

The role of the Northern Sea Route in Russian LNG Projects Development

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Abstract. Currently, there has been a significant increase in the volume of freight traffic on the Northern Sea Route (NSR). The following advantages of the Northern Sea Route can be mentioned: no piracy in the region, less time taken for cargo transport, ship bunkering with natural gas from onshore or offshore fields. The paper indicates that the requirements for the bunker fuel quality and the amount of pollutant emissions into the atmosphere during shipping in the Arctic zone are very stringent. This work states that one of the most important ways to follow the emission limits is changing the fuel of the ice-rated vessels for liquefied natural gas (LNG). It is noted that Russia has a number of opportunities to apply LNG both to supply the Arctic Region with water and surface transport and to supply the onshore settlements and enterprises. It is noted that the use of gas as fuel will decrease air pollutant emissions. Furthermore, shift to LNG as bunker fuel will resolve a major environmental problem of accidental spillage of marine fuel and crude oil. The article states that LNG is a reliable and competitive fuel for shipping in the Arctic Region. It is indicated that the growth of the Russian domestic LNG market in the form of industrial consumers and ships bunkering can be an incentive for the intensive domestic LNG-projects development.

1. Introduction

The Northern Sea Route (NSR) is the shortest sea way between Europe and Asia. It goes through the seas of the Arctic Ocean (the Kara Sea, the Laptev Sea, the East Siberian Sea, and the Chukchi Sea) for around 2,500 nautical miles. On an average, passing along the Northern Sea Route will take 10.6 of a day [7]. Due to the development of new industrial projects in the Arctic Region, a significant increase in traffic volume along the Northern Sea Route can be currently observed (table 1).

To protect the environment against polluting emissions from shipping, now, requirements to the quality of marine fuel are being updated and tightened, new environmental regulations worked out [1]. The strictest regulations are applied to some air pollutant Emission Control Areas (ECA). In Europe, ECA include Baltic Sea and Northern Sea areas, in the Northern America – Pacific and Atlantic coast areas.

Tight restrictions applied to air pollutant emissions (i.e. soot, nitrogen oxides and sulfur oxides) in use of marine fuel in ECA zones adopted by the International Maritime Organization can be implemented by taking the following measures:

- use of low-sulfur oil fuel of higher quality;
- installation of treatment facilities;
- liquefied natural gas preference (LNG).



Table 1. Traffic Volume Forecast along the Northern Sea Route until 2030, mln tons

Cargo	Fact	Forecasted		
	2016	2020	2025	2030
Hydrocarbons, total	8.7	30.7	50.8	69.4
including:				
oil and gas condensate	8.7	19.7	31.7	36.7
LNG	0.0	11.0	19.1	32.7
Ore and concentrated ore	0.7	1.0	1.0	1.0
Carbon	1.0	8.0	20.0	30.0
Northern Supply	1.0	1.5	2.0	2.0
Transit	0.0	1.0	1.2	2.0
TOTAL	11.4	42.2	75.0	104.4

Source: [7].

Possessing considerable resources of natural gas in the Arctic Region and investing heavily in LNG production in the region, Russia has all the conditions to use this fuel both for supply of water and surface transport in the Arctic Region, and for supply of onshore settlements and enterprises.

2. Research questions

According to the data from the Russian Registry of Shipping, today, in the ports of the Arctic Region of Russia, 439 ships of all rates are recorded [8]. Of these, 74% use diesel fuel, 1% are running on oil residue, and 25% - on motor and diesel oil. This ratio will make shifting to low-sulfur fuels quite painless, without significant change in the fuel system of a ship. Furthermore, age class composition of the fleet, and the fuels used can be deemed conducive to the shifting to LNG of some vessels. At the present time, it seems technologically viable to shift all kinds of vessels operating in the Arctic Region of Russia. In addition, there are projects for use of LNG within the process of large-scale fleet upgrade and ship building for new industrial projects in the Arctic Region.

The forecasted increase in cargo carriage in the Arctic Region is primarily determined by exploration of hydrocarbon resources in the Timan-Pechora province, Yamal, and Taimyr. Carriage of equipment for field development in the Arctic Region and the necessity to remove the found raw material will require the establishment of a large-scale and complex infrastructure for delivery and storage of oil fuels. Alternatively, the Arctic LNG projects can be integrated in transportation and energy generation patterns of already existing ones [5]. It should be emphasized that implementation of the projects for the construction of industrial and extracting facilities in the Arctic region will inevitably result in significant increase in cargo carriage volume and aggravating of negative impact on the environment by the ships delivering materials and equipment and removing finished products.

