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PROVIDING THE BEST SERVICES, CREATING A BETTER WORLD
KR is a world-leading, technical advisor to the maritime industry, safeguarding life, property and the environment through the pursuit of excellence in its rules and standards.

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As IMO and EU GHG regulations continue to tighten, the biggest challenge facing the shipping industry is how to bring fossil-fuel powered ships, which account for 90% of the existing fleet, into compliance. Existing ships may face many more constraints in meeting GHG regulations than new ships. This issue focuses on solutions for existing ships to comply with GHG regulations.

The first approach is to blend biofuels with conventional fossil fuels. The IMO has already approved guidelines for the use of biofuels based on Life Cycle Assessment (LCA) in MEPC 80, and global trials for the use of biofuels in ships are underway. Shipowners' main concerns about biofuels are whether they can be supplied economically and at reasonable prices, and whether there are any technical problems with engines or fuel supply systems when using biofuels, and how these can be resolved. This issue comprehensively covers IMO and EU regulations on biofuels, production volumes and prices, and onshore and offshore demonstrations to address technical issues related to biofuels.

The second approach involves converting conventional fossil fuel propulsion to LNG or methanol. Generally, shipowners have to bear the cost of conversion, the reduction in cargo load due to the installation of fuel tanks and supply systems, and the loss of business during the conversion period. However, there are benefits, such as a significant reduction in carbon taxes if the remaining life of the ship is sufficient, and compliance with shippers' ESG management. This issue focuses on shipowner trends, as well as the technical considerations and costs of converting container ships to methanol propulsion.

This issue features interviews with industry experts on topics of particular interest to readers. OCCS, a technology that directly captures carbon dioxide from exhaust gases, is of great interest to many shipowners, shipyards, and equipment companies. With active technology development and real-world demonstrations underway in Korea, company experts have discussed the current status and future prospects of OCCS technology.

With the EU ETS coming into effect from 2024, greenhouse gases have become an economic issue that requires direct payment rather than mere compliance. Therefore, the implementation of the ETS is not only a new challenge for shipowners, but also an opportunity to gain empirical experience for medium-term measures to be adopted by the IMO in the future. Considering that shipowners face many difficulties due to new regulations they have not experienced before, this issue provides easy-to-understand and detailed guidelines for ETS responses.

Inside KR presents the third party greenhouse gas reduction verification certificate issued to HMM. Currently, shippers around the world are incentivizing the reduction of GHG emissions by using environmentally friendly fuels in marine transportation to reduce Scope 3 GHG emissions. Such demand from shippers is expected to explode, and KR plans to expand its third-party verification services starting with the issuance of this verification certificate. KR plans to release guidelines for ammonia-fueled ships and for ships carrying liquefied carbon dioxide, methanol, and biofuels as marine fuels this year, following the launch of ammonia-fueled ships in 2022. In addition, guidelines for electric propulsion will be published in the future, which will provide very useful information for customers. Futhermor, various activities such as AIP for ammonia fuel supply systems, company audits for the implementation of SEEMP Part III, and the publication of technical guidelines for the safe maritime transport of electric vehicles will be introduced.

The IMO MEPC is accelerating the development of mid-term measures that will shape the future of the maritime industry. Our Decarbonization Magazine will continue to monitor the development of mid-term measures and provide insights into the current status and future prospects of the industry's efforts to achieve decarbonization, helping to collectively consider the direction of the maritime industry.

Head of KR Decarbonization · Ship R&D Center SONG Kanghyun

KR Decarbonization Magazine

Insights_

Biofuel as Marine Fuel

MOON Gunfeel, General Manager of KR Alternative Fuel Technology Research Team

The Role of Biofuels in Alternative Marine Fuels

In the maritime industry, the application of various alternative fuels with high greenhouse gas reduction effects is anticipated to achieve goals of greenhouse gas reduction and carbon neutrality. Currently, carbon dioxide (CO_2), the primary greenhouse gas emitted from ships (Tank to Wake, TtW), is subject to greenhouse gas regulations. However, in the future, regulations are anticipated to encompass greenhouse gases with high Global Warming Potential (GWP), such as methane (CH_4) and nitrous oxide (N_2O), throughout the entire process, from raw material extraction to transportation, fuel production, and emissions (Well to Wake GHG emissions). Notable examples of such changes include the IMO's LCA guidelines and the EU's FuelEU maritime. In the future, under continually strengthened greenhouse gas regulations, fuels with recognized greenhouse gas reduction effects, particularly from a Well-to-Wake (WtW) perspective, should be used even in fossil-based alternative fuel propulsion systems.

LNG	Enhanced compliance with GHG regulations is anticipated through the utilization of traditional LNG and the blending or substitution of Bio-LNG or E-LNG. Additionally, technologies to reduce methane slip are expected to be widely implemented.
LPG	Currently, LPG propulsion systems are primarily applied in LPG carriers, and it is anticipated that the blending or substitution of traditional LPG fuel with Bio-LPG will occur.
Methanol	In terms of TtW regulations, the reduction rate is lower compared to other low-carbon fuels. However, when considering WtW GHG reduction, the blending or substitution of methanol based on biomass or green hydrogen is expected to have a high reduction rate. This is likely to drive an increase in orders for ships powered by this fuel.
Ammonia	Development of ammonia engines is underway, with the majority of ammonia currently produced through natural gas reforming. Consequently, there is an expectation for the utilization of blends or substitutes such as Blue ammonia or E-Ammonia to align with WtW GHG regulations.

These alternative fuels each have their own advantages and disadvantages. It is anticipated that future shipping will consist of a mix of alternative fuel vessels, complementing each other. Biofuels are expected to play a vital role in meeting decarbonization objectives, especially in the initial phases of implementation towards achieving net zero emissions.

Biofuels are produced using raw materials such as biomass and can be blended or substituted with conventional fuels for use without any modifications to existing internal combustion engines and infrastructure. In other words, biofuels serve as 'drop-in' fuels that can be directly used in engine fuel systems without modification, prompting numerous shipping companies to conduct sea trials through the blending or substitution of biofuels. To implement biofuels, considerations must be made regarding quality, safety, cost-effectiveness, and environmental impacts.

Types and Classification of Biofuels

Biofuels are environmentally friendly fuels produced from a variety of raw materials and manufacturing processes, including vegetable oils, animal fats, waste cooking oil, and wood waste. In this article the discussion is limited to biofuels that can be immediately applied in diesel engines or dual-fuel engines operating in diesel mode. The manufacturing processes and characteristics of each fuel are as follows:

1. FAME (Fatty Acid Methyl Esters)

FAME (Fatty Acid Methyl Ester), commonly known as biodiesel, is typically derived from raw materials such as vegetable oils, animal fats, and waste cooking oil. It is manufactured through an ester exchange reaction with methanol and the resulting fuel has an oxygen content of approximately 10%. FAME exhibits strong hydrophilicity, necessitating caution during long-term storage, and requires considerations regarding oxidation stability, low-temperature flow properties, and material compatibility.

2. HVO (Hydrotreated Vegetable Oils)

HVO (Hydrotreated Vegetable Oil) is produced using similar raw materials as FAME, such as vegetable oils or lignocellulosic biomass. This fuel is created through a hydrogenation process, similar to fossil fuel refining, where paraffinic hydrocarbons are formed through hydrogen treatment and decomposition processes. Due to the removal of oxygen-containing impurities during the manufacturing process, HVO fuel possesses properties similar to marine gas oil (MGO) and is suitable for long-term storage. However, its low viscosity requires verification of lubricity during use.

3. FP Bio-oil & HTL Bio-oil

Atmospheric pressure and oxygen-depleted, nitrogen-rich environments, typically at high temperatures (400~600℃), can create a process that thermally decomposes biomass to produce fuel. Fuel upgraded from this process is referred to as fast pyrolysis bio-oil. On the other hand, hydrothermal liquefaction bio-oil is derived from biomass that has been pulverized to an appropriate size, mixed with water, and subjected to hydrothermal liquefaction under high pressure and temperature conditions, resulting in liquid hydrothermal liquefaction bio-oil.

Both of these bio-oils have low technological maturity and require modifications to the fuel supply system for engine application. Therefore, this discussion primarily focuses on FAME and HVO, which are 'drop-in' fuels immediately applicable to engines.

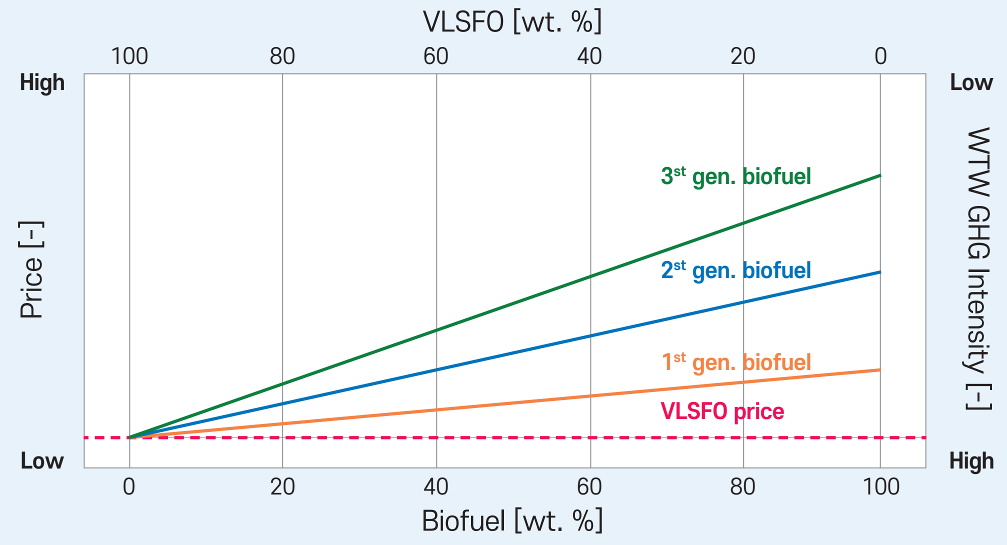
Furthermore, biofuels can be categorized into generations based on their feedstock, which is closely linked to sustainability, environmental impact, and other factors. As a result, third-generation fuels, produced using microalgae, for example, have the lowest carbon intensity according to the WtW criteria, resulting in the greatest greenhouse gas reduction effect. However, they tend to have higher fuel purchase costs. On the other hand, first-generation fuels have lower purchase costs but relatively higher carbon intensity, resulting in lower greenhouse gas reduction effects. Therefore, it is essential to understand the tradeoff relationship between ease of compliance with GHG regulations and economic feasibility and adopt a strategic approach to the application of biofuels.

