KOREAN REGISTER

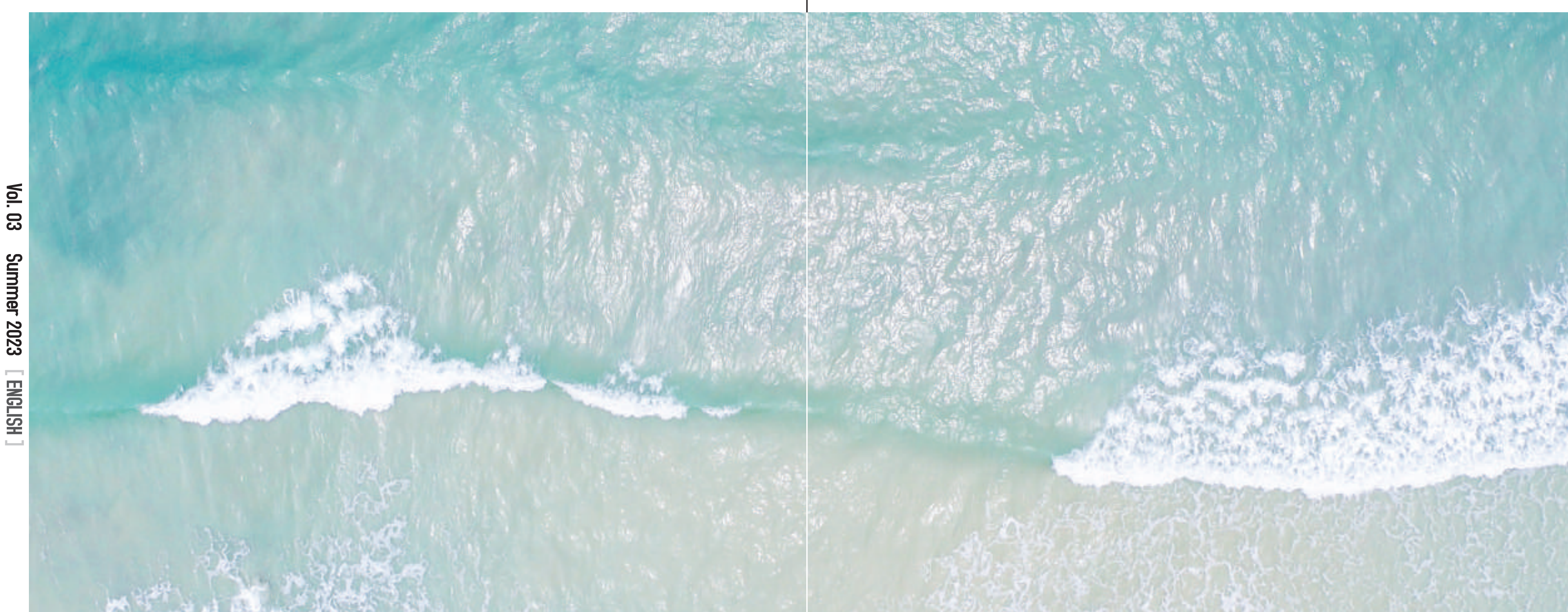
Providing the Best Services, Creating a Better World

Decarbonization Magazine

Vol. 03 Summer 2023 [ ENGLISH ]

[ ENGLISH ]

# Decarbonization Magazine



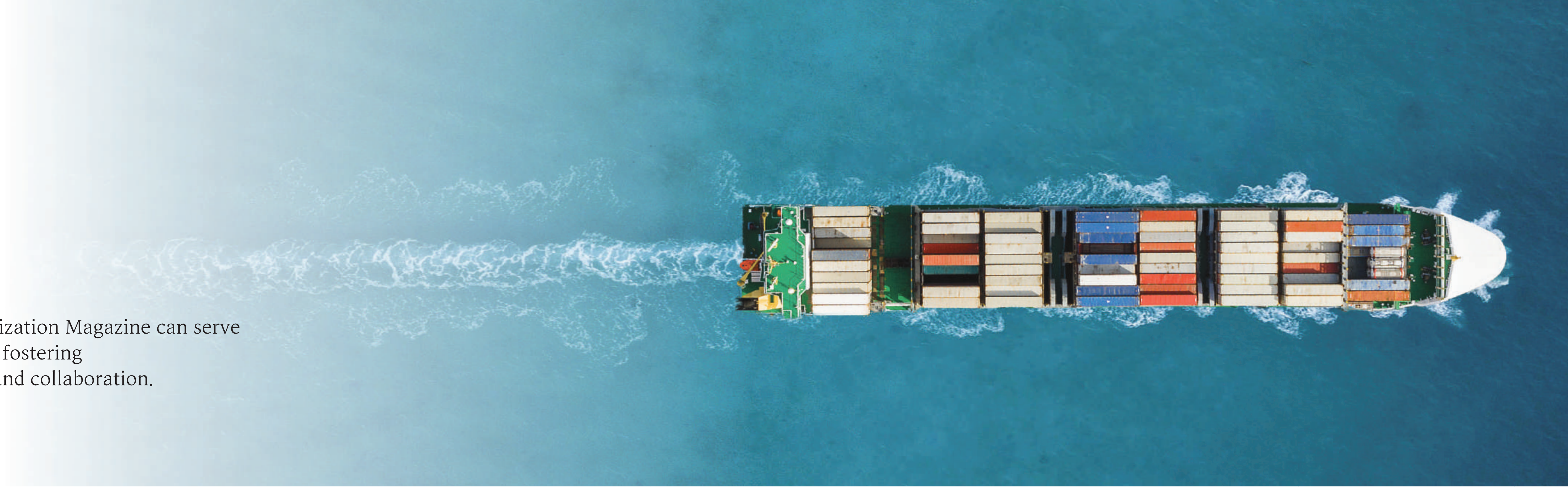
Vol. 03

Summer 2023

## 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.

# CONTENTS



We hope that
the KR Decarbonization Magazine can serve
as a platform for fostering
communication and collaboration.

The eyes of the maritime industry were on the 80th session of the Marine Environment Protection Committee (MEPC), held from 3 to 7 July. The session saw the adoption of the '2023 IMO Strategy on Reduction of GHG Emissions from Ships', which reaffirms the IMO's ambitions to reach net-zero GHG emissions by or around, i.e. close to 2050 taking into account different national circumstances. Indicative check points for 2030 and 2040 were suggested as milestones along the way. The selection of a GHG Fuel standard and a timeline for the further adoption of mid-term measures were agreed. Although there were intense debates due to geopolitical factors among member states, it was an opportunity to reaffirm the shipping industry's commitment to achieving full decarbonization.

The impact of each IMO decision on the industry is profound, and the industry's response must be completely different. In this summer edition, we have summarized the key discussions of the MEPC 80 through regulatory updates. In the subsequent autumn edition, we will publish an analysis of the more detailed decisions and their impact on the shipping industry. We invite you to follow these developments with interest.

