PROJECT
Japan's Ambitious Challenge for Decarbonized New-Fuel Vessels

NET ZERO
SHIPBUILDING IN JAPAN 2025

PUBLISHED BY

Japan Ship Technology Research Association　The Shipbuilders' Association of Japan
The Cooperative Association of Japan Shipbuilders　Japan Ship Exporters' Association
Japan Ship Machinery and Equipment Association

SUPPORTED BY

The Nippon Foundation

COOPERATED BY

Maritime Bureau, Ministry of Land
Infrastructure, Transport and Tourism

PRODUCED BY

Star Marine Public Relations Co., Ltd.
Tosei Printing Co., Ltd.

NET ZERO
SHIPBUILDING IN JAPAN 2025

Supported by
THE NIPPON FOUNDATION

PROJECT

Japan's Ambitious Challenge
for Decarbonized New-Fuel Vessels

INTRODUCTION

Contributions from the international maritime sector have become crucial to achieving the IMO's revised GHG Strategy, which includes an increased common ambition to achieve net-zero GHG emissions from international shipping by or around 2050. The Japanese maritime sector, especially the shipbuilding and ship machinery industry, is seeking to meet the IMO's ambition of a 20-30% reduction by 2030, a 70-80% by 2040 and net zero emission by or around 2050.

The use of new fuels is essential to meet the IMO target. The Japanese industry has already adopted LNG and methanol as alternative fuels. Moreover, the industry's efforts are underway to introduce technologies for practical application, decomposition, and safe use of hydrogen and ammonia - energies that do not emit CO_2 during use - into new shipbuilding.

The Japanese industry is strongly focused on the sustainable development of shipbuilding towards decarbonization and is rapidly advancing world-leading research and implementation of technologies to convert the alternative energies into high quality, safe and cost-effective fuels. The Japanese industry is also advancing comprehensive technologies that make use of a variety of new fuels. Ships using wind propulsion is one of the attractive solutions for achieving decarbonization.

The features in this brochure are expected to serve the audiences as a reference which introduces Japan's maritime industry as it becomes more unified together with the public, private, and academic sectors in order to provide the world with ships that contribute to achieving this ambitious goal.

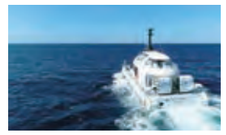
"V" means a Vessel, Japan's challenges will navigate a future victory

Supported by THE NIPPON FOUNDATION

We would like to express our sincere gratitude to the Nippon Foundation for their generous support in the publication of Shipbuilding in Japan 2025.

PROJECT

Japan's Ambitious Challenge for Decarbonized New-Fuel Vessels



NEW VESSEL PROJECTS

NEW BUILDING VESSELS

SHIP MACHINERY EQUIPMENT

HANARIA, A Hydrogen-Powered Vessel

A New Milestone in the Nippon Foundation's Zero Emission Ships Project

A hydrogen fuel cell vessel, HANARIA, developed as part of the Nippon Foundation's Zero Emission Ships project, successfully completed zero-emission operations on March 27th 2024. Mr. Mitsuyuki Unno, the Executive Director of the Foundation, stated, 'Various new fuels are being considered, but ultimately hydrogen will be key. By 2026, we aim to achieve the world's first zero-emission vessel equipped with a solely hydrogen-fueled engine', emphasising the Foundation's commitment to promoting hydrogen-fueled vessels.

HANARIA is a passenger vessel designed for transporting personnel to offshore wind power generation facilities, as well as for inspections and tours. The project, which was completed in March 2024, has resulted in a vessel with a gross tonnage of 238, capable of accommodating up to 100 passengers. The vessel is powered by two hydrogen fuel cells, two lithium-ion batteries, and a diesel generator. The vessel can seamlessly switch between two modes of operation: zero-emission and normal operation mode. In zero-emission mode, it utilises hydrogen fuel cells and lithium-ion batteries, while in normal operation mode, it uses hydrogen fuel cells and biodiesel fuel. This flexibility allows the vessel to reduce CO_2 emissions by 53–100% compared with using only fossil fuels. The vessel has a maximum speed of 10.2 knots, and it can travel at 8 knots for approximately six hours in the zero-emission mode. Additionally, equipped with one thruster at the bow and another at the stern, the vessel can easily manoeuvre even in narrow waters.

The vessel was developed by a consortium led by MOTENA-Sea, a subsidiary of MOL Techno-Trade (Tokyo, Japan), and its hull was constructed by Hongawara Ship Yard Co., Ltd. (Fukuyama-shi, Japan). Ownership of the vessel is held by MOTENA-Sea, Kanmon Kisen (Kitakyushu, Japan) is responsible for its operation, and Taiyo Nippon Sanso (Tokyo, Japan) is responsible for the supply and procurement of hydrogen. The marine hydrogen fuel-cell system installed on the vessel was developed by Yanmar Power Technology (Osaka, Japan), using a fuel-cell unit produced by Toyota's Mirai. Mr.Yoshihiko Hamamura, Chief Project Leader at Toyota Motor Corporation's Hydrogen Factory, emphasized the significance of the technology, stating, 'The application of fuel cell technology, which generates electricity from hydrogen and oxygen, and the technology for safely storing hydrogen at high pressure and supplying it to fuel cells on the HANARIA, marks the first step in implementing hydrogen fuel cells in vessels.'

During the successful demonstration experiment on March 27th, the HANARIA vessel operated entirely in zero-emission mode using hydrogen fuel for a 30 km round trip between the Port of Kokura and offshore wind power generation facility of Shirashima. The entire journey emitted no CO_2 and took approximately 3 hours and 45 min.

Executive Director, Mr. Unno remarked, 'The zero-emission operation was a success, and we confirmed that hydrogen can be effectively used as a vessel's fuel. HANARIA is Japan's first hydrogen fuel-cell vessel with a capacity exceeding 20 gross tons. We hope that this study will serve as a model for future developments.'

HANARIA is used for cruises through the Kanmon Strait and for offshore shrine visits and makes it an ideal choice as sightseeing vessels that offer pleasant sea views.

During the trial voyage at the Port of Kokura, noise and vibrations from the generator were noticeable when leaving and approaching the shore. However, once the vessel switched to hydrogen fuel cells, it became much quieter.

Despite its use as a sightseeing vessel, Mr. Unno emphasised that HANARIA's main purpose is to serve as a crew transfer vessel (CTV) for offshore wind turbines, 'The CTV function is the primary focus.' However, with only 70 offshore wind turbines currently installed in Japan, this technology is not yet commercially viable. Therefore, the vessels will be used for sightseeing and CTV operations until the wind power market expands.

However, hydrogen fuel supply challenges remain. The hydrogen used in HANARIA was loaded into tanks at hydrogen stations in Fukuoka Prefecture, transported by dedicated vehicles, and loaded onto the vessel using cranes at the quay.

Mr. Kazutoshi Takao, the former president of MOTENA-Sea, remarked, 'Securing hydrogen is becoming increasingly difficult as the decarbonization journey accelerates. The longer the transportation distance, the higher the costs. We are considering establishing our own offshore station to procure hydrogen independently.'

Additionally, Executive Director Mr. Unno highlighted, 'When considering domestic coastal vessels, we need to accommodate larger vessels in the 1,000–2,000 gross ton range, but hydrogen fuel cells have their limitations.' He emphasized the importance of quickly advancing the development of hydrogen-fueled engines capable of powering larger vessels.

Aside from HANARIA, the 'Zero Emission Ships project' is focused on developing vessels powered solely by hydrogen-fueled engines. All these projects are scheduled for demonstration experiments by fiscal year 2026. The Tsuneishi Group's project is particularly focused on exploring the establishment of infrastructure for hydrogen supply.

The 'Hydrogen Engine Zero Emission Vessels Consortium', represented by JPN H_2YDRO Co,. Ltd., in collaboration with a Belgian leading shipping company, one of the major contributors, and the shipbuilder Tsuneishi Shipbuilding Co., Ltd., aims to develop a car ferry powered by a medium-speed hydrogen-only engine.

Another project titled 'Development and Demonstration of Marine Hydrogen 4-Stroke Engines and Large Hydrogen-Powered Coastal Tankers', led by Yanmar Power Technology, aims to develop a system that converts heavy oil fuel to hydrogen. This can be achieved by retrofitting existing coastal tankers with small, high-speed, hydrogen-fueled engines.

HANARIA, the first hydrogen-fueled vessel in the Nippon Foundation's Zero Emission Ships project, is open to the public, along with JPN H_2YDRO Co., Ltd.'s Hydro BINGO, which is funded by the Tsuneishi Group. These initiatives confirm HANARIA as a key player in the commercialisation of hydrogen-fueled vessels.

