Toward Green Shipping by 2050

2023 National Action Plan

Ministry of Oceans
and Fisheries

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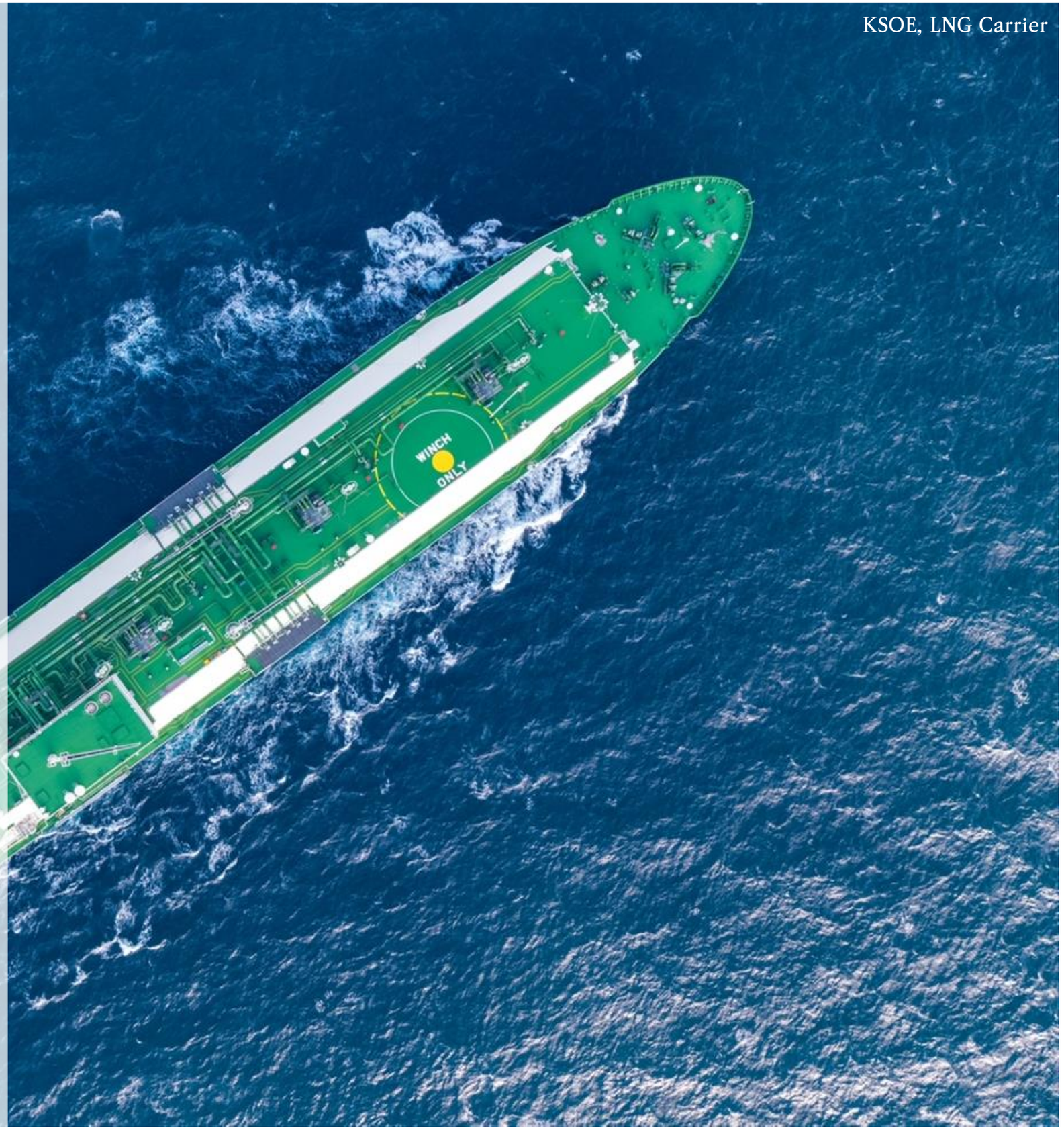


KSOE, LNG Carrier

Minister’s Message

“Our mission is for the Republic of Korea to set a leading example in sustainable shipping and decarbonization of the shipping value chain.”

Throughout Korea’s history, the sea has been a source of wealth, establishing a solid foundation for the nation’s economy and giving it a competitive edge. In addition to providing abundant high-quality food, the sea has also served as a sanctuary for the physical and mental well-being of Koreans.

The Ministry of Oceans and Fisheries (MOF), which oversees the marine, fisheries, shipping, and port industries in Korea, is committed to securing the "Sustainability of the Marine and Fisheries Sector for Future Generations." Under the vision of "Advancing the Ocean Economy with a Vibrant Marine Community," MOF is dedicated to implementing marine and fisheries policies that serve the best interests of the Korean people.

In December 2020, the government announced the "2050 Net-Zero Vision." To support the achievement of this vision, the "2050 Net-Zero Scenarios" were developed. In alignment with this vision and these scenarios, MOF established the "2050 Net-Zero Roadmap for the Marine and Fisheries Sector" in December 2021.

Notably, at the 27th Conference of the Parties (COP27) to the UNFCCC, held in Sharm el-Sheikh, Egypt on November 7, 2022, the international shipping sector announced a global decarbonization initiative. This initiative aimed to establish a green cargo shipping corridor for Zero-Emission Vessels (ZEVs) between the Port of Busan in Korea and the Port of Tacoma in the US. By February 2023, MOF had developed the "Strategy for Decarbonization of International Shipping," which included policies and technologies for reducing Greenhouse Gas (GHG) emissions in the shipping and shipbuilding sectors. Moreover, MOF has also devised policies for decarbonizing port infrastructure and reducing GHG emissions from ports.

The course toward the ambitious goal of decarbonizing the shipping sector has already been set, and we are accelerating our efforts to reach this target. Decarbonization is an inevitable future. With international rules and directions being established, now is the time to strategically develop policies and responsive strategies that can guide the international community.

MOF will spearhead the transition to a decarbonized shipping and related industries in Korea by implementing and enhancing existing decarbonization policies. The government, however, cannot achieve this transition alone. Solidarity and cooperation among businesses, academia, and partner countries are essential. We humbly ask for your interest and active support in every step of this journey toward a sustainable ocean that will benefit us all.

Thank you.

Minister of Oceans and Fisheries

CHO, Seung-Hwan

PREFACE

In October 2020, Korea declared its goal to achieve Net-Zero as its national vision. This declaration was followed by the enactment of the Framework Act on Carbon Neutrality and the Green Growth for Coping with Climate Crisis (also known as the Carbon Neutrality Act). Subsequently, the Republic of Korea (ROK) became the 14th country to establish a legislative framework for achieving Net-Zero by 2050 and implementing the necessary systems to realize this vision. Under the Carbon Neutrality Act, which mandates a 2030 target for the Nationally Determined Contributions (NDCs) to be set at 35% or higher, the Republic of Korea (ROK) increased its 2030 NDC target from 24.4% in 2018 to 40% in October 2021. Furthermore, mid- to long-term targets and strategies were established for each industrial sector to meet this NDC target.

Consistent with these directions, MOF established a comprehensive plan for overseeing the marine, fisheries, shipping, and port industries in December 2021, aiming to achieve the 2030 NDC target.

In addition, MOF established the "Strategy for Decarbonization of International Shipping" to set a leading example in reducing GHG emissions for international shipping, which are not included in the national GHG inventory. Through this strategy, the ROK has set a milestone for implementing Net-Zero. Based on the established framework, Korea's shipping industry will implement changes in stages towards net-zero society.

Given the complex interplay between different value chains within the shipping industry, achieving Net-Zero requires active participation from all stakeholders, not just the shipping industry. Therefore, the Decarbonization Strategy for Shipping Industry can be divided into three chapters: Net-Zero Strategy in Korea, Shipping, and Port.

This report was prepared for submission to the International Maritime Organization (IMO) to present the National Action Plan (NAP) of the ROK and developed to include and reflect all eight elements presented in RESOLUTION MEPC.367(79), wherever possible.

Shipping and Policy

This report includes not only the strategy of the MOF's strategy for reducing GHG emissions in the shipping sector but also the activities of the private sector in detail. In this report, the terms "domestic shipping" and "international shipping" are used when necessary to distinguish between the two. In all other contexts, "shipping" is used to refer to general shipping.

For the international shipping sector, as a member state of the IMO, the ROK is in full compliance with the regulations on reducing GHG emissions from ships according to international conventions (e.g., MARPOL). Examples of these regulatory measures include the mandatory measures for ship energy efficiency improvement adopted at the 62nd session of the IMO Marine Environment Protection Committee (MEPC) in July 2011 and the mandatory measures for carbon intensity improvement (Energy Efficiency eXisting ship Index (EEXI) and Carbon Intensity Indicator (CII)), which were adopted at the 76th session of the MEPC in June 2021 as short-term measures following the adoption of the Initial IMO Strategy on reduction of GHG emissions from ships.

Shipbuilding and R&D

In response to active decarbonization, the ROK plans to work with the world-leading shipbuilding industry to secure green ship technologies through R&D projects.

Technologies for zero-emission vessels such as ammonia-fueled engines, ship propulsion systems, and hydrogen fuel cell systems are currently under development. New technologies will be gradually commercialized based on testing and validation of performance and safety through onshore / offshore demonstration projects and real ship building.

In addition, to operate ships, we must establish a supply chain and infrastructure that enable the supply of low / zero-emission ship fuels. The government is reviewing plans to establish bunkering facilities for fuels such as LNG, methanol, ammonia, and hydrogen during the stage of the National Port Development Plan. Furthermore, there are plans to expand production technologies for biofuel for ship. Above all, laws and regulations will be either created or amended to address the entire lifecycle of future ship fuels, from production, storage, and sales, to supply. This will facilitate the utilization of low / zero-emission fuels in the Korean shipping industry.

Green Shipping Corridor

Recently, the international community has been discussing the need for a joint effort to establish a zero-emission shipping pilot route and develop green technologies. Green Shipping Challenge at COP27 of the UNFCCC has accelerated multilateral initiatives on the Green Shipping Corridor. Korea participated in the Green Shipping Challenge and, along with the US, announced plans to establish a green cargo shipping route between the Port of Busan and the Port of Tacoma. A joint pre-feasibility study with the US will be undertaken, and the results will be reported at COP28.

Summary

This report presents the ROK's plans and aspirations for the decarbonization of the shipping industry. The strategy can be summarized as follows:

For the decarbonization of the shipping industry,

1. We will contribute to the global efforts in response to the climate crisis and prepare for the future.
2. We will enhance competitiveness in the shipping and port sector by expanding infrastructure for zero-emission fuel.
3. We will actively participate in a wide range of global initiatives related to sustainable shipping and increase global influence.

The ROK is committed to faithful implementation of the Decarbonization Strategy for the Shipping Industry. We assure you that we will provide regular updates on the National Action Plans (NAPs) and share the NAP with the IMO Member States.

CHAPTER Ⅰ

Net-Zero Strategy in Korea

Ilshin Marine Transport Co., Ltd.

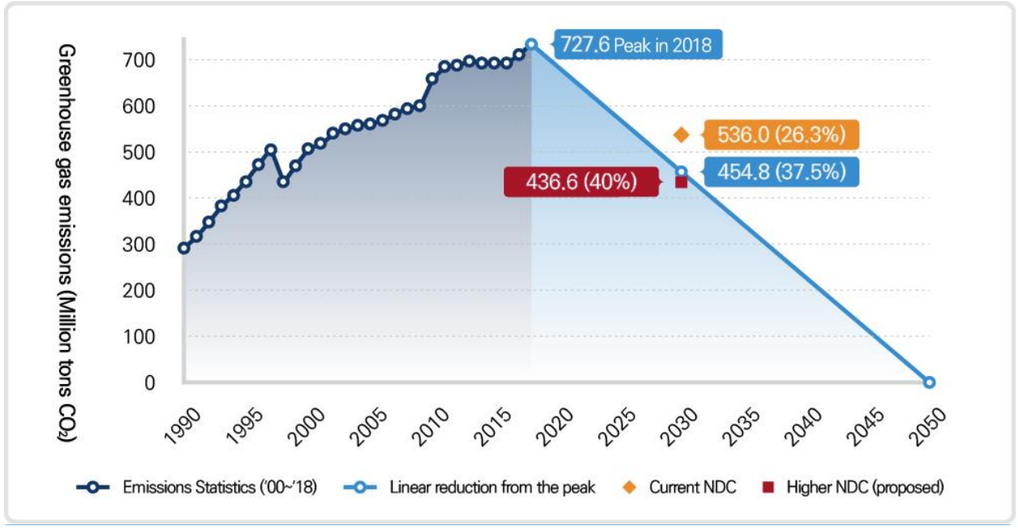
01. The New Wave of Net-Zero in the Republic of Korea

The 2050 Net-Zero Announcement

In 2015, the Paris Agreement, an international treaty mandating efforts to reduce GHG emissions and adapt to climate change, was adopted. It aimed to elicit commitments from all participating states to establish Long-Term Low Emission Development Strategies (LT-LEDS) by 2020 from the perspective of a long-term vision for climate change response policies. Accordingly, the government joined the global efforts in mitigating and adapting to climate change. The LT-LEDS was established for nationwide implementation, and finally, the 2050 Net-Zero Announcement was made in October 2020.