The role of the Arctic Region as a transportation corridor is currently becoming more prominent due to reduced ice cover in some Arctic basins. Therefore, the Arctic Region of Russia can be considered an important transport route bridging Europe and Asia. The main advantages of the Northern Sea Route include the absence of piracy in the region and cutting time for carriage. For example, cargo carriage from Norway to Japan may take up to 21 days less than through the Suez Canal [9].

Moreover, the Northern Sea Route provides ships with a possibility to bunker with natural gas from both onshore and offshore fields. This will also promote competitive advantage of the Northern Sea Route [6].

In the Arctic Ocean area, 3 major projects on LNG production are currently being implemented. Yamal LNG, Pechora LNG, and Arctic LNG-2. It is viable to arrange bunker centers in the vicinity of LNG production plants. Also, storage and bunkering facilities in the ports of Murmansk, Archangelsk, Dikson, Tiksi, and Anadyr will be required.

Directions and prospects for LNG application as bunker fuel depend on the transportation geography. In the Arctic Region of Russia, ships are designed for shuttle runs along permanent routes, while their high ice rate enables them to run during the entire term of operation.

If compared with oil fuels, LNG has the superior calorific value and the best physical characteristic (Table 1). However, a fuel system of greater capacity is required onboard because of the lower density of LNG.

Table 2. Physical properties of different fuels

Physical properties	Gasoil	Residual oil	LNG
Density, kg/m ³	860 – 900	920 – 1010	422
Net calorific value, MJ/kg	41,4 – 43,3	40,5 – 41,4	50,02
Boiling point, °C	180 – 360	x	- 162
Self-ignition point, °C	250 – 300	x	595
Lower explosion level, vol. %	0,5	x	4,4
Upper explosion level, vol. %	7,5	x	15 – 17

Source: [7], data from companies

However, it should be noted that the existing marine fuel system capacity for oil fuels is sufficient to make shuttle runs on LNG in the Arctic Region even in ice-bound conditions. Availability of LNG for carriage guarantees ship bunkering in the Yamal semi-peninsular region, which does not require increased capacity of a fuel system, nor it leads to cargo capacity loss. In the absence of ice, LNG stored in oil fuel tanks can procure passage along the route Dudinka – Murmansk – Dudinka.

Therefore, LNG is a reliable and competitive fuel for shipping in the Arctic Region. With increase of shipping and routes length, efficiency of LNG application also significantly increases. The payback period for LNG is from 2.5 to 5.5 years [2].

Using gas as fuel favors reduction of air emissions. The most notable reduction is observed with SO_x, i.e. particulates. NO_x emissions will decrease by 80% [1]. In addition, greenhouse gases emissions are reduced. Environmental safety of LNG usage is primarily determined by modes and kinds of ship engines. Engines operating on gas as well as two-fuel modified engines allow for methane emissions. Making improvements in gas engines will eliminate this drawback.

Shifting to LNG as bunker fuel will assist in resolution of the acutest environmental problem of accidental spillage of marine fuel and crude oil. Oil spillage has negative impact on all food chain elements in the Arctic Region. Some representatives of the Arctic fauna are particularly sensitive to oil spillage, since pollution with oil and oil products destroys fur and feather heat insulation properties. Currently, there is no reliable technique for elimination of accidents of this kind under the ice-bound conditions. The problem is very acute for polar basins where accident management activities are complicated not only by thick ice coverage but also by polar night, low temperature, strong winds, and lack of infrastructure facilities.

Experts estimate that the expenses for elimination of effects of residual oil spillage of 100 tons in the Arctic region will bring to naught all price advantages from use of this cheap yet environmentally hazardous fuel by all ships of the global Arctic fleet for three years [10]. In this respect, in 2011, resolution adopted by the International Maritime Organization took effect. It prohibits use and transportation of crude oil with the density exceeding 900 kg/m³, heavy oil products, tars, and pitch in the Antarctic waters. Similar restrictions seem desirable for the Arctic Region as well.

Obviously, for some segments of shipping, the transition to LNG will be in demand. Given the political will and positioning of the Northern Sea Route as the world's first sea transport corridor for LNG, the opportunities and scope of LNG using will be maximally realized. At the same time, Russian gas resources will reach a new promising and rapidly developing segment in the world - bunker fuel.

In fact, absolute compliance with existing and planned environmental requirements ensures the attractiveness of using LNG in the long run. The high economic and environmental efficiency of LNG using can ensure the dominance of LNG as bunker fuel in the Arctic zone.

If the existing fleet does not require significant investments in its infrastructure and there is a possibility of supplying low-sulfur fuels in the required volumes, with the expected increase in cargo turnover and, accordingly, fuel requirements of up to 5-6 million tons, there are justifiable doubts about the ability to provide ships with fuel in the required volume and at competitive prices.