<Vessel Features>
Gross tonnage: 238 tons
Length : 33.0 m
Breadth : 10.0 m
Draft: approx. 1.6 m
Deadweight: 19 tons
Maximum speed : 10.2 knots
Passenger capacity : 103 people
Propulsion method : Electric propulsion
Fuel used : Hydrogen/biodiesel
Area of operation : Flat water areas

【Main Feature of Vessel】
Power Ark 100 - First Ship "X"series
Length Overall (LOA): Approx. 147.0 m
Beam : 19.0 m
Draft : 5.5 m
Gross Tonnage: Approx. 9,200 MT
Range : 300 km
Cruising Speed : 10 knots (Max Speed: 14 knots)
Charging/Discharging Time : 3 hours each
Classification : Nippon Kaiji Kyokai (ClassNK),DNV
Flag : Japan

Power X
Battery Tanker Power Ark 100
The world's first ship to carry electric ity, a challenge for a Japanese startup

On April 23, 2024, Power X, a startup focused on promoting the use of battery energy storage systems and realizing the world's first "Battery Tanker" announced the establishment of Ocean Power Grid as a subsidiary dedicated to developing and marketing Battery Tankers. After finalizing the detailed specifications for the "Power Ark 100" Battery Tanker, the company will proceed with the project in one of the following regions: Kyushu, Hokkaido, or Kanto. In parallel, the construction schedule will be confirmed, and the first vessel will be built. Construction is expected to commence in 2025, with completion and the start of commercial operations planned as soon as possible in alignment with the project timeline.

Masahiro Ito, who serves as President of both Power X and Ocean Power Grid, stated, "The idea of Battery Tanker has existed for some time, but we've now reached the point where we can officially launch this as a new business."

The first of the 100 TEU Power Ark 100 Battery Tankers is currently under development by Ocean Power Grid, Power X is a 9,200 gross ton, 147-meter-long, battery-powered electric propulsion vessel capable of carrying 96 lithium-ion iron phosphate (LFP) batteries in a 20-foot container, for a total battery capacity of 240 megawatt hours. The ship can carry 96 LFP (lithium-ion iron phosphate) batteries in a 20-foot container, with a total battery capacity of 240 megawatt hours. The batteries can be charged and discharged in as little as three hours, and the design takes into account the large amount of heat generated during charging and storage, which is discharged from the vessel.

The "Power Barge" is being developed as a derivative of the "Power Ark 100." The "Power Barge" is a large barge, approximately 81 meters in length and 6,000 tons in deadweight, designed to efficiently carry a large volume of cargo without a propulsion engine.
President Ito explains, "Ocean Power Grid is a company that proposes a completely new method of transporting electric power, using the ocean as a power grid."

"In the offshore power grid, the shipowner's function comes first. The Battery Tankers themselves will be owned, and decisions regarding operation will be made on a project-by-project basis. The business model will differ depending on whether it is used for offshore wind power or for onshore power storage. There may be a case in which Ocean Power Grid or a group company will own the vessel as a special purpose company (SPC) and then ask for consignment," said President Ito.

Battery Tankers were planned as ships that would literally carry electric power as cargo by loading large quantities of large storage batteries. For example, in areas where there is a surplus of electricity generated by nuclear power plants, solar power, wind power, etc., the container-type storage batteries could be charged and loaded onto the ship, which would then transport the electricity to areas where there is a shortage. It is also envisioned that the system could be used to transport electricity from offshore wind farms that are built in areas where it is difficult to lay submarine cables from land.

Power X has already begun test operation of a production line for water-cooled battery modules to be used mainly for ships at its own storage battery factory, Power Base, located in Tamano City. In addition to the electric carriers, orders have been received for land power facilities at ports in Japan and for EV (electric propulsion) ships, and the company plans to obtain type approval from classification societies in the first half of next year before concentrating on production.

The water-cooled battery modules will be manufactured by Power X at its own plant and shipped by land to Mitsui E&S Tamano Works (Tamano City), a nearby partner. Mitsui Engineering & Shipbuilding & Special Machinery Engineering, a member of the Mitsui E&S Group, will then containerize and assemble the batteries, which will be shipped as "Power X Mega Power for Marine."

On the other hand, "Safety standards for ships are quite high, and we cannot just put ordinary storage batteries on board as is," said President Ito. Power X has developed a new water-cooled battery module as a safe storage battery that complies with international ship classification certifications and applicable standards, in order to load storage batteries on electric carriers. After obtaining certification from classification societies such as Class NK (Nippon Kaiji Kyokai) and DNV (Norwegian Register of Shipping) in 2025, we will proceed with intensive mass production.

President Ito said, "Now that we finally have a battery that can be put on a ship, we are finally at the point where we can build a ship and start doing business.

Ocean Power Grid has concluded a memorandum of understanding (MOU) with Tokyo Electric Power Grid, a member of the Tokyo Electric Power Group, and the City of Yokohama for the future vision of the power network required to make the Port of Yokohama a carbon neutral port (CNP) and to establish a new green power supply base. It is envisioned that the electric carriers will be connected to the onshore grid in the Port of Yokohama for charging and discharging, and will function as a storage station for grid supply and demand adjustment.

Cruise ships use anywhere from 6 megawatts to 10 megawatts of electricity. To put it in the extreme, it's like Tokyo Midtown all of a sudden. But they use that much electricity and are gone for a day or two. If we could have storage batteries to supply power at such times and hybrid power, we would be able to reduce the load on the electric grid," said President Ito.
In addition to this, as the location of offshore wind turbines is expected to expand from the current territorial waters to the exclusive economic zone (EEZ), the plan is to utilize them to transport electric power from offshore wind turbine facilities, which will be built in areas where it is difficult to lay submarine cables, to land, and six electric carriers will be deployed in the Tokyo metropolitan area to transport the power from offshore wind turbines with a 1 gigaton facility capacity to Yokohama daily. In the Tokyo metropolitan area, six electric carriers will be deployed to transport electricity from offshore wind power generation facilities with a capacity of 1 gigawatt to Yokohama every day.

The wind is strongest on the Miura Peninsula, about 100 kilometers from Yokohama City, where the wind is good. If we can get the windmills to float, we can bring electricity to the TEPCO service area in the shortest distance.

In this regard, Battery Tankers can fulfill the dual role of not only transporting electricity to supply cruise ships with power derived from renewable energy sources, but also serving as storage depots to balance supply and demand when large vessels with large numbers of passengers' dock.

Regarding the "Power Barge," company director Naoki Sato said, "Battery Tankers can navigate far and in rough seas. On the other hand, we decided that a barge would be sufficient for transport over short distances with calm waves that do not require expensive vessels."

And he added that "We would like to use Battery Tankers and Barges to transmit electricity from Kyushu, which has an abundance of renewable energy, to the Chugoku and Shikoku regions. In particular, there are many remote islands in Kyushu, and we think it is possible to use the model of an electric carrier to deliver surplus electricity in Kyushu to these remote islands where renewable energy has not progressed very well."

Mitsubishi Shipbuilding Delivers a Next-Generation LNG-Fueled Vessel to the Shipping Company

NET ZERO SHIPBUILDING IN JAPAN 2025

A Roadmap to Decarbonization: Starting with the State-of-the-Art LNG-Fueled RoRo Cargo vessel, TRANS HARMONY GREEN

Mitsubishi's " Project V" Professionalists to lead a building for Trans Harmony Series
(From Right) Mr. KazuhiroMiyawaki, Project manager (Middle) Mr. Nobuhiro Kushida, Construction manager (Left) Mr. Atsushi Nakada, Business administrator

Mitsubishi Shipbuilding is currently progressing with the design and construction of environmentally friendly ships, using energy transition as a key guiding principle. "Toyofuji, a group company of Toyota Motor Corporation, has recently ordered two LNG (liquefied natural gas)-fueled RoRo Cargo vessels to Mitsubishi Shipbuilding.
The first vessel, TRANS HARMONY GREEN has delivered on 31 January 2025. According to Toyofuji, "The shipbuilding concept of 'Harmony with the global environment and people, while prioritising the safety' has been maintained and further refined in the construction of this ship."
The second vessel, TRANS HARMONY EMERALD, was launched in November 2024 and is scheduled to enter the Japan-Southeast Asia service route in June 2025. Additionally, the company announced a plan to develop two of Japan's first methanol-fueled RoRo Cargo vessels with Mitsubishi shipbuilding for Japan's coastal services.