Shipowners need to proactively consider various technological and operational measures to prepare for the strengthening GHG policies by the IMO and the EU. However, choosing among a plethora of technologies is no easy task. The most important factors in this selection process are practical feasibility, economic viability, and sufficient flexibility to adapt to future uncertainties. In this edition, we introduce shipowners to a range of options available for complying with GHG regulations. These options encompass practical methods to enhance the Carbon Intensity Indicator (CII) of existing vessels, the introduction of energy-saving devices along with considerations for their selection, as well as stepwise phased response strategies. We hope this will serve as a valuable reference for shipowners in devising appropriate measures.

As the adoption of diverse and innovative technologies is necessary, it also entails potential risks. To address these conflicting issues, KR has issued guidelines for assessing the suitability of new technologies, known as 'New Technology Qualification.' Through this initiative, we aim to actively support the effective adoption of new technologies while ensuring the safety of ships. Furthermore, KR hosted an international conference on wind-assisted propulsion in Pusan, bringing together developers and shipowners from Europe and Korea, which has gained prominence as a new energy saving device. Additionally, we held a seminar on methanol propulsion, an alternative fuel that is receiving increased attention, covering its production, supply, ship application, and prospects. We have also been engaged in various activities, including granting Approval in Principle (AIP) to domestic shipyards for methanol-fueled ships and $LCO_2$ carriers at the 2023 International Maritime and Marine Industry Exhibition in Oslo, Norway.

Many experts argue that there is no definitive answer yet to the question of the best way to respond to decarbonization. However, one thing is certain: finding the best answer is impossible without effective communication and collaboration. As the shipping industry faces significant challenges from the IMO this summer, we hope that KR Decarbonization Magazine can serve as a platform for fostering communication and collaboration.

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

# Insights

# How to Ensure Compliance with CII Criteria for Existing Ships that Depend on HFO

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

Comparing and analyzing various technological and operational methods is crucial to enhancing CII.

## Choosing the Next Green Fuel

The shipping industry is currently at a critical juncture when it comes to decarbonization, thanks to the International Maritime Organization's (IMO) decarbonization objectives. These objectives, outlined in the IMO's GHG Strategy, aim to achieve carbon neutrality by 2050. This means that the industry is facing one of the most important decisions in its history.

Once the IMO 2050 targets are finalized, it is anticipated that the criteria for the Carbon Intensity Index (CII) will undergo significant strengthening after 2027. To comply with these enhanced criteria, the shipping industry will need to employ all available measures and technologies to reduce carbon emissions. It is crucial for the industry to be prepared and proactive in meeting these requirements.

Satisfying the CII criteria is particularly challenging for existing vessels that rely on Heavy Fuel Oil (HFO), which constitutes around 90% of the industry. Retrofitting the engines and fuel supply systems to switch to LNG or methanol as fuels is very expensive , and the additional costs are much higher than for newbuildings . It also entails operational losses during the retrofitting period.

## Technological Method 1 - Ship Speed Reduction

Various technological and operational methods can be employed to enhance the CII. It is crucial to assess the cost-effectiveness of these technologies. One of the most effective and practical methods is to reduce the speed of a vessel. As vessel resistance is proportional to the cube of velocity, reducing speed significantly reduces fuel consumption. Shipowners need to gradually reduce speed and monitor CII to keep a minimum C-rating or above and comply with the increasingly stringent CII regulations each year. However, there are limitations to reducing speed, and alternative measures to improve CII need to be explored once the minimum acceptable speed from a business perspective is reached.

## Technological Method 2 – Blending Biofuel as a Drop-in Fuel

Using Energy Saving Devices (ESDs) does not make it easier to increase vessel speed as desired. Therefore, a realistic solution is to blend biofuel as a drop-in fuel, which can address the reduced speed issue. However, biofuel is approximately three times more expensive than HFO, and its production is limited due to feedstock constraints, resulting in price volatility. Furthermore, competition with other industries, such as the aviation and automotive industries, is necessary to secure the fuel supply. Fortunately, the demand in the shipping sector is increasing, leading to expanded infrastructure and increased production from domestic and international energy companies. Shipowners can gradually increase the blend ratio, such as B20, B30, B50 and B100 to comply with the strengthened CII. If penalties or market-based measures like a Carbon Tax are established when receiving CII ratings of D or E in the future, shipowners need to analyze cost-benefits during this process to determine the blend ratio.

## Technological Method 3 - Energy Saving Devices

Considering that biofuel is very expensive, it is essential to explore various ESDs to ensure that not even a drop of fuel is wasted. Although the contribution of each ESD to fuel savings ranges from 2% to 5%, shipowners can save significant costs if fuel prices rise and the payback time decreases. The key to ESD installation also lies in cost-effectiveness. Examples of ESDs include fins, rudder bulbs, ducts, which increase the flow rate entering the propeller to enhance efficiency, replacing the propeller or improving the bulbous bow shape to match the reduced vessel speed, and using low-friction coatings. Additionally, installing fuel-saving devices such as Air Lubrication System's (ALS), rotor sails, wing sails, and shaft generators could be considered. When installing multiple ESDs simultaneously, the combination can affect efficiency, and careful consideration is needed to select the optimal combination based on vessel type and size. Furthermore, shipowners require third-party verification from institutions with procedures and expertise to objectively validate the performance suggested by the technical providers.

## Operational Methods

In terms of operational methods, there are several ways to improve CII in shipping. These include optimizing ship speed, trim optimization, implementing weather routines, optimizing loading and unloading operations at ports, and utilizing shore power.

The effectiveness of operational methods in improving CII can vary depending on the quality of data obtained and the appropriate analysis techniques used, including artificial intelligence. Even if two ships operate on the same route, their ratings can differ, and performing root cause analysis through data analysis can help identify the optimal operating patterns. The more data that is available, the better decisions can be made. Therefore, it is important to secure sufficient data over a period of three years until 2026 and prepare for the strengthened CII requirements in 2027.

To enhance CII, it is crucial to consider various technological and operational methods and compare and analyze them to find the most cost-effective and efficient solutions. Collaboration with technical providers, third-party verification agencies, and ports is essential to this process.

By adopting these approaches and fostering collaboration, the shipping industry can work towards improving CII and achieving the goals set out by the IMO in reducing carbon emissions.

# Innovative Energy Saving Technology

By KIM Sangyeob,
Senior Surveyor of KR Ship & Offshore Technology Team

The total volume of greenhouse gases (GHGs) emitted by the shipping industry increases daily due to the surge in maritime traffic. In response, the IMO (International Maritime Organization) has established regulations to reduce GHG emissions from ships. The first, most economical, and practical measure to comply with these environmental regulations is to limit engine power, which naturally leads to ship speed reduction. However, ship's speed directly influences its trade volume and cannot be arbitrarily restricted as it is regulated by the ship's operational plan. Consequently, it becomes crucial to adopt innovative energy-saving technologies that can increase the ship's speed at the same engine power. This dual approach will both meet environmental regulations and maintain ship's target speed.

## Innovative Energy Efficiency Technologies

The IMO categorizes innovative energy-saving technologies into Category A, Category B, and Category C, depending on the energy-saving power source (main engine or generator), physical characteristics of the device, and the impact of environmental factors on performance.