The Government has identified the climate crisis as a crucial challenge for the survival and prosperity of humanity. Following the 2050 Net-Zero announcement, the ROK has fully committed to achieving Net-Zero. As a part of its follow-up actions, the Carbon Neutrality Act was enacted in September 2021. This legislative framework is geared toward achieving Net-Zero, thus making Korea the 14th country globally to commit to this vision by 2050. The act has allowed the ROK to establish an integrated system that is legally grounded, encompassing various actions such as the reduction of greenhouse gas emissions, adaptation to the climate crisis, and transition to net-zero society. It also aims to minimize unintended consequences, including job loss, damage to the local economy, and impact on the underprivileged. Additionally, the government is promoting green growth to harmonize economic development and environmental conservation.

<Figure 1-1> Greenhouse Gas Emissions Reduction Target in the ROK



The 2030 Reduction Target

According to the Paris Agreement, all parties must establish the national GHG reduction target periodically. Most of the parties submitted the Intended Nationally Determined Contribution (INDC) in 2015 as per the Lima decision. When parties ratified the Paris Agreement in 2016, the INDC was converted to Nationally Determined Contributions (NDC), which was required to be updated or re-submitted by 2020 in accordance with the respective Agreement.

The ROK submitted the INDC in 2015 and shared its 2030 GHG target with the international community. The revised 2030 Roadmap was released in July 2018 to expedite the delivery of the national GHG reduction target. The NDC, which initially aimed to reduce GHG emissions by 37% from the Business-As-Usual (BAU) levels by 2030, was revised to a reduction of 24.4% compared to the 2017 levels in December 2020. In August 2021, the Framework Act on Carbon Neutrality was enacted, defining the minimum NDC target for 2030 as at least a 35% reduction from the 2018 levels. Consequently, in October 2021, the NDC was updated once again, setting a target of reducing emissions by 40% from the 2018 levels, which amounts to 727.6 $MtCO_2eq$.

Basic plans are being developed for each sector to set mid- to long-term goals and strategies, aiming to reach these targets through specific systems and measures. Concurrently, various policies are underway to increase the share of new and renewable energy and promote an energy transition through the Renewable Portfolio Standard (RPS). For the industry sector, the Energy Efficiency Resource Standard (EERS) is being introduced, while policies to improve transport and logistics systems are being promoted to support the transportation sector.

<Table 1-1> Progress of 2030 Reduction Target Updates

Category	「Basic Roadmap to Achieve the National GHG Reduction Target for 2030」(Dec 2016)	「Revised Basic Roadmap to Achieve the National GHG Reduction Target for 2030」(Jul 2018)	「Updated National GHG Reduction Target for 2030 (NDC)」(Dec 2020)	「Revised GHG Reduction Target for 2030」(Oct 2021)
Scope of Analysis	31 sub-sectors in eight sectors	8 sectors		
Reduction Target	37% ↓ from 2030 BAU levels (domestic 25.7%, overseas 11.3%)	37% ↓ from 2030 BAU levels (domestic 32.5%, overseas 4.5%)	24.4% ↓ from 2017 levels (709.1 $MtCO_2eq$) by 2030	40% ↓ from 2018 levels (727.6 $MtCO_2eq$) by 2030
Mitigation Pathway	Amount of emissions to be reduced in 2030	Amount of emissions to be reduced every three years from 2013 to 2030		Amount of emissions to be reduced in 2030

Establishment of the Korean Green Taxology (K-Taxonomy)

To overcome the climate crisis wisely and achieve the Sustainable Development Goals (SDGs), the direction of technological and economic development must align with that of the SDGs. In this way, we can achieve three objectives at once: develop new growth engines, create decent jobs, and achieve the SDGs.

Meanwhile, following the sweeping impact of the COVID-19 pandemic, major countries have introduced Green New Deal policies for a green recovery. To that end, large amounts of funding or subsidies are anticipated to be concentrated on green economic activities. In this process, to prevent unintended damage from false misleading, or untrue information related to green economic activities - collectively referred to as greenwashing - relevant standards should be established as preventive measures against such misinformation or claims.

Against this backdrop, Korean Green Taxology (K-Taxonomy) was developed. Its purpose is to support and facilitate the allocation of green funds rightfully to green projects or technologies by clearly defining principles and standards on what truly green economic activities are.

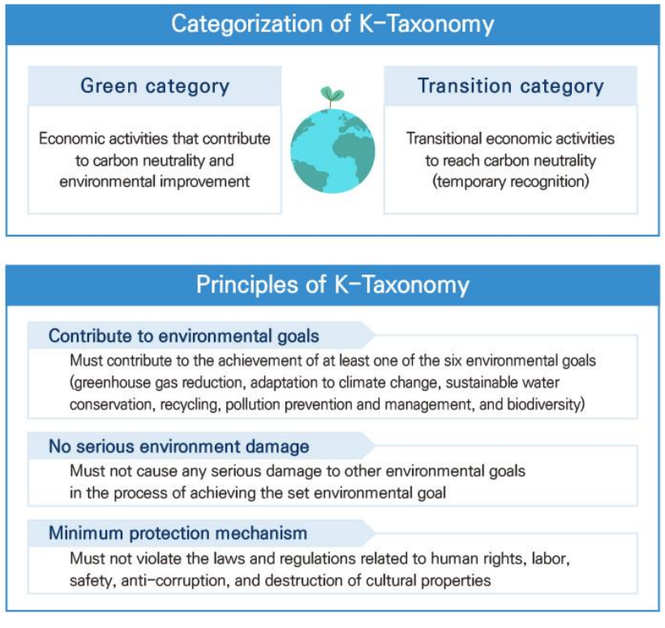
K-Taxonomy serves as a guideline for green economic activities. It can be used in green finance to support and promote environmentally responsible investments. K-Taxonomy can be applied to projects subject to green bond investments along with the “Korean Green Bond Guidelines” published by the Ministry of Environment and the Financial Services Commission in December 2020. Financial institutions issuing green bonds use K-Taxonomy to select projects involving true green economic activities, thereby increasing trust among investors. K-Taxonomy will continue to be improved and updated after considering international trends, national policies, opinions of stakeholders, social consensus, and technological development.

K-Taxonomy categorizes major green economic activities into two: the green category and the transition category. The green category refers to activities of significant contributions to GHG emissions reduction, and the transition category refers to economic activities aimed at achieving Net-Zero for a transitional period temporarily.

Activities in the green category, which are especially focused on reducing GHG emissions, include building ZEVs powered by electricity, solar power, or hydrogen constructing and operating equipment to charge or maintain these vessels, introducing zero-emission passenger ships and ferries, and operating facilities required for maintenance. They also involve introducing or retrofitting ZEVs powered by electricity, solar power, or hydrogen for the transport of passengers or cargo, along with building and operating associated maintenance facilities.

Activities in the transition category, which are recognized temporarily until 2030 and aimed at reducing GHG emissions, include building, introducing or retrofitting green ships and constructing and operating maintenance facilities for these green ships. Green ship-related activities are classified as part of the temporary transition category, rather than the green category, because a green ship certification can be obtained even when low-carbon fuels, such as LNG and LPG, are used. Therefore, following the transition period, discussions will take place on applying stricter criteria for green ship certification, shifting from low-carbon fuels to zero-emission fuels. This will enable the reclassification of green ship-related activities from the transition category to the green category.

< Figure 1-2 > Composition and Principles of the Korean Green Taxonomy (K-Taxonomy)



Detailed Information

K-Taxonomy and Ship Finance

The government released the “Korean Green Taxonomy (K-Taxonomy) Guidelines” in December 2021. These guidelines are considered a stepping stone toward the goal of net-zero society and serve as the basis for the active utilization of green finance. K-Taxonomy serves as a guideline that defines green economic activities contributing to six environmental goals: GHG reduction, adaptation to climate change, sustainable water management, resource recycling based on the circular economy, prevention and management of pollution, and biodiversity. It is used as the basic principle and standard for green finance investment and green technology development.

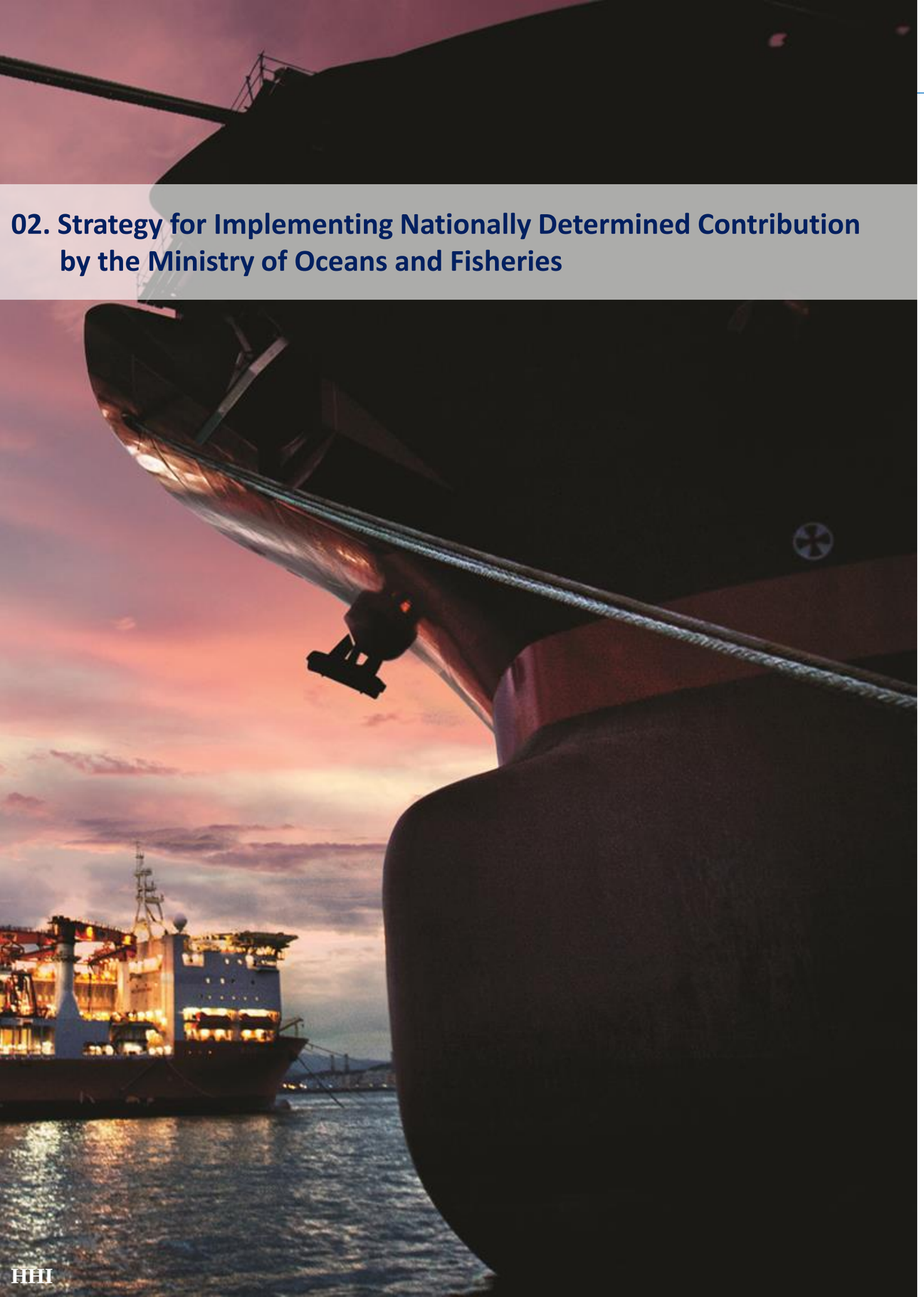
In the shipping sector, green ship construction and green shipping have been recognized as green economic activities until 2030, and are classified as the transition category in the K-Taxonomy. According to the “Green Ship Act,” domestic financial institutions can provide ship finance as green finance for ships that have received a Green Ship Certification of rating three or higher.

< Table 1-2 > Classification of the Korean Green Taxonomy (K-Taxonomy)

Category	Description
Green Category (64 activities)	Green economic activities essential for Net-Zero and environmental improvement - hydrogen-based direct reduced iron, non-carbonate materials, solar power, electric / hydrogen vehicles, Carbon Capture, Utilization, Storage technology (CCUS), etc.
Transition Category (5 activities)	Economic activities temporarily included in the K-Taxonomy in the transition to Net-Zero - energy production based on LNG and mixed gas, blue hydrogen production, sustainable shipbuilding (construction of green ships), sustainable shipping, etc.

The “Green Ship Certification Scheme” is a national certification system according to Article 6 of the Green Ship Act. This scheme, implemented in 2021, serves as a basis for various government-funded projects that encourage domestic private shipping companies to adopt green ships. The scheme is also used for green finance by policy finance institutions based on the K-Taxonomy. In the future, it will serve as a foundation for promoting the adoption of green ships in Korea in line with stricter regulations and policies related to Net-Zero.

The government is working to ensure the seamless implementation of Green Ship Certifications and the supply of certified green ships. These efforts are made to lay the groundwork for building ZEVs and promoting green shipping after 2030.