Comparison of Technological Maturity by Alternative Fuel

Type of biofuel	Process pathway and Technology Readiness level (TRL)				Feedstock
	Process step 1	TRL	Process step 2	TRL	
Fatty Acid Methyl Ester (FAME)	Transesterification	9	-	-	Waste fats, oils, greases (FOG)
Hydrotreated Vegetable Oil (HVO)	Hydroprocessing	9	-	-	
Fast Pyrolysis (FP) bio-oil	Pyrolysis	8-9	Upgrade	6	Lignocellulosic biomass, forestry /agricultural residue
Hydrothermal liquefaction (HTL) bio-oil	Hydrothermal liquefaction (HTL)	6	Upgrade		Lignocellulosic biomass, forestry /agricultural residue, wet waste

Source: Maersk Mc-Kinney Moller Center

Comparison of Price and WtW Greenhouse Gas Intensity According to Biofuel Generation Classification



Biofuel Implementation Considerations

The international standards for biofuels currently used in ships are mainly limited to criteria for 7% v/v FAME and distillate fuel oil blends, with guidelines provided by the International Council on Combustion Engines (CIMAC). With the revision of ISO 8217, additional requirements for the blending of biofuels with conventional fuels are expected to be included. To accelerate net zero goals, there is a need for further international standard development to support the use of biofuels. Singapore has already taken the lead by adopting national standards allowing up to 50% v/v or m/m marine biofuel blends. While HVO fuel is not currently included in marine fuel standards, there are standards for paraffinic diesel fuel used on land.

Additionally, it is necessary to prepare for potential issues that may arise during engine operation. While maritime trials for biofuel use on ships are underway, they are primarily limited to short-term and small-scale biofuel or blend usage, making it difficult to establish standardized responses. Therefore, it is important to be aware of potential issues that may arise with long-term usage and to be prepared with measures to address them.

Firstly, microbial growth must be inhibited. FAME fuel, being highly hydrophilic, can suffer from fuel contamination by microbes during long-term storage. These microbes can cause sludge formation in fuel systems, as well as clogging of filters or pipelines. To prevent this, it is recommended to use small amounts of FAME fuel or blends as soon as possible. Temperature management of the fuel and tanks, as well as moisture removal, are necessary during long-term storage, and caution is required when using insecticides or other additives, as they may pose environmental and health risks. In contrast, HVO can be stored and handled in much the same way as conventional fuel.

Secondly, ensuring oxidation stability of biofuels is essential. Oxidation stability of fuel indicates its resistance to oxidation during storage and use. The unsaturated compounds in FAME fuel can increase its susceptibility to oxidation. Compounds formed as a result of oxidation can lead to clogging of filters, separators, and fuel injection devices, as well as corrosion of fuel systems. Considering the addition of antioxidants to enhance oxidation stability may be an option, although there are no known cases of such additives being added to biofuels supplied to ships. Additionally, since certain metal ions can promote oxidation, careful selection of materials for components is necessary.

Additionally, FAME exhibits reduced fluidity under low-temperature conditions, and the Wax Appearance Temperature (WAT) and Wax Disappearance Temperature (WDT) can vary depending on the feedstock or blend, necessitating proper temperature control. It is recommended to maintain the fuel temperature at least 10°C higher than the pour point, while cautioning against temperatures exceeding 40°C above the pour point to avoid the formation of gel-like polymers.

Lastly, certain metals such as copper, iron, lead, tin, and zinc can accelerate the oxidation process of FAME fuel, increasing the formation of precipitates. Furthermore, exposure to FAME fuel can cause swelling or deterioration of seals and gaskets, leading to equipment leaks or malfunctions. Therefore, it is essential to confirm the compatibility of components or materials with biofuels through equipment suppliers and engine manufacturers.

Production, Price, and Bunkering Infrastructure of Biofuels

The International Energy Agency (IEA) forecasts that by around 2050, the demand for bioenergy will be approximately 1.5 times higher than in 2022. It is especially expected that the supply of bioenergy produced from waste resources and woody biomass will increase in the future. In the shipping sector, the current usage of bioenergy, hydrogen, and hydrogen-based fuels, which is currently less than 1%, is anticipated to increase to approximately 15% by 2030 and up to 80% by 2050. As shown in Table 2, biofuels are expected to continue to grow not only in the shipping sector but also in the aviation sector, highlighting the significance of biofuels in achieving net zero.

Predicted Biofuel Usage Proportions by Transportation Sources

IEA Milestones for Biofuels	2022	2030	2034	2050
Biofuels Share in Road Sector	5%	11%	12%	3%
Biofuels Share in Shipping	0%	8%	13%	19%
Biofuels Share in Aviation	0%	10%	22%	33%

Source: IEA

On the other hand, the use of bioenergy in various transportation sectors and almost all industrial sectors can trigger competition for sustainable biomass and biofuels, potentially leading to limitations in availability and price increases of biofuels in the shipping sector. While many institutions do not anticipate significant fluctuations in future biofuel prices, the expansion of biofuel usage in transportation and across industries is expected to result in price increases due to limitations in feedstock.

At present, the global infrastructure for bunkering biofuels is limited. However, with the increasing demand for sustainable fuels due to strengthened greenhouse gas regulations, the number of ports capable of bunkering is steadily growing. Nevertheless, regarding Ship-to-Ship

(StS) biofuel bunkering, the standards specified for bunkering vessels in the IMO's IBC Code could pose initial barriers, prompting discussions on solutions, which are expected to commence from the 81st MEPC session of the IMO.

Regulatory Considerations for Biofuels

Major air pollutants emitted from ships include nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter, among others, which are generated during the combustion process and can have environmental and human health impacts. Therefore, the IMO's International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI regulates the emissions of these pollutants. Even when using biofuels for greenhouse gas reduction, air pollutants can still be emitted, so compliance with regulations must be verified based on the properties and combustion characteristics of the fuel.

The use of FAME, which includes oxygen in the fuel, is known to increase nitrogen oxide emissions, necessitating compliance with nitrogen oxide emission limits. To expedite compliance with greenhouse gas emission requirements, unified interpretations of the rules in Annex VI of MARPOL have been approved. Vessels utilizing biofuels blended at less than 30% can do so without undergoing a NOx verification process. If the mixture exceeds 30%, verification is required according to the NOx Technical Code 2008, unless confirmation is received from the engine manufacturer that the fuel can be used without changes to NOx-related components, settings, and operating values.

Biofuels, due to their low sulfur content, result in reduced sulfur oxide emissions when the biofuel blend ratio is increased, leading to a decrease in particulate matter emissions by reducing the formation of particles such as sulfuric acid or sulfate. FAME, containing oxygen, can improve combustion and reduce particulate matter emissions that may arise from incomplete combustion.

Regarding IMO DCS and CII greenhouse gas regulations, according to the provisional guidelines approved at MEPC 80, only biofuels that meet sustainability criteria and achieve a WtW GHG intensity reduction of over 65% (less than $33gCO_{2eq}/MJ$) compared to fossil fuels can calculate a CO_2 conversion factor based on a WtW GHG intensity. The CO_2 conversion factor for biofuel blends can be calculated through a weighted average. Fuels that do not meet these criteria will be subject to the CO_2 conversion factor of fossil fuels. It should also be noted that these provisional guidelines will be revoked once the LCA guidelines are finalized.

In Table 3, the improvement in Carbon Intensity Indicator (CII) resulting from the application of biofuels compared to conventional HFO fuel for a hypothetical vessel is presented. When applying biofuels or biofuel blends, it is assumed that they replace 50% of the usage of conventional fuel, while maintaining the same route and distance. Additionally, the WtW GHG intensity of biofuels is assumed to be 26.48 gCO_{2eq}/MJ.

Comparison of Expected CII Ratings Based on Biofuel Application

Vessel Information (10,000 TEU Container)	Fuels*	2023	2024	2025	2026
Deadweight: 120,000 M/T	Case A	D	D	D	D
Gross Tonnage: 114,200 M/T	Case B	C	C	C	D
Distance Travelled: 70,000 Nautical Mile	Case C	B	C	C	C
Fuel Consumption (HFO): 18,240 M/T	Case D	A	A	A	A

* Case A: HFO 100% (Base), Case B: B30 (HFO 70% m/m, Biofuel 30% m/m)
Case C: B50 (HFO 50% m/m, Biofuel 50% m/m), Case D: Biofuel 100%

The results indicate that without taking any action and operating solely on conventional fuel (Case A) from 2023 onwards, the vessel maintains a D rating until 2026. However, when operating with a fuel blend containing 30% biofuel (Case B), it is projected to achieve a C rating by 2026. With a 50% biofuel blend (Case C), a B rating in 2023 and a C rating from 2024 onwards are expected. If the vessel switches entirely to biofuels (Case D), it is anticipated to maintain an A rating from 2023 to 2026. It's important to note that these predictions are based on a hypothetical vessel and assumptions regarding the characteristics of biofuels (WtW intensity and lower heating value), so the actual improvement effects may vary for each vessel. Nevertheless, the use of biofuels or biofuel blends can be considered an effective solution for compliance with GHG regulations.

