

For Our Sustainable Growth

Special Feature

MOL Opens Up a New Sea Route for LNG Trade —Joining the Yamal LNG Project

The Yamal LNG is a project that ambitiously makes use of the world's first Arc7 class ice-breaking LNG carriers to transport liquefied natural gas (LNG) from the plant in Russia's Yamal Peninsula to markets around the world. The project continues to run smoothly, with our first of three vessels having been in operation over a year since March 2018, and the second one since October of the same year.

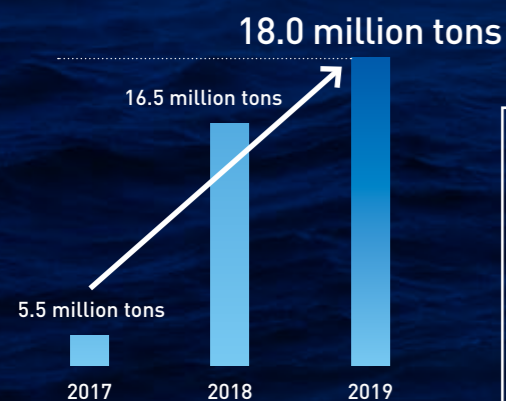
This section will describe the MOL Group's bold venture into unknown territory, namely, entering the Northern Sea Route for LNG transport.



Potentiality of the Arctic

Due to growing concern over global warming, more emphasis is being placed on natural gas as a source of clean energy. As a result, worldwide demand for LNG is on the rise. Although roughly 30% of the world's undiscovered natural gas reserves are said to lie beneath the Arctic Circle, the lack of proper means of transport has limited the full use of these resources. The Yamal LNG project became the first one to break through this situation.

LNG production capacity of Yamal and other Novatek-related LNG projects



The Yamal LNG Project

The Yamal LNG project is a large-scale LNG production and export project jointly owned by Russia-based Novatek, France-based Total, and China-based China National Petroleum Corporation (CNPC). The project, which began operations in December 2017, enabled year-round LNG transport from Russia's Yamal Peninsula to markets around the world by utilizing the world's first Arc7* class ice-breaking LNG carriers. Leveraging our expertise of LNG carriers garnered from years of experience, we signed a long-term charter contracts for three Arc7 class ice-breaking LNG carriers and four conventional-type LNG carriers, and are now responsible for part of the overseas shipping for the project.