Cooperation with the Shipping companies, Mitsubishi shipbuilding continues to challenge toward to the Decarbonization

Mr. Kazuhiro Miyawaki, a project manager of Mitsubishi Shipbuilding shared the project background that "The project began during the COVID-19 pandemic when we received an offer from Toyofuji Shipping, asking whether we could build an LNG-fueled vessel that could safely accommodate 3,000 units of Toyota's Crown model while being environmentally friendly. This was the third DF-fired propulsion vessel built at our Shimonoseki yard. We take pride in the fact that our experience in building a domestic ferry that achieved decarbonization additionally, the experiences for a construction of RORO cargo vessels for Toyofuji Shipping and we have deals with fuel gas supply systems (FGSS) were highly regarded. However, even with this background, we held more than 40 in-depth discussions internally, and it took two years from the start of the project to bring it to fruition. Many departments were involved, not only design and outfitting but also sales, quality assurance, and others. We also incorporated innovative ideas from younger employees across the company to ensure the project's steady progress." as one of the project members, reflecting on both the challenges and rewards of the endeavor.

TRANS HARMONY GREEN, the first liquefied natural gas (LNG)-fueled RoRo Cargo vessel developed by Mitsubishi Shipbuilding was launched on 7 June 2024. After its delivery in January 2025, its services will commence in February 2025, transporting Toyota and other finished vehicles from Yokohama and Nagoya to ports across Southeast Asia, including Laem Chabang (Thailand), Port Klang (Malaysia), Singapore, Patimban (Indonesia), and Batangas (Philippines).

TRANS HARMONY GREEN is positioned as Toyofuji's flagship vessel for environmental initiatives in Asia. Measuring 195 meters in overall length, 30.6 meters in width, and 49,500 tons in gross tonnage, the vessel has been built as 'one of the largest ships that could be built at the Mitsubishi's Shimonoseki Shipyard.' At a sailing speed of 19.5 knots, the vessel can carry approximately 3,000 vehicles (Toyota Crown equivalents) or 4,000 RTs (standard vehicles). "When considering the building of this vessel, there was an internal discussion regarding the type of fuel for the new ship. Post the discussions, aligned with the 'Toyofuji Environmental Challenge 2050,' we decided to take on a new challenge and chose LNG as the fuel." Mr. Makino from Toyofuji explained the reason of the LNG Fueled vessel.

Mr. Nobuhiro Kushida, a construction manager, also commented that "On conventional heavy fuel oil-powered ships, the smell and oily dirt in the engine room were quite noticeable. However, with LNG-fueled ships, there is almost no odor, and the oily dirt and necessity of cleanliness and maintenance is significantly reduced. This has greatly improved the working environment for crew members on board. As the adoption of new fuel-powered vessels increases, we believe it will also contribute to attracting the next generation of maritime professionals."
As explained by Mr. Makino, Toyofuji shipping, "This is the largest RoRo Cargo vessel that is regularly serving on the Japan-Southeast Asia route. The cargo consists of domestically produced vehicles, including Toyota vehicles, shipped from Japan to various Southeast Asian countries. Additionally, there are assembly plants for finished vehicles in Thailand and Indonesia, which are exported to other Asian regions and back to Japan. Considering the sequential loading of such cargo during the entire sailing schedule, we concluded that a capacity of 3,000 vehicles or 4,000 RT is the ideal size."

Furthermore, TRANS HARMONY GREEN is equipped with a dual-fuel (DF) engine capable of operating in LNG and light oils. Compared with heavy-oil-fueled vessels of the same size, TRANS HARMONY GREEN will reduce CO_2 emissions by 35%, including the effects of hull form improvements. Additionally, SOx emissions are expected to decrease by 99%. Normally, ships are equipped with filters to reduce the emission of soot particles, but with the DF system, soot emissions can be almost all avoided. This not only enhances GHG reduction but also allows for more flexible fuel switching, contributing to more economically efficient operations. Looking ahead, Mitsubishi Shipbuilding is also working on the development for next generation fuels.

"The vessels 'TRANS HARMONY GREEN' and 'TRANS HARMONY EMERALD' are deployed on the "Asia Weekly Service", which connects major Asian ports on specific days and regular intervals. Essentially, RoRo Cargo Vessels are arriving on liner routes like container vessels and thus tend to call at ports where LNG bunkering is reliable. Consequently, the ports in Singapore and Malaysia were considered for our company's main bunkering locations for the time being." added Mr.Makino of Toyofuji who is a responsible for this project.

The vessel will load the Toyota completed cars and finally set sail! Crew enthusiasm is becoming high with the new fuel-powered Vessel.

Toyofuji and Mitsubishi Shipbuilding's Challenge in Developing Methanol-Fueled Car Carrier Vessels

TRANS HARMONY GREEN
【Main Particulars】
Length : 195m
Width : 30.6 m
Gross tonnage : approx. 49,500 tons
Cargo Capacity : 3,000 units of Toyota Crown

Toyofuji Pathway Towards Future Environmental Responsibility

Toyofuji Shipping, committed to achieving net-zero CO_2 emissions by 2050, introduced two liquid natural gas (LNG)-fueled and two methanol-fueled car carrier vessels for ocean-going and Japan coastal services respectively. In June 2024, Toyofuji signed a contract with Mitsubishi Shipbuilding to construct two car-carrier vessels that primarily use methanol as fuel. Delivery of the vessels is scheduled for 2027. These two vessels will be the first methanol-powered car-carriers in Japan. One of the two is solely owned by Toyofuji, and the second will be jointly owned by Toyofuji and Fukuju Shipping.

Maintaining a car-carrier capacity and ensuring methanol as the environmental output

Mr. Kazuaki Makino, General Manager of Corporate Planning Division at Toyofuji, explained,
"When considering the adoption of a new fuel source, we determined that methanol fuel was not only the optimal choice but also the only viable solution for our coastal car-carrier vessels. This is because methanol-fueled vessels can maintain cargo space onboard, similar to current heavy oil-fueled vessels. Toyofuji's domestic fleets are almost the maximum size that can enter and berth at our calling ports in Japan, except for international-scale ports such as Nagoya and Yokohama."

The specifications of the new methanol-fueled RORO vessel include a length of approximately 169.9 meters, width of 30.2 meters, gross tonnage of 15,750, and cargo capacity of approximately 2,300 Toyota crown-equivalent units. The vessel is designed with a windscreen and vertical stem at the bow to reduce propulsion resistance. Additionally, its energy-saving system, high-efficiency propeller, and drag-reducing high-performance rudder further enhance fuel efficiency.

The main engine features a high-performance dual-fuel system that uses methanol and marine gas oil. Methanol reduces environmental impact by reducing CO_2 emissions by more than 10% compared to heavy oil in similar vessels. In the future, green methanol fuel could be available to use, further contributing to CO_2 emissions reduction.
"Currently, Toyofuji's coastal service reaches 19 ports across Japan. Among our coastal car carrier fleets, the standardized capacity of the vessel is 2,000 Toyota crown-equivalent units (2,600 RT in standard vehicle equivalents). However, apart from major ports such as Yokohama and Nagoya, the vessel's size makes operations particularly challenging when entering and berthing at smaller regional ports. For liquid natural gas (LNG)-fueled vessels, the large LNG tank onboard occupies extra space and reduces cargo capacity. Conversely, maintaining the number of vehicles carried would require an increase in vessel size, and given the recent increase in maritime transport demand, reducing the number of vehicles carried has become impractical," Mr. Makino elaborated.

Towards the "Toyofuji Environmental Challenge 2050" Vision

'Toyofuji Environmental Challenge 2050,' is the company's long-term environmental vision that highlights its commitment to addressing global environmental issues and includes the adoption of next-generation fuel technologies. This effort includes the construction of new ships that use methanol as their primary fuel with the aim of reducing CO_2 emissions compared to traditional fuel oil-powered ships.

Since April 2023, the company has officially used biofuels for TOYOFUJI MARU (12,687 gross tons, capacity of 2,000 vehicles) in coastal vessels. For ocean-going vessels, Toyofuji has been using biofuel as a trial since October 2023 on the Japan–Oceania route with DREAM JASMINE (41,662 gross tons). The biofuel used for DREAM JASMINE is produced from used cooking oil blended with 76% low-sulfur heavy oil and 24% biofuel oil. This biofuel is expected to reduce CO_2 emissions by approximately 20% compared to conventional fossil fuels.

For ocean-going vessels, the LNG-fueled RORO vessel, TRANS HARMONY GREEN, will commence service on the Japan-Southeast Asia route in February 2025. This vessel can carry approximately 3,000 Toyota crown-equivalent units or approximately 4,000 RT in standard vehicle terms. For car carriers of this size, LNG is a viable option, fulfilling the size requirements of overseas vessels.