02. Strategy for Implementing Nationally Determined Contribution by the Ministry of Oceans and Fisheries

Net-Zero Policy by MOF

MOF, which oversees the marine, fisheries, shipping, and port industries of the ROK, strives to reduce GHG emissions in line with the global trend of Net-zero and the direction of national policies in Korea.

To support and facilitate the implementation of the 2050 Net-Zero Scenarios announced in October 2021, MOF established the “2050 Net-Zero Roadmap for the Marine and Fisheries Sector,” which presents the direction of net-zero policy in the marine and fisheries sector in Korea.

MOF has set the 2050 emissions target as “negative” emissions, going beyond Net-Zero, and has established detailed plans such as policy directions and measures to achieve this target. Specifically, these plans include reducing CO_2 emissions from business activities in the marine and fisheries sectors such as shipping and fisheries activities, the use of alternative ocean energy sources such as wave and tidal energy instead of fossil fuels, and the expansion of the areal coverage of carbon sinks by utilizing blue carbon such as tidal flats and seagrass meadows.

2050 Net-Zero Roadmap for the Marine and Fisheries Sector

Following the 2050 Net-Zero announcement by the Korean government, MOF announced the "2050 Net-Zero Roadmap for the Marine and Fisheries Sector" in December 2021 as part of a government-wide effort. As of 2018, GHG emissions from the marine, fisheries, shipping, and port sectors were 4.061 $MtCO_2eq$, accounting for 0.56% of the total emissions in Korea.

Considering that ocean plays a significant role in mitigating climate change by absorbing 20% to 30% of anthropogenic GHG emissions, and due to the growing emphasis on the importance of the oceans' roles, MOF presented a comprehensive roadmap with targets for CO_2 emissions for the relevant sectors.

In particular, MOF announced the 2050 Negative Emissions, which goes beyond the 2050 Net-Zero, by reducing CO_2 emissions from the shipping, ports, and fisheries sectors. These efforts also include using carbon sinks such as blue carbon and shifting to ocean energy as an alternative to fossil fuels.

Specifically, the 2050 GHG emissions target for the marine, fisheries, shipping, and port sectors managed under MOF is -3.237 $MtCO_2eq$, a very ambitious and forward-looking target equivalent to cutting 7.298 $MtCO_2eq$ compared to 4.061 $MtCO_2eq$ in 2018.

The reduction target and policy measures for each sector are described as follows.

① Domestic Shipping

First, the target emissions for the domestic shipping sector by 2050 is 307,000 tCO_2eq, equivalent to a 70% reduction compared to the 2018 levels of 1.019 $MtCO_2eq$. Based on the "National Plan for the Development and Popularization of the Green Ship," MOF plans to accelerate the pace of technological development, ranging from low-carbon ships, such as LNG and dual fuels, to ZEVs, such as hydrogen and ammonia. MOF also strives to facilitate a seamless transition to green ships in stages for the private and old government vessels.

In addition, MOF will continuously strive for the timely, commercial application of the ZEV technologies, such as the construction of testbeds for safety testing of new green ship technologies and supporting the international standardization of technologies developed in Korea.

② Fisheries

Second, the target emissions for the fisheries sector and fishing villages by 2050 are 115,000 tCO_2eq, equivalent to a 96% reduction compared to the 2018 levels of 3.042 $MtCO_2eq$. To achieve such a drastic cutting of emissions, MOF will push for engine replacement and shipbuilding to replace old fishing boats, development and supply of eco-friendly fishing boats, such as electric or hybrid boats, and facilitation of energy-efficient equipment supply for the aquaculture and fish processing industries. Accordingly, the ROK government is promoting projects to replace old coastal fishing boats and old engines with high-efficiency ones to improve energy efficiency and reduce GHG emissions. In 2020 and 2021, 32 fishing boats were replaced, and by 2030, 732 boats are expected to be built as replacements, and old engines in 4,500 boats will be replaced.

In addition, MOF will make utmost efforts across all areas of the fisheries sector, such as the installation of small hydropower plants and photovoltaic facilities in fish farms to establish the foundation for the utilization of renewable energy in fisheries and fishing village infrastructure, and support the transition to eco-friendly coolants for chillers and freezers for fisheries products.

③ Marine Energy

Third, through expanded utilization of ocean energy, power generation by fossil fuel power can be replaced, which will contribute to the reduction of GHG emissions by 2.297 $MtCO_2eq$ by 2050. To this end, we will make active investments in technology development, such as expanding tidal power generation and commercial application of tidal and wave power generation. In particular, a feasibility study will start for the expansion of the Sihwa Lake Tidal Power Plant, which is expected to supply renewable electricity for 500,000 people annually. In addition, MOF will contribute to the transition to the hydrogen economy by establishing an ocean-based green hydrogen production system linked with ocean energy and marine biology.

④ Blue Carbon

Fourth, the blue carbon sector also plans to absorb 1.362 $MtCO_2eq$ of CO_2 by 2050 Blue carbon refers to a carbon sink captured by coastal and marine ecosystems. Typical examples include tidal flats, salt marsh vegetation, and seagrasses. MOF plans to restore 30 km^2 of tidal flats by 2050 by using abandoned salt and fish farms, and expanding seagrass meadows.

⑤ Port

Fifth, the port sector will also undergo a transition to zero-emission ports. Ports serve as a hub of domestic and international logistics, and thus, achieving Net-Zero in ports has significant implications. We plan to achieve carbon-neutral ports by 2050 by converting engines of cargo handling equipment, such as yard tractors and transfer cranes, to low-emission engines, expanding the supply of Diesel Particulate Filters (DPFs), improving the energy efficiency of port facilities, and utilizing renewable energy. Hydrogen ports will be constructed to lead the transition to the hydrogen economy. A hydrogen port refers to a port with a hydrogen energy ecosystem encompassing production, import, storage, transport, and utilization of hydrogen. A total of 14 hydrogen ports are to be constructed by 2040, and 13 $MtCO_2eq$ of hydrogen will be provided through the ports annually, thereby taking the lead in achieving a successful transition to the hydrogen economy.

⑥ Carbon Sink, and CCS

Carbon Capture and Storage (CCS) is a crucial tool and a project that the ministries jointly undertaking to store 60 $MtCO_2eq$ of CO_2 under the national scenarios. MOF will fulfill its role to achieve successful commercialization of CCS in Korea, such as the selection of optimal sites for sub-seabed storage and sequestration of CO_2, implementation of safe storage technology in the ocean, and minimization of environmental impact. To promote CCS projects overseas, MOF will promptly adopt relevant procedures, such as the ratification of amendments to the London Protocol, which allow for cross-border transportation of CO_2. We plan to actively explore various possibilities of ocean-based GHG reduction measures, such as increasing the recycling of marine waste and utilizing waste as an energy source.

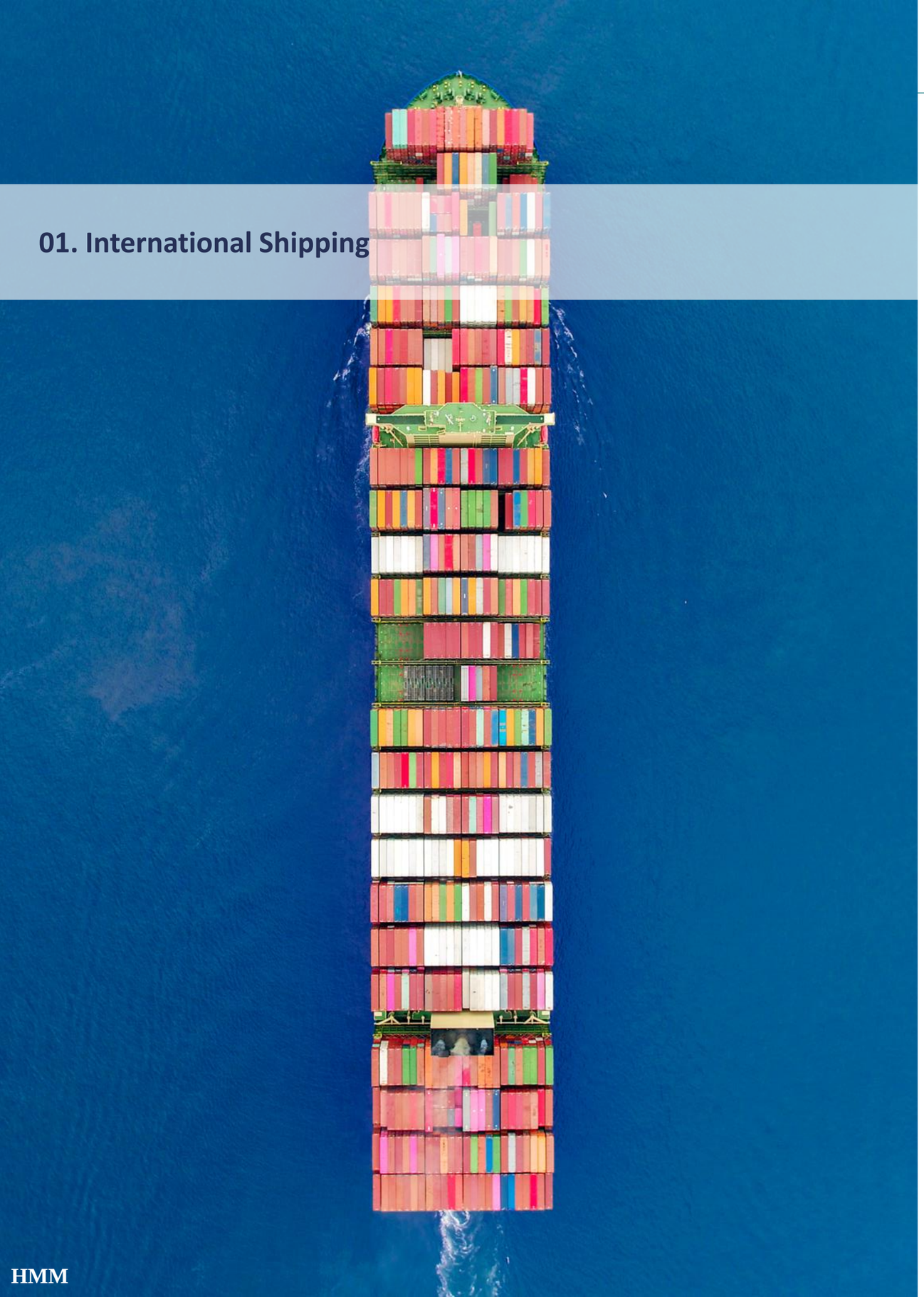
Detailed Information

CHAPTER Ⅱ

SHIPPING

LNG Propulsion Ship HL Green

01. International Shipping



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The Paradigm Shift Toward Zero-emission Shipping

The International Maritime Organization (IMO) adopted the “IMO Initial GHG Strategy” in 2018. This strategy presented a vision to phase out GHG emissions in this century, and announced a long-term goal of reducing GHG emissions by 50% compared to the 2008 levels by 2050. However, the “IPCC Special Report on the impacts of global warming of 1.5℃” in 2018 provided scientific evidence, revealing that global warming may be limited to an increase in the global average temperature to 1.5°C above pre-industrial levels only when the target of Net-Zero is reached by 2050 across all industrial sectors. Following the report, the international shipping industry is also facing the demand to set the 2050 Net-Zero goal. Against this backdrop, the IMO Initial GHG Strategy will also be revised, raising the 2050 target to achieve Net-Zero.

Until now, the IMO's general approach to regulating the energy efficiency of ships has limitations in reducing GHG emissions above a certain level. IMO is discussing the introduction of market-based measures such as a carbon tax and an Emission Trading Scheme (ETS) to achieve Net-Zero transition in the international shipping industry. If market-based measures are implemented, ships powered by fossil fuels will lose their competitiveness in the market even if there are no forceful actions such as suspension.

To align with more stringent regulations on GHG emissions, the global shipping and shipbuilding markets are expected to undergo a rapid change from the existing diesel-fueled ships to green ships. The most significant change in recent years is that industries, rather than IMO or governments, have been demanding the decarbonization of the shipping sector. Not only the shipping industry but also the financial sector and global corporations call for zero-emission shipping; thus, transitioning to Zero-Emission Vessels (ZEVs) is imperative for the operation of shipping businesses in the future.

Decarbonization Strategy for International Shipping

Establishing Zero-emission Shipping Policy of the ROK

The government enacted the Act on the Promotion of the Development and Distribution of Environment-Friendly Ships (also known as The Green Ship Act) in January 2020. This act includes active responses to the upward revisions of the 2050 GHG emissions reduction target as well as tightened regulations. Subsequently, as a follow-up measure, the "2030 Green Ship-K (The Korean Green Ship) Promotion Strategy" was established in December of the same year. This strategy serves as a mid-to-long-term plan for green ship development and distribution, aligning with the Green New Deal and Net-Zero policies.

However, since 2020, there has been a global demand for raising the IMO's target of GHG emissions reduction by 2050 to the level equivalent to Net-Zero. As IMO will decide on raising the 2050 target in July 2023, MOF concluded that a more specific and upgraded governmental plan is needed. This plan needs to encompass more diverse aspects than the existing Green Ship-K Promotion Strategy, which focused on technology development and popularization. Thus, in February 2023, MOF announced the "Strategy for Decarbonization of International Shipping."