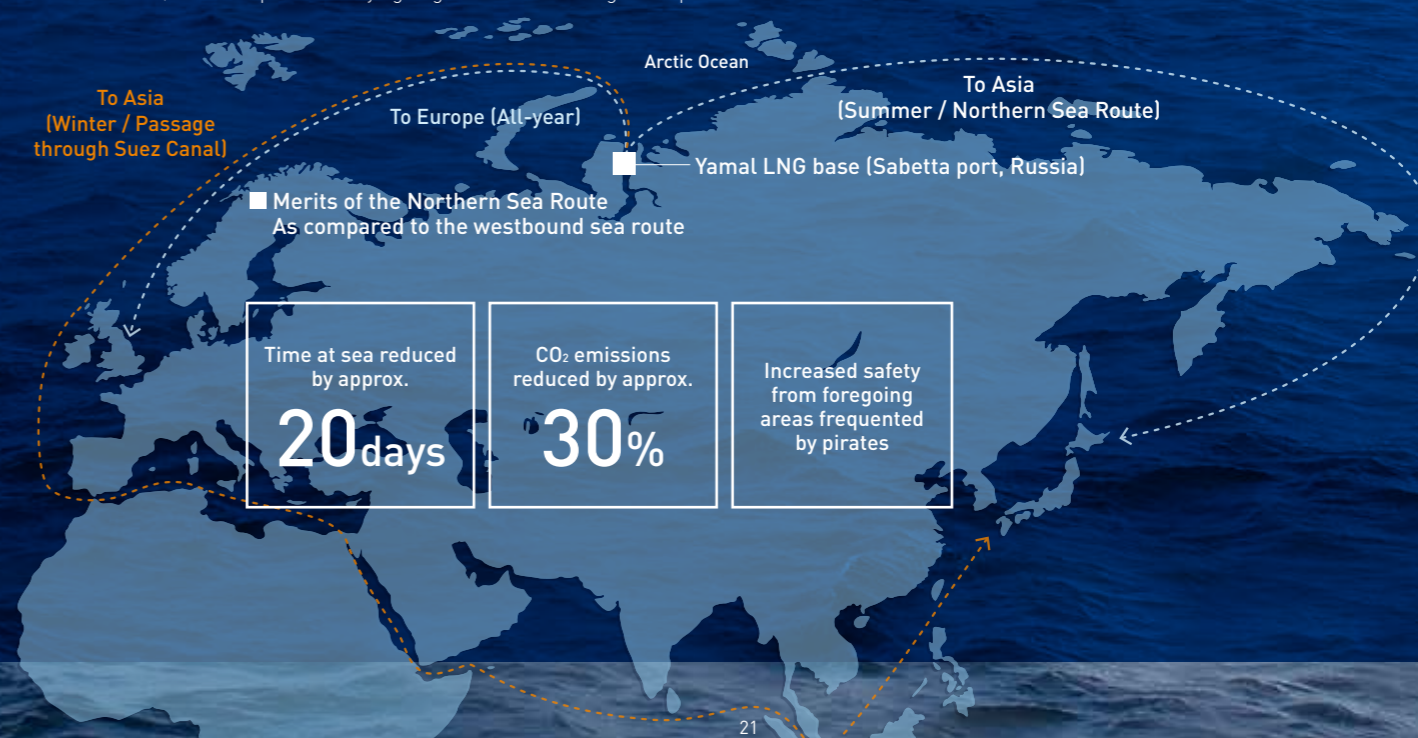
* Ice-breaking and ice-resistant carriers are assigned an "ice class" based on their ice-breaking capabilities and degree of ice resistance as determined by hull strength and onboard equipment. There are nine classes determined by the Russian Maritime Register of Shipping: Ice1 to Ice3 and Arc4 to Arc9, with higher numbers denoting higher ice-breaking capabilities and a higher degree of ice resistance.

Yamal LNG Project	
Operator	Yamal LNG
Production timeline	Train 1: 2017 Train 2: 2018 Train 3: 2018 Train 4: 2019
Production volume	17.4 million tons/year (3 trains of 5.5 million tons plus 1 train of 0.9 tons)
Transport	Ice-breaking LNG carriers (Ice class Arc7): 15 (including three co-owned by MOL and China COSCO Shipping) Conventional-type LNG carriers: 11 (including four co-owned by MOL and China COSCO Shipping)

The LNG Transport Route from Yamal

The most defining characteristic of the marine transport aspect of the Yamal LNG project is the use of Arc7 class ice-breaking carriers to open up the Northern Sea Route for LNG transport. High-spec ice-breaking carriers made it possible to pass through thick-ice eastbound sea routes in the summer, in addition to year-round use of the westbound sea routes where the ice is relatively thin. Most importantly, transport to East Asia, which requires 35 days going westbound through Europe

and the Suez Canal, is now possible in a considerably shorter time period of about 15 days by navigating eastbound. Establishment of the Northern Sea Route for LNG transport has major merits, including a significant reduction in CO₂ emissions and lower transport costs, both a result of the shorter passage.



For Our Sustainable Growth

Special Feature



20–30 year long-term contracts for a total increase of ¥100 billion in ordinary income

* A transfer of cargo between two ships positioned alongside each other

Entering the Unchallenged Route

The Yamal Peninsula, which means “the end of the world” in the local language, is an extremely cold land with air temperatures reaching -60°C in winter. The key issue was how to facilitate year-round transport of LNG from this place closed off by permafrost to Asia and Europe.