Methanol is an ultimate fuel with a well-established technology for coastal vessels

On the other hand, for coastal vessels, Mr. Makino indicated that in response to the increasing demand for marine transportation, while also adhering to port entry and docking restrictions, and without reducing the operational efficiency during bunkering, a comprehensive investigation on a fuel that could meet environmental standards was conducted. And a decision was made to use methanol fuel, which is well-established and usable at room temperature.

With the experience of LNG-fueled vessels, Toyofuji came up with a new bunkering idea of Methanol fueled vessels. "Our idea was to explore whether the existing 120 chemical vessels in Japan could be utilized as bunkering vessels. After discussions with Kokuka Sangyo Co., Ltd., an operator of the Mitsubishi Gas Chemical Group, we ultimately decided to promote a new methanol-fueled vessel project by effectively leveraging on the existing chemical vessels." Methanol will be supplied in cooperation with the Mitsubishi Gas Chemical Company, which holds the largest share of the methanol market in Japan, and a fuel transport vessel operator, Kokuka Sangyo. Mitsubishi Gas Chemical provides the methanol fuel, whereas Kokuka Sangyo utilizes its existing methanol transport vessels to conduct ship-to-ship bunkering.

This initiative will contribute to achieving carbon neutrality by 2050. Toyofuji provides ocean transportation services in both domestic and international markets. For international purposes, the company is proactively exploring various scenarios for compliance with global regulations. Although domestic standards have not yet been fully established, this does not imply indefinite use of heavy-oil-fueled vessels. Mr. Makino indicated that Toyofuji will proceed through trial and error to achieve the goals set forth in the 'Toyofuji Environmental Challenge 2050.'

Mr. Kazuaki Makino, General Manager of the Corporate Planning Division at Toyofuji.
Toyofuji plans to introduce new domestic vessels with dual-fuel Methanol engine.
The vessel has been ordered to Mitsubishi Shipbuilding and is scheduled for completion in FY2027 as Japan's first domestic car carrier that uses methanol as its primary fuel.

• Eiji Takeichi, President of Toyofuji Shipping Co.,Ltd.
• Shin Ueda, President of Mitsubishi Shipbuilding Co., Ltd.

Cooperative New Shipbuilding Projects Between Shipbuilding Sector × Trading Company

Installation of Wind Propulsion Assists System on Imabari Shipbuilding's Panamax Bulk Carriers

NET ZERO SHIPBUILDING IN JAPAN 2025

To achieve zero emission in international shipping by 2050, as set by the IMO, the maritime industry is adopting LNG and methanol as transitional fuels while advancing the practical application of carbon-free energy sources such as hydrogen and ammonia. However, compared to heavy oil, these new fuels require larger fuel tank spaces and come at higher costs. With even a 1% improvement in operational cost efficiency being significant, the introduction of wind-assisted propulsion systems using sails has gained attention as a potential solution.

Japanese shipbuilding companies are increasingly exploring the adoption of Wind Assisted Propulsion Systems (WAPS) as part of their efforts to achieve decarbonization. Imabari Shipbuilding, in partnership with a trading company, has recently decided to install a WAPS developed by a company on one of Panamax Bulk Carriers. Additionally, several other manufacturers are engaging in discussions with Japanese shipbuilders, positioning WAPS as a significant option for decarbonization alongside the shift to alternative fuels. In this background, also shipowners, charterers and operators are very eager to introduce new technologies collaborating as trial and also if its new technology will be widely beneficial, they intend to promote them across the Japanese maritime industry.

Marubeni Corporation, a major trading company has partnered with engineering firm "bound4blue (b4b)" to market the wind-assisted propulsion system（WAPS）. The system is being installed on company's various vessels, including RoRo ships and MR tankers, and is scheduled to be installed on the 84,000 DWT Panamax bulk carrier "Crimson Kingdom" owned by MMSL, Marubeni Corporation in Singapore.

Mr. Tadayuki Miyata, General Manager of Ship Project Sec II., Ship Project Dept of the Trading company commented, "As IMO regulations tighten, new fuel initiatives will attract attention, but I believe there is also value in installing Energy Saving Devices on existing ships before their age limits. By conducting pilot tests on wind-assisted propulsion systems, we aim to evaluate their effectiveness and explore what initiatives we can undertake as a trading company's ship department, and how we can enhance the value of our fleet."

In general, depending on the manufacturer, the combination of WAPS and autonomous navigation has, in some cases, resulted in a 40–50% reduction in greenhouse gas (GHG) emissions compared to fuel-powered ships. This conclusion is based on one year of demonstration operations conducted on car carriers. Based on the significant decarbonization results achieved through the installation of WAPS, Mr. Miyata explained the reason for selecting Imabari Shipbuilding's bulk carrier as the installation target. He commented, "The decision to install WAPS on a vessel operated in the Panamax pool, jointly managed by our shipping company (MMSL) and an overseas shipping company, was influenced by the operational convenience and the ease of verifying fuel efficiency improvements within the pool. As a result, we chose a bulk carrier owned by the pool and built by Imabari Shipbuilding."

Interviewed with Mr. Tadayuki Miyata, General Manager of Ship Project Sec II, Ship Project Dept

This trading company owns 40-50 vessels, primarily bulk carriers, with capacities ranging from Handy to Panamax Bulk Carriers, enabling them to meet shipping demands. "In my view, there are two ways to reduce GHG emissions. One is by introducing decarbonized fuels to promote fuel conversion, and the other is by installing Energy Saving Devices. Our company has a sizable in-house fleet as a trading house, so we are focusing on enhancing the value of our own fleet by evaluating devices that support this goal," said Miyata.

In the second phase, wind-assisted propulsion systems, air lubrication systems, and fuel cells, categorized as new technologies with added CAPEX, may be introduced as options that can further enhance existing energy-saving effects. Miyata stated, "I believe that, once infrastructure for new fuels like ammonia and methanol is established and commercial feasibility, including pricing, becomes clear, we will be ready to take action."
"New fuels are easier to implement on large size ships i.e. Capesize Bulk Carrier and container ships that have fixed routes. With this in mind, we decided to focus on wind-assisted propulsion systems as part of the next category of Energy Saving Devices we are testing, with the aim of promoting their adoption within the maritime industries," said Miyata.

The "Crimson Kingdom," owned by MMSL and selected by Marubeni for the installation, was completed on March 30, 2016, at the Marugame Business Headquarters of Imabari Shipbuilding. Through the joint project of MMSL and b4b, they will verify the actual reduction effects and support the vessel's compliance with EEXI (Energy Efficiency Existing Ship Index) and CII (Carbon Intensity Indicator). After installation, the vessel will be operated by "MaruKlav," a joint venture between Marubeni and Norwegian shipping company Torvald Klaveness, which manages a pool of Panamax bulk carriers.

Project image for the panamax bulker installed wind-assisted propulsion systems

As another activity, this trading company has introduced an innovative pay-for-performance model for antifouling ship bottom paint, aiming to accelerate reduction of GHG emissions in the maritime industry.

The scheme allows shipowners and or charterers to upgrade to high-performance low-friction paint without additional upfront costs. The company takes risk of ineffectiveness of upgrade and covers the initial price difference. Shipowners pay a portion of the fuel savings achieved during operation. This approach addresses the barrier of initial costs at drydocking and concerns about effectiveness.
By shouldering the risk and providing financial support, the company facilitates the adoption of eco-friendly technologies in the maritime sector. This provides shipowners and or charterers merit without additional fee such as a portion of fuel cost, improvement in vessel rating and reduction in payment for EUAs, ultimately supporting sustainable maritime development. It has been reported that the use of antifouling ship bottom paint can improve a vessel's fuel efficiency by 5–8%, thereby contributing to the reduction of GHG emissions.

As conclusion, Mr. Miyata said, "Japanese shipyards make a lot of efforts to improve the fuel efficiency of the design and keep leading the maritime industry. Therefore, fleet replacement by newbuilding order contributes to decarbonization in the shipping market. In the meantime, the industry shall focus on the improvement on fuel efficiency of the existing fleet. We are open to introduce new technologies as trial and if effective, we will continue to use them within the company, and if widely beneficial, aim to promote their adoption across the maritime industry."

CERULEAN ACE
Mitsui O.S.K. Lines' LNG-Fueled Car Carrier

NET ZERO SHIPBUILDING IN JAPAN 2025

<Main Specifications>
Ship Type : 7,050 RT Class LNGDF Car Carrier (High-Pressure Main Engine)
Shipyard : Shin Kurushima Dockyard, Onishi Shipyard
Length Overall : 199.95 m
Breadth (Molded) : 38.00 m
Maximum Vehicle Capacity : 7,050 units

The next-generation fuel wave has arrived in Japan, marking the birth of a new flagship for the car carrier fleet.