In this new strategy, the commitment of the ROK government to achieve Net-Zero by 2050 nationwide will also be applied in the international shipping sector to take the pioneering step in the decarbonization movement in international shipping as a Member State with best practices in climate change responses. MOF presented the target of "Net-Zero by 2050 in International Shipping," before the IMO's decision. The strategy for implementing the updated target was established, striding toward sustainable shipping. In addition, the strategy presents the national vision and policy direction to enhance the export base and the global competitiveness of related industries through the green transition of the shipping industry.

With the goal of becoming the leading country in the green transition of shipping, we expect the effects of virtuous cycles, enabling synergistic growth in Korean shipping and shipbuilding industries with the implementation of the green transition of the national flag carriers. Thus, we aim to utilize the green transition of shipping as a new engine for driving the growth of the national economy in the era of Net-Zero by increasing the share of Korean shipping companies in the global sustainable shipping market and creating positive economic effects by enhancing the productivity of downstream / upstream industry such as shipbuilding / marine equipment.

Detailed Information

Decarbonization Strategy for International Shipping

Vision

No.1 country in shipping and shipbuilding realizing Net-Zero by 2050

Goals

Carbon reduction in international shipping :
by 60%(2030) → 80%(2040) → 100%(2050)

4 Major Strategies	12 Action Items
01 Conversion to eco-friendly fleets and regulatory response	1. Reorganization of eco-friendly fleet structure for national flag carriers 2. Support for ship modification and facility improvement 3. Reduction and management of carbon emissions from operating ships
02 Improving investment conditions for the shipping industry	1. Tax and financial support for eco-friendly ship operators 2. Preparation of plans to support small and medium-sized shipping companies' eco-friendly conversion 3. Establishment of an eco-friendly conversion model in which shipping companies and shippers cooperate
03 Expansion of eco-friendly technology and fuel infrastructure	1. Eco-friendly ship technology development and commercialization 2. Commercialization of future fuel and construction of supply chain infrastructure 3. Deregulation led by the private sector to preoccupy the market
04 Establishment of zero-emission shipping routes and international cooperation	1. Promotion of the global green shipping project 2. Establishment of Korea-led international environmental governance 3. Formation of industry-academia-research-government international shipping decarbonization council

① Green Fleet Transition

As the first strategy of the plan, Korean shipping companies will respond to international regulations by converting ships they own into vessels powered by green fuel (low- and zero-emission fuels) and secure future competitiveness in the shipping industry in preparation for the net-zero era by 2050. For 867 ocean-going vessels with a 5,000 gross tonnage and above, which are subject to international regulations such as those of IMO, MOF supports the transition to green fuel-powered vessels when replacing old ships.

In addition, with the goal of replacing 100% dilapidated ocean-going vessels with green ships by 2050, a mid-to-long-term green transition roadmap for ocean-going fleets has been implemented. In the case of building new vessels, by 2030, conversion to dual-fuel vessels that can utilize green fuels such as e-methanol and LNG will be achieved. Depending on the progress in technology development related to ZEVs, MOF plans to introduce the ammonia or hydrogen-fueled vessels.

Moreover, to respond to the CO_2 emissions regulations for ships in service, MOF will monitor the implementation status and strengthen management through periodic consulting and training for shipping companies.

② Improving Investment Climate of Shipping Industry

In order to mitigate the impact of cost increases caused by introducing green ships, MOF will prepare systems such as tax benefits and green financing for long-term service contract shippers. In addition, we plan to develop and present the “Private Sector Ship Investment Promotion Plan” within the year. This includes issuing green bonds to facilitate financing for shipbuilding by shipping companies and introducing fintech technology to ship finance.

Despite these support measures in policies and financing, small and medium-sized shipping companies with limited investment capacity due to poor financial conditions may still face challenges. For these companies, MOF plans to provide support for green transition and business stabilization through funds.

MOF plans to support green transition and business stabilization of small and medium-sized shipping companies through funds scaled up to KRW 1 trillion. Through Korea Ocean Business Corporation, investment of small and medium-sized shipping companies will be increased, and a special credit guarantee will be provided. In addition, MOF will review the support of green ship construction for small- and medium-sized shipping companies through public shipowner projects.

③ Establishment of Infrastructure for Green Ship Technology and Green Fuels

MOF promotes the development of green shipping technologies and the expansion of infrastructure for future ship fuels to secure a leading position in the green ship market. Development of proprietary core technologies for low-carbon / zero-emission shipping will be implemented through the “Innovative Green Ship Technology Development Project” jointly undertaken by the Ministry of Trade, Industry and Energy (MOTIE) and MOF. We plan to advance and localize low-carbon ship technologies like LNG and hybrid fuels, and develop source technology for zero-emission shipping, such as ammonia propulsion systems and hydrogen fuel cells.

To build future ship fuel supply chains and infrastructure, we are promoting the expansion and renovation of port facilities in preparation for the conversion of fuel to next-generation fuels, such as e-methanol, ammonia, and hydrogen. We plan to reflect the analysis of future fuel market demand in the National Port Development Plan and build fuel supply and storage facilities in line with the short- and mid- to long-term plans. Detailed descriptions related to ports can be found in Chapter 3 of this report. In addition, we plan to secure future ship fuel production technology by implementing the integrated biofuel technology development project (2023~2024, preliminary feasibility study) and by reviewing and implementing floating offshore infrastructure for zero-emission fuels. Furthermore, MOF will undertake the amendment of relevant laws, institutions, and systems in all stages of the ship fuel lifecycle, encompassing production, storage, sales and supply of the fuels.

④ Establishment of Zero-emission Shipping Routes and International Cooperation

MOF is promoting policies of international cooperation, such as establishing zero-emission shipping routes, in an effort to take the lead in the global shipping industry by spreading the Korean green shipping industry model.

In October 2022, following the joint announcement of the “Green Shipping Challenge” between Korea and the US at COP27 of the United Nations Framework Convention on Climate Change (UNFCCC), a pre-feasibility study for the establishment of a zero-emission green shipping route between Busan and the western United States was commenced in January 2023. The partnership will support the pilot operation of ZEVs. Through this initiative, we aim to develop the Korean green shipping industry model, and plan to introduce and provide the model to Europe and Asia.

In addition, MOF establishes international governance in which the ROK leads the discussion of responses to the climate crisis. MOF plans to hold a ministerial conference at the “Korea Maritime Week” event to be held in June to consolidate international cooperation with major countries in the shipping sector as well as with developing countries while leading international discussions such as the development of IMO-funded projects. Activities promoting green shipping will be discussed in more detail in “04. Promoting Green Shipping” on page 58 of this chapter.

HMM

02. Domestic Shipping

ULSAN TAEHWA, a smart electric passenger vessel

Implementing NDCs in Domestic Shipping

Emissions from domestic shipping are calculated as part of the national GHG inventory and included in the Nationally Determined Contributions (NDCs); therefore, the same emissions reduction system is implemented as in other industrial sectors nationwide.

The domestic shipping sector is categorized within the transportation sector along with road, rail, and air. The transportation sector's GHG emissions in 2018 were 98 $MtCO_2eq$. Of this, GHG emissions from domestic shipping were approximately 1.02 $MtCO_2eq$ in 2018, accounting for roughly 0.14% of the total emissions of 727 $MtCO_2eq$ in the ROK and approximately 1.04% of the total transport sector emissions. While these figures do not constitute a substantial portion, MOF is committed to achieving the common value and goal of Net-Zero in Korea.

Green Transition for Government Vessels

In accordance with the “2030 Green Ship-K (The Korean Green Ship) Promotion Strategy (2021~2030),” established to promote the development and popularization of green ships, MOF announced plans to convert a total of 388 public ships into green ships by 2030. This figure represents approximately 83% of the total government vessels as of 2020.

A total of 199 government vessels over 25 years of age will be replaced with green ships, while 189 vessels less than ten years of age will be equipped with a Diesel Particulate Filter (DPF) for renovation.

Green Ship and Green Ship Equipment Certification Scheme

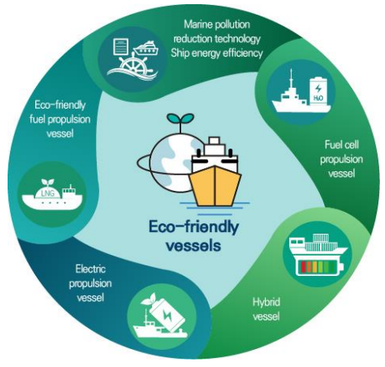
The government introduced the Green Ship Certification Scheme in 2021. This scheme is a national certification system to ensure the quality of newly developed technologies for net-zero shipping, and support the widespread use of these technologies in preparation for the expanded adoption of green ships and green ship equipment. Applicants for the certification scheme are evaluated based on the effectiveness of GHG and air pollutant reduction through the green ship and green ship equipment, as well as the complexity of the technologies. A five-grade rating, on a scale from one to five is given as a result of the evaluation.

A green ship as defined in the Green Ship Act

- Ships equipped with marine pollution reduction technology or ship energy efficiency improvement technology
- Ships powered by clean energy (LNG, NH3, etc.)
- Ships powered by electrical energy charged from an external power supply
- Hybrid vessel powered by a combination of ship fuels and electric energy
- Hydrogen fuel cell-powered vessel

Standards applied in the Green Ship Certification Scheme

- The application of green ship technology and the use of green fuel (%)
- Air pollutants (NOx, SOx, particulate matter) reduction (%)
- Energy Efficiency Design Index (EEDI), etc.



Maritime Demonstration Test Bed for New Green Ship Technologies

MOF and MOTIE are implementing the Green Ship-K Prototype Building Project so that new technologies can go through a series of processes, from onshore / offshore demonstrations to final commercialization. In this way, the technical and economic feasibility of the green ship technology can be tested and verified, and the technologies can be further deployed and popularized into ocean-going vessels of shipping companies and shipbuilders in the private sector.

By 2025, technologies that have been tested through onshore performance evaluation or those that have already been commercialized will undergo further advancements and updates. By 2027, a green ship prototype with new GHG reduction technologies will be built and in operation, thereby accumulating records of operations for the verification of technical feasibility. Subsequently, by 2030, the government set the sub-goal to provide the support required for the global market entry of the newly developed green ship technologies.

< Figure 2-1 > An example of a government vessel selected as a test bed in 2022

Pilot Project on Establishment of Decarbonized Shipping Route for Coastal Passenger Ships

To ensure the safety of coastal passenger ships used by the public and improve passenger convenience, MOF established a 5-year plan for modernizing coastal passenger ships. The 2nd phase of the plan for modernizing coastal passenger ships (2021~2025) was put together in 2020 to reflect domestic and international requirements for Net-Zero. It includes eco-friendly vessels operation, such as electric ships, aiming to support the construction of ten vessels or more by 2025.

For this plan, government-funded research on “the Development of Electric Car Ferries and Removable Battery Pack Systems” will be conducted from 2020 to 2024. A decarbonized shipping route with zero GHG emissions will be established for pilot operations, running from port to port, with the newly developed ships from this research program.

To this end, Jeonnam province, in which many coastal passenger ships are in operation due to many islands in the region, is designated as a regulation-free special zone for eco-friendly domestic vessels. Moreover, a test bed will be established for testing and verifying the green coastal passenger ships, and records of real maritime operations will be obtained.

The pilot routes will be gradually expanded, starting from short-sea routes for car ferries involved in both passenger and cargo transportation. In addition, government support will be provided for developing fuel supply infrastructure, such as charging stations and battery replacement systems, depending on the types of ships, such as car ferries and fast-sailing ships, as well as energy sources, such as electricity and hydrogen.

<Figure 2-2> Electric Car Ferries

Korea Express Ferry Co., Ltd

03. Research & Development (R&D)

Panasia CCS Research Facilities

Development of Next-generation Green Ship Technology

The following research and development projects are underway to support the phased transition for the development of green shipping technologies, as well as the establishment of a supply chain and the related infrastructure for next-generation fuels.

① Technology Advancement for Propulsion Systems (LNG / electric / hybrid)

In the advancement of technological development for zero-emissions shipping with ultra-large ocean-going vessels, transition technologies such as LNG, electric ships, and hybrid ships or technologies for reducing GHG emissions for small to medium-sized vessels are being actively developed.

LNG

Compared to fossil fuels, Liquified Natural Gas (LNG) is recognized as a ship fuel with lower CO_2 emissions, fully complying with the requirements for regulatory control of air pollutants. To that end, there has been a significant increase in the demand for LNG-fueled ships, requiring the commercialization of core parts and components that can meet the quality and level of LNG vessel construction technologies in Korea. In consideration of such needs, the government has set the following key directions for technology development in the LNG-fueled ship sector the advancement of core ship equipment technology, the development of smart marine engine technology, and after-treatment technology to address fuel slip issues.

Electric / Hybrid

In the case of electric ships, domestic shipbuilders receive orders and construct vessels domestically. Therefore, the key directions for technology development are as follows: the commercialization of electric / hybrid ships for domestic shipping, technological advancement related to major ship equipment for electric vessels, and large-scale hybrid propulsion technology for ocean-going vessels. In addition, the research aims to construct and demonstrate ICT-convergent electric smart ships. For hybrid domestic vessels, technologies for power sources and inverters will be further advanced by 2025. For ocean-going vessels, large-capacity propulsion technology will be developed, such as large-capacity electric podded propulsor technology and shaft generator / motor package technology, by 2026. By 2029, the research aims to develop high-power solid-state transformers technology.