The revolutionary project that solved this crucial issue really began picking up steam in 2011. In 2013, Novatek, Total, and CNPC teamed up to materialize the plan of exporting LNG from a base at Sabetta port in the Eastern Yamal Peninsula. They called out for international marine transport companies who were willing to take part in the project. Due to the staggering amount of technical difficulty compounded by the political risks attached to the project, some companies were hesitant to be involved, but we, based on risk assessments honed over many years of business, judged that it was manageable. Ultimately, it was determined that a joint venture of MOL and China COSCO Shipping would own and operate three out of the 15 ice-breaking LNG carriers committed to the project, and accordingly shipbuilding orders for these ships were placed with Daewoo Shipbuilding & Marine Engineering Co., Ltd in 2014. Out of all the marine transport companies in Japan, we were the only one participating in this project.

Overcoming Obstacles with Comprehensive Strength from Years of Experience

We faced a variety of obstacles in executing this unprecedented project, such as construction of special ships, training of the crew, and financing. For the ship construction, this project required the world's first LNG carriers capable of breaking through ice up to 2.1-meters thick on its own, without the assistance of a separate ice-breaking ship.

Because LNG carriers must keep and carry LNG at -162°C in their tanks, even conventional-type ones require a particularly high level of technical prowess and safety measures compared to other merchant ships. To construct a ship with specifications required to withstand the harsh environment of the Arctic Ocean, even more careful and complicated steps have to be taken. To this end, all parties involved, including the shipyard, worked together from the planning stage to thoroughly uncover all possible risks. From there, we solved each issue through repeated trial and error, examining things from different angles, for everything from the materials to structure.

Crew training was another issue. Navigation through polar waters requires compliance with the Polar Code,* which includes requisite training for crew members. At that time, none of our seafarers had polar sailing experience. Therefore, with the help of the outside partners, we had them complete special training from scratch.

Financing brought its own set of challenges. After concluding the shipbuilding agreement, sanctions against Russia were tightened, which forced us to adopt a different funding structure than we initially planned. However, we were able to achieve it by utilizing our deep well of financing experience across a range of projects.

It was our experience, expertise, and partnerships, accumulated through our many years of taking on challenges, that enabled us to overcome these various obstacles. Without a doubt, the success in this project was the fruit of our comprehensive capability as a marine transport company.

In December 2017, construction of our first ship was completed. The ship was christened the VLADIMIR RUSANOV, after the early 20th century Russian Arctic explorer and geologist. With the same trailblazing energy of its namesake, the VLADIMIR RUSANOV began operation in the Arctic Ocean in March 2018.

* International standards adopted by the International Maritime Organization (IMO) to ensure ship safety and environmental conservation for vessels navigating through polar waters.

Applying Accumulated Expertise to Bigger Challenges

Since the beginning of operation over one year ago, the VLADIMIR RUSANOV has been keeping good working order with no major trouble, and has been accumulating new accomplishments. Further progress is on the horizon, with our second ship having begun operation last year, and the third one set for completion this summer. At the same time, this opens up opportunities for us to apply the expertise acquired from the Yamal LNG project to other areas in the Arctic Ocean in addition to Russia, such as Canada or the coast of Alaska, that have also been confirmed to contain an abundance of resources. The Yamal LNG project was a challenge that took us into uncharted territory. With this accomplishment, we have cleared the path for new possibilities. Leveraging the experience acquired from this project, we will keep driving forward as one of the world's leading marine transport companies.

Tackling the Northern Sea Route

To execute a project amid the cruel environment of the Arctic Ocean, some special specifications had to be installed to the ships and specialized training for the crew had to be arranged. Below are some examples of such preparations.

