbon-neutrality/

Sporrer, A. (2022, January 28). World's Busiest Trans-Pacific Shipping Lane Targeted as Green Corridor. American Shipper. https://www.freightwaves.com/news/worlds-busiest-trans-pacific-shipping-lane-targeted-as-green-corridor

Sylvain, V. (2022, February 28). 10 Biggest Shipping Companies in the World. SINAY Maritime Data Solution. https://sinay.ai/en/10-biggest-shipping-companies-in-the-world/

Tan, J. (2021, December 17). MEPC 77 - A Summary. UK P&I. https://www.ukpandi.com/news-and-resources/articles/2021/mepc-77-a-summary/

The Editorial Team. (2020, February 4). Do You Know What Happens to a Ship When It's Too Old to Sail Anymore? Safety4Sea. https://safety4sea.com/cm-do-you-know-what-happens-to-a-ship-when-its-too-old-to-sail-anymore/

The White House. (2021, April 23). FACT SHEET: President Biden's Leaders Summit on Climate. https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/23/fact-sheet-president-bidens-leaders-summit-on-climate/

United Nations Conference on Trade and Development (UNCTD). (2021a). Review of Maritime Transport 2021. https://unctad.org/webflyer/review-maritime-transport-2021

United Nations Conference on Trade and Development (UNCTD). (2021b). The UNCTAD Handbook of Statistics 2021.

US Department of State. (2022, November 7). U.S. Announcements Under the Green Shipping Challenge at COP27. https://www.state.gov/u-s-announcements-under-the-green-shipping-challenge-at-cop27/

US Environmental Protection Agency (US EPA). (2022, May 12). Scope 3 Inventory Guidance. United States Environmental Protection Agency. https://www.epa.gov/climateleadership/scope-3-inventory-guidance

Wang, Y., & Wright, L. A. (2021). A Comparative Review of Alternative Fuels for the Maritime Sector: Economic, Technology, and Policy Challenges for Clean Energy Implementation. World, 2(4), 456–481. https://doi.org/10.3390/WORLD2040029

Wood, A. (2022, May 11). Shining the spotlight on shipping's busiest routes. MarineTraffic Blog. https://www.marinetraffic.com/blog/shining-the-spotlight-on-shippings-busiest-routes/

World Bank. (n.d. -a). Container port traffic (TEU: 20-foot equivalent units) - Korea, Rep. Retrieved November 10, 2022, from https://data.worldbank.org/indicator/IS.SHP.GOOD.TU?locations=KR&most_recent_value_desc=true

World Bank. (n.d. -b). Trade (% of GDP) - Korea, Rep. Retrieved November 10, 2022, from https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS?locations=KR

SFO°C
Solutions for Our Climate

PACIFIC ENVIRONMENT

Korea's Green Shipping Pathways:

The Korean Shipping Landscape and Policy Recommendations for Ocean-Climate Leadership in Shipping