<Table 2-1> Examples of Target Ship Types and the Required Technologies for Green Transitions of Domestic and Ocean-going Vessels

Category	Domestic Vessels		Ocean-going Vessels
Target Vessels	Tugboats, etc.	Hospital ships (passenger ships), etc.	174k LNG Carrier
			
Engine	LNG/ Battery (fuel cell)	LNG (+fuel cell)	Dual-fuel (LNG-ammonia)+fuel cell Hybrid
MCR	3.0 MW	5.0 MW	13 MW
Length / Breadth Gross Tonnage (capacity)	28.0 m / 10.0 m 180 GT	37.0 m / 12.0 m 350 GT	290.0 m / 47.0 m 174,000 m^3
Required Technologies	• LNG methane slip technology • Demonstration of hybrid technology (fuel cell + battery) • Demonstration of motor and converter technologies • Demonstration of propulsion motor control technologies • Demonstration of electric / rim-driven motor technologies • Demonstration of monitoring / control, etc.	• Demonstration of hybrid technology (fuel cell + LNG) • High voltage distribution system technology • Propulsion control • Parallel deployment of fuel cells • 50m^3 LH_2 storage tank	• 2 stroke (or 4-stroke) LNG-ammonia dual fuel cycle • Fuel cells as substitute of generators, a concept of high voltage switchboard • General arrangement design with a hull form specialized for ammonia storage facilities and propulsion motor • Approval in Principle (AiP) awarded at the basic design level • AiP awarded for conceptual design drawings

② Technology Development for Dual-fuel Marine Engines

Until the commercialization of ZEVs is completed, a transitional step is required to reduce GHG emissions within the shipping sector.

To this end, technology development is underway utilizing dual-fuel marine engines. Dual fuel refers to the combined use of conventional fuels such as Marine Gas Oil (MGO) or LNG with zero-emission fuels such as hydrogen, ammonia, biofuel, or electricity. The higher the ratio of zero-emission fuels in the mix, the greater the potential for reducing GHG emissions. The government-led projects on dual-fuel technology development are divided into four categories for phased implementation:

- Technology development for the commercialization of dual-fuel ships in domestic shipping
- Technology development related to dual-fuel engines, fuel supply systems, and fuel storage facilities
- Technology development related to the evaluation system for quality and safety of the dual fuel and bunkering technologies
- Evaluation system for the quality and safety of dual fuel

<Table 2-2> Examples of Ship Types and the Required Technologies for Green Transitions of Domestic and Ocean-going Vessels

Category	Domestic Vessels	Ocean-going vessels
Target Vessels	Liquid cargo carriers , etc.	Aframax Tanker
		
Engine	Dual-fuel engine with ammonia	Marine engine with fuel oil blending (low sulphur fuel oil-CO_2 capture)
MCR	8.2 MW	10.4 MW
Length / Breadth	137.0 m / 22.4 m	243.0 m / 43.8 m
Gross Tonnage	12,300 GT	-
Required Technologies	• Utilization of re-liquefied NH_3 and corrosion resistance	• 2 stroke HFO-biodiesel dual fuel cycle • 4 stroke HFO-biodiesel dual fuel generator • Combustion and exhaust gas aftertreatment technology • AiP awarded at the basic design level • AiP awarded for conceptual design drawings

③ Technology Development for Zero Emission Vessels (hydrogen, ammonia, etc.)

The development and demonstration of green ships using hydrogen and ammonia as fuels are long-term research goals for these technologies. In addition, research is underway to secure the relevant technologies.

Hydrogen

To develop domestic vessels powered by hydrogen fuel cell-powered, technology development is planned in the areas of cryogenic liquefied hydrogen fuel storage and supply systems, as well as large-capacity fuel cell hybrid technology. The research will be conducted on safety technology for fuel storage and supply system for domestic vessels by 2026. For ocean-going vessels, fuel cell-ESS hybrid propulsion technology and testing and evaluation methods for liquefied hydrogen bunkering equipment will be developed by 2029. By 2030, technology development for hydrogen fuel tank safety evaluation / maintenance and liquified hydrogen bunkering will be completed.

Ammonia

In the case of ammonia fuel, the research on ammonia fuel cell-based propulsion technology will be carried out by 2025, and ammonia engines by 2026.

<Table 2-3> Examples of Target Ship Types and the Required Technologies for Green Transitions of Domestic and Ocean-going Vessels

	Domestic Vessels		Ocean-going Vessels
Category	**Hydrogen**	**Ammonia**	**Ammonia**
Target vessels	Government vessels (car ferries), etc.	Feeder container ship, etc.	24,000 TEU Container Carrier
			
Engine	Battery or fuel cell	Ammonia engine	Ammonia engine
MCR	~1.0 MW	8.4 MW	60 MW
Length / Breadth	-	150.0 m / 22.0 m	399.9 m / 61.5 m
Gross tonnage	~200 GT	9,800 GT	24,000 TEU
Required technologies	Demonstration of the following: • 1MW fuel cell (F/C) module • 1m^3 LH_2 storage tank • 1MW F/C module • 500kW propulsion motor • Standard hull form, propulsion system, etc.	Demonstration of the following : • Ammonia (single-fuel) engine technology • Fuel Gas Supply System (FGSS) technology • Ammonia aftertreatment technology • Ammonia / hydrogen reforming technology, etc.	• 2 stroke ammonia cycle • 4 stroke ammonia generator • ammonia combustion and exhaust gas aftertreatment technology, - General arrangement design in consideration of ammonia storage facilities • AiP awarded for conceptual design drawings

④ Technology Advancement for Energy Efficiency Improvement and Development of Core Ship Equipment

Even after the development and commercialization of ZEVs, regulations aimed at improving ship energy efficiency will be further tightened with raised targets. To that end, it is crucial to continue developing and implementing high-energy efficiency technologies in ships.

Energy Efficiency Improvement (Hull)

To reduce the frictional resistance of ships, technology development will focus on frictional resistance reduction technology and marine biofouling management systems with IoT by 2025. The development of biomimetic technology for the reduction of frictional resistance is aimed at completion by 2030. ② For optimal structural ship design, the development of an optimal hull form for green ships will be carried out by 2028, and a range of appendages for energy-efficient ship design will be implemented by 2030. ③ To optimize operational efficiency, technology development on big data and AI-applied performance analysis, shipping route navigation, and monitoring systems will be completed by 2030. ④ To design a high-efficiency propulsion system, an ultra-light, high-efficiency composite propeller will be developed by 2025 as well as a high-efficiency, ultra-light, fully-automated rudder by 2028. ⑤ For new materials and weight reduction, technology development will be undertaken by 2026 in the following areas: weight reduction of structures, alternative composite materials for ship outfitting components, and lightweight metal sandwich panels.

Facilities for Alternative Energy Sources

⑥ For energy harvesting, a waste heat recovery system is planned to be developed by 2025. Energy-saving technology for reefer containers will be developed by 2029 and a power generation system that utilizes unused waste heat onboard will be built by 2030. ⑦ As for CO_2 capture technology, the Carbon Capture Utilization and Storage (CCUS) system, technologies such as wet flue gas / membrane-based CO_2 capture, onboard CCUS, CO_2 power generation systems, and replacements with new industrial materials are the key areas for development.

<Table 2-4> Methods of Energy Efficiency Improvement and Types of Major Equipment

Energy Efficiency Improvement (Hull)	Facilities for Alternative Energy Sources
① Reduction of frictional resistance	⑥ Energy harvesting equipment
② Hull form design optimization (Design of optimum shape)	⑦ CO_2 capture and power generation equipment
③ Optimization of operational conditions	–
④ Design of high-efficiency propulsion system	–
⑤ New / composite materials	–

<Table 2-5> Roadmap for Implementing R&D Related to Eco-friendly Vessels

Category		2022	2023	2024	2025	2026	2027	2028	2029	2030
LNG Fuel Technology	**Domestic vessel**									
	Ocean-going vessel									
High-capacity Hybrid Technology	**Domestic vessel**									
	Ocean-going vessel									
Zero Emission Vessel Bridge Technology	**Ocean-going vessel**									
Energy Efficient Technology (common application technology)	**Domestic vessel / Ocean-going vessel**									
Hydrogen Fuel Technology	**Domestic vessel**									
	Ocean-going vessel									
Ammonia Fuel Technology	**Domestic vessel**									
	Ocean-going vessel									

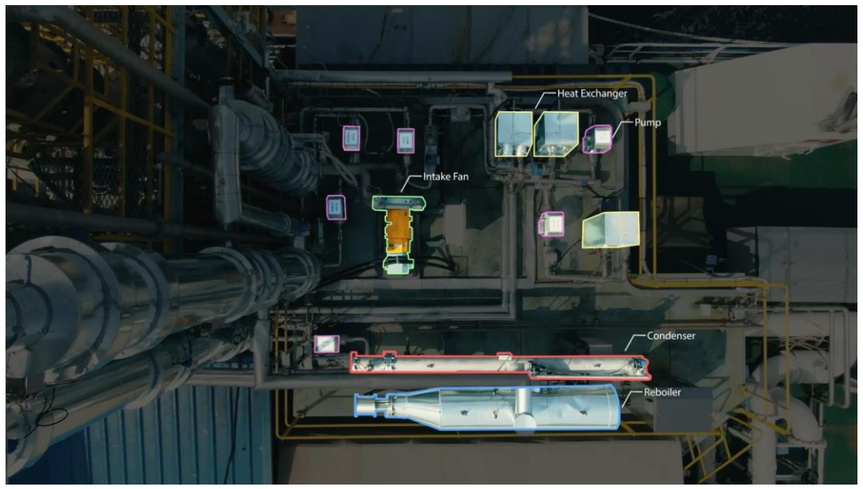
⑤ Technology Development for Construction of Eco-friendly Vessels in the Private Sector

The Republic of Korea is a global powerhouse in the shipbuilding sector. To maintain this status, a wide range of R&D projects are currently underway to develop technologies related to green ships, considering the national and global trends of net-zero shipping and shipbuilding.

Development of Onboard Carbon Capture System

Korean shipbuilding and marine equipment companies possess advanced technologies for onboard carbon capture systems. Feasibility studies will be conducted to assess the cost-effectiveness and safety of the ship-based carbon capture systems through onboard demonstrations.

<Figure 2-3> Onboard Carbon Capture System



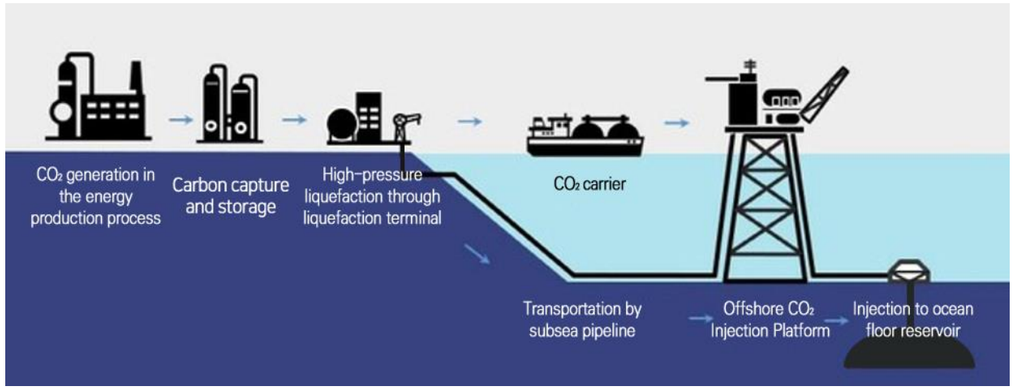
Liquefied CO_2 Carriers

Major Korean shipbuilders are expected to play an active role in the growth of market-related Carbon Capture through Utilization and Storage (CCUS) technology. This points to the potential future growth of liquefied CO_2 carriers. To this end, Hyundai Glovis has partnered with Hyundai Heavy Industries (HHI) to grant Approval in Principle (AiP) from registers for the basic design of an ultra-large liquefied CO_2 carrier. To safely transport a large amount of liquefied CO_2, it is required to maintain environmental conditions at a high pressure of 5.1 bar and a low temperature of -56℃. The carrier, having been awarded the AiP, is designed to maximize loading capacity and advance the system that can safely preserve cargo s by maintaining tank pressure during operation.

Korean Offshore CO_2 Injection Platform

HHI and the Korea Shipbuilding & Offshore Engineering (KSOE) have developed the “Korean Offshore CO_2 Injection Platform” in partnership with the Korea National Oil Corporation. And, DNV has awarded the AiP for this developed platform. This platform stores CO_2 captured from land, liquefies it under high pressure, and transports it via carriers or pipelines. That is, the captured CO_2 is stored beneath the ocean floor. This developed platform is expected to store 400,000 tCO_2eq of CO_2 annually underground in the East Sea gas field of Korea starting in 2025.

<Figure 2-4> Offshore Carbon Dioxide Injection Platform



Wind-powered Auxiliary Propulsion System

Rotor sails, a wind-powered auxiliary propulsion system for ships, are large cylinders installed on the ship deck. The device uses wind to generate propulsion, reducing fuel consumption by 6-8%, and thereby lowering GHG emissions. HHI was granted an AiP from the Korea Register for the first time in Korea in 2022 for an independent model of the wind-powered propulsion system.