Special Specifications for the Ships

Double-Acting Ice-Breaking System

One important feature of the ice-breaking LNG carriers to ensure safe and unfailing navigation, even through the thick ice covering the waters of the Arctic Ocean, is the “double-acting ice-breaking system.”

Typically, the ship will navigate ahead through open water and thin ice, but when facing thick ice, it will turn 180° using the double-acting ice-breaking system and proceed astern (backwards). By going astern, it can navigate through thicker ice up to 2.1 meters, as opposed to 1.5 meters with the bow ahead, because the stern is heavier and its shape is better suited for breaking ice. This is the first time that this technology has been adopted in an LNG carrier, and it plays an important role in the safe operation of the ship.



Specialized Training for Navigating the Northern Sea Route

The Polar Code, a set of international standards for shipping in polar regions, is set in place to ensure ship safety and environmental conservation. As we place the highest priority on safety measures for our ship crew, we give training to a broader range of crew members, not just the ones required by the code. Below are a few examples of such training.

On-Land Training for Icy Waters

At the Makarov Training Centre and Sovcomflot Training Centre in St. Petersburg, Russia, crew members acquire essential knowledge for ice navigation, including the characteristics of ice, and usage of ice charts. In addition, crew complete a practical training program for ice navigation maneuvers utilizing simulators at these facilities.

At-Sea Training for Icy Waters

The Polar Code requires that captains and first officers have a minimum of two months of experience aboard a vessel operating in a polar region. We managed to meet this requirement thanks to the cooperation from other companies. Our captains and first officers were given the opportunity to board ships transporting modules and materials for construction of the LNG plant in Sabetta of the Yamal LNG project, which were operated by two Dutch module ship and heavy carrier operating companies, and also atomic ice-breaking ships operated by Russian State shipping company Atomflot.



For Our Sustainable Growth

Special Feature

“This Groundbreaking Project Would Not Have Succeeded without the Hard Work of All Its Crew Members.”

To lead the world’s first ice-breaking LNG carrier project to success, we had to make careful preparations for navigating through a harsh natural environment and operating Arc7 ice-breaking LNG carriers. We had to complete not only ice navigation training as required by the Polar Code but also training for operating a type of propulsion engine with which the Company had no previous experience. Training programs varied from those using simulators to numerous on-site ice navigation training programs at sea. All in all, the thorough preparation spanned two and a half years.

The VLADIMIR RUSANOV is an ice-breaking LNG carrier that is equipped with outstanding specifications for adapting to severe environments and ensuring safety. Still, there are hardships that you only experience during the actual voyages. As we continued to take on new challenges such as ice trials,



Robert G Valentine
Master / VLADIMIR RUSANOV

eastward sailing to Asia, and Ship-to-Ship LNG Transfer operation, we occasionally faced extreme bad weather and ocean conditions. However, thanks to our well-trained crew members who came together to fulfill their duties and the well-designed special equipment onboard such as ice radars, we managed to overcome these challenges. Overall, these voyages were extremely meaningful experience in which we were able to utilize and confirm the effectiveness of our training and the proper functionality of the equipment aboard the vessel.

In closing, I am extremely proud of the fact that I was able to fulfill my duties as a member of this exceptionally challenging and groundbreaking project. The success of the voyage is the direct result of the hard work and efforts of all crew members involved.

“The Project Progressed Smoothly Because We Dealt With Problems before They Appeared.”

Over its first year, the VLADIMIR RUSANOV provided service continuously without halting operations once. This gives me confidence that the project is progressing well. In order to complete construction of this new type of ship on-schedule and according to the required specifications, we held risk assessment meetings with all parties involved, including the shipyard. Starting with the designing stage, we went over every aspect with a fine-tooth comb to figure out the potential risks and their countermeasures. By doing this, we were able to take actions to avoid anticipated difficulties we could face in later stages. In addition, I believe that the relationship with Daewoo Shipbuilding & Marine Engineering that had already been cultivated from other projects we had worked on together previously allowed for an open exchange of opinions at an early stage, which was one of the reasons that the project progressed so smoothly. With regard to the technical aspect, we focused most on ensuring safe and stable operations of the vessel because we all understood that was the biggest issue for an LNG carrier that would navigate along the Northern Sea Route. In the event that the