In relation to the EU's greenhouse gas regulations, the 'Fit for 55' package has set a target to reduce greenhouse gases by 55% by 2030 compared to 1990 levels. Consequently, in the maritime sector, the EU Emission Trading System (ETS) has been implemented since January 2024, requiring ships entering and leaving EU ports to purchase emission allowances through emissions accounting. Additionally, the FuelEU Maritime regulation is scheduled to be implemented from 2025, mandating the use of environmentally friendly fuels on ships, with penalties for non-compliance. Biofuels, recognized as sustainable fuels under EU renewable energy guidelines, are expected to see expanded use as they can be assigned as zero coefficient.

Summary and Recommendations

Derived from biomass, biofuels share similarities with fossil fuels, and some can be readily utilized in existing internal combustion engines. This characteristic has drawn attention from shipping companies and shippers, primarily because of their favorable compliance with greenhouse gas regulations. Biofuels generally have higher technological maturity and fewer issues to resolve compared to other zero-carbon fuels. Furthermore, concerning regulatory compliance, the utilization of biofuels can enhance CII grade ratings, as biofuels with lower WtW carbon intensities are anticipated to offer significant regulatory advantages.

However, despite the sustainability and greenhouse gas reduction potential of biofuels, there are several technical challenges, including the absence of fuel quality standards for marine biofuels. Additionally, the availability and price of biofuels may be unstable due to resource limitations and competition with other industries. Therefore, the shipping industry needs to develop medium to long-term strategies considering both the technological and economic aspects of biofuels.

KR recognizes the importance of biofuels in responding to greenhouse gas regulations and has been actively publishing technical documents, regulatory newsletters, and conducting research activities in this regard. Recently, KR published a technical document titled 'Biofuel as Marine Fuel' to facilitate understanding of biofuel use in relevant industries. In collaboration with the industry, an MOU has been signed with domestic shipping companies, engine manufacturers, and fuel suppliers. Maritime trials for bio-blended fuels were successfully conducted with a 13,000 TEU container vessel in March 2021. Presently, we are collaborating with both domestic and global shipping companies on research initiatives to promote biofuel usage and formulate safety guidelines. Furthermore, technical services are provided for measuring and analyzing engine performance as well as air pollutants (including GHG) using biofuel or biofuel blends on the low-speed engine (7.4 MW) test bench at our Greenship Test and Certification Center (TCC).

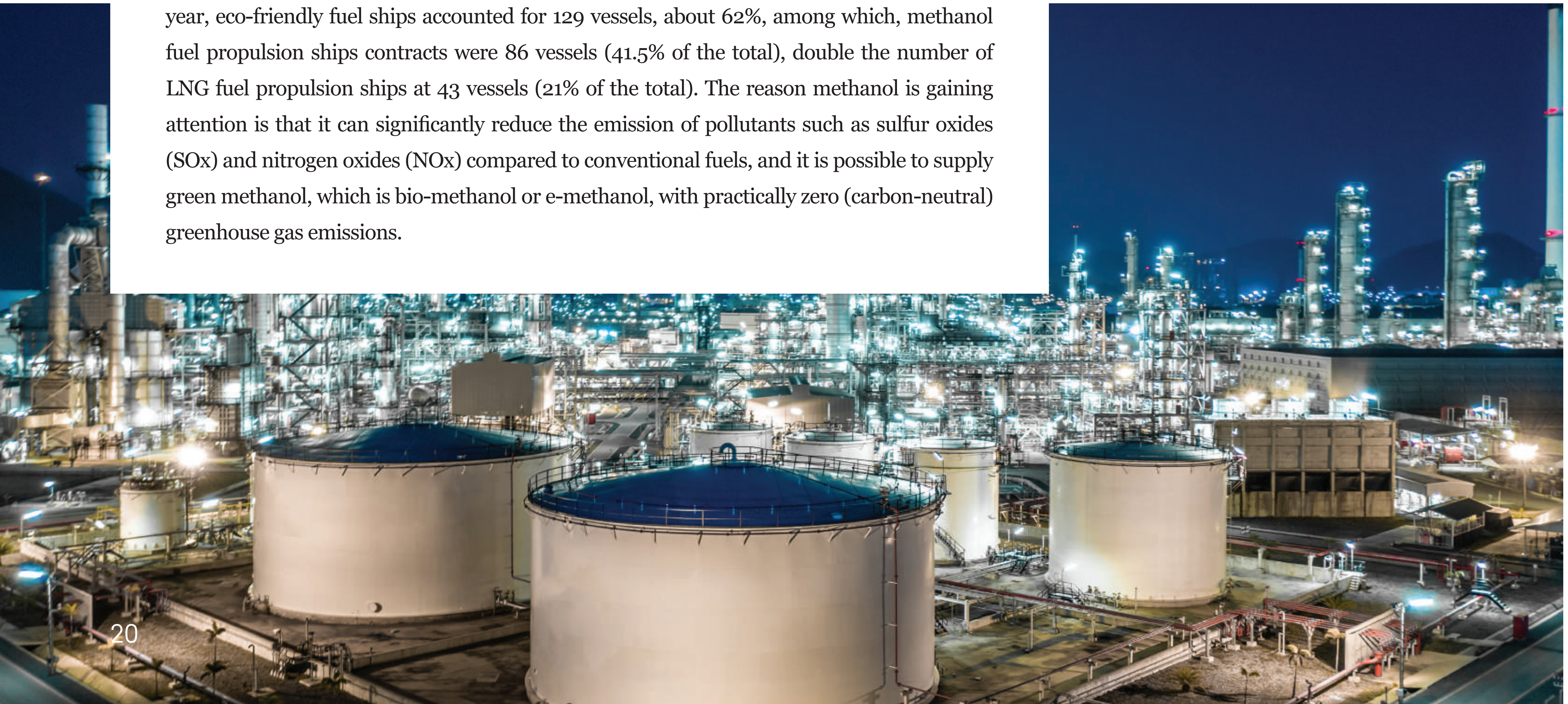
Ultimately, KR is committed to collaborating continuously with relevant industries until the activation and safety of biofuel use are ensured. This commitment underscores our crucial role in the early implementation of greenhouse gas reduction efforts towards achieving net zero emissions.

Market and Key Technologies for the conversion to Eco-Friendly Methanol Fueled Container ship

PARK Seungmin, Senior Surveyor of KR Dry Cargo Ship Team

Efforts for Carbon-Neutral and Methanol Fuel

Amidst the increase in greenhouse gas emissions leading to global warming and severe issues like climate change, the International Maritime Organization (IMO) has adopted the '2050 Carbon net-zero target' at 80th MEPC session. As many countries and companies intensify their efforts to achieve carbon-neutral, methanol, along with LNG, is primarily being chosen as an eco-friendly ship fuel at the current time. Especially, according to Clarkson data as of February 5th this year, out of the total 207 newly contracted container ships worldwide last year, eco-friendly fuel ships accounted for 129 vessels, about 62%, among which, methanol fuel propulsion ships contracts were 86 vessels (41.5% of the total), double the number of LNG fuel propulsion ships at 43 vessels (21% of the total). The reason methanol is gaining attention is that it can significantly reduce the emission of pollutants such as sulfur oxides (SOx) and nitrogen oxides (NOx) compared to conventional fuels, and it is possible to supply green methanol, which is bio-methanol or e-methanol, with practically zero (carbon-neutral) greenhouse gas emissions.



Conversion to Methanol Fueled Container Ships

From the shipping company's perspective, converting existing container ships to eco-friendly fuel (Dual Fuel) propulsion involves considering the ease of conversion, scope and cost of conversion, cargo loss, bunkering, etc. Importantly, unlike other eco-friendly fuels, methanol is in a liquid state at room temperature, making it easy to store on ships without the need for cryogenic independent tanks or membrane-type fuel tanks required by LNG, allowing methanol fuel tanks to be integrated into the ship's structure using general structural steel. For this reason, converting operational ships to eco-friendly fuel ships is relatively easier in terms of ship structure and layout when applying methanol fuel. For the conversion to methanol dual-fuel ships, main engines, auxiliary engines, generators, fuel supply systems, and methanol fuel tanks need to be supplied. Depending on the size of the ship, the engines applied, and the capacity of the methanol tanks, about 20% of the cost compared to a new building container ship is required. Additionally, an optimized conversion plan and process work must accompany the effort to retrofit an operating ship.

During conversion, part of the existing container cargo hold (1-2 bays) should be converted into fuel tanks, which can result in up to a 4% loss of existing container cargo for ships over 10K TEU(twenty equivalent unit) class. The stable supply of methanol fuel must also be considered, with currently about 120 million tons produced annually at around 90 production sites worldwide. According to the 『Methanol as a Marin Fuel』 published by KR, the future methanol production market is expected to grow, with current production growth rates indicating that production could increase from 120 million tons in 2025 to 500 million tons by 2050.

Conversion Market for Methanol Fueled Container Ship

Currently, major container shipping companies like Maersk and CMA CGM are increasing the proportion of methanol fuel propulsion container ships through not only new builds but also conversions of part of their existing fleets. In November last year, Maersk contracted with China's Zhoushan Xinya Shipyard for the first project to convert an operational container ship into a methanol dual-fuel propulsion ship. The methanol dual-fuel engine for the conversion is from Germany's Man-Energy Solution, and the targeted ships for conversion are known to be 11 vessels, with the first ship expected to undergo about 3 months of conversion work starting from June this year. CMA CGM has signed a project contract with China's CSSC Group's Qingdao Beihai Shipbuilding for the conversion of 8 operational container ships of 9,200 TEU to methanol duel fuel propulsion. In the future, major container shipping companies including HMM, HAPAG-LLOYD, and SEASPAN are also pushing for methanol duel-fuel propulsion ship conversions, with currently about 70 large operational container ships planned to be converted to methanol dual-fuel propulsion.

Joint Development for the Conversion of a 16,000TEU Large Container Ship

In Korea, 'HD Hyundai Marine Solution (HD HMS)', a comprehensive marine industry solution company of HD Hyundai, has started a business in the field of eco-friendly decarbonized methanol dual-fuel propulsion ship conversion. HD HMS carried out a joint development project (JDP) for methanol fuel propulsion ship conversion with KR, HD Hyundai Heavy Industries (HD HHI), and HD Hyundai Engineering & Technology (HD Hyundai E&T), targeting HMM's largest 16,000 TEU container ship in operation, and obtained basic certification (AIP, Approval In Principle) from KR at the end of 2023.