Methanol-fueled Ships

Methanol-fueled ships are drawing attention as post-LNG-fueled ships. Using methanol as a ship fuel reduces air pollutants such as sulfur oxides by 80-90% compared to conventional ship fuels. The low emissions of methanol contribute to reduced GHG emissions. Unlike LNG, which requires high pressure and cryogenic conditions, methanol can be transported and stored more easily under room temperature conditions and atmospheric pressure. Hyundai Mipo Dockyard delivered the world's first two methanol-powered tankers in 2016. Approximately one-third of the more than 20 methanol-fueled ships currently in service worldwide were built in Korea. KSOE won orders for 19 methanol-fuelled container ships in 2022. Unlike hydrogen / ammonia-powered ships, which still face many obstacles to commercialization, methanol-fueled ships can be operated with current levels of technology and require relatively low initial infrastructure construction costs. Therefore, they are increasingly attracting attention during this transitional period toward zero-emission fuels.

<Figure 2-5> Wind-powered Auxiliary Propulsion System: Rotor sail

<Figure 2-6> Methanol-fueled Ships

Detailed Information

Joint Project Group for Green Ship Lifecycle Innovation Technology Development

MOF and MOTIE launched the “Joint Project Group for Green Ship Lifecycle Innovation Technology Development” at the Korea Marine Equipment Research Institute in Busan in 2022. The project group composes the development division (supported by MOTIE) and the demonstration division (supported by MOF), as well as a technology advisory committee consisting of experts in various fields to collect information from different areas of expertise.

In this way, the technology development within the project can be linked and shared in unity to maximize the effect of the developed technologies.

<Figure 2-7> Joint Project Group for Green Ship Lifecycle Innovation Technology Development

<Figure 2-8> Green Ship Life Cycle Innovation Technology Development Project

Detailed Information

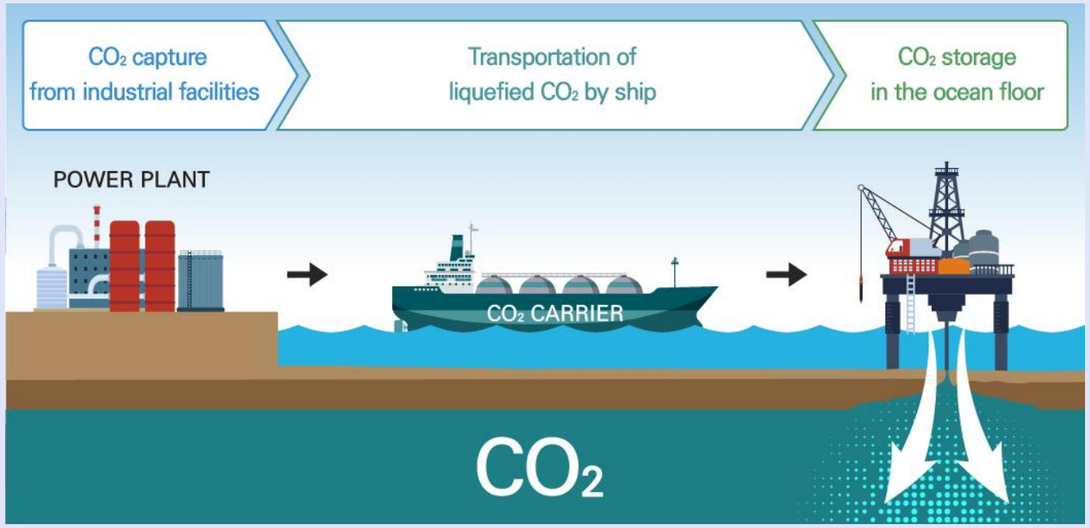
Embarking on the Development of the World’s Largest Liquefied CO_2 Carrier

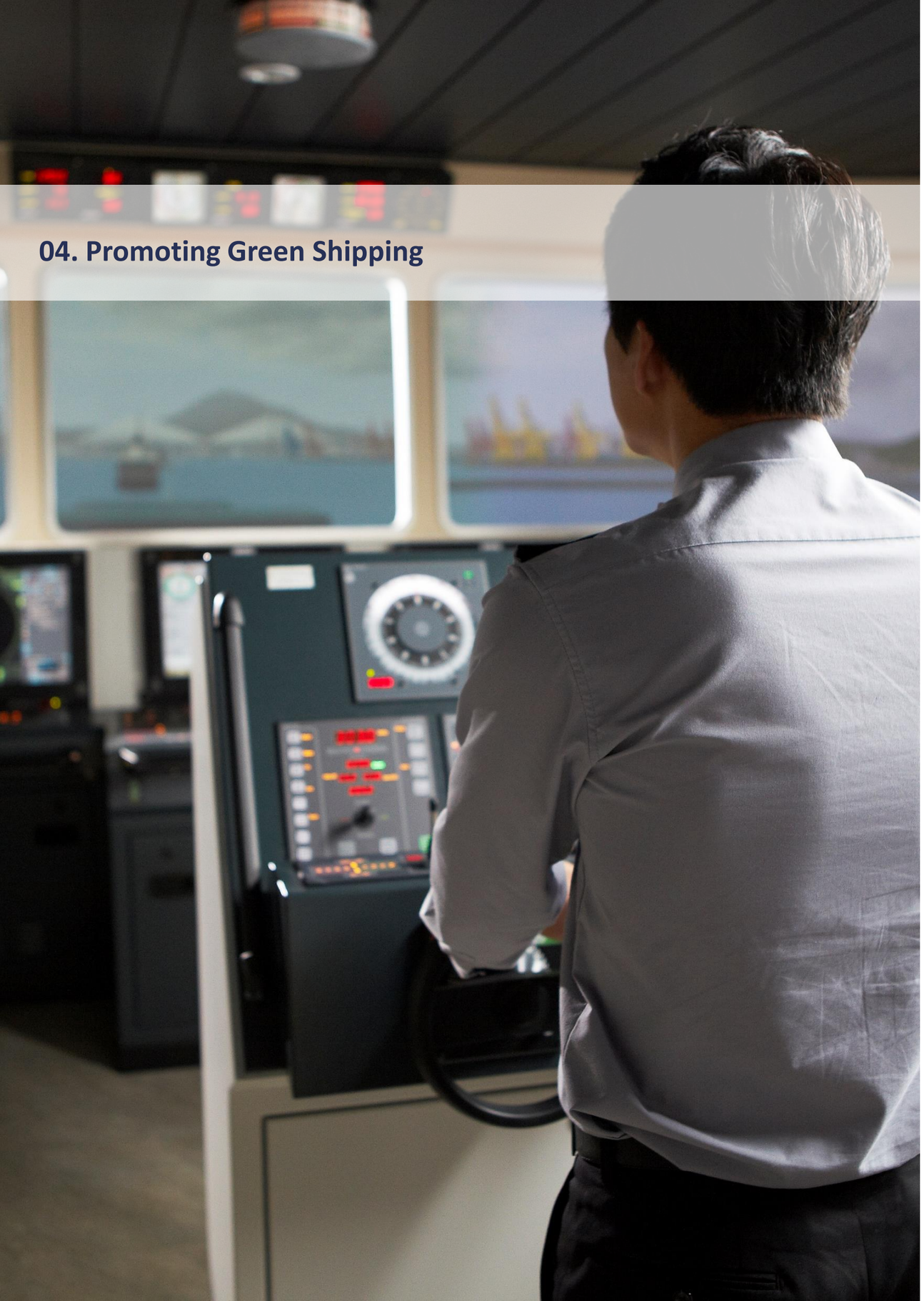
Hyundai Glovis succeeded in obtaining a AiP, which is the first step in developing the world's largest liquefied CO_2 carrier. As a result, from the early stages of ship development, technical feasibility, safety, stability, and an effective conceptual design of ships were recognized officially by institutions.

The technologies of injecting CO_2 emissions from fossil fuels underground or utilizing the captured CO_2 in oil fields are an important technology to achieve Net-Zero. The liquefied CO_2 carrier is considered an essential vessel for the seaborne transportation of liquefied CO_2.

Hyundai Glovis aims to build the world's largest liquefied CO_2 carrier in the upcoming pipeline. The vessel is 284 meter-long and 42 meter-wide. It will be equipped with an LNG-powered engine. Considering these dimensions, specifications and a maximum loading capacity suitable for specific ports can be calculated and reflected in the ship design. Furthermore, HHI and KSOE aim to achieve technological advancement in the area of a Cargo Containment System (CCS) and Cargo Handling System (CHS) for the stable storage of liquefied CO_2 and the implementation of the hull form design for maximum loading capacity.

<Figure 2-9> Conceptual Diagram of CO_2 Maritime Transport





04. Promoting Green Shipping

Green Shipping Initiative

Green Shipping Corridor

The Green Shipping Corridor refers to the decarbonization of a maritime route connecting two or more ports. The multilateral framework for the Green Shipping Corridor was officially launched through the “Clydebank Declaration” at COP26 in November 2021.

In line with the Paris Agreement, the government has set a target to achieve Net-Zero by 2050 across all sectors, including shipping. This is to limit the global average temperature rise to 1.5°C above pre-industrial levels due to global warming. To advance the introduction of ZEVs on global shipping routes by 2030, the government participated in the Green Shipping Challenge at COP27 in November 2022. It also formed a partnership with the U.S. to develop technology for the establishment of the Green Shipping Corridor, considering the age of ships (25 to 30 years) and the stability of the global supply chain through maritime logistics.

The ROK and the U.S. have announced a collaboration on the production and supply of zero-emission fuels, the establishment of infrastructure such as bunkering facilities, and the demonstration and deployment of low or zero-emission vessels. To this end, the U.S. Department of State and the Department of Energy, in partnership with MOF, the Ministry of Foreign Affairs (MOFA), and MOTIE of the ROK will conduct a feasibility study on the zero-emission shipping routes between the Port of Busan and major ports in the western United States starting from 2023. Furthermore, collaborations in the area of production and supply of zero-emission fuels will be conducted with other countries taking part in the Green Shipping Challenge. To be specific, the government began a preliminary feasibility study for the Green Shipping Corridor between the Port of Busan and the Port of Tacoma with the U.S. The results of the joint study will be reported at COP28 in December 2023. The government will continue to investigate and explore potential collaborations related to the Green Shipping Corridor with other ports and countries.

<Figure 2-10> ROK - U.S. Releasing a Joint Statement Announcing Collaboration on Green Shipping Corridor

Getting to Zero Coalition

The Getting to Zero Coalition is an alliance composed of more than 200 stakeholders, including governments, Intergovernmental Organizations (IGOs), and 160 players in the shipping, energy, infrastructure, and finance value chain. Members of the coalition share the goal of establishing infrastructure to achieve Net-Zero in the shipping sector by 2050 and having commercially viable ZEVs in operation by 2030.

The ROK is one of the 14 countries that have joined the Coalition. Korean companies and governmental agencies that are members or supports the coalition are as follows.

Coalition members

- Hanwha Ocean
- Hyundai Merchant Marine (HMM)
- Korean Register (KR)

Supported by

- Korea Maritime Transportation Safety Authority (KOMSA)
- Korea Research Institute of Ships & Ocean engineering (KRISO)

To support the overarching goal of the Getting to Zero Coalition, which is the commercialization of ZEVs and the establishment of infrastructure, the Korean government focuses on supporting key areas as follows: ① R&D investments, ② decarbonization of domestic vessels, ③ incentives for ship fuel (energy) transition, and ④ facilitating innovative policies and technologies, and compliance with international regulations.

Zero Emission Shipping Mission

The Zero Emission Shipping Mission (ZESM) aims to have at least 5% of the world's international shipping fleet capacity served by ZEVs by 2030. The role of ZESM is to ally with countries, the private sector, research institutes, and civil organizations to jointly develop, demonstrate and deploy zero-emission fuel, ships, and fuel infrastructure by 2030. The efforts will lead to the expansion of the Green Shipping Corridor. The government is also participating as a Mission Support Group along with France and Ghana and working in joint efforts to achieve the goals of ZESM, such as participating in the Green Shipping Challenge.

IMO Cooperation Programs

The Implementation of GHG SMART Program

Least Developed Countries (LDCs) and Small Island Developing States (SIDS) are highly vulnerable to the impact of climate change. Many are also economically reliant on their maritime transport. Following the true spirit of the United Nations (UN), “Leave No One Behind,” IMO has been working with LDCs and SIDS to support the implementation of the IMO Initial GHG Strategy on reducing GHG emissions from ships by employing the development of the GHG SMART Program as capacity building activities for these countries. Following the Memorandum of Understanding (MOU) between IMO and MOF of ROK, this program provides four years of the Voyage Together Trust Fund, which was established based on donations from the ROK, amounting to USD 2 million.

The GHG SMART program aims to achieve a sufficient level of capacity building for human resources required for the implementation of the Initial IMO Strategy on the reduction of GHG emissions from ships. The program consists of three stages: a comprehensive training program, post-training monitoring, and evaluation and refinement. The delegations for the program are trained by Subject Matter Experts (SMEs) on all-encompassing aspects of the IMO GHG Strategy. This will help build the capacities necessary for the implementation of the National Action Plans (NAPs), enabling active engagement in policy-making, national action planning, and raising finance.