Yuta Orito
Coordinator, LNG Carrier Project Team
Technical Division, Technology Innovation Unit
Mitsui O.S.K. Lines, Ltd.

ship was to stop in icy waters, not only would this be a danger to the crew members stuck at sea, but the ship would also be unable to keep the cooled LNG in its tanks, as LNG would vaporize even in the cold temperatures of the Arctic Ocean. In a worst-case scenario, this gas would have to be released into the atmosphere. To prevent this kind of situation, we incorporated mechanisms to enhance ship’s mobility, including the “double-acting ice-breaking system” and all the details such as the engine room design. Furthermore, we engaged in detailed dialogues with the crew members who were going to board the ship and incorporated their requests into the ship specifications.

The knowledge and experience we have acquired from this project, from risk assessment to actual operation of the ship is invaluable, as it can only be gained by overcoming new challenges. It will be a strength that we can leverage when taking on new projects and working with other shipyards going forward. I cannot wait to apply this expertise to our next project.

“There Is a Feeling That We Are Making History at This Very Moment.”

I am very proud that we are making important milestones in the Yamal LNG project, which is the very first to transport LNG from the Arctic Circle to the rest of the world. I strongly believe that this project has major social significance in a sense that it made year-round transport of the previously difficult-to-access natural gas locked in the Arctic Circle possible and that use of the eastbound Northern Sea Route greatly reduced transit time and the amount of CO₂ emissions.

One of the key reasons why we got selected for the project was our experience and performance as a marine transport company boasting the world’s largest fleet of LNG carriers with a track record of safe operations. I also feel our attitude to actively having taken part in new overseas projects and the fact of having built mutual trust-based relationships with worldwide partners were taken positively.

To take on this new challenge, there were initially some concerns over the risks within the Company. However, we conducted independent risk assessments on the Northern Sea Route, identified each risk from every aspect including safety, financial, and political factors, and then established fully thought-out countermeasure for each risk. We were able to participate in this project because we finally had everyone on the same page after communicating closely with those within the Company who were skeptical, explaining the feasibility of the project properly and carefully, and earning their understanding.

Be that as it may, as one would expect with an unprecedented project like this one, we faced considerable difficulties along the way. However, with any issue we faced, we were able to eventually overcome it by utilizing our accumulated knowledge and sometimes leveraging our network of outside partners. As an example, we had previous experience working as partners with China COSCO Shipping, our joint venture partner in this project, and with Daewoo Shipbuilding & Marine Engineering, the company responsible for shipbuilding. These existing trust-based relationships were a major help in moving the project forward. As another example, we were able to leverage our Group connections and received cooperation from outside companies to secure opportunities for our crew’s required special training for Northern Sea Route operations. Execution of an LNG transport project requires all aspects of a marine transport company, including risk assessment before participation, negotiations until concluding the charter contract, supervision of shipbuilding, financing, post-construction ship management, and safe operation of the ship. Accomplishing this project, despite the many issues we had to overcome, is truly the result of

the comprehensive strength we have fostered up to this point.

Fortunately, our first ship, the VLADIMIR RUSANOV, has been running well without any major issues. In addition, our second ship began operation last year and our third will be delivered this summer. Operating the world’s first ice-breaking LNG carriers gives us a feeling that we are making history at this very moment. The project is off to an amazing start, but it is just the start. With the utmost care and attention, we will strive for safe navigation and work to create a presence in the Northern Sea Route to be recognized as the top player.



Kazuya Hamazaki
General Manager
Energy Transport Business
Unit, LNG Carrier Division
Mitsui O.S.K. Lines, Ltd.

Stories from Key Members