Mitsui O.S.K. Lines (MOL) completed the first LNG-fueled car carrier, the CERULEAN ACE, on March 13, 2024, at Shin Kurushima Dockyard's Onishi Shipyard. Expected to become the new flagship of MOL's car carrier fleet, the CERULEAN ACE is one of the company's largest ships, with a capacity of 7,050 vehicles. Along with its environmentally friendly LNG-fueled engine, the vessel incorporates various innovative features that exemplify next-generation shipping technology. The hull's color design has also been updated. A company representative commented, "Automobile manufacturers are highly environmentally conscious, and LNG-fueled car carriers will appeal to them. This ship symbolizes our commitment to reducing GHG emissions, even if only by a small margin."

The CERULEAN ACE is being used to transport finished vehicles, between Japan and Europe. With a length of 199.95 meters and a gross tonnage of 77,695 tons, the ship's width has been increased from the previous 32 meters to 38 meters, allowing it to carry approximately 7,050 vehicles, up from around 6,400. The ship has a 12-layer structure, with the placement of the ramps and the flow of traffic optimized to enhance the speed and efficiency of cargo handling, while ensuring a high level of safety.

The cargo hold is equipped with AI cameras that can detect vehicle fires early and prevent them from spreading. The AI analyzes footage in real time, and when it detects smoke, it immediately triggers an alert to inform the crew of any abnormalities. Additionally, to enhance crew welfare, the satellite communication service "Starlink," which provides high-speed, low-latency connections, has been introduced. This improvement in the communication environment now makes it possible to conduct video calls with family members and watch videos, which was previously difficult, greatly improving the crew's well-being.

As part of its environmental measures, the installation of dual-fuel (DF) main engines using LNG plays a key role. LNG is being increasingly adopted in international shipping because it can reduce CO_2 emissions by about 25-30%, SOx by about 98%, and NOx by about 85%, compared to conventional fuel oil.

The ship also features an aerodynamic design with a sloping structure at the top of the bow, which reduces wind resistance by 20%. Furthermore, the latest propeller model has been combined with the Propeller Boss Cap Fin (PBCF) energy-saving device, which eliminates the hub vortex that occurs behind the propeller, improving propulsion efficiency.

In its "Environmental Vision 2.2," announced in April 2023, Mitsui O.S.K. Lines set a goal of achieving net-zero emissions by 2050. As part of its efforts to meet this target, the company plans to introduce 90 ships that use LNG or methanol as fuel by 2030, as part of its "GHG emission reduction initiatives that are feasible at the present time." As of September 2024, 38-LNG-fueled ocean-going vessels are planned, including those under construction.

Of the new LNG-fueled car carriers, 14 have been confirmed for service, with 11 of these ships to be built in Japan as part of the BLUE series. The naming of these ships reflects the MOL Group's corporate philosophy: "From the blue oceans, we sustain people's lives and ensure a prosperous future," and the desire to "connect the diverse beauty of the blue sea, sky, and forests to future generations."

The new hull design features a modern interpretation of the letter "A," symbolizing MOL ACE (MOL Auto Carrier Express), the global unified brand for MOL's car transport service, reflecting the brand's evolution. Additionally, the bow is colored turquoise blue, representing the fusion of the strong environmental imagery of green with MOL's brand color of blue, signifying the MOL Group's ongoing commitment to addressing environmental challenges. The blue color extending from the stern to the bow is the same as that was used in the previous FLEXIE series, signifying the continuation of tradition.

Currently, the MOL Group's fleet of car carriers consists of approximately 100 ships. The service, which began in 1965 with the 1,200-car capacity OPPAMA MARU, has evolved to transport all types of self-propelled cargo, from passenger vehicles to construction machinery, and the CERULEAN ACE can now transport up to 7,050 cars at a time.

The CERULEAN ACE, the new flagship vessel, and its sister ships have also been featured in events for children. On July 15, 2024, the second ship, TURQUOISE ACE, was unveiled at the Tokyo International Cruise Terminal. Designed by Nihon Shipyard (NSY) and built by Tadotsu Shipyard of the Imabari Shipbuilding Group, TURQUOISE ACE had just been delivered on July 12, 2024.

Daiichi Meta Maru

Kanasashi Heavy Industry's First Methanol Fueled Japanese Coastal Tanker

【Main Feature of Vessel】
Gross tonnage = 574 tons
Total length = approx. 65.00 m
Overall width = 10.00m
Draft = approx. 4.38 m
Sailing speed = 11.15 knots or more
Main engine = 1 "LA28M" methanol-fueled engine for marine use by Hanshin Internal. Combustion Engine Co.Ld

A new domestic methanol-fueled tanker is expected to become the next mainstream fuel after LNG.

In December 2024, Kanasashi Heavy Industries Co.,Ltd. (HQ =Shizuoka City) of the Murakami Hide Shipbuilding Group delivered a Japan's first domestically built methanol-fueled tanker, the 574-gross-ton Daiichi Meta Maru. At the vessel's launching ceremony in July 2024, MOL Coastal Shipping, Ltd. President, Mr. Hiroshi Kobayashi remarked, "Methanol shows great promise as a new fuel that is both efficient and environmentally friendly, comparable to conventional fuel oil. We aim to lead the way in expanding the fleet of methanol-fueled vessels."

NET ZERO SHIPBUILDING IN JAPAN 2025

Daiichi Meta Maru is Japan's first domestic coastal vessel to use environmentally-friendly methanol fuel, and is a state-of-the-art vessel equipped with the most advanced energy-saving devices and operational support and automated cargo handling systems. The vessel was delivered by Kanasashi Heavy Industries Co., Ltd. in December 2024. The vessel is equipped with a LA28MRG-type main engine, the world's first methanol-fueled, low-speed, four-stroke marine engine developed by Hanshin Diesel Works. It measures Approx. 65 meters in length, 10 meters in width, has a draft of approx.4.38 meters, and a cruising speed of approx. 11.15 knots, with a cargo capacity of 1,230 cubic meters.

In addition, to improve the working environment for the crew, an operation support system has been adopted that allows shore-based monitoring of the engine condition using sensor information. The vessel is also equipped with an automatic cargo handling system that enables centralized monitoring and operation of cargo-related equipment, including liquid level gauges, cargo handling pipe valves, cargo pumps, ballast pumps, and loading calculators.

Mr. Norio Tabuchi, President of Tabuchi Kaiun, said, "We have been handling chemical cargo for decades. Methanol is easier to handle than ammonia because it is less toxic."
With the goal of achieving carbon neutrality in the coastal shipping sector by 2050, studies are underway to introduce next-generation fuels such as liquefied natural gas (LNG) and hydrogen. Compared to heavy oil, methanol can reduce carbon dioxide (CO_2) emissions—classified as greenhouse gases (GHGs)—by up to 15% during combustion. It can also decrease emissions of sulfur oxides (SOx) by up to 99%, particulate matter (PM) by up to 95%, and nitrogen oxides (NOx), which contribute to acid rain, by up to 80%.
On the other hand, MOL Coastal Shipping, Ltd, President, Mr. Kobayashi mentioned, "I believe this ship represents a very advanced concept, as it not only carries methanol as cargo but also uses methanol as fuel."

Methanol fuel, which can help reduce the environmental impact of marine transportation, is being introduced primarily by AP Moller Maersk, a major Danish shipping company, and is available at approximately 130 major ports worldwide. Additionally, the use of methanol derived from non-fossil sources—such as e-methanol, produced by synthesizing CO_2 recovered from various emissions sources like factories and hydrogen generated from renewable energy sources like wind and solar power, and biomethanol derived from biogas—will further contribute to GHG emissions reduction.

MOL currently operates one of the world's largest fleets of 19 methanol carriers, five of which are methanol-fueled vessels. MOL also has a newly built methanol carrier on order that will be dual-fueled with methanol and heavy oil. The vessel is scheduled for delivery in 2025 from Hyundai Mipo Dockyard in Korea.

However, there are concerns about the bunkering of methanol fuel. MOL Coastal Shipping, Ltd. President, Mr. Kobayashi acknowledges, "Supply locations are limited at this time." He adds, "Regarding this particular vessel, there is no fuel supply issue as we are working with a customer who transports methanol. Methanol tankers can also serve as fuel suppliers. There is potential to use any surplus vessels as bunkering vessels. By increasing the number of supply points and methanol tankers, the use of methanol tankers will gradually expand."

Mr. Norio Tabuchi, President of Tabuchi Kaiun, also commented, "The bunkering infrastructure is still in its early stages. If the number of bunkering sites doesn't increase, it will be challenging to ensure supply. The price issue will also impact usage rates—if prices remain high, adoption will be difficult." He added, "I have high expectations for domestic vessels that use methanol fuel."