The annual curriculum of the program consists of “Core Training (CT)” and “Practical Training (PT).” CT is performed through online courses at the beginning of the year, providing a series of training on global regulations (e.g., MARPOL Annex VI, IMO GHG Strategy), national policies and plans of implementation, and information on fuels for achieving decarbonization of shipping. In PT, the delegations make direct visits to Korea and tour research institutes of excellence and industrial sites related to green shipping activities or research. In 2022, the first year of the program, 19 trainees from 13 countries completed the program.

The GHG SMART program supports case studies and training for LDCs and SIDS to develop and implement NAPs. We hope that the program will be able to bridge the technological and policy gaps related to regulations on the reduction of GHG emissions from ships.

<Figure 2-11> 2022 GHG SMART Program

Future Fuel & Technology Project (FFT project)

The Future Fuels and Technology for Low- and Zero-Carbon Shipping Project (FFT project) is a partnership project between the Korean government and IMO aiming to support the reduction of GHG emissions from international shipping by adopting technologies related to future fuels, which are primarily low-carbon or zero-emission fuels.

Since 2016, the ROK has made annual donations of USD 2 million to the Voyage Together Trust Fund (VTTF). For the period between 2022 and 2025, the ROK plans to fund the FFT project to reduce GHG emissions from international shipping by facilitating the introduction of future fuels and technologies, which will be implemented by the IMO Secretariat.

Key Goals of the FFT Project

The FFT project aims to support the revision and implementation of the Initial Strategy and the development of mid-term measures of GHG emissions reduction from shipping by providing results of technical analysis and research in support of relevant discussions on GHG reduction held by the IMO.

- (**Workstream 1**) Research on the current progress and projections regarding the adoption and widespread of low-carbon / zero-emission technologies
- (**Workstream 2**) Identifying incentive-based / regulatory mechanisms, including safety and seafarer training issues, to facilitate the progress of implementing low- and zero-emission fuels and technology, including a mid- to long-term measures for GHG emissions reduction
- (**Workstream 3**) Bolstering technical cooperation (e.g., pilot projects) and organizing outreach activities to enhance mutual understanding and cooperation among developed countries, developing countries, and the global shipping industry.

CHAPTER Ⅲ

PORT

Panoramic View of Busan New Port

01. Roadmap for Carbon-Neutral Ports

Busan New Port

Establishment of the 2050 Roadmap for Carbon-Neutral Ports

MOF established the “2050 Net-Zero Roadmap for the Marine and Fisheries Sector and presented the construction of carbon-neutral ports as a vision. The roadmap includes “zero-emission ports” and the “construction of hydrogen ports” as the key policy measures.

In addition, by outsourcing the “Master Plan for Carbon Neutral Port Construction, MOF plans to devise specialized strategies per port and define the functions of ports for the 2050 carbo-neutral goal, improving the quality of life for Koreans and creating synergy between ports and cities.

Port Infrastructure Construction and Incentive Systems for Carbon-neutral Ports

To achieve “zero-emission ports,” the government plans to focus on managing major cargo handling equipment identified as a significant contributor to emissions. Fuel supply infrastructure for low-emission fuels, such as LNG charging stations and Alternative Maritime Power (AMP) facilities, will be expanded substantially up to 2030, in line with the progress in the distribution of green ships. In addition, to form a stable environment for ship operations after deploying green ships, the government will provide incentives such as reducing fees for using port facilities to more businesses.

In line with government policies, domestic ports are considering to implement several projects to promote Net-Zero, including constructing and adopting electric ships, using renewable energy, and building hydrogen terminals.

Hydrogen Port Building and Technology Development for Efficient Port Operations

According to hydrogen production technology trends, the government plans to build hydrogen ports in phases by 2040. From 2026, a demonstration project for hydrogen imports will be carried out, and the development of fundamental technologies for hydrogen production from water electrolysis is also expected to be completed by 2030. Additionally, using renewable energy and hydrogen supply as ship fuels are also expected in 2030 through acquiring of propriety hydrogen production systems based on water electrolysis. These innovations help achieve cost-effectiveness in hydrogen production. Furthermore, to improve the efficiency of various operations in ports, several R&D projects are underway, such as a renewable energy management system and a system for the prediction of port container traffic volume.

02. Implementation of Carbon-Neutral Ports

Port of Gwangyang

Phased Implementation

① (Short-term) The Construction of Low-carbon Sustainable Ports

MOF plans to drive the transition to low-emission engines for cargo handling equipment in ports, such as yard tractors and transfer cranes, and further provide more Diesel Particulate Filters (DPFs). MOF aims to improve the energy efficiency of various port facilities and the utilization of renewable energy, thereby implementing GHG reduction efforts in phases.

By 2025, MOF aims to complete the transition to low-emission equipment for key items of cargo handling, which contributes significantly to GHG emissions in ports. This strategy considers the scale of operations and the equipment utilization ratio during cargo handling operations. The ministry strives to facilitate the transition to green ports that reduce particulate matter and GHG emissions. This can be achieved by installing DPFs and converting cargo handling equipment from diesel to LNG.

Port support vessels such as tugboats, pilotage, and port guide ships operated in ports will also be gradually converted to ships powered by low-carbon fuels.

In addition, after the establishment of new and renewable energy generation infrastructure, such as solar power generation facilities using the port area, 20 photovoltaic facilities in major ports, such as the Port of Busan, are generating clean electricity.

<Figure 3-1> LNG-powered Yard Tractor

<Figure 3-2> LNG-fueled Port Guide Ship

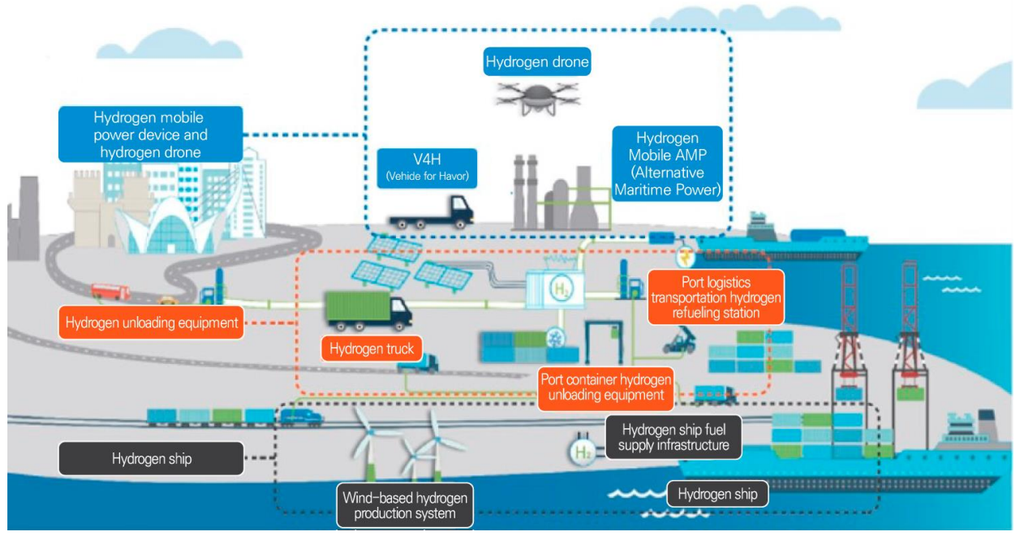
② (Long-term) Hydrogen Port Construction with a Hydrogen Energy Ecosystem

A hydrogen port is a port that supports a hydrogen energy ecosystem, encompassing hydrogen production, import, storage, transportation, and utilization. The ROK has devised a plan to construct hydrogen ports, facilitating the transition to a hydrogen economy. These ports will not only produce hydrogen using LNG and marine renewable energy but also act as logistics hubs for the import, storage, and supply of hydrogen from abroad. Furthermore, with the surge in hydrogen-powered transportation, such as hydrogen-fueled ships and trucks, these hydrogen ports will become major consumption centers within the hydrogen economy.

The government plans to establish hydrogen ports in phases by 2040, in alignment with the technological environment and hydrogen policies of each ministry. Given that hydrogen production through LNG reforming has now become viable, pilot facilities for hydrogen production will be built at two ports by 2028. Subsequently, by 2030, the construction of ports equipped with infrastructure for importing hydrogen from overseas will be completed. Lastly, by 2040, the port's construction designed for green hydrogen production using marine renewable energy will be completed. The plan anticipates the construction of 14 hydrogen ports in total.

In pursuit of constructing hydrogen ports, the government has established key guidelines. These include prioritizing public-private partnership projects to pioneer the hydrogen port model. The guidelines also emphasize developing infrastructure for hydrogen consumption within the port, laying the groundwork for the hydrogen energy ecosystem. Detailed plans for these ports feature hydrogen fuel (bunkering) for ships, installation of power supply systems, construction of charging facilities for hydrogen-powered vehicles, and conversion of port equipment to low or zero-emission power systems.

<Figure 3-3> Conceptual Diagram of a Hydrogen Port



Detailed Information

The Construction of Hydrogen Ports

In November 2020, the ROK unveiled the “2030 Port Policy and Implementation Strategy,” outlining a mid- to long-term vision and development plan for ports across the country.

To prepare for the advent of green ships, this strategy includes plans for building LNG bunkering terminals at some ports and developing hydrogen bunkering technologies. The power supply for port cargo handling equipment is expected to be switched from diesel to LNG and electricity.

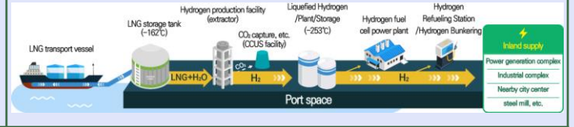
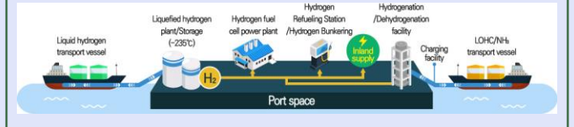
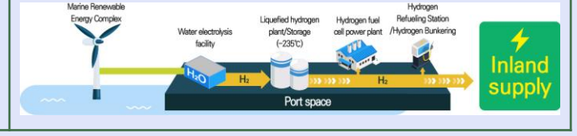
In line with the trend of increasing utilization of renewable energy, such as offshore wind power and hydrogen, the related support facilities, in ports including piers and hinterland, will also changes accordingly. In particular, the development of hydrogen port infrastructure will be explored through R&D, taking into consideration the pace of advancements in hydrogen carriers, hydrogen bunkering technologies, hydrogen-powered ships, and equipment for hydrogen transport and handling.

Based on hydrogen production technologies, the ROK predicts that the hydrogen port model will evolve into port infrastructure with extracted hydrogen, imported hydrogen, and hydrogen produced by water electrolysis. In light of this prediction, the government has devised a three-stage plan for hydrogen port construction.

The first stage involves a port designed for the production and supply of extracted hydrogen by integrating the LNG supply chain. Korea believes that the construction of the port is feasible with current technological capabilities. However, research and development are underway to enhance technologies, such as liquefied hydrogen plant storage and CCUS technologies.

The second stage of a hydrogen port includes a terminal for storing and supplying importing hydrogen (liquefied and liquid compound state) from overseas in Korea. In this regard, R&D is being carried out for technologies related to hydrogen carriers, cargo stations in ports, and hydrogenation and dehydrogenation methods.

The third stage of a hydrogen port encompasses a port terminal powered by renewable energy for the production, storage, and supply of hydrogen produced by water electrolysis Various technologies, such as those for improving production efficiency and hydrogen production system by water electrolysis, are being developed while renewable energy.

Stage	Role and Technology Level	Conceptual Diagram
[Stage1] Reforming	• Producing and supplying hydrogen by reforming LNG • Possible to build with the current technology level	
[Stage2] Import	• Importing overseas hydrogen (liquefied or compound) • Requiring technology development, and verification (hydrogen transport ship, loading and unloading, dehydrogenation, etc.)	
[Stage3] Water Electrolysis	• Hydrogen production and supply through water electrolysis as renewable energy • Requiring basic technology development (water electrolysis production system, securing economic feasibility, etc.)	