### · Category A

Category A includes bulbous bow modifications, vortex flow control fins, rudder fins, ducts, and nozzles, etc. which are installed on the hull to contribute to drag reduction or increased propeller thrust. They are considered as an integral part of the hull and are not separated from the overall ship speed and power performance.

### · Category B

In contrast, Category B comprise technologies that can be switched on and off so it can be distinguished by their energy savings separately from the ship's overall speed and power performance. Recently popular technologies like Air Lubrication Systems (ALS) and Wind Assisted Propulsion Systems (WAPS) are classified as Category B.

Selecting the appropriate energy-saving technology necessitates conducting comprehensive reviews to evaluate the ship's size, design, and operating route.



| Innovative Energy Efficiency Technologies | | | | |
|---|---|---|---|---|
| Reduction of Main Engine Power | | | Reduction of Auxiliary Power | |
| Category A | Category B-1 | Category B-2 | Category C-1 | Category C-2 |
| Cannot be separated from overall performance of the vessel | Can be treated separately from the overall performance of the vessel | | Effective at all time | Depending on ambient environment |
| | $f_{eff} = 1$ | $f_{eff} < 1$ | $f_{eff} = 1$ | $f_{eff} < 1$ |
| - Low friction coating<br>- Bare optimization<br>- Rudder resistance<br>- Propeller design | - Hull air lubrication system (Air cavity via air injection to reduce ship resistance) (Can be switched off) | - Wind assistance (Sails, Flettner-rotors, Kites) | - Waste heat recovery system(Exhaust gas heat recovery and conversion to electric power) | - Photovoltaic cells |

(Source: MEPC.1/Circ.896)

### · Air Lubrication Systems (ALS)

ALS is a technology that can reduce the main engine's energy consumption by spraying fine air particles onto the ship's bottom creating an air layer between the hull's surface and the water, thereby reducing the resistance of the ship (frictional resistance). It is classified as Category B-1 because its energy-saving performance is independent of the environmental condition (wind, waves, etc.). For ALS to be effective, the air layer must be well retained on the ship's bottom, so the energy-saving performance is significantly dependent on the ship's draught and bottom shape. The main technical issues are the size and quantity of air particles sprayed onto the hull, along with the positioning and shape of the air nozzles. In addition, if the system is operated continuously, it can be expected to reduce fouling on the hull, which has an indirect energy-saving effect and maintenance cost benefits for the ship.

### · Wind Assisted Propulsion Systems (WAPS)

WAPS is a technology that generates propulsion from wind energy. Unlike ALS, which operates independently of the weather condition, WAPS's energy saving performance is affected by wind speed and direction, so it is classified as Category B-2. There are several types of WAPS, including soft-sail, hard-sail (also referred to as a wing sale), and rotor-sail. Recently, hard-sail and rotor-sail have been attracting attention. Hard-sail is a technology that generates ship propulsion by adjusting the wind's angle of attack to create a speed difference in the air around the sail. Its performance varies depending on the cross-sectional shape of the sail. Rotor-sail technology on the other hand, generates propulsion by inducing a speed difference in the air around the sail (known as Magnus effect) by rotating a cylindrical sail. In essence, both hard-sails and rotor-sails share similar characteristics as they generate propulsion by adjusting the airflow around the sail. Both technologies also give high propulsion power near beam-wind conditions.

The amount of thrust that can be obtained by a WAPS varies depending on the wind's projected area. Hard sails hold the advantage of being installable on a larger scale than rotor sails. Rotor sails, however, have the benefit of generating a substantial amount of thrust relative to their size. Therefore, when considering the introduction of WAPS, it is essential to comprehensively consider the thrust to be obtained and the amount of available deck space. The main technical issues for WAPS are sail geometry (cross-section and aspect ratio), the relative interference effects of installing multiple sails, and the risk of resonance due to vortex shedding around the sails.

As we've discussed, the effectiveness of energy-saving technologies varies greatly depending on a vessel's characteristics and its operational routes, Therefore, it is challenging to recommend a universally efficient energy-saving technology for all vessels. In order to choose an appropriate energy-saving technology, it is necessary to conduct comprehensive reviews of the ship's size, design, and operating route, and to calculate the selected technology device's specifications, taking into account initial investment cost and expected fuel savings.

The Right Approach

# Clear Path to Decarbonizing the Shipping Industry: Step-by-Step Response Strategy

By HUR Yoonjung,
Senior Surveyor of KR Business Support Team

The upcoming IMO MEPC meeting in July has captured the attention of maritime industry officials. During this meeting, revisions and strengthening of the initial strategy for greenhouse gas regulation, established in 2018, will take place. Additionally, the EU has separate plans for implementing the Emissions Trading System (EU ETS), and FuelEU Maritime which are penalty regulations based on life cycle evaluation. These regulations are set to be implemented sequentially from 2024 and are separate from the IMO.

Various private organizations, including finance, insurance, shippers, and charterers, are also evaluating the implementation of regulations using their own indicators. Consequently, shipping companies are facing significant challenges in finding comprehensive decarbonization solutions that comply with not only IMO regulations but also regional EU regulations and private requirements. As a result, the most common question shipping companies have these days is how to effectively respond to these diverse and strengthened regulations.

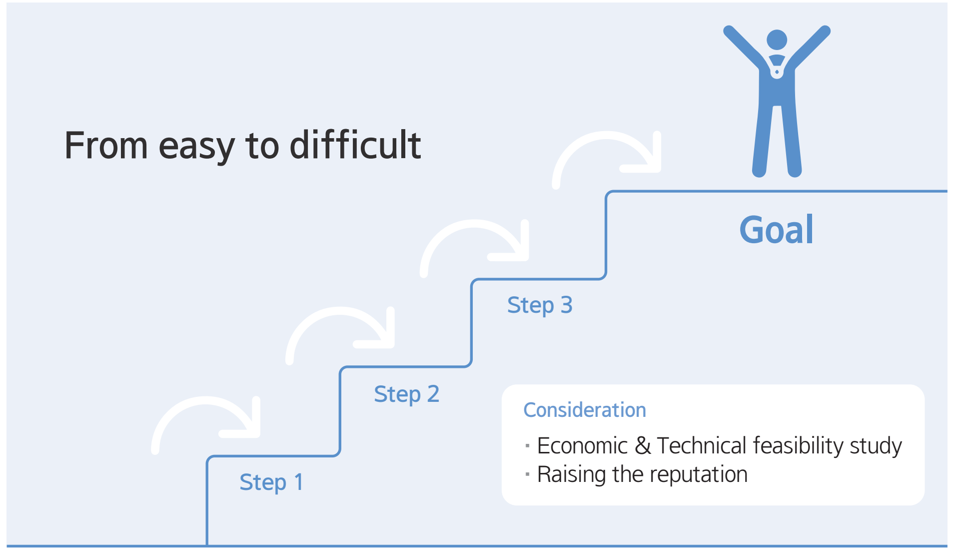
Greenhouse gas emissions from ships are influenced by numerous factors, including the ship's design elements, operational patterns, and sea conditions. Uncertainty factors such as route, speed, weather, tide, cargo contracts, fouling, and anchoring time further complicate the search for solutions.