The use of methanol fuel reduces emissions of carbon dioxide (CO_2), which causes global warming, and nitrogen oxides (NOx), which cause acid rain, in addition to sulfur oxides (SOx), compared to the heavy fuel oil used by conventional merchant ships.

The MOL Group will continue working to reduce the environmental impact of marine transport in cooperation with joint shipowners. Compared to heavy oil, which is currently the primary marine fuel oil, the use of methanol fuel can reduce SOx emissions by up to 99%, particulate matter (PM) emissions by up to 95%, NOx emissions by up to 80%, and CO_2 emissions by up to 15%. Methanol fuel is already in practical use and can be supplied and bunkered at about 130 major ports worldwide. The use of methanol derived from non-fossil energy sources, such as e-methanol produced by synthesizing CO_2 recovered from various emission sources and hydrogen produced using renewable energy, as well as biogas-derived bio-methanol, can lead to further reductions in net GHG emissions. Methanol is used as an environmentally friendly fuel in oceangoing vessels, including five MOL Group-operated ships, and its use is expected to significantly expand in the next few years. However, this marks the first time it has been used for a coastal vessel.

You can see the VIDEO by Youtube

On December 13, 2024, the naming and delivery ceremony was held for the vessel "Daiichi Metamaru," a methanol-fueled chemical tanker and oil tanker (flash point below 60°C) with a gross tonnage of 574 G/T, ordered by MOL Coastal Shipping, Ltd., Tabuchi Kaiun Co., Ltd., and Niihama Kaiun Co., Ltd. (Hull No. S700).

24,000 TEU Container Carrier ONE INFINITY

NET ZERO SHIPBUILDING IN JAPAN 2025

Imabari Shipbuilding, Japan's largest shipbuilder, collaborated to build with JMU. This magenta-colored mega container ship was selected as Ship of the Year 2024.

The 24,000 TEU containerships operated by Singapore-based container shipping company Ocean Network Express (ONE) were developed and built by combining the technological expertise of two major Japanese shipbuilding companies, Imabari Shipbuilding and Japan Marine United (JMU). In May 2024, the Japan Society of Marine Engineers selected "ONE INNOVATION," the first ship built by JMU's Kure Shipyard, and "ONE INFINITY," the second ship built by Imazaki-Marugame Shipyard, as "Ship of the Year Ship of the Year 2023.

【Main Feature of Vessel】
Main dimensions = Length: 399.95 m / Width: 61.40 m / Depth: 33.20 m / Draft: 16.50 m
Gross tonnage = 235,311 gross tons
Main engine = 1 MITSUI-MAN-B&W 9G95ME-C10.6 diesel engine
Capacity = 34
Class = DNV or ABS
Ship's registry = Liberia

One of the reasons why the world's largest class of containership, the 24,000 TEU class, was built in Japan is that Japan was far ahead of China and South Korea in orders for ultra-large containerships. As marine transportation continued to grow, containerships on key Asia-Europe routes increased in size to achieve economies of scale. To ensure uniformity of service, shipping companies have been deploying the same type of vessels on regular service routes simultaneously when building new vessels.

Major Chinese and Korean shipbuilders, with large shipyards capable of constructing multiple vessels in succession with short delivery times and at lower costs, have frequently been selected for these projects.

Against this backdrop, ONE, which merged the container businesses of Japan's major shipping companies NYK, MOL, and Kawasaki Kisen Kaisha, plans to build a mega container ship for the first time. Imabari Shipbuilding and JMU, which have been rivals, will work together to win orders for the 24,000 TEU model, and the Japan Overseas Investment Corporation for Transport and Urban Development (JOIN), a government-affiliated overseas infrastructure fund, has decided to invest 4.2 billion yen to provide financial support for the new shipbuilding. JOIN has also decided to invest 4.2 billion yen to finance the construction of the new ship.

ONE signed a long-term charter contract for an ultra-large container ship with the ship owner, Shoei Kisen Kaisha, on December 24, 2020. In a truly all-Japan effort, Imabari Shipbuilding and JMU won the contract for six vessels. In January 2021, Imabari Shipbuilding and JMU will establish a joint venture company, Nihon Shipyard (NSY), to handle the sales and design of commercial vessels. NSY, a joint venture between Imabari Shipbuilding and JMU, was launched in January 2021 to develop a hull form to realize the world's largest and highest standard container ship.

The construction of ONE's 24,000 TEU model required two different shipbuilders to work simultaneously on the construction. The vessel was designed based on a JMU container ship, but the largest previous vessel JMU had worked on was a 14,000 TEU model. The Kure Shipyard's No. 3 dock is 508 m long and 80 m wide, which is large enough to build the vessel, but the assembly was subject to various restrictions, such as space for block placement and outfitting piers, because the plant site was cramped and other ships under construction and repair overlapped.

On the other hand, Imabari Shipbuilding's Marugame Division has a 610-meter-long, 80-meter-wide No. 3 dock completed in 2017, and the Saijo Works has a new 420-meter-long, 89-meter-wide dock completed in 2000, which has built 20,000 TEU-type container ships in the past. This track record and new construction facilities made it possible for the company to build a lot of 24,000 TEU mega containerships. However, the two companies had to overcome a number of differences, including the use of JMU's proprietary "structural arrest technology" for the hull structure, and other differences in drawing designations and symbols, and were able to build an unprecedentedly large 24,000 TEU container ship.

Now, Imabari Shipbuilding has built four ships, the Ship of the Year award-winning ONE INFINITY, ONE INTEGRITY, ONE INGENUITY, and ONE INTELLIGENCE. Specific loading capacity is 24,136 20-foot container equivalents. Space for containers to be loaded on deck is 24 rows. In the hold (onboard), containers can be stacked 12 high, while on-deck (on deck) containers can be stacked up to 13 high. The hull size to support this is 399.95 m long and 61.40 m wide, with an air draft of 73.5 m.

The structure with a large "ONE" on the bow is called a "wind shield," which reduces wind resistance from the bow side to the containers on deck when sailing, thereby reducing fuel consumption. Bow Wind Cover" developed by NSY. It is said to reduce wind resistance by an average of 10% or more and fuel consumption by about 2%. In addition, for the first time in the world, a container loading space has been provided on the mooring deck inside the windshield, improving performance in terms of both fuel efficiency and loadability. If you look at the lashing bridge, you can see the power plugs for the reefer containers used to transport frozen and refrigerated cargo. More than 2,000 locations are available on this vessel, allowing for more flexible service in line with customer needs. Of course, the vessel is also compatible with CA containers, which can be filled with nitrogen inside the containers for ocean transport while maintaining the freshness of the produce.

The bridge instrumentation is also packed with the latest technology. In conventional vessels, various navigational and operational instruments such as radar, ECDIS (Electronic Charting and Data Acquisition System), and the main engine remote control system are located separately. The 24,000 TEU models, including the ONE INFINITY, use a seating-type Integrated Navigation System (INS) to enable efficient operation even with a small number of passengers. The INS allows the operator to check navigational information and operate equipment simultaneously at hand without having to move around the bridge.

The bridge is an all-weather type, with the left and right wings all housed indoors. When taking off from a berth, the bridge can be operated by looking down through the windows on the floor and using the joysticks at the ends of the wings.

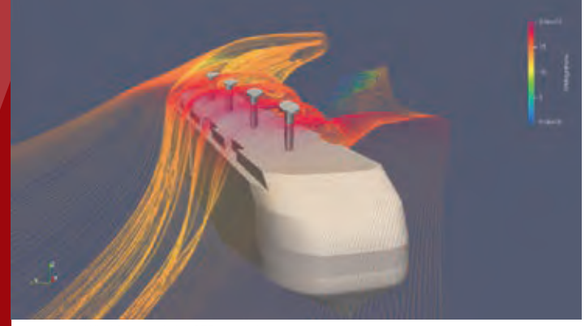
The main engine is equipped with the latest electronically controlled 2-stroke diesel engine developed by MAN, and in addition to a scrubber that collects SOx (sulfur oxides), it is equipped with an AMP (onshore power supply system) that enables the diesel generator to stop operation when unloading cargo, thereby meeting various environmental regulations. As a result, fuel consumption has been reduced by approximately 20% compared to the existing 20,000 TEU model. To improve propulsive performance, the ALV-Fin fin, SURF-BULB valve, and RUPAS high-lift rudder are installed as energy-saving devices. In addition, a high-efficiency propeller developed by NSY has been adopted.