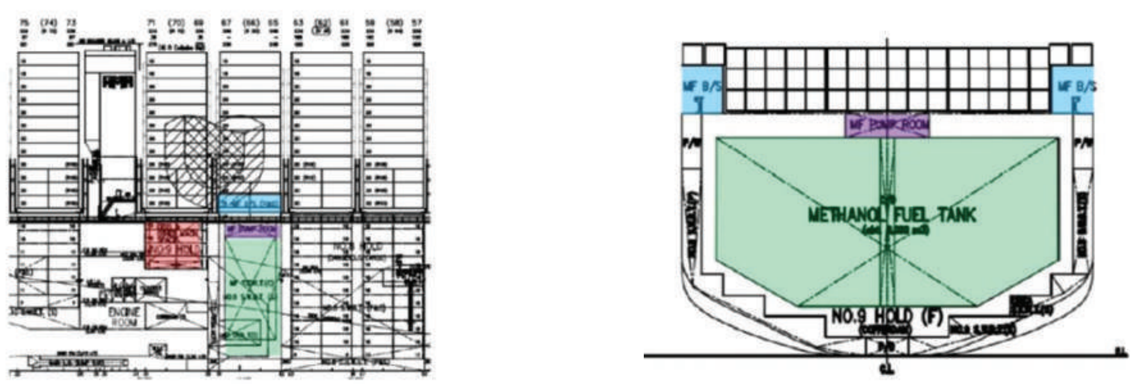
Technologies for Methanol Fuel Propulsion Ship Conversion

HD Hyundai Marine Solution performed the basic design for the system configuration for the conversion of large container ships to methanol fuel propulsion ships, and HD Hyundai ENT was responsible for 3D modeling and detailed design. Additionally, a newly developed 'Low Flashpoint Fuel Supply System (LFSS)' by HD Hyundai Heavy Industries was applied, and the design was based on MAN's main engine and HD Hyundai Heavy Industries' own developed methanol dual-fuel generator engine, the HIMSEN engine. The methanol dual-fuel engine, generator, low flashpoint fuel system, tanks, and cofferdams were designed and arranged in compliance with the IMO's MSC.1/Circ.1621 Interim Guideline.

The existing container cargo hold located in front of the engine room's bulkhead has been modified to load methanol fuel, enabling it to operate on the Europe-Asia one-way route. The material for the methanol fuel tank is generally carbon steel applied to the ship's hull, but considering the corrosiveness of methanol, a special zinc silicate coating was applied. The methanol fuel tank was designed as one large block to minimize the conversion time and cost of existing ships and facilitate the conversion work. Additionally, the tank's support structures were placed at key locations to efficiently connect and weld to the existing ship structure.

The fuel tank was designed to be suitable for the harsh environmental loads and internal loads required by KR's rules for the classification of Steel ships. A direct strength assessment was conducted for various fuel oil tank/container loading scenarios to evaluate yield strength, buckling strength, etc. Especially, structural stress concentrations around the main support structures connecting the hull and tank were identified through detailed fine mesh analysis, and appropriately reinforced.

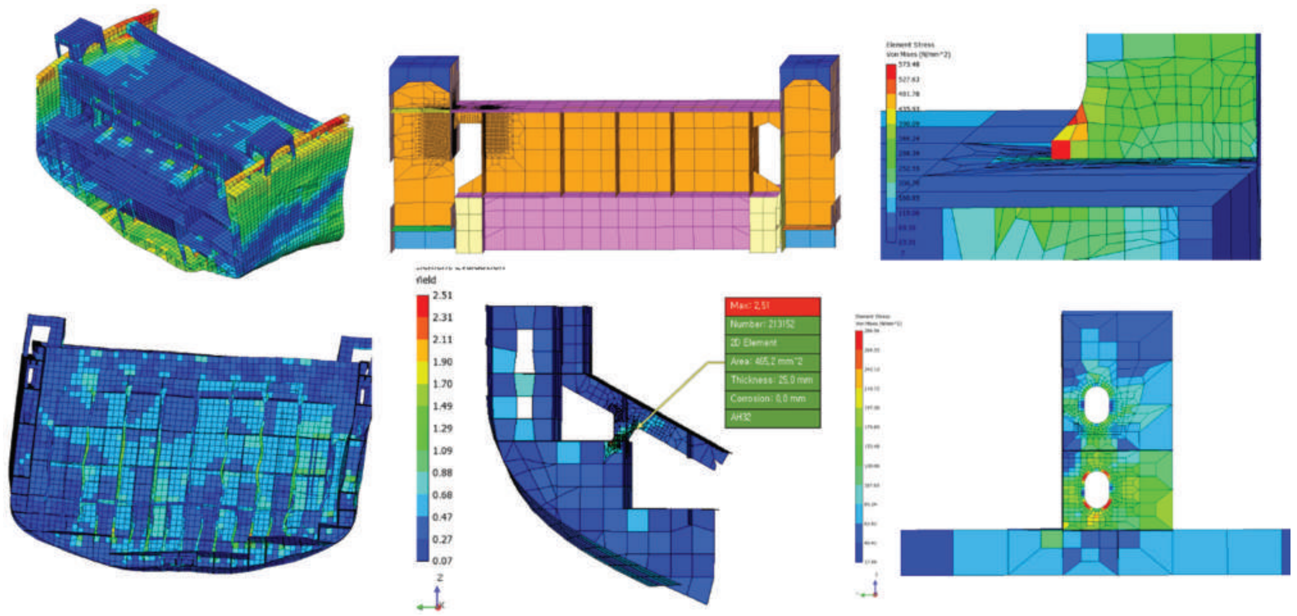
Design for methanol fuel propulsion ship conversion



| Elevation View | | Section View |

M/F Preparation Room (Incl. LFSS, MeOH Serv. Tk)
M/F Storage Tank (abt. 8,000 m^3)
M/F Pump Room
M/F Bunkering Station (P&S)

Structural analysis of methanol fuel propulsion ship conversion



KR's roles

KR has actively supported HD Hyundai Marine Solution to secure methanol duel fuel propulsion conversion technology through this joint project, as well as maintaining an active technical support and cooperation relationship with major shipyards, shipping companies, and makers in conducting joint research and new builds of methanol dual-fuel propulsion large container ships, including engine, structure, equipment layout, convention requirements, and risk assessment (HAZID & HAZOP). KR plans to expand its role as a trusted partner to help our customers swiftly respond to the decarbonization era and explore new areas through such close cooperation.

Interview_

Status of OCCS Technology Development and Economic Viability

Interview with **CHEON Sang-gyu**, Head of the Research Institute at PANASIA

Carbon capture technology is becoming one of the most important technologies for reducing global greenhouse gas (GHG) emissions as regulations to decarbonize intensify. In the shipping industry, numerous researchers have been focusing on the development and implementation of on-board carbon capture systems (OCCS) on ships. OCCS presents an attractive solution for reducing GHG emissions by directly capturing carbon dioxide from ship exhaust.

Several companies in Korea are actively developing OCCS, with PANASIA leading the way. PANASIA has signed Memorandums of Understanding (MOU) with KR, HMM, and Samsung Heavy Industries, positioning itself to be the first to apply OCCS in Korea. In this issue, we interviewed Cheon Sang-gyu, Head of the Research Institute at PANASIA, to discuss the OCCS development process, core technologies, demonstration plans, and prospects for commercialization from various perspectives.

Q. Could you please tell us what prompted PANASIA to start developing OCCS?

A The shipbuilding industry is currently focused on decarbonization, and OCCS is seen as a promising technology for achieving this goal. Since we have experience and technology for scrubbers, Selective Catalytic Reduction (SCR) systems, and Ballast Water Management Systems (BWMS), we believed that leveraging our expertise and experience in post-treatment equipment like scrubbers and SCR could lead to the development of a competitive OCCS. This encouraged our decision in developing OCCS.

Q. Could you share your current progress in the development of OCCS?

A As the International Maritime Organization (IMO) initiated discussions on OCCS, we started a joint development project with Samsung Heavy Industries in 2020. We have installed an HFO engine and OCCS on a barge for testing and successfully completed its verification. This June, in collaboration with HMM and KR, the developed OCCS will be installed on a 2.1K container ship for real-ship verification.

Q. What are the primary functions and key technologies of OCCS?

A The core technology of OCCS is the absorbent. We have developed the optimal absorbent by mixing additional chemicals into the already proven amine-based absorbent and continuously improving it. It is possible to capture up to 90% of the carbon dioxide in the inhaled exhaust by absorbing a certain amount from the total exhaust generated by the ship. The maximum scale that can be applied to ships at this time is 3 tons of carbon dioxide per hour. The project applied to the actual ship will be able to capture and store 1 ton of carbon dioxide per hour, saving approximately 14% of the total carbon dioxide emissions. Specifically, our OCCS for ships is composed of a multi-stage absorption tower and a scrubbing tower in one piece to minimize the volume and height of the space.

Q. How much additional energy does OCCS consume?

A Minimizing the energy required for capturing and liquifying, particularly the regeneration heat, is crucial for OCCS. Typically, it requires about 40% additional energy. Therefore, for a carbon capture performance of 1 ton/hour, the net capture rate is approximately 0.6 ton/hour, after accounting for the energy consumed.

Q. That seems quite energy-intensive. Is there a way to reduce the energy consumption for CO_2 capture?

A Yes, by utilizing cold heat or waste heat generated onboard through heat exchange, we can enhance efficiency. Especially with LNG propulsion, the cold heat from LNG can significantly reduce the system's energy input, making the OCCS more effective and reducing the need for regeneration heat. Additionally, LNG produces less CO_2 compared to other fuels, offering the advantage of reducing the OCCS system size.