Given the complexity of these effects, it is important to explore multiple perspectives when seeking methods to reduce greenhouse gas emissions. Employing a one-size-fits-all approach is not advisable as it can be costly and ineffective in addressing all aspects simultaneously. Shipping companies should instead consider various possibilities and combine different methods. Furthermore, a customized approach that suits the specific characteristics of each shipping company, such as ship type and operational patterns, is necessary.

Consequently, adopting an approach that starts with the most easily implementable method and gradually incorporates more challenging methods is a recommended course of action. To facilitate this approach, in addition to the technical research conducted thus far, conducting economic feasibility studies will now be essential in determining the viability of these measures.

KR, a reliable partner
for a step-by-step approach
to decarbonization






## Priorities for Reducing GHG Emissions

**· Step 1 | Identify GHG emissions and set reduction targets**

First of all, shipping companies need to figure out the total GHG emissions and CII rating of all ships they own and simulate penalty costs for related regulations such as EU ETS and FuelEU Maritime. Based on this assessment, GHG reduction targets should be set for each individual ship.

**· Step 2 | Improvement through operational measures**

To begin the improvement process, it is recommended to focus on operational measures such as optimizing vessel speed and navigation routes, improving hull cleaning cycles, and minimizing anchoring time and ballast water usage. Additionally, it is essential to adopt a real-time monitoring and management platform that can oversee and control these measures effectively. In response to this need, several shipping companies are already implementing smart ship solution platforms across their fleet, starting with newly constructed ships. This trend has prompted the expansion of monitoring platform providers.

As it becomes evident that greenhouse gas-related regulations will not be one-time events but rather continually strengthened and updated, the implementation of a comprehensive platform for systematic management has become a necessity.

**· Step 3 | Apply energy-saving technology**

After implementing operational measures, another viable approach is to explore energy-saving technologies. These technologies encompass a range of energy-saving devices (ESDs) in addition to the smart ship solution platform mentioned in the previous step.

There are various energy-saving devices (ESDs) that can be considered for ships. These include well-known components such as ducts, fins, and rudder bulbs, which are typically installed in front or behind the propeller to enhance propulsion efficiency. Additionally, options like low-friction paint and air lubrication systems that minimize frictional resistance on ships are worth considering.

For main and auxiliary engines, implementing ESDs like scavenge air coolers, VFD control, LED lights, and micro boilers can be beneficial. Moreover, newer devices such as wind propulsion assistance devices and shaft generators have emerged as promising options. The development of on-board carbon capture systems is currently in its early stages. While there are still uncertainties surrounding the regulations associated with these

Categorization for EEDI calculation based on energy savings and characteristics

| Category | Item | CAPEX | Energy Saving |
|---|---|---|---|
| A | Low Friction Coating<br>Duct & Fin, Rudder Bulb & Pro. Boss Cap<br>Bulbous Bow & Propeller Ret. | Low | Low |
| B | Air Lubrication System<br>Wind Assistance(Sails, Flettner Rotors, Kites) | Medium | Medium |
| C | Waste Heat Recover System,<br>Photovoltaic Cell | High | High |
| Etc. | Scavenge Air Cooler, VFD Control, LED Light,<br>Micro Boiler, Smart Ship Solution | Low | Low |

systems, they are garnering attention as a solution that merits ongoing monitoring and evaluation.

When considering the implementation of these technologies, it is crucial to carefully assess the actual application effect, cost implications, and installation timeline in relation to the specific vessel in question. The key is to select the optimal combination of technologies that aligns with the vessel's requirements and objectives.

· **Step 4 | Transition to alternative fuels**

Currently, it is not advisable to pursue modifications for converting existing ships to alternative fuels due to the significant additional costs and lengthy installation period involved. However, depending on the strictness of future regulations, this approach could be worth considering specifically for younger ships that still have a substantial amount of operating time remaining.

Biofuels are also very attractive options as they require few additional fuel storage tanks or systems, resulting in virtually no retrofit costs. The biggest constraint is whether a sustainable supply can be secured. Nevertheless, biofuel can be a good alternative for small ships where it is not easy to secure additional space for an alternative fuel storage tank.

Considering the escalating costs associated with stricter GHG reduction regulations, it is inevitable that existing ships will need to be replaced with new ones at some point. With a typical ship lifespan of approximately 25 years, it is essential to incorporate the use of alternative fuels during the new construction phase, alongside design optimization and the application of suitable energy-saving devices (ESDs).

Before implementing alternative fuels, a thorough evaluation of technical and economic feasibility is crucial. This involves conducting a technical review of the ship's design, taking into account factors such as the intended route, available bunkering ports, fuel tank type and arrangement. Based on these considerations, the capital expenditure (CAPEX) must be assessed. Additionally, the operating expenditure (OPEX) needs to be calculated, which includes evaluating the fuel costs associated with each alternative fuel, the penalty costs for GHG regulations, and maintenance expenses.

While precise calculations are challenging due to evolving technologies and uncertainties surrounding future GHG regulations, conducting this feasibility study serves as a foundational step in determining which alternative fuels are suitable for each ship's specific requirements.



## Bridging the Role of Operational Measures and Energy-Saving Technologies

In conclusion, shipping companies must continuously update their GHG emission reduction strategies by following the step-by-step approach outlined, to adapt to increasingly strict GHG regulations. Given the growing significance of energy security, as demonstrated by recent events such as the crisis in Ukraine, the transition to alternative fuels, as set out in Step 4, may not occur rapidly.

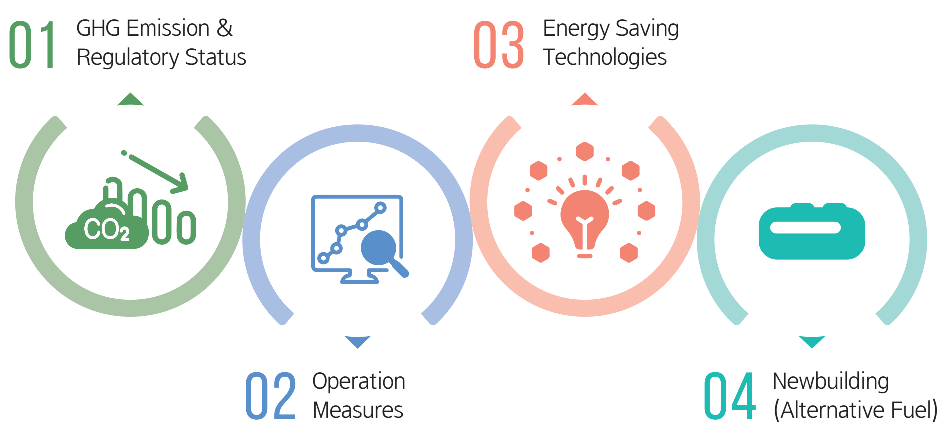
According to a report from Clarksons, the financing required for newbuilding projects over the past decade averaged $92 billion annually. However, the cost for fuel conversion over the next decade is expected to be 1.6 times higher. Moreover, considering the decarbonization scenario, it is projected that the cost will be 4.4 times higher by 2050. For shipping companies planning to construct new ships, this will undoubtedly pose a significant burden.