The ONE 24,000 TEU series began with ONE INNOVATION, delivered in June 2023 at JMU's Kure Shipyard, and the entire series was completed with the sixth vessel, ONE INTELLIGENCE, delivered in December 2023 at Imabari Shipbuilding's Saijo Works. The six ships in the series are deployed on the FE3 Asia-Europe route of The Alliance (TA), calling at Ningbo and Xiamen in China, Kaohsiung in Taiwan, and Singapore in Asia, and Rotterdam in the Netherlands, Hamburg in Germany, and Antwerp in Belgium in Europe. The cruise will take 84 days.

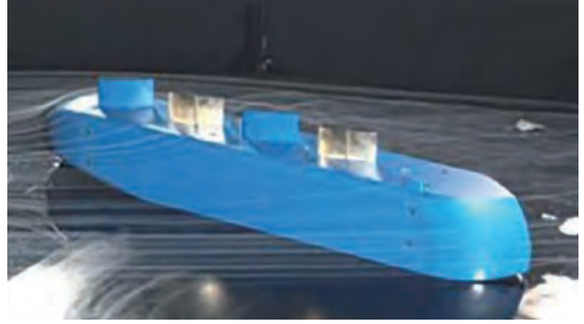
MOL Techno Trade Co.Ltd

Proposed a Joint Research on Wind-Propulsion Vessels Incorporating Aerospace Engineering

NET ZERO SHIPBUILDING IN JAPAN 2025



Wind flow study by CFD analysis



Verification by model test

Announced the results of the Sailed Ishin hull form, a wind-powered hull form that better utilizes the propulsive power of the next generation of wing sails.

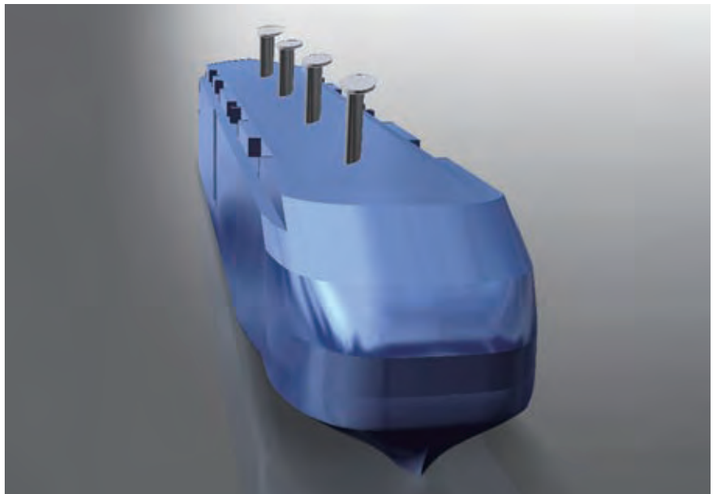
MOL Techno-Trade, Ltd. (MOLTT), a technology trading company in the maritime industry, has been collaborating with academia, government, and industry to conduct joint research on wind-assisted propulsion vessels incorporating aerospace engineering. Since 2021. MOLTT has partnered with the Department of Aeronautics and Astronautics, the School of Engineering of Tokai University, Mitsui E&S Akishima Laboratory, and Mitsui O.S.K. Lines (MOL) to undertake joint research on Wind Assisted Propulsion Systems (WAPS) utilizing aerospace engineering (Note 1). The results of this collaboration were demonstrated through the development of the Sailed-Ishin Vessel design, which features a streamlined hull form and small sails optimized for wind propulsion. The latest achievement of this project is the development of the Sailed-Ishin vessel design, which integrates the Short Height-Low Aspect sails with a streamlined hull form optimized for wind utilization. This innovative design was recognized for its potential in emission-reduction technology for vessels and is expected to be widely proposed to the industry. As part of this project, MOLTT applied for and was selected in FY2022 for the New Product Development Subsidy Program conducted by the Nippon Foundation and the Japan Ship Machinery and Equipment Association. After a two-year implementation period, the project reached a level of development ready for practical application in 2024.

ISHIN hull form that realizes the operation reducing 12% emission

The ISHIN hull form (Note 2) is a wind-powered design that minimizes wind resistance from the bow to the aft-end through vessel sides body, streamlines the airflow, and derives lifting force from wing effect with oblique headwinds to propel the vessel forward. The "Sailed ISHIN" hull form optimizes the streamlined shape of a box-like hull (such as that of a Ro-Ro vessel and a car carrier), which typically has a large wind-receiving body area above the waterline. Some small sails are mounted on the upper deck to generates lifting force by fairing wind currents through the sail with ISHIN Hull form. The hull form design, optimized for the use of small sails on upper deck, incorporates a streamlined shape (referred to as the ISHIN hull form) that effectively utilizes wind pressure and reduces drag. This system is reported to reduce emissions by as much as 12% theoretically with one set of small sail. This innovative hull shape has been being partially implemented on some vessels to date.

Regarding the small sails, development efforts are focused on minimizing their height and weight to meet the air-height restrictions imposed by some of navigation channels and to expect low-costs for installation as well. At the early stage of development, they found that the performance of a low-aspect-ratio sail (with reduced height) cannot achieve expecting effect. It was a normal sail which simply correcting wind pressure and fairing wind flow, then selected the new design of wing-sail which was based on “high-lift force” wing principles used in aerospace equipment, specially developed by Professor Fukuda of Tokai University. After the development was completed, they have applied for both an industrial design right and a patent right for the innovative sail-hull body combination configuration.

Sailed Ishin image (based on PCC hull form)

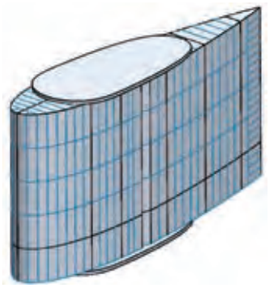


MOL Group’s Environmental Vision 2.1 to achieve Net Zero emissions by 2050

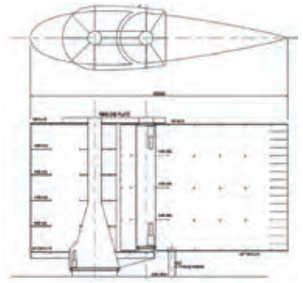
MOLTT, a Technical-Trade company in the Mitsui O.S.K. Lines (MOL) Group, is striving to achieve net-zero emissions by 2050 as part of the MOL Group Environmental Vision 2.2. The entire group is actively developing and implementing technologies aimed at reducing GHG emissions from vessels, thereby contributing to the realization of a decarbonized society. These efforts address the growing demand from both customers and society to minimize environmental impact. The ISHIN hull form, developed by MOLTT, marks a significant milestone in achieving this group-wide goal. In addition, as a technology trading company, MOLTT aims to extend its contributions beyond the MOL Group by promoting emissions reduction across the maritime industry. Through these initiatives, the company seeks to play a pivotal role in fostering sustainable development in the sector.

[Note 1]
Launch of Joint Research on Wind-Propelled Vessels Incorporating Aerospace Engineering – A New Phase in Vessel Development Utilizing Wind Power

[Note 2] ISHIN Hull Form
This technology, jointly developed by MOL Techno-Trade (MOLTT), Mitsui O.S.K. Lines (MOL), and Akishima Laboratories Inc. (Mitsui Zosen), has been patented and registered as a design. The hull shape is designed to reduce wind pressure from the bow and sides, facilitating smoother airflow. Additionally, it utilizes the lift force generated by diagonal headwinds as propulsion for the vessel. This technology is planned for partial application in the following two state-of-the-art LNG-fueled ferries, whose construction has been decided by MOL– February 17, 2022: Decision to construct two state-of-the-art LNG-fueled ferries ~ Introducing the Super Eco Ferry that Harnesses the Wind, Supporting the Acceleration of the Modal Shift ~



Structural Design



Overall View

Hull Design.	Modified ISHIN Hull Form Optimized for Sail Installation. Reduction of wind resistance and increase in thrust force under diagonal headwinds, as well as optimized airflow over the upper deck.
Sail Shape	Wing-shaped sail, split into two sections
Sail Weight	Approximately 30 tons
Main Material	Steel
Expected Benefits	theoretical improvement 12% in efficiency when combining the modified ISHIN hull form with a small sail (Based on the average round-trip on a North Pacific route with a single sail; theoretical research value)

ISHIN wants to add value to its hull form and drive Net Zero

Mr. Tetsuya Yamada, CTO and lead developer of the energy-saving ISHIN hull form, shared the challenges encountered during its development:
"Initially, we aimed to incorporate wings, but we quickly realized that airplanes and vessels operate under vastly different principles, as such wind velocity and thrust force effect. Integrating various technologies proved to be a significant challenge. We believe that achieving net zero emissions by 2050 will be difficult if we rely solely on fuel switching. To further enhance the value of the ISHIN hull form developed in this project, we plan to integrate existing technologies and wind propulsion blades developed based on aerospace engineering principles. Our goal is to install these blades onto the ISHIN hull. Furthermore, a hull structure that can achieve higher speeds while supporting decarbonization will be indispensable."