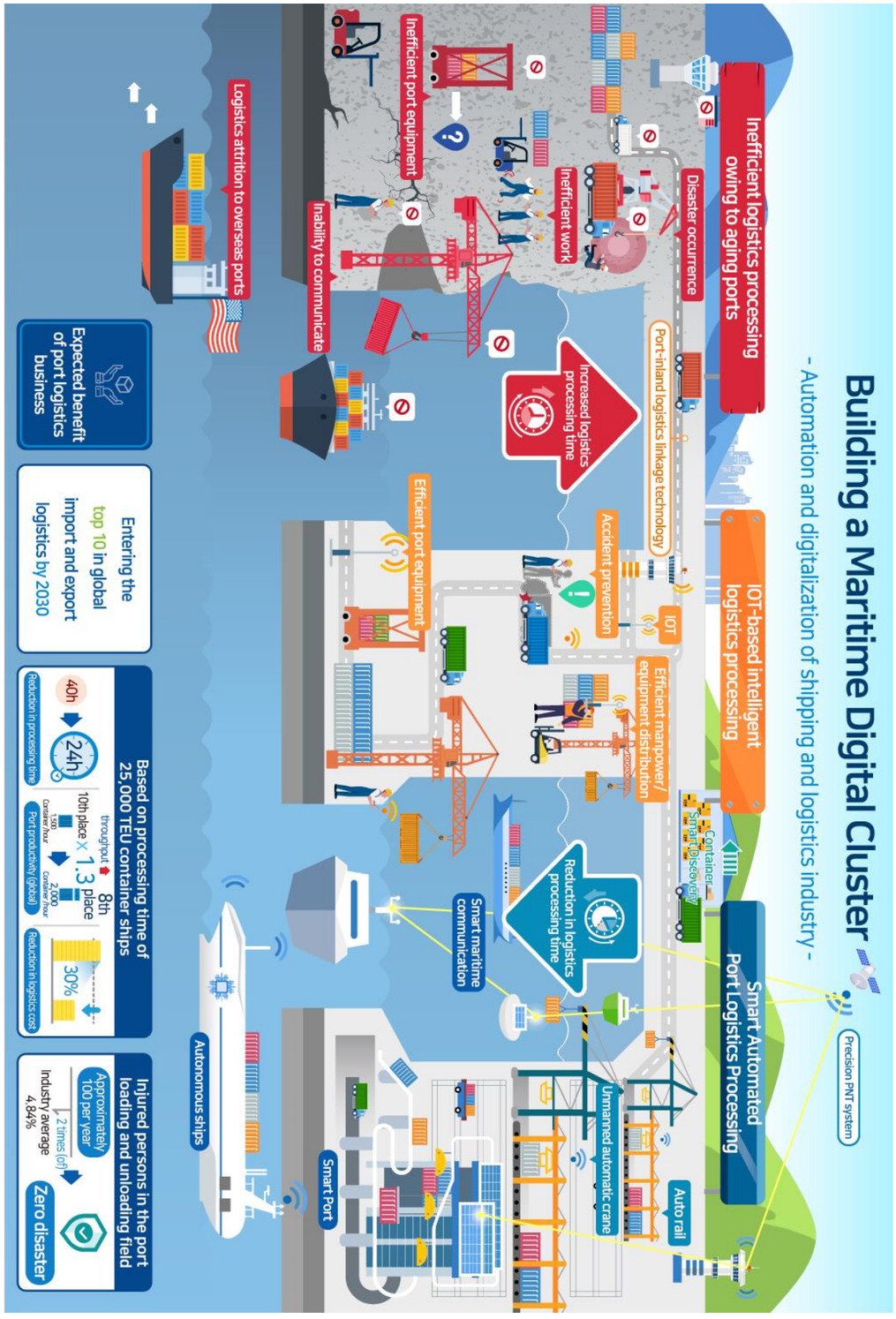
③ (The 4th Industrial Revolution) The Development of Smart Maritime Logistics Infrastructure

The rapid evolution of information technology is shifting the paradigm in the port industry to smart ports. Smart ports adopt a variety of technologies, such as IoT and AI, for efficient port operation, contributing to the improvement in energy efficiency and the construction of green ports. They also serve as a hub to facilitate information flow, enabling the seamless collection, processing, analysis, and sharing of data while connecting all relevant resources.

The government is promoting smart maritime logistics to optimize port logistics via port and container intelligence and port facility automation. This initiative aims to build automated and intelligent digital ports and smart ports based on low or zero-emission facilities. Firstly, a next-generation port centered on 24/7 operations with minimal human input can be constructed through the phased implementation of automation and intelligent port resource management in all areas, including quay, transfer, and yard operations for cargo handling, transport, and loading. This approach includes the development of a "Logistics 3-Chain" that optimizes logistics and improves port productivity by integrating maritime, port, and onshore logistics data.

By 2026, to garner data from operational experience, a port automation testbed will be established through an investment of KRW 691.5 billion for the development and demonstration of technologies. Following testbed verification, some ports, such as the Port of Busan, will adopt automation technologies. By 2030, Korean smart ports are expected to be fully operational. Moreover, the ROK plans to establish a platform that facilitates information sharing among users such as shipping companies and terminal operators. This platform will play a pivotal role in completing an intelligent port logistics system by integrating autonomous ships and trucks. To accomplish this, research and application of ICT technologies, including smart construction technology and analysis of port facility aging status, will be conducted by 2025.

Furthermore, the ROK is in the process of developing a system to systematically manage data, including GHG, and air pollutants in port areas, based on data analysis and statistics from ship fuel consumption.



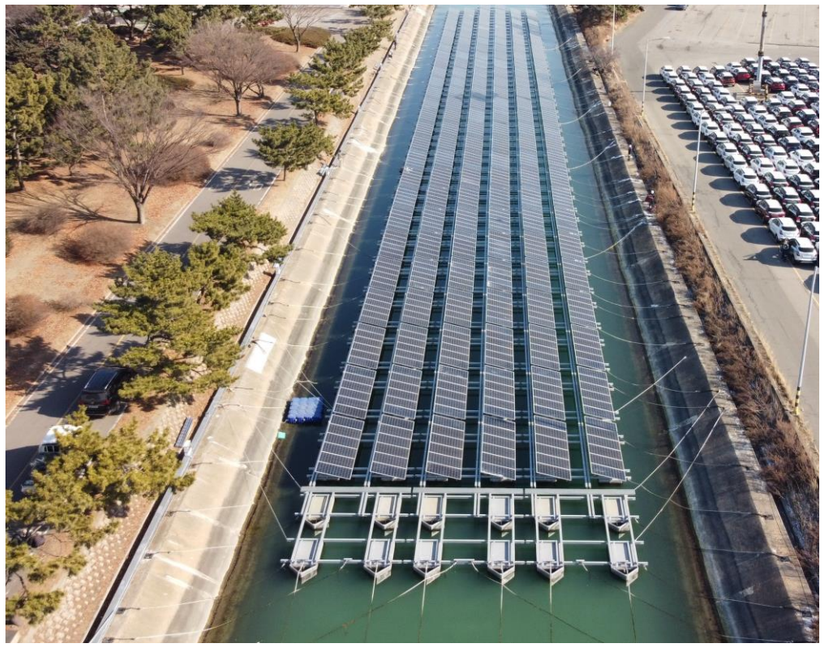
④ Expanded Integration of Renewable Energy

The ROK is promoting projects associated with the transition to alternative energy sources, forming a foundation to achieve Net-Zero. These projects aim to encourage widespread adoption of new and renewable energy sources such as solar power, wind power, and geothermal heat.

In the port sector, the primary focus is on solar power generation projects that utilize the extensive rooftop spaces available on warehouses. Through these projects, the ROK strives to enhance the energy independence of ports.

Given the abundant wind resources in port areas, the construction of both onshore and offshore wind farms is also gaining momentum as part of the renewable energy projects. As such, the role of ports has been redefined and expanded to serve as "support facilities for offshore wind power," with plans for additional installations in the mid-term.

<Figure 3-4> Offshore Solar Power Plant, Port of Incheon



Detailed Information

Offshore Wind Power

In line with the trend of expanding the use of new and renewable energy, the ROK is focusing on offshore wind power in ports, often referred to as the "power plants on the sea." Ports offer more favorable wind conditions and a higher utilization rate for wind power generation facilities compared to inland environments. Additionally, due to high demand, the power distribution system is well established, and the port infrastructure needed for the construction and maintenance of power generation facilities is readily accessible. As such, the Korean shipbuilding industry and local governments are rapidly preparing to enter the offshore wind power industry.

With the goal of building sustainable large-scale offshore wind farms, the government is undertaking two key projects: ① identifying optimal sites for offshore wind farms and ② supporting the development of offshore wind farms through local authorities.

The first project, “offshore wind farm site seeking,” involves conducting surveys and analyses of wind conditions, resources, and potential sites to identify the most suitable locations for offshore wind farms. The second project, "offshore wind farm development support," involves the government funding a portion of the three-year project cost for the development of offshore wind farms, facilitating their timely construction.

<Figure 3-5> Offshore Wind Turbines Installed on a Ship

Major Projects

① Transition to Zero-emission Cargo Handling Equipment

The government is undertaking a project to transition cargo handling equipment, which is a significant source of GHG emissions, to eco-friendly alternatives. This is being done while considering the scale of the port's operations and the proportion of human and material resources dedicated to cargo handling.

Supported by government funding, this project has been seeking to reduce air pollutants, such as particulate matter since 2017. Projects, which involve transitioning fuel sources from fossil fuels to electricity or LNG for cargo handling equipment operation, secured additional GHG emissions reduction. Therefore, from the perspective of mitigating air pollution, the ROK is aiming to completing transition to green equipment by 2025.

Building upon the success of these initiatives, the plan after 2025 is to further transition to green cargo handling equipment, extending to low- or zero-emission machinery. This progression aligns with the broader objective of reaching national and port-specific targets for net-zero emissions by 2050.

② The Establishment of Fuel Supply Infrastructure for Low-carbon / Zero-emission Fuels

According to the “2050 Net-Zero Roadmap for the Marine and Fisheries Sector,” eco-friendly fuel supply infrastructure is expected to show a significant expansion by 2030, compared to the level of 2020, due to the popularization of green ships.

By promoting the distribution of green ships and expansion of fuel supply infrastructure for green ships, the government plans aim to establish fuel supply infrastructure through undertaking projects such as LNG bunkering demonstration, operation of LNG bunkering ships and vehicles, improvement of bunkering process and diversify LNG fuel supply channels such as building shore terminals.

Preparation is underway for the establishment of supply infrastructure not only for low-carbon fuels such as LNG but also for zero-emission fuels such as methanol and ammonia, according to the roadmap and plans to meet the target.

③ Deployment of Alternative Maritime Power (AMP)

Alternative Maritime Power (AMP) is a system that supplies the electrical power needed from the shore while a ship is docked at the port. This system effectively reduces air pollutants such as particulate matter, GHG emissions, and sulfur oxides generated during power supply using fossil fuels.

The government plans to promote the distribution of green ships and establish fuel supply infrastructure for them by diversifying LNG fuel supply channels. This plan would include operating LNG bunkering ships, building shore terminals, and utilizing the AMP of berthing vessels as a high-speed charging facility for small electric / hybrid ships.

The Port of Incheon has succeeded in the technological development of five types of core AMP components, a first for Korea, contributing to the expanded application of AMP. Additionally, the Port of Busan introduced a “mobile AMP connection cable” at the Busan New Port in June 2022. This allows for shore-to-ship power supply regardless of the docking position, significantly contributing to the active use of AMP and the reduction of air pollutants.

The Port of Ulsan has begun developing a hydrogen fuel cell-based mobile AMP. In line with the 2050 Net-Zero Policy, Ulsan is committed to successfully transitioning to a green port. Moreover, the Ulsan Port Authority, Ulsan Coast Guard, and Korea Marine Environment Management Corporation signed a business agreement for projects concerning carbon emission allowance trading in the field of AMP. These efforts will help reduce about 100 tCO_2eq of GHG emissions from the use of conventional fuels.

<Figure 3-6> Mobile AMP Cables Introduced to Busan New Port

<Figure 3-7> Alternative Maritime Power System

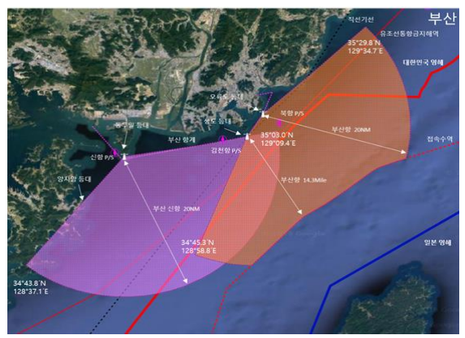
④ Green Ship Port Incentives

To make a stable ship operating environment after introducing green ships, the government is incentivizing the use of green ships by introducing measures, such as levy discounts for ships using LNG fuel and lower electricity rates, including special rates for electric ships.

⑤ The Implementation of Vessel Speed Reduction (VSR) Program

Slowing a vessel's speed by 20% can yield fuel savings of up to 50%, which in turn leads to a significant reduction in the emission of GHGs and air pollutants. Consequently, Vessel Speed Reduction (VSR) Program Sea Areas have been designated for the five major ports in South Korea - the Port of Busan, the Port of Ulsan, the Port of Yeosu / Gwangyang, and the Port of Incheon - which handle the highest number of incoming and outgoing vessels. These ports now operate a Vessel Speed Reduction (VSR) program, which provides incentives in the form of reduced port facility fees when vessels maintain speeds below a certain threshold. Container ships, which typically approach ports at higher speeds and therefore have a substantial impact on particulate matter levels, can benefit from reductions of up to 40%. Other vessels can benefit from reductions of up to 25%.

<Figure 3-8> Vessel Speed Reduction (VSR) Program



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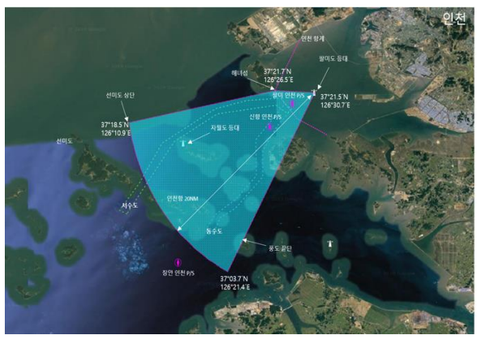

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