Q. Cost-effectiveness is a major concern for shipowners. How do you assess the economic viability of OCCS?

A It's challenging due to uncertainties and varies by ship type. The CAPEX for a 1 ton/hour capture and storage facility is estimated to be between 7.7M to 1.1M dollars, depending on the OCCS size. Economic viability must be analyzed by comparing it with potential carbon taxes, taking into account the cargo reduction for each ship type. Analyzing the lifetime costs of installing OCCS on LNG versus using carbon-free fuels like ammonia is also necessary to determine the most cost-effective approach. Given the current uncertainties, it's difficult to assert confidently, but we estimate that the carbon tax should be over $200 per ton of CO_2 to be viable. Precise economic analysis and further considerations, such as cost reductions through mass production, are needed. We also plan to utilize the captured CO_2 in industrial applications, such as CO_2 welding. The acceptance of this approach's carbon reduction effect by the international organizations remains uncertain, but it could enhance the system's economic feasibility if recognized.

Q. KR is also performing economic analyses on alternative fuels, highlighting the importance of fuel price and carbon tax uncertainties. Collaborating on economic analyses in the future could be beneficial. Will this demonstration include an economic analysis?

A Thank you for the suggestion. The primary focus of this demonstration will be on performance and safety. A preliminary economic analysis will also be conducted. However, HMM's main concern is improving the CII rating. Since storing more CO_2 increases cargo reduction, we plan to load approximately two 20-feet containers. The vessel will primarily operate on short routes, such as Korea to Asia.

Q. What is your perspective on the outlook for OCCS?

A Technologically, I don't see any critical challenges with the development of OCCS. Economically, I believe the future of OCCS will depend on the IMO's decision regarding the recognition of GHG reduction and the pricing of alternative fuels, among other factors. For ships that face challenges in converting to alternative fuels but have a long service life ahead, I see OCCS as a promising alternative.

Thank you for sharing valuable insights on OCCS for our readers today. We extend our best wishes for a successful demonstration.

Considerations to how to reflect onboard CO_2 capture in various IMO instruments

MEPC 81 considered the proposals relating to the onboard CO_2 capture system as follows:

1. Initiating Study on Onboard Carbon Capture System Regulation

Given the historical background that demonstrates the broad experience that has been gained in the study and development of guidelines for the regulation of EGCS, it is proposed to initiate the study of onboard carbon capture system to develop the relevant regulation for residues and/or emission, as well as the transportation, storage and disposal at reception facilities.

2. Developing Workstreams for Onboard CO_2 Capture within IMO's Framework

As part of the development of a work plan to accommodate onboard CO_2 capture within IMO's regulatory framework, it is proposed to review the current IMO regulatory framework for the development of new workstreams on onboard CO_2 capture, including:

- Regulations in MARPOL Annex VI as appropriate
- Guidelines for testing, surveying and certification of onboard CO_2 capture systems
- Guidelines for the development and approval of a ship CO_2 management plan
- Form of the CO_2 record book
- An approval or certification/accreditation scheme for CO_2 terminals to ensure that the CO_2 is not emitted to the atmosphere; and safe storage and utilization of CO_2 which is consistent with international environmental law and standards.

3. Draft Amendments for EEDI and CII Calculation Reflecting Onboard CO_2 Capture

Draft amendments to technical guidelines related to EEDI and CII calculation for reflecting GHG reduction effect from onboard CO_2 capture system.

4. Newly Proposed MEPC Circular on CO_2 Receipt Note Format

A newly proposed MEPC Circular on sample format for the information to be included in the CO_2 receipt note, providing evidence for the quantity of CO_2 delivered ashore.

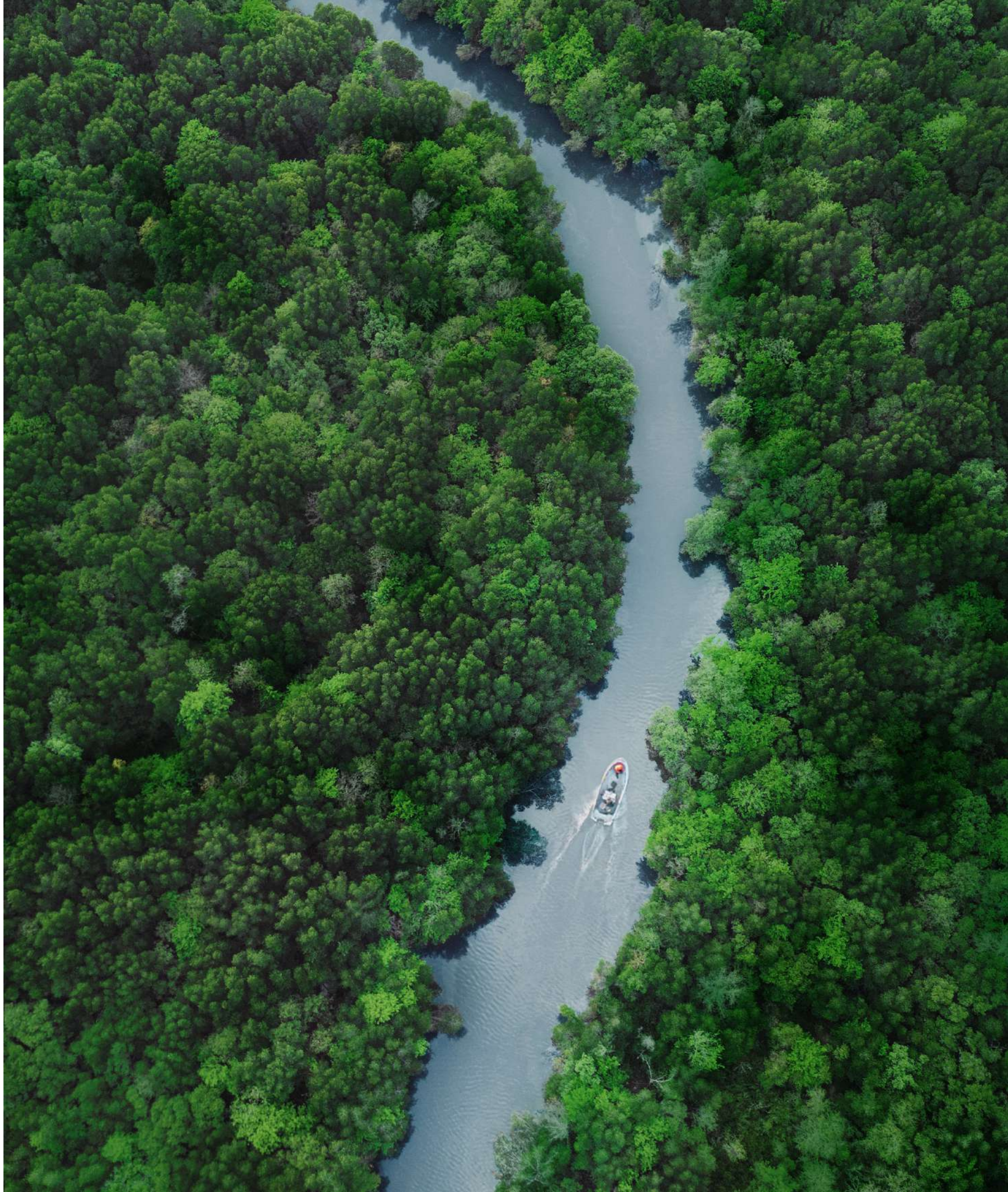
Agreement on Establishing a Correspondence Group for the Development of Regulatory Framework for Onboard Carbon Capture Utilization!

In reviewing the proposals, there was a preference towards prioritizing efforts to incentivize the adoption of zero or near-zero emission fuels, rather than focusing on onboard CO_2 capture, due to the latter's technical immaturity and associated safety concerns. As a result, MEPC 81 couldn't reach a consensus on how to incorporate onboard CO_2 capture within the IMO regulatory framework due to the various views expressed that a more holistic approach was needed as part of the further development of the LCA framework.

However, considering that onboard CO_2 capture can play an important role in the reduction of GHG emissions from international shipping, MEPC 81 agreed to establish a correspondence group to develop a work plan on the development of a regulatory framework for the use of onboard CO_2 capture.

KR Decarbonization Magazine

Regulatory Updates_



| EU Regulatory Trends |
EU ETS Requirements and Securing Allowances

Independently from the IMO global initiative, the European Union (EU) announced the Fit for 55 package in July 2021, following the proposal of the European Green Deal.

The Fit for 55 package comprises several legislative proposals aimed at various industrial sectors to meet the med-term reduction goal outlined in the European Climate Act (aiming for at least a 55% reduction by 2030 compared to 1990). It directly pertains to international shipping. Related issues include the expanded application of the European Union Emissions Trading System (ETS) to marine transportation emissions from 2024, and the regulation to promote the use of renewable and low-carbon fuels in maritime transportation (FuelEU Maritime), which will take effect from 2025.

ETS is a system that allows the rights to emit greenhouse gases to be bought and sold as emission permits. EU ETS has been applied to EU land-based industries since 2005 and was expanded to the aviation sector operating in the EU from 2012. As part of the EU ETS revision proposals within the Fit for 55 package it will now cover the emissions of the shipping sector from 2024. EU ETS in the shipping sector applies to all ships above a gross tonnage of 5,000 operating in the European Economic Area (EEA), regardless of the ship's registered flag, and requires the monitoring, reporting and verification of greenhouse gas emissions. Emission allowances corresponding to the reported emissions according to EU MRV must be surrendered to the EU Administering Authority. The entity responsible for implementing EU MRV and EU ETS requirements (such as emission monitoring and reporting, emission credit submission, etc.) is the shipping company.