The qualitative assessment of LNG used on new vessels shows increased capital costs, certain capacity limitations due to the need to install volumetric fuel tanks and lower operating costs. Individual estimates show that higher capital investments in LNG vessels result in a slight (1-2%) increase in the cost of transportation [4].

The main advantages of LNG in the Arctic zone will be its availability in the long run and compliance with current and future environmental requirements.

The creation of LNG infrastructure for bunkering ships will create conditions for the social development of the Arctic ports areas.

Data on the cost of ships on LNG and the transfer of vessels to LNG use are very limited due to the limited number of vessels on LNG. The available estimates provide the following information on additional capital investments in ships for the LNG using:

- for the dry cargo ship of the ice class with a deadweight of 70 thousand tons and a propulsion system of 40 MW, the additional costs amount to \$ 26.7 million;
- for a tanker with a propulsion system of 12 MW and a deadweight of 75 thousand tons, additional investments of \$ 9.5 million are required [7].

The Russian Arctic zone requires the use of powerful ships of high ice class. However, the cost difference is solely related to the fuel system and engine of the ship, therefore for economic calculations it is possible to use a range of additional capital investments from \$ 9.5 to \$ 26.7 million for vessels with propulsion systems of 12 and 40 MW or \$ 790-670 per kW, respectively [5].

With the actual absence of modern infrastructure for storing and distributing oil fuels in the Arctic, for the purposes of this analysis one can accept the thesis of equal capital costs for creating an infrastructure for LNG and for oil fuels, with the expected significant increase in cargo turnover. Thus, the difference in capital costs will be concentrated only in the difference in the acquisition of ships working on LNG and oil fuels.

The main attraction of LNG usage, in addition to the fact this type of fuel has to meet modern and future environmental requirements, is its relatively low price. Over the past 6 years LNG has had significantly lower energy unit prices compared to petroleum fuels, and this creates additional positive effects from the use of LNG in addition to environmental benefits.

As a rule, the main LNG consumption centers are located at a considerable distance from the production centers, so the transportation of LNG to the consumer adds to its cost.

Due to the use of new world-class deposits and environmental cold Russian projects in the Arctic make it possible to obtain LNG at low prices.

3. Conclusion

Liquefied natural gas is a new fuel to be used for marine ship bunkering. In the view of tough requirements to the pollutant emissions from ship engines running on oil fuel, and price advantage of

LNG, liquefied natural gas can be regarded as a fuel that can come to dominate the marketplace of marine fuel.

The problem of extending usage of LNG as marine fuel is particularly acute for Russia possessing considerable gas reserves in the Arctic Region, and liquefying production facilities. Shifting to LNG will require essential upgrade of the vessels operating in the region. However, the problem must be solved anyway, because of the high degree of the Arctic fleet wear in Russia. Construction of new ships designed for LNG seems to be the first choice. Alternatively, re-equipment of the existing ships can be considered.

LNG will reduce the risk of spillage of oil and marine fuel, and diminish air pollutant emissions. Extensive activities in the area will strengthen positions of the Russian manufacturers on LNG-based fuel market promoting implementation of advanced construction technologies for ice-rated ships.

Use of LNG as bunker fuel will give rise to an opportunity to supply industrial facilities and settlements of the Arctic Region with LNG-based energy. Combined use of LNG infrastructure for bunkering to supply electric power plants and heat generating facilities with gas, will reduce operating expenses and set favorable prices for all classes of customers.

Implementation of major LNG production projects in the development of transit carriage along the Northern Sea Route will increase the LNG consumption rate significantly. Growing competition on LNG marketplace necessitates the search for new segments of this market. The LNG domestic market growth represented by industrial consumers and ship bunkering may initiate intensive development of the domestic LNG projects.

It is evident that the use of LNG as fuel will reduce the environmental impact, including, but not limited to CO_x, NO_x, SO_x emissions.

Implementation of LNG production projects in the Arctic Region such as Yamal LNG, Pechora LNG, Arctic LNG will strengthen Russian position in the global LNG market, and form a transportation corridor between Europe and Asia for exclusive LNG bunkering.

Availability of LNG and reliability of supplies from different production facilities may ensure essential price advantage of LNG as compared with other routes. Thus, LNG cargo carriage may significantly increase.

Intensive exploration of the Arctic Region is associated with growing supplies of marine fuel, as well as with the establishment of infrastructure for transshipment, storage and bunkering for the purpose of transit and removal of oil, carbon, and gas, from scratch. Under these conditions, extensive substitution of oil fuels with LNG is of immediate interest for Russia. It will reduce costs for carriage and transit, and protect the delicate Arctic ecosystem from pollutant emissions and effects of spillage of oil and oil products.

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