Consequently, the role of operational measures and energy-saving technologies (Steps 2 & 3) as transitional solutions in the decarbonization process may receive increased attention. The possibility of policy regulations to incentivize their adoption cannot be dismissed either. Although this is undoubtedly a challenging journey for the shipping industry, it is crucial to effectively prepare for decarbonization by considering these factors.

KR plays a crucial role in assisting shipping companies with a step-by-step approach to decarbonization. Through the KR GEARS platform, CO2 emissions and Carbon Intensity Index (CII) ratings are provided to help companies track their progress. Furthermore, KR evaluates the anticipated penalty costs associated with the EU's 'FIT FOR 55' regulations and assesses the economic feasibility of adopting alternative fuels.

Recently, KR has collaborated with multiple shipping companies to analyze the operational patterns of their entire fleets and develop tailored GHG emission reduction strategies. By working closely with these companies, KR aims to find collective solutions and serve as a reliable partner in the maritime industry's response to decarbonization.

GHG emission reduction strategies



KR Decarbonization Magazine

# Regulatory Updates_

# MEPC 80 Highlights

The Marine Environment Protection Committee (MEPC), at its 80th session, made the following decisions to further reduce GHG emissions from international shipping.

## 1. Adoption of the 2023 Strategy on Reduction of GHG emissions from ships (Res.MEPC.377(80))

1) **Additional ambitions for 2030**

- Accelerating the uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources to represent at least 5%, striving for 10%, of the energy used by international shipping by 2030.

2) **Addition of indicative checkpoints for 2030 and 2040**

- Reduction of the total annual GHG emissions from international shipping by at least 20%, striving for 30%, by 2030 and at least 70%, striving for 80% by 2040, compared to 2008.

3) **GHG emissions from international shipping reach net-zero**

- To peak GHG emissions from international shipping as soon as possible and to reach net-zero GHG emissions by or around, i.e. close to 2050, taking into account different national circumstances, whilst pursuing efforts towards phasing them out as called for in the Vision consistent with the long-term temperature goal set out in Article 2 of the Paris Agreement.

## 2. Selection of Mid-term measures for further reducing GHG emissions from international shipping

1) **A basket of measures combining technical and economic elements**

- [Technical element] Agreed to select "GHG Fuel Standard" which is a goal-based fuel standard as a technical element.
- [Economic element] Reaffirming the conflicting views in favor of and against universal GHG levy.
- Agreed to further consider the review of the economic elements proposed so far and details on raising and disbursement of revenues by technical and economic elements under the phase III (Development of measures to be finalized within agreed target date) of the work plan for development of mid- and long-term measures as a follow-up action of the initial IMO Strategy on reduction of GHG emissions from ships approved by MEPC 76.

2) **Establishment of a timeline for the development of candidate mid-term measures and associated comprehensive impact assessment, as follows :**

- ① MEPC 80 (July 2023): Initiation of Comprehensive impact assessment of the basket of candidate midterm measures;
- ② MEPC 81 (April 2024): Finalization of development of the basket of candidate mid-term measures;
- ③ MEPC 82 (October 2024): Finalization of comprehensive impact assessment of the basket of candidate mid-term measures;
- ④ MEPC 83 (April 2025): Approval of the MARPOL amendments for implementing the basket of candidate mid-term measures;
- ⑤ Extraordinary session of MEPC: Adoption of measures (6 months after MEPC 83); and
- ⑥ 16 months after adoption (May 2027): Entry into force of the measures

## 3. Approval of the draft Guidelines on Life Cycle GHG Intensity of Marine Fuels (Res.MEPC.376(80))

1) These Guidelines provide guidance on assessment of life cycle GHG intensity assessment for all fuels and other energy carriers (e.g. electricity) used on-board a ship, and aim at estimating GHG emissions for whole fuel life cycle from feedstock extraction/cultivation/recovery, feedstock conversion to a fuel product, transportation as well as distribution/bunkering, and fuel utilization on-board a ship.

2) The guidelines provide calculation methods to address Well-to-Tank (WtT), Tank-to-Wake (TtW), and Well-to-Wake (WtW) GHG intensity related to marine fuels/energy carriers used for ship propulsion and power generation onboard, as well as default GHG emission values for various marine fuels, and its corresponding sustainability criteria which is to be assessed considering particular aspects on a life cycle basis such as GHG, carbon source, source of electricity/energy, DLUC and ILUC, etc.

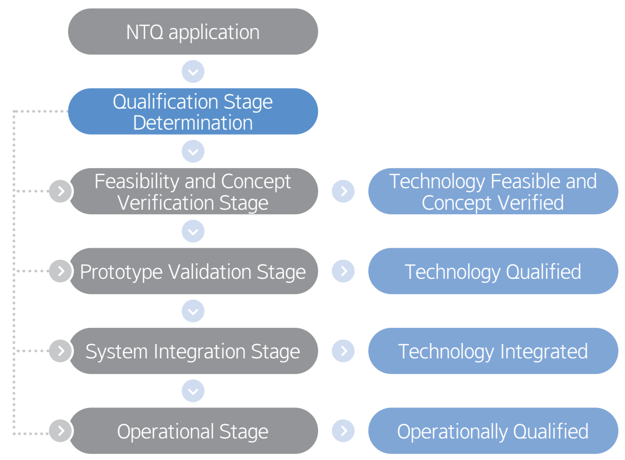
3) MEPC 80 agreed to establish the correspondence group to complete the identification of default emission factors for the existing pathways and to further consider specific methodological issues that are relevant for measuring actual emission factors. In addition, MEPC 80 further agreed to hold a dedicated expert workshop to consider the more detailed way to implement LCA Guidelines and to facilitate the development of procedures and criteria to recognize certification schemes and guidance for third-party verification as well as the operationalization of the sustainability criteria.

# Inside KR_

# KR Launches New Technology Qualification Service


In April, KR established the 'Guidelines for New Technology Qualification' to support the efficient implementation of new technologies. The New Technical Qualification (NTQ) technical service was also fully implemented.

The NTQ process consists of four stages: feasibility and concept verification, prototype validation, system integration, and operational evaluation.