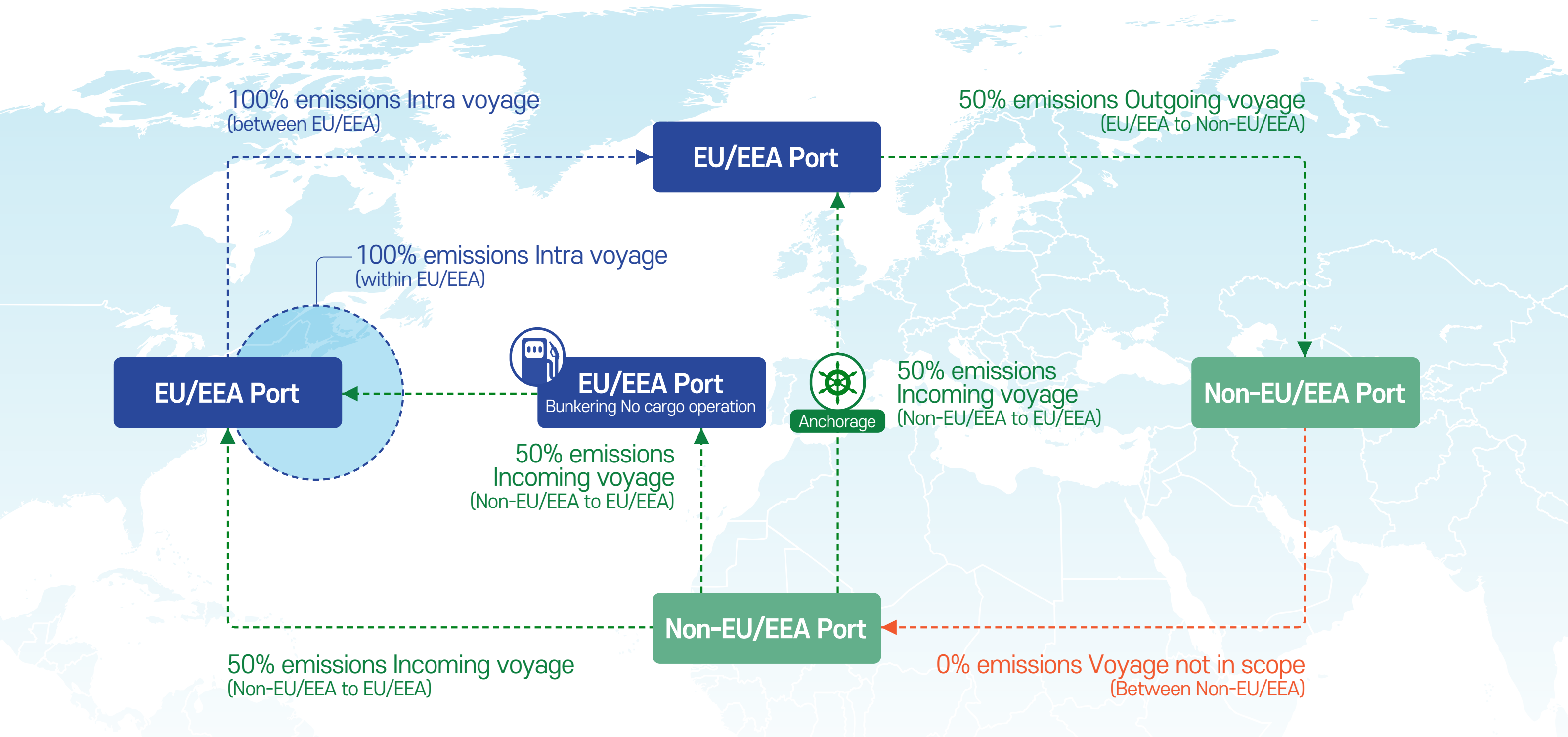
1. Scope of GHG Emissions from EEA Voyages

In the EU MRV and EU ETS regulations, a voyage means any movement of a ship that originates from or terminates in a port of call. Port of call means the port where a ship stops to load or unload cargo or to embark or disembark passengers. This means stops for the sole purpose of refueling, obtaining supplies, etc., and the stops of containerships in a neighbouring container transshipment port[1] listed in the implementing act adopted pursuant to Article 3ga(2) of the EU ETS Directive are excluded.

While EU MRV calculates and reports greenhouse gas emissions for all voyages related to the European Economic Area (EEA), EU ETS applies different greenhouse gas emissions calculation rates depending on the type of EEA-related voyage as follows:

- 50% of emissions generated from voyages departing from a port of call under the jurisdiction of the EEA and arriving at a port of call under the jurisdiction of a third country.
- 50% of emissions generated from voyages departing from a port of call under the jurisdiction of a third country and arriving at a port of call under the jurisdiction of the EEA.
- 100% of emissions generated from voyages departing from ports of call under EEA jurisdiction and arriving at ports of call under EEA jurisdiction.
- 100% of emissions from ships within a port of call under EEA jurisdiction.

1) EAST PORT SAID in Egypt and TANGER MED in Morocco (Implementing Regulation (EU) 2023/2297, As of 26 October 2023)



2. Type of GHG Included in EU ETS

EU MRV requires reporting of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions starting in 2024.

The EU ETS includes only carbon dioxide (CO_2) emissions from 2024, but from 2026 carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions will be included.

	2024	2025	2026
Carbon Dioxide(CO_2)	MRV+ETS		
Methane(CH_4)	MRV		MRV+ETS
Nitrous Oxide(N_2O)	MRV		MRV+ETS

3. Phase-in of requirements for surrendering allowances

EU ETS requires the surrender of emission allowances equivalent to the emissions for the reporting period (y), which are reported by March of the following period (y+1) under EU MRV. Emission allowances shall be surrendered to EEA Member States by September of the following period (y+1) according to the phase-in rates applicable for the reporting period (y):

- 40% of CO_2 emissions in 2024 (surrendered by September 2025)
- 70% of CO_2 emissions in 2025 (surrendered by September 2026)
- 100% of CO_2, CH_4 and N_2O emissions from 2026 (surrendered by September each year from 2027)

4. Shipping Company's Responsibilities

The 'Shipping Company' is responsible for the implementation of EU MRV (emissions monitoring, reporting and verification, etc.) and EU ETS (surrender of emissions allowance, etc.).

The 'Shipping Company' means a shipowner or a manager or charterer delegated by the shipowner with responsibility for the operation of a vessel, where such responsibility is in accordance with the International Safety Management Code (ISM Code) set out in Annex I of Regulation (EC) No 336/2006.

The 'Shipowner' refers to the registered owner identified on the ship's Certificate of Registry and having an IMO Unique Company and Registered Owner Identification Number.

The European Commission announced the results of the EU Administering Authority allocation to Shipping Companies on January31, 2024 and will update the allocation list every two years.

Shipping Companies must submit information about the vessel(s) for which they are responsible under Implementing Regulation (EU) 2023/2599 to the EU Administering Authority.

If the Shipping Company is designated as an ISM Company, the ISM Company must submit documents proving that responsibility for EU MRV and ETS obligations has been delegated by the shipowner to the EU Administering Authority and verifier. If there is no supporting documentation, the Shipowner is considered to be subject to MRV and ETS obligations.

All Shipping Companies are now obligated to open a maritime operator holding account ("MOHA") used to deliver and trade emission allowances within 40 days[2], counting from the publishing date of the list. For Shipping Companies not included in the list, the deadline is 65 working days of the first port of call falling within the scope of the EU ETS Directive. A Shipping Company must submit allowances from its MOHA. Contact information for each EU Administering Authority to apply for MOHA opening can be found at the following link[3].

2) Within 65 working days after first EEA port of all falling within ETS scope

3) https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/union-registry_en#links

4) https://www.bimco.org/insights-and-information/contracts/20231208-ets-clauses

5. Transfer of the costs of the EU ETS

If an entity other than the Shipping Company is responsible for the purchase of fuel or the operation of the ship, the Shipping Company may be reimbursed by that entity for the costs incurred in submitting emissions credits.

Operation of a ship means determining the route and speed of cargo or a vessel.

EU Member States must take national action to ensure that Shipping Companies receive reimbursement and provide judicial access to enforce that right.

The Baltic and International Maritime Council (BIMCO) has proposed provisions[4] containing standard terms and conditions to clarify the costs and responsibilities associated with the ETS.

- Emission Scheme Freight Clause for Voyage Charter Parties 2023
- Emission Scheme Surcharge Clause for Voyage Charter Parties 2023
- Emission Scheme Transfer of Allowances Clause for Voyage Charter Parties 2023
- SHIPMAN Emission Trading Scheme Allowances Clause 2023