Supported by 日本財団 THE NIPPON FOUNDATION

Mr. Tetsuya Yamada, CTO of MOLTT, led the development of this project. During the development process, a prototype model was built, and the structural strength was evaluated to confirm the feasibility of mounting wing sails on board.

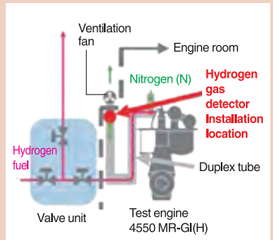
Riken Keiki Oxygen-Free Hydrogen Leak Sensor for Marine Engines

NET ZERO SHIPBUILDING IN JAPAN 2025

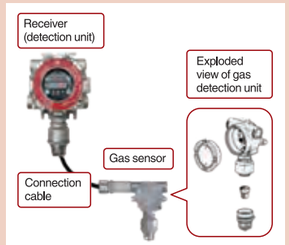
World's first technology to accurately detect the hydrogen gas lower explosion limit concentration (%LEL) in oxygen-free (N2) conditions in a field-mounted, continuously monitored, explosion-proof gas detector

The shipping industry's push for hydrogen engines has raised safety concerns around hydrogen fuel supply lines. The IGF Code from the IMO requires dual-piping systems with nitrogen to keep the outer environment oxygen-free. Existing hydrogen leak detectors, however, cannot function without oxygen. To solve this, Riken Keiki developed the world's first hydrogen gas sensor that works in oxygen-free conditions, supported by development grants from the Nippon Foundation and Japan Ship Machinery and Equipment Association.

Examples of development sensor installation locations



Development image (overall equipment configuration)



Items to be implemented in 2024

1. Verification of various sensor performances according to engine operating conditions (field tests).
2. Mass production measures and evaluation tests

Addressing the Safety Challenge in Marine Hydrogen Fuel Systems

Riken Keiki is the leading manufacturer of industrial gas detection systems and alarms, widely used on vessels, in factories, and at energy facilities, holding a domestic market share of more than 70%. Leveraging its expertise, the company has conducted research since FY2023 with the support of the Nippon Foundation and in collaboration with Mitsui E&S. This research has successfully led to the development of a hydrogen gas leak detection sensor capable of detecting hydrogen leaks in anoxic (N_2) conditions, thereby preventing hydrogen engine explosion accidents.

One of the key features of the hydrogen gas leakage detection sensor developed by Riken Keiki is its "high-speed response." This sensor is capable of quickly detecting hydrogen gas even in oxygen-free environments, with a response time of T50 within 20 seconds (the time required to reach 50% of the introduced test gas concentration). This significantly shortens the detection time, and performance tests conducted in 2023 confirmed a response time of under 12 seconds. Additionally, the sensor's high-precision detection capability has also garnered attention.

Riken Keiki has developed a technology capable of accurately measuring hydrogen concentrations at 1/10th of the lower explosive limit (10% LEL, or 0.4 vol%). As a result, this achievement has also contributed to improving data accuracy in low-concentration ranges.

Another standout feature is the sensor's robust design, which ensures stable operation even in the harsh environments of a vessel's engine room, including high humidity, extreme temperatures, continuous vibrations, and oxygen-free conditions.

Contributing to a Safer, Sustainable Future

The hydrogen gas leak detection sensor developed by Riken Keiki enables continuous monitoring of marine hydrogen fuel engines and their supply lines. This advanced solution significantly enhances ship management safety by preventing hydrogen and other fuel explosion accidents that could result in catastrophic damage. Additionally, it offers a reliable technology to improve the overall safety of fuel supply systems.

Furthermore, the sensor is not limited to marine use; it can also operate in general atmospheric conditions. This versatility allows its deployment in hydrogen supply facilities on land, providing a broad range of applications for both maritime and terrestrial systems. Looking ahead, the sensor is expected to play a vital role in achieving Japan's target of a hydrogen fuel utilization rate of approximately 55% for domestic vessels and 30% for ocean-going vessels by 2050. Its ability to detect hydrogen leaks even under oxygen-free conditions makes it a highly anticipated technology that will support the shipping industry's carbon neutrality goals.

The shipping industry faces an urgent need to transition toward a carbon-neutral society by 2050. To achieve this, it is crucial to develop hydrogen-fueled engine demonstration facilities and supply infrastructure, both at sea and on land. The hydrogen gas leak detection sensor will serve as a key innovation in realizing this sustainable future.

Supported by THE NIPPON FOUNDATION

Mr. Hiroyuki Sato (left) and Mr. Atsuhiro Fujitani (right), who developed the hydrogen gas leak detection sensor technology for next-generation marine fuel engines capable of detection in oxygen-free environments.

VOLCANO Co.,Ltd. Volcano Announces Technological Development of DF (Dual-Fuel) Burners for Ammonia-Fueled Vessel

NET ZERO SHIPBUILDING IN JAPAN 2025

Leading the Adoption of New Fuels for global maritime sectors with the Innovative Combustion Technology

Volcano is working on the development of advanced DF burners for marine boilers that utilize next-generation fuels. Volcano is currently focusing on ammonia, hydrogen, and methanol. Since these new fuels have distinct combustion characteristics, innovative combustion technologies are essential for utilizing them as marine fuels in the decarbonization of the maritime industry. Recently, Volcano reported notable progress in the development of ammonia-fueled DF burners.

DF burner "Vignis" for auxiliary boilers

Supported by THE NIPPON FOUNDATION

Addressing International Regulations and Decarbonization as Urgent Challenges.

With the strengthening of regulations by IMO (the International Maritime Organization), the global reduction of GHG (greenhouse gas) emissions from vessels is being required. In response, the maritime industry is advancing the construction of vessels powered by a variety of alternative fuels. Ammonia, which offers relatively low transportation costs, has garnered attention as a clean fuel since it does not emit CO_2 when burned. However, addressing the issue of unburned gas emissions caused by the difficulties in the combustion of ammonia has been a significant task.

Technical development of DF burners for auxiliary boilers

In large commercial vessels, including ammonia-fueled and transport vessels, steam is essential. The demand for ammonia-fueled boilers equipped with GCU*1 function, which can also generate steam, is expected to grow.
Volcano's development of DF burners for boilers utilizing ammonia fuel was carried out as a grant project by JSMEA, with support from the Nippon Foundation.
Building on its prior experience in GCU development, Volcano has successfully completed the world's first technological development of DF burners for auxiliary boilers designed for ammonia fuel.

Boilers have the characteristic of performing heat exchange within the furnace.
The development of DF burners for auxiliary boilers using ammonia fuel involves the additional challenge of burning ammonia, which is inherently difficult to combust, under even lower temperature conditions. At the same time, it is critical to ensure that no unburned fuel or other emissions are present in the exhaust gases—a task made even more challenging by the nature of ammonia combustion in low-temperature environments.

Volcano conducted prototype testing and evaluation, maintaining the ammonia (NH_3) concentration in the exhaust gas at "25 ppm or less*2" and the dinitrogen oxide (N_2O) concentration at "50 ppm or less*3," which are within the allowable limits. In these tests, Volcano achieved an ammonia co-firing ratio of 80% (based on calorific value) for oil in a DF burner designed for a 1.5 t/h boiler.

*1 GCU: Abbreviation for "Gas Combustion Unit". A device that safely processes the evaporated gas containing combustible and inert gases that occur in various situations on gas-fueled vessels.

*2 Based on NK classification standards

*3 Based on the safety data sheet "8. Exposure Prevention and Protection Measures" issued by the Ministry of Health, Labor, and Welfare.

Prospects for Next Generation Fuels

Volcano continues to lead the way in this technology and has successfully developed DF burners not only for ammonia-fueled vessels but also for hydrogen-fueled and methanol-fueled vessels.
Moving forward, we will collaborate closely with major shipowners and research institutes in Japan and overseas to further improve the co-firing ratio of ammonia DF burners, aiming for the practical implementation of next-generation vessel technology.
This development is expected to make a significant contribution to the global shipping industry's efforts toward a decarbonized society.

Gas Combustion Unit (GCU)

For ammonia-fueled vessels	Commercialisation	Initial commercial application with the ammonia-fueled tugboat "SAKIGAKE"
For hydrogen-fueled vessels		Sales began in November 2023.

DF burner for auxiliary boiler

For ammonia-fueled vessels	Technical development completed	・Successfully achieved an 80% ammonia co-firing ratio, with ongoing efforts to further increase the co-firing ratio. ・Available on demand
For hydrogen-fueled vessels		Available on demand
For methanol-fueled vessels		Available on demand