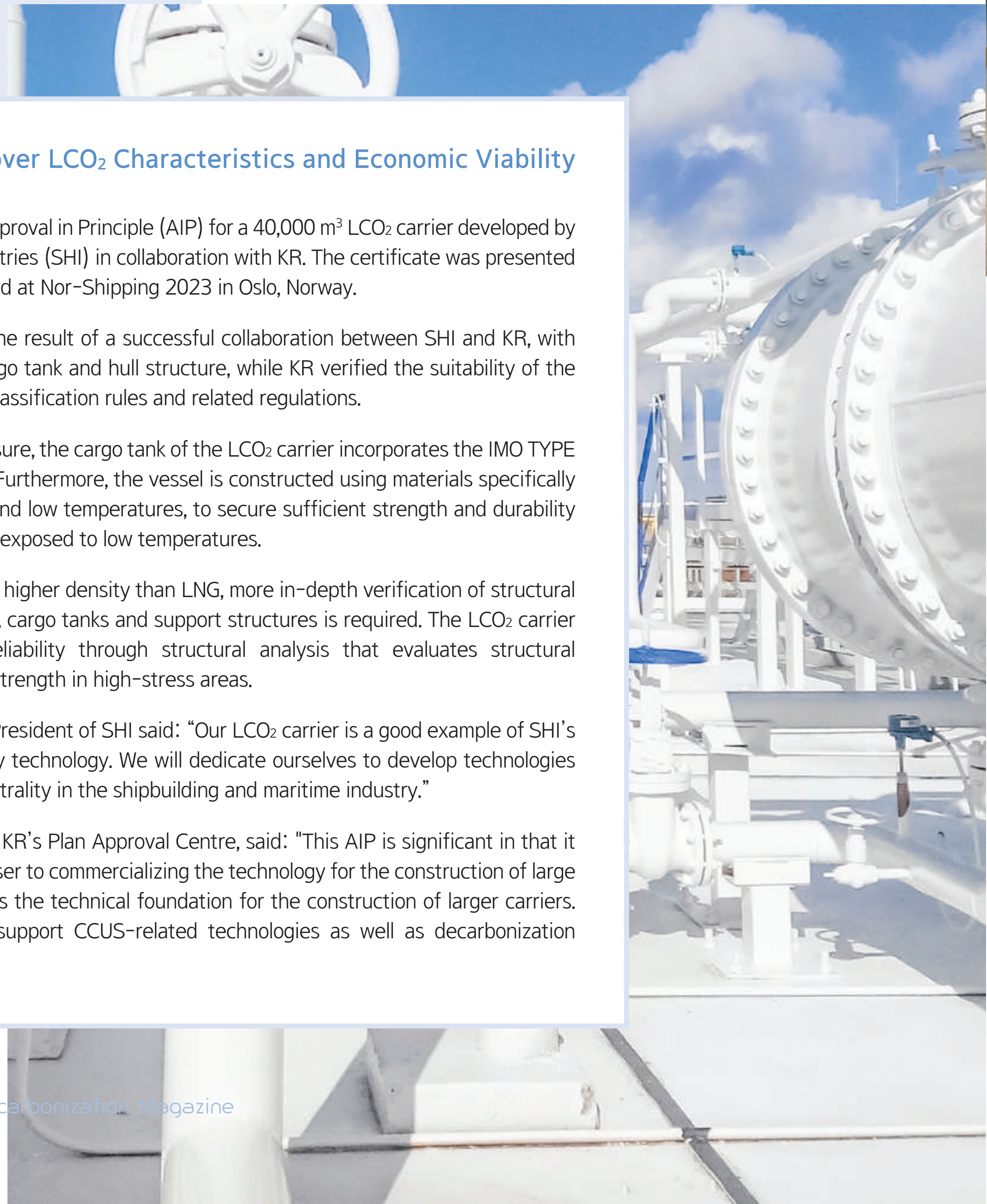



It is generally applicable to all new technologies for offshore units and marine vessels that are not normally subject to Rules, Guidance, or industry standards. The process provides a systematic and consistent evaluation of new technologies as they mature from a concept through confirmation of operational integrity in their intended application.

Through this new NTQ process, customers will be able to achieve the stability and credibility of their system at the new technology development stage. KR will actively introduce the NTQ process when working with shipbuilders and owners for the development of alternative fuel ships.

# KR Awards AIP for 40Km³ $LCO_2$ Carrier, Jointly Developed by DSME & SHI

With the maritime industry experiencing a growing requirement for Carbon Capture, Utilization and Storage (CCUS) technology in response to decarbonization demands, there arises a parallel need for safe and reliable liquefied carbon dioxide carriers. These vessels play a crucial role in transporting the captured carbon dioxide to storage facilities. In the past, small vessels with a capacity of less than $3Km^3$ were primarily constructed for food transport. However, in recent years, there has been a notable shift in market demand towards larger carriers, driven by the need for enhanced economic efficiency. To align with this growing demand and stay abreast of technological advancements, KR has collaborated with renowned shipyards worldwide to develop liquefied carbon dioxide ($LCO_2$) carriers.

## · SHI Designs Cover $LCO_2$ Characteristics and Economic Viability

KR has awarded an Approval in Principle (AIP) for a 40,000 $m^3$ $LCO_2$ carrier developed by Samsung Heavy Industries (SHI) in collaboration with KR. The certificate was presented during a ceremony held at Nor-Shipping 2023 in Oslo, Norway.

This achievement is the result of a successful collaboration between SHI and KR, with SHI designing the cargo tank and hull structure, while KR verified the suitability of the design by reviewing classification rules and related regulations.

To maintain high pressure, the cargo tank of the $LCO_2$ carrier incorporates the IMO TYPE Independent-C tank. Furthermore, the vessel is constructed using materials specifically engineered to withstand low temperatures, to secure sufficient strength and durability even in environments exposed to low temperatures.

Given that $LCO_2$ has a higher density than LNG, more in-depth verification of structural safety for cargo holds, cargo tanks and support structures is required. The $LCO_2$ carrier has demonstrated reliability through structural analysis that evaluates structural strength and fatigue strength in high-stress areas.

AHN Youngkyu, Vice President of SHI said: "Our $LCO_2$ carrier is a good example of SHI's advanced eco-friendly technology. We will dedicate ourselves to develop technologies to achieve carbon neutrality in the shipbuilding and maritime industry."

YEON Kyujin, Head of KR's Plan Approval Centre, said: "This AIP is significant in that it brings us one step closer to commercializing the technology for the construction of large CCUS carriers and lays the technical foundation for the construction of larger carriers. We will continue to support CCUS-related technologies as well as decarbonization technologies."


## · Structural Design of the Vessel and Conceptual Design of the Cargo Handling System by DSME, Taking into Account $LCO_2$ Characteristics

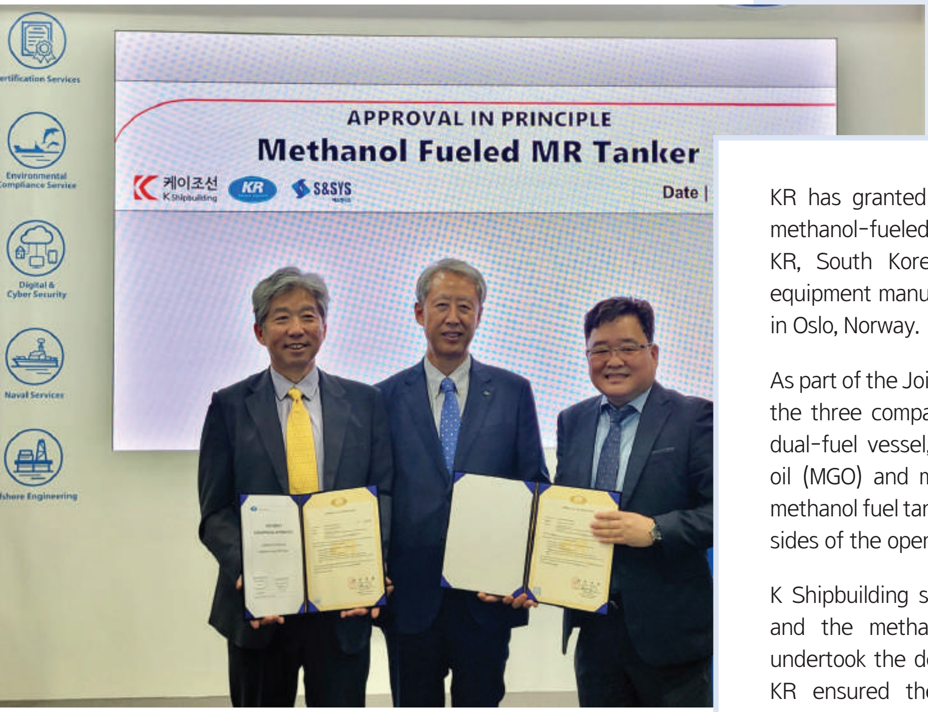
KR granted an Approval in Principle (AIP) to a $40Km^3$ liquefied carbon dioxide ($LCO_2$) carrier concept developed by Daewoo Shipbuilding & Marine Engineering (DSME).