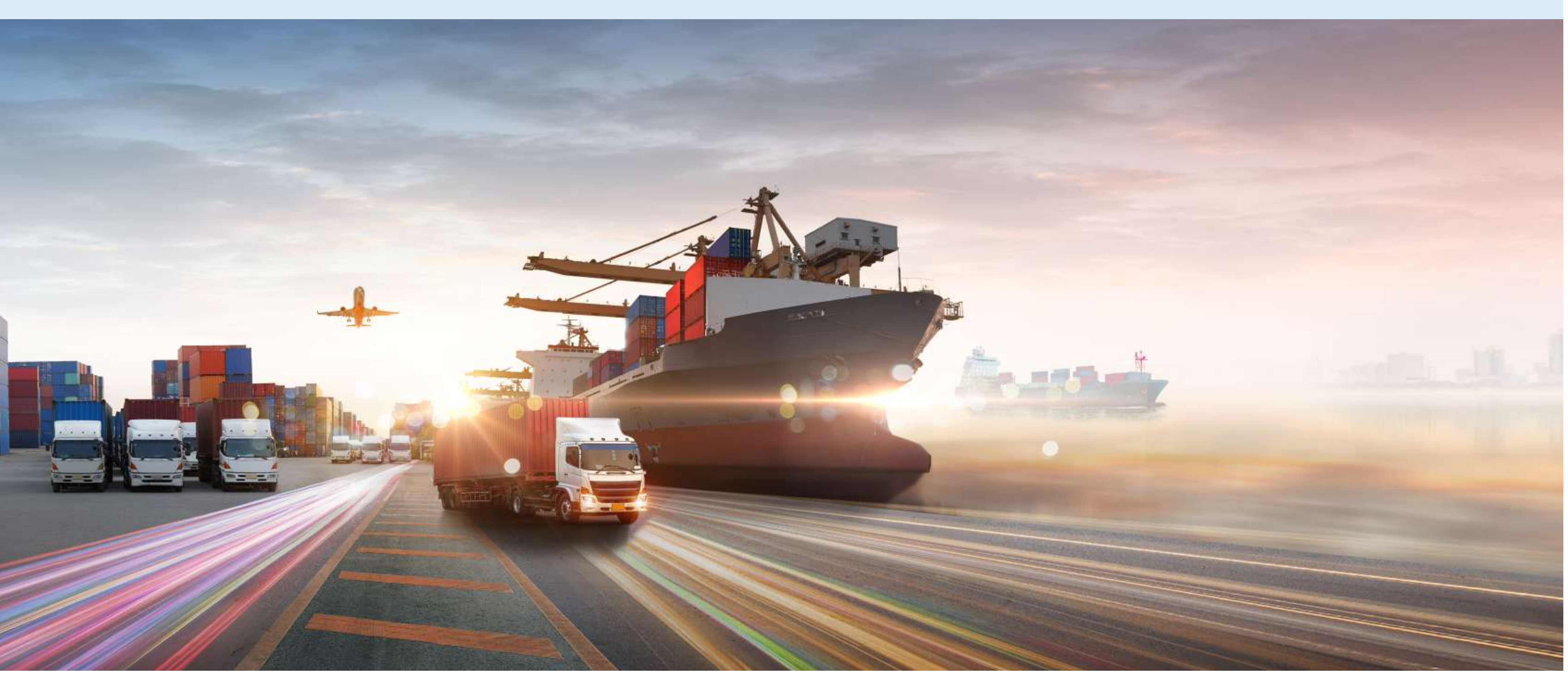
6. Ways to Obtain emission allowances

EUA (European Union Allowance) is the official name for the emissions rights traded in the EU ETS. One EUA grants the holder the right to emit one tonne of greenhouse gases (tCO_{2eq}).

In order for a Shipping Company to purchase and trade EUA, it must open an account (MOHA) at the Union Registry. The methods to obtain EUA are as follows:

- **Auction**
  Purchase by participating in an auction in the primary market through the European Energy Exchange (EEX), the EU ETS auction platform.

- **Trading**
  EUA spot or future trading in secondary markets through emissions exchanges or over-the-counter markets.



7. Calculation of GHG emissions

A ship's greenhouse gas emissions must be calculated using the following formula in accordance with Delegated Regulation (EU) 2023/2776.

$$GHG_{MRV} = CO_{2MRV} + CH_{4MRV} \times GWP_{CH4} + N_2O_{MRV} \times GWP_{N2O}$$

$$CO_{2MRV} = \sum_i (M_i - M_{iNC}) \times EF_{CO2,i}$$

$$CH_{4MRV} = \left[\sum_i (M_i - M_{i,NC}) \times EF_{CH4,i}\right] + CH_{4S}$$

$$N_2O_{MRV} = \sum_i (M_i - M_{i,NC}) \times EF_{N2O,i}$$

where GHG_{MRV} is greenhouse emissions (tCO_{2eq}), CO_{2MRV}, CH_{4MRV} and N_2O_{MRV} are total aggregated each GHG emitted (tGHG), GWP_{CH4} and GWP_{N2O} are the global warming potential of each GHG over 100 years as referred to in the Annex to Delegated Regulation (EU) 2020/1044, i is the fuels used on board the ship in the reporting period, j is emission sources on board the ship including the main engines, auxiliary engines, gas turbines, boilers and inert gas generators, $EF_{CO2,i}$, $EF_{CH4,i}$ and $EF_{N2O,i}$ are tank-to-wake emission factors by fuel i.

$M_{i,NC}$ which is total mass of fuel i not combusted but released into the atmosphere and CH_4 which is the amount of CH_{4s} non combusted released into the atmosphere are calculated with the following formula.

$$M_{i,NC} = \sum_i \sum_j M_{i,j} \times C_j / 100$$

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Inside KR_

KR Verifies HMM's Greenhouse Gas Reduction Calculation Methodology

KR has awarded a third-party verification certificate for a "Greenhouse Gas Reduction Calculation Methodology" developed by HMM, South Korea's largest shipping company. The methodology is based on the Renewable Energy Directive Ⅱ, a regulatory framework adopted by the EU to promote the use of renewable energy to all member states.

Last year, the International Maritime Organization (IMO) set a goal of achieving net zero carbon emissions in international shipping by 2050. Discussions on the Life Cycle Assessment (LCA) methodology for marine fuel oil are underway, accelerating the movement towards carbon neutrality.

In response to current regulatory changes, shipping companies are diligently searching for suitable alternative fuels and their efficient application. Biofuel, a blend of biodiesel from used cooking oil and standard marine oil, is gaining traction due to its compliance with IMO regulations without necessitating engine modifications.

HMM is at the forefront of adopting biofuel, collaborating with GS Caltex and KR. Last year, they marked a significant milestone with the successful biofuel trial on its 6,400 TEU container ship, HMM TACOMA.

The greenhouse gas reduction methodology verified by KR involves calculating the amount of reduced greenhouse gases based on the fuel's life cycle emissions (WtW, Well-to-Wake), which includes WtT (Well-to-Tank) and TtW (Tank-to-Wake) emissions.

HMM uses this verified methodology in their 'Green Sailing Service'. This service aims to help shippers and stakeholders reduce Scope 3 carbon emissions, by allowing them to report carbon reductions directly resulting from HMM vessels sailing on low-carbon fuels.

SONG Kanghyun, Head & Senior Vice President of KR's Decarbonization · Ship R&D Center, commented on the industry's challenges in adopting new technologies amidst fierce competition for next-generation alternative fuels. He emphasized KR's commitment to aiding shipping companies in adhering to greenhouse gas regulations through the proactive development of alternative fuel technologies and the monitoring of international regulations.

New Technical Publications on Decarbonization Have Been Published

The IMO recently decided to significantly strengthen its CO_2 and GHG reduction strategy to achieve a 70% CO_2 reduction and net zero GHG emissions by 2050. Additionally, the EU is implementing a stronger carbon reduction policy than the IMO by establishing the FuelEU Maritime Regulation, which mandates the use of green fuels through the 'Fit for 55' package of legislation.

In response to these carbon reduction policies, KR has published three publications that provide technical information on decarbonization.

△ Methanol as a marine fuel

△ Outlook of liquified carbon dioxide carriers

△ Biofuel as marine fuel

The publications cover not only KR's various R&D achievements on decarbonization but also domestic and international trends on decarbonization and GHG emission reduction, and collaboration within maritime industries.

KR Decarbonization Ship R&D Center plans to regularly provide customers with the latest information on decarbonization and GHG emission reduction.

KR-UPA-Lotte Fine Chemical -HD Hyundai Heavy Industries- HMM MOU to Boost the Ammonia Bunkering Industry

On January 9, KR signed a Memorandum of Understanding (MOU) with Lotte Fine Chemical, HD Hyundai Heavy Industries, and HMM to boost the ammonia bunkering industry at the Ulsan Port Authority (UPA) headquarters.

The MOU is expected to further strengthen KR's role in environmentally friendly marine fuel bunkering, one of the major challenges facing the global shipping industry.

Since the IMO tightened its greenhouse gas regulations in July 2023, ammonia, which does not emit carbon, is gaining traction as the next alternative fuel for ships. Orders for ammonia-powered ships are also on the rise, making advanced preparation for bunkering essential.

While ammonia is considered a hazardous substance, the collaborating parties plan to use this opportunity to improve the system and regulations for its use as a marine fuel. They will cooperate in various areas, including building infrastructure for stable ammonia supply and conducting research and demonstrations to develop new businesses related to ammonia bunkering.

KR Grants DongHwa Entec and DongHwa Pneutech Approval in Principle (AIP) for Ammonia Fuel Supply and Re-liquefaction System

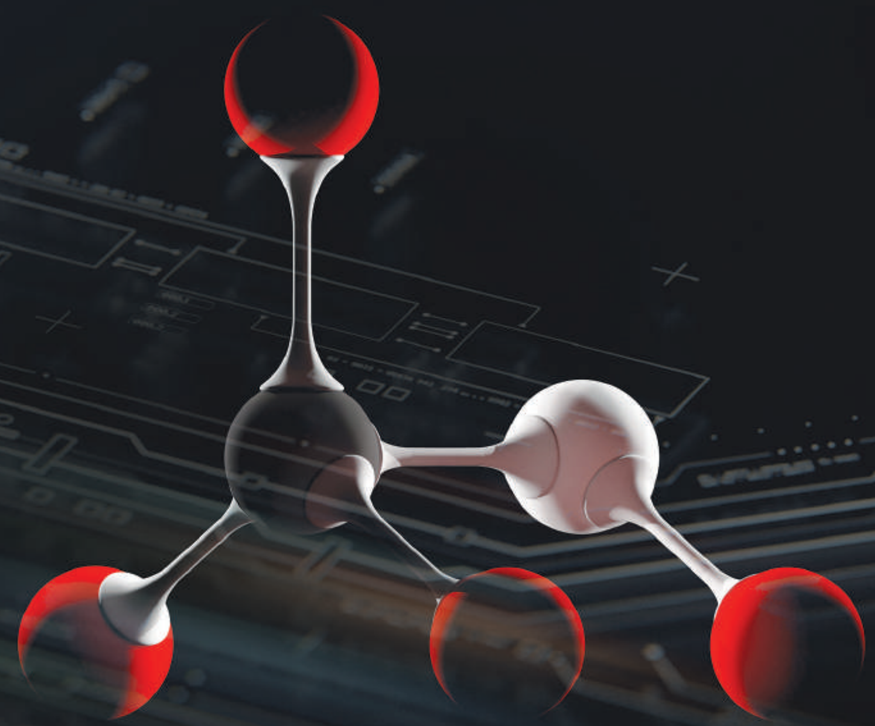
KR awarded DongHwa Entec and DongHwa Pneutech Approval in Principle (AIP) for the Ammonia Fuel Supply and Re-liquefaction System at Marintec China held on 6 December, 2023 in Shanghai, China.