The ship that received the AIP was developed under a Joint Development Project (JDP) between KR and DSME. DSME carried out the basic and structural design of the vessel and the conceptual design of the cargo handling system. KR verified its compliance by reviewing classification rules and domestic and international regulations.

Unlike cargoes such as LNG and ammonia, which can be transported as liquids if only one of the conditions of low temperature or high pressure is met, carbon dioxide can only be transported as a liquid if both conditions of low temperature and high pressure are maintained simultaneously. At present, there are only a limited number of materials and thicknesses available for carrier tanks to maintain these conditions, making larger carbon dioxide carriers a relatively advanced technology among cargo-carrying vessels.

KIM Hyoungseog, VP & Head of DSME's Ship Basic Design Division, said: "With the completion of the conceptual design of the $40Km^3$, following the $12.5Km^3$ and $70Km^3$, DSME has completed its range of representative sizes of LNG carriers. This will enable us to continue to lead the market with our advanced technology in the LNG carrier sector, which has great potential for growth in the future."

## Methanol-Fueled MR Tanker, Jointly Developed by K Shipbuilding and KR Approved




KR has granted an Approval in Principle (AIP) for a methanol-fueled MR tanker, jointly developed by KR, South Korean Shipbuilders K Shipbuilding and equipment manufacturer S&SYS at Nor-Shipping 2023 in Oslo, Norway.

As part of the Joint Development Project (JDP) between the three companies, the MR tanker is designed as a dual-fuel vessel, harnessing the power of marine gas oil (MGO) and methanol. The vessel incorporates two methanol fuel tanks positioned on the port and starboard sides of the open deck.

K Shipbuilding spearheaded the vessel's basic design and the methanol fuel tank design, while S&SYS undertook the development of the fuel supply system. KR ensured the safety and regulatory compliance of the design by thoroughly reviewing national and international regulations, leading to the issuance of the AIP for the methanol-fueled MR tanker.

Methanol possesses significant advantages as a marine fuel. It is a liquid fuel similar to bunker fuel at room temperature, eliminating the need for pressurization. Compared to extreme temperature fuels like LNG, hydrogen, and ammonia, methanol is easier to store and transport. Furthermore, it is considered a green fuel with strong potential for commercialization in the maritime sector due to its technical feasibility, less toxic nature compared to ammonia, and lower technical requirements compared to LNG fuel.

KR remains committed to advancing decarbonized alternative fuel technologies, with a particular focus on providing technical support for decarbonization efforts. The 'Methanol Fueled MR Tanker' Joint Development Project stands as a testament to KR's dedication to driving the industry's transition towards greener solutions.



## KR Conference 2023: How Far Have We Come with Methanol-Powered Ships and Methanol Fuel Distribution?


In April, KR hosted the KR Conference & MacNet Strategy Seminar "How far have we come with methanol-powered ships and methanol fuel distribution?" online and offline.

Jointly organized by Maritime Cluster Networking in Korea (MacNet) and supported by the Ministry of Oceans and Fisheries and Busan Metropolitan City, the seminar was designed to share the status of methanol powered ship technology development and discuss the pros and cons of methanol as an alternative fuel and the sustainability of fuel supply.

Prior to the presentations, 40 experts from shipyards, shipping companies, research institutes, government organizations and maritime equipment manufacturers met to discuss preliminary issues, challenges, and ways forward for each presentation topic.

The first session consisted of three presentations on the status and prospects of methanol ship technology development, the status of shipping companies' response to greenhouse gas regulations, and the potential of methanol as a marine fuel.

The second session included presentations on methanol alternative fuel production technology and global market trends, prospects for e-methanol and eDME production using carbon capture utilization (CCU) technology, and methanol supply chain analysis and future prospects.

Among other alternative fuels, methanol is attracting market attention not only because engines have already been developed, but also because it has several advantages, such as lower carbon emissions than LNG and easy transportation in a liquid state even at room temperature.

The seminar was an opportunity for KR customers to learn more about the sustainability of methanol-powered ships and methanol fuel supply. The presentations can be viewed on KR's official YouTube channel (www.youtube.com/TheKoreanregister).

# KR Inks JDP Agreement for Fuel/GHG Emission Reduction and Verification by Autonomous Navigation


On 14 March, KR signed a Joint Development Project (JDP) agreement to verify an autonomous navigation system developed by Avikus.

Five companies, including KR, Pan Ocean, POS SM, Korea Shipbuilding & Offshore Engineering (KSOE), and Avikus, attended the signing ceremony. This JDP is significant because it will be the first time in the world that Korean shipbuilders, autonomous navigation specialists, and shipping companies will work together to verify the fuel-saving effect of using autonomous navigation systems on actual ships.

Until now, the verification of energy savings on ships, including optimal routes, has primarily relied on simulations conducted by shipbuilders or equipment manufacturers. However, this project aims to enhance reliability by verifying the results using actual ship operating data. HiNAS 2.0, the autonomous navigation system developed by Avikus to be used for this verification, was approved by KR in January this year after verifying the safety and feasibility against classification rules and international and national regulations. HiNAS 2.0 leverages augmented reality (AR) technology to empower ships in navigating optimal routes, maintaining ideal speeds, and avoiding collisions. This is achieved through the integration of data collected by artificial intelligence (AI) from sensors attached to the vessel and its sailing equipment.

KR will conduct an evaluation of the fuel savings verification framework developed in this project and verify the reliability and safety of HiNAS 2.0. Pan Ocean and POS SM will provide operational vessels and data and conduct a feasibility review of the demonstration process. KSOE will develop a fuel savings verification framework through data analysis.

Close collaboration is also expected in the future as KR undertakes technological development and demonstration work on the use of environmentally-friendly solutions. This includes pilot testing of rotor sails with Pan Ocean and certification of alternative fuel supply systems such as hydrogen, carbon dioxide and ammonia.

## KR-HMM-SHI-PANASIA, Collaborate to Conduct OCCS Field Tests


KR signed an agreement with HMM, Samsung Heavy Industries (SHI), and PANASIA to conduct integrated field tests on onboard carbon capture systems (OCCS) for ships.