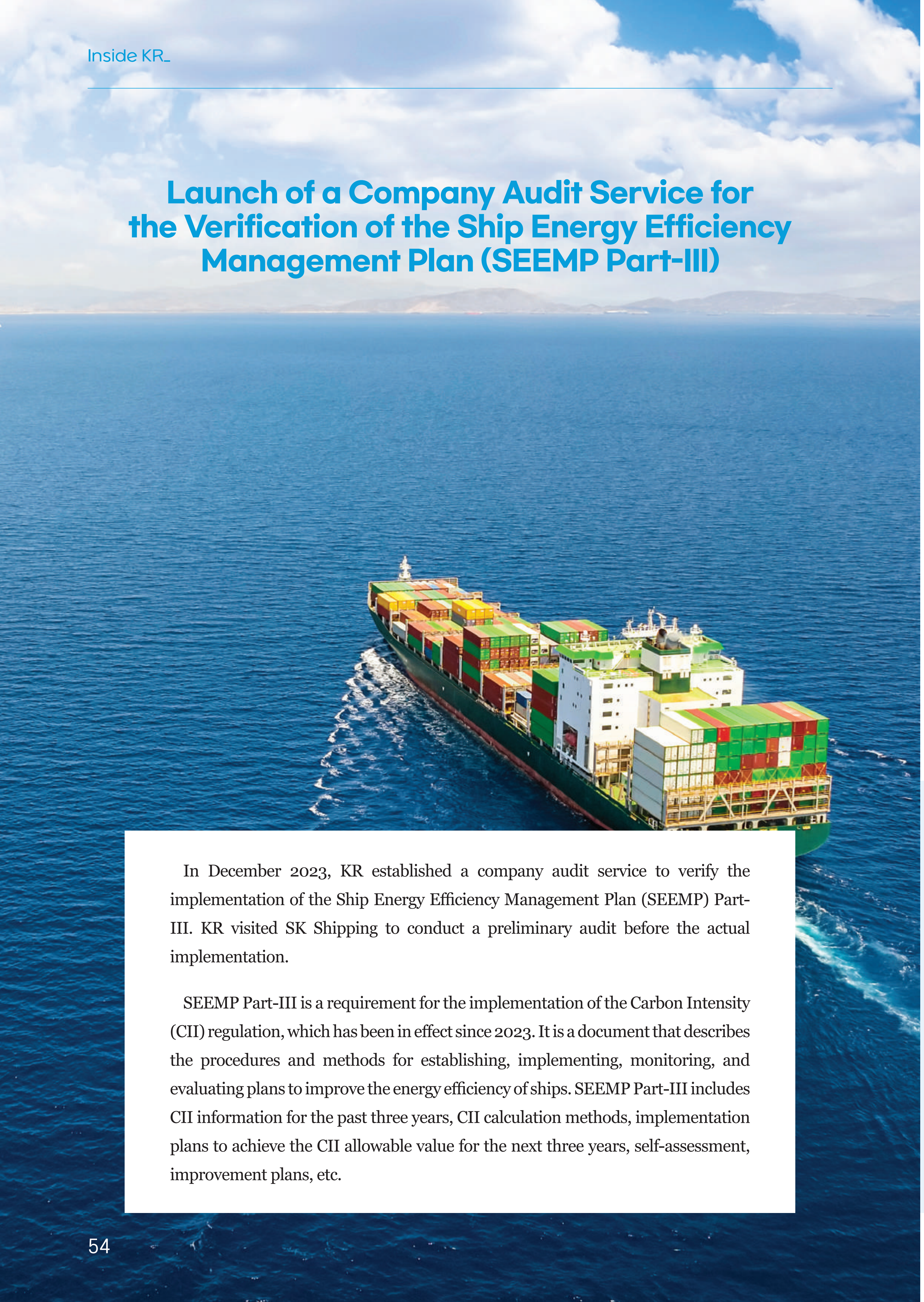
The Ammonia Fuel Supply and Re-liquefaction System is the result of a Hazard and Operability Analysis (HAZOP) of operation and control with APAVE Korea (ABS Consulting) to identify and improve process hazards and operational issues in advance.

Ammonia has the characteristics of being lighter than air, so it can be effectively controlled in case of gas leakage and has a low explosion potential compared to other fuels. However, it is accompanied by problems of toxicity and corrosiveness, so it is essential that the design addresses these issues.

In response, DongHwa Entec completed the overall process design for the fuel supply, reliquefaction, and neutralization system, considering the unique characteristics of ammonia. Specifically, the core equipment for ammonia reliquefaction is a reciprocating compressor from DongHwa Pneutech.

KR will continue to collaborate with companies developing environmentally friendly technologies to contribute to the global goal of carbon neutrality and will provide ongoing support for successful technology development.





Launch of a Company Audit Service for the Verification of the Ship Energy Efficiency Management Plan (SEEMP Part-III)

In December 2023, KR established a company audit service to verify the implementation of the Ship Energy Efficiency Management Plan (SEEMP) Part-III. KR visited SK Shipping to conduct a preliminary audit before the actual implementation.

SEEMP Part-III is a requirement for the implementation of the Carbon Intensity (CII) regulation, which has been in effect since 2023. It is a document that describes the procedures and methods for establishing, implementing, monitoring, and evaluating plans to improve the energy efficiency of ships. SEEMP Part-III includes CII information for the past three years, CII calculation methods, implementation plans to achieve the CII allowable value for the next three years, self-assessment, improvement plans, etc.

CII is a regulation that calculates carbon intensity (Attained CII) based on a ship's actual annual fuel consumption and distance traveled. It assigns a grade from A (high grade) to E (low grade) compared to the required CII allowance (Required) for the ship over the period.

The 2023 classification for individual ships based on their fuel consumption will be derived by March 2024. If a ship's CII rating is D for three consecutive years or E for a single year, a corrective action plan to achieve the CII allowable value must be developed and included in SEEMP Part-III.

Therefore, shipping companies operating internationally voyaging ships of 5,000 gross tonnes or more should have developed a SEEMP Part-III of their carbon intensity action plan for the three-year period up to and including 2023 before the CII is fully implemented this year. They should have obtained a Confirmation of Compliance (CoC) from a competent authority or verification body last year and need to undergo a company audit every three years.

KR has established the 'Company Audit Service for SEEMP Part-III Implementation Verification' to ensure that shipping companies can receive company audits for overall monitoring, including verification of the implementation of these regulations, within the set deadline.

"Based on the experience and feedback we received from the preliminary audit of SEEMP Part-III, we are preparing to provide the service to shipping companies earnestly from this year," said KIM Kyungbok, Executive Vice President of KR's Statutory Division. "In addition, we will strive to provide a wide range of services next year, including preparing integrated guidelines through KR GEARs to support the overall response to CII regulations."

The application process for SEEMP Part-III will be available on the website of KR-GEARs*, Korea's GHG management system.

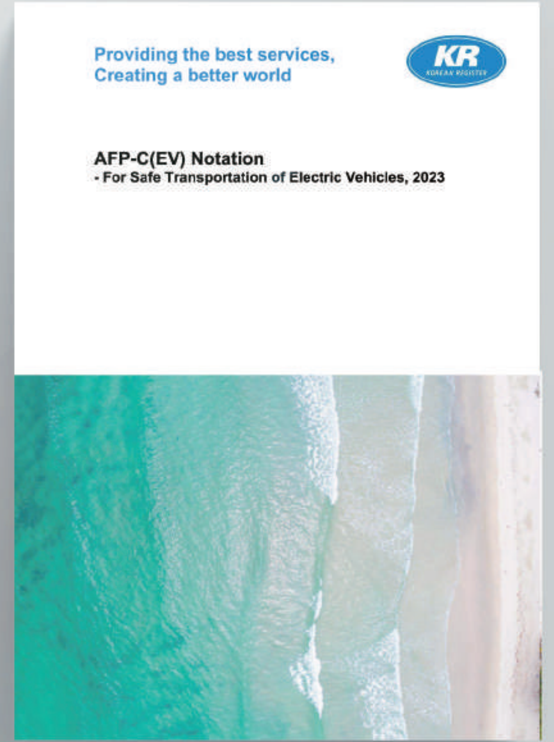
* http://gears.krs.co.kr/Main.aspx

KR Publishes Technical Information for Safe Marine Transport of Electric Vehicles

KR has unveiled technical information to support the safe marine transportation of electric vehicles (EVs). This new guidance provides a practical and realistic understanding of the AFP-C(EV) notation, which has been developed by KR to strengthen safety standards for PCTCs (Pure Car and Truck Carriers)/PCCs (Pure Car Carriers).

The maritime industry is increasingly concerned about the safety of transporting electric vehicles due to the rising number of such vehicles being carried. There have already been instances of fires involving vehicle carriers, and the International Maritime Organization (IMO) and related organizations have underscored the importance of establishing safety regulations for the maritime transportation of electric vehicles. However, the process of developing comprehensive regulations is still in the discussion phase, and practical guidelines are not yet available.

In response to industry demands for safer EV transportation and the need for effective measures in case of EV-related fire incidents, KR has worked in collaboration with shipping companies and shipyards to introduce the AFP-C(EV) notation.



The new information helps to explain the requirements for the AFP-C(EV) notation, which includes the fire detection and fire alarm system, fixed fire-extinguishing system, and fire-fighting equipment.

The technical information can be downloaded from KR's Homepage.

In keeping with our passion for the protection of the natural environment,
KR offers survey and certification services for renewable energies, including wind and ocean power.
KR is continuously working on new and innovative green ship technologies
to reduce emissions and fuel usage, using these advances
to enable our customers to meet their environmental goals.

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