KR, HMM, SHI, and PANASIA will form a joint working group to conduct a maritime field test by directly installing the domestically developed OCCS on a 2,100 TEU container ship operated by HMM within the year. The demonstration, the first of its kind in Korea, will feature a high-capacity OCCS capable of capturing and storing 24 tonnes of carbon dioxide per day in liquid form.

KR will carry out the risk assessment of the vessel, SHI and Panasia will be responsible for the design, manufacture, installation and commissioning, and HMM will operate the vessel.

The carbon dioxide captured from the container ship during the demonstration period will be delivered to shore for use in smart farms or dry ice production.



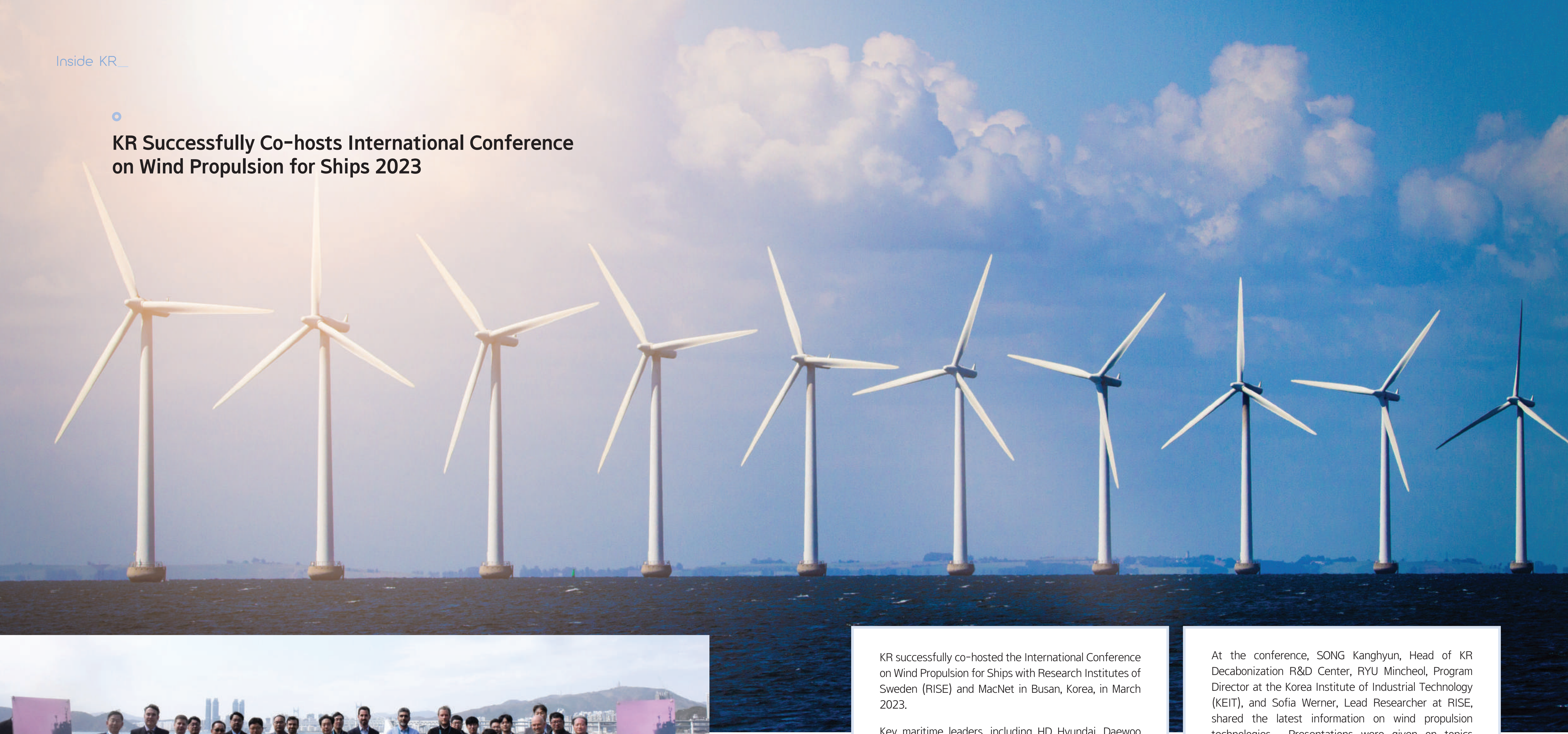
## KR Joins Forces with Shipbuilding Industry to Standardize Scope 3 Emissions

On 16 March, KR signed the first-ever Joint Development Project with Korean shipbuilders, including HD Hyundai, Daewoo Shipbuilding & Marine Engineering (DSME), Samsung Heavy Industries (SHI), and the American Bureau of Shipping (ABS), to develop a method for calculating GHG Scope 3 emissions for shipbuilding.

KR and the Korean shipbuilding industry have taken a joint approach in response to market demands for disclosure of Scope 3 emissions, such as the European Union's (EU) Corporate Sustainability Reporting Directive (CSRD), the International Sustainability Standards Board (ISSB), and the US Securities and Exchange Commission's (SEC) Climate Disclosure Standards.

Together with HD Hyundai, DSME, SHI and ABS, KR will share, compare, and analyze each company's Scope 3 GHG emission calculation methodology, standardize the process through consultation, and prepare international guidelines by the end of this year.

# KR Successfully Co-hosts International Conference on Wind Propulsion for Ships 2023




KR successfully co-hosted the International Conference on Wind Propulsion for Ships with Research Institutes of Sweden (RISE) and MacNet in Busan, Korea, in March 2023.

Key maritime leaders, including HD Hyundai, Daewoo Shipbuilding & Marine Engineering (DSME), and Norsepower, the wind power specialist, gathered to share the latest trends and insights on wind propulsion technology.

At present, shipping companies are considering various measures to effectively respond to internationally tightened environmental regulations. Among them, wind propulsion technology for ships is one of the key technologies to reduce greenhouse gas (GHG) emissions.

KR organized this event to present the latest research and development trends in the domestic and international maritime industry on wind propulsion technology, as well as to forecast the future demand and exchange opinions with stakeholders.

At the conference, SONG Kanghyun, Head of KR Decabonization R&D Center, RYU Mincheol, Program Director at the Korea Institute of Industrial Technology (KEIT), and Sofia Werner, Lead Researcher at RISE, shared the latest information on wind propulsion technologies. Presentations were given on topics such as the status of wind propulsion technologies for responding to GHG regulations, practical verification of wind propulsion technologies, the introduction of various wind propulsion systems (rotor sails, wing sails, etc.), and the impact of wind propulsion on the maritime industry.

The presentations were followed by an open discussion session where participants exchanged views on wind power technology.

Effective collaboration among shipyards, owners, research institutes, and classification societies is crucial to effectively address the stringent regulations. KR remains committed to organizing opportunities for industry stakeholders to come together and collectively seek better solutions.

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.

KR Decarbonization Magazine

Vol. 03 Summer 2023

**Korean Register**

(46762) 36, Myeongji ocean city 9-ro, Gangseo gu, Busan Republic of Korea

Tel +82 70 8799 8871
E-mail krgst@krs.co.kr

www.krs.co.kr