Arctic Shipping Development Prospects Evaluation: Nuclear Icebreaker Fleet in the Northern Sea Route

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Abstract

This paper supports the concept of developing a nuclear icebreaker fleet in Russia until the year 2030, and it takes into consideration the country's regional economic development and social conditions. The role of the Northern Sea Route (NSR) as the strategic route for shipping hydrocarbons and mineral resources from prospective deposits as well as the transit route between the European and Asian ports is highlighted, and cargo flows on the NSR are forecasted. A proposed scenario for the development of the nuclear icebreaker fleet, up until the year 2030 is outlined, and includes characteristics of the various fleet development stages and measures that need to be taken along way. First, the proposed scenario takes into account the present and future requirements of the fleet composition. Second, it considers the Government's operational needs for the nuclear icebreaker fleet's services. And thirdly it examines the commercial needs for the fleet's services - based on cargo flows from scheduled investment projects of Russia's industries and infrastructure.

1. Introduction

In his address at the international Arctic conference *North Sea Route Towards Strategic Stability and Equal Partnership in the Arctic*, the President of the Russian Federation mentioned that: "The Arctic is a region rich in mineral reserves and it's also home to the shortest shipping route between Europe and Asia, the Northern Sea Route (NSR). For these reasons, the sustainable and stable development of the region, based on the principles of cooperation and unconditional respect for international law, is of paramount importance". His address went on to confirm that "Russia is ready to further contribute to preserving the

Arctic's unique nature and implement joint international projects in the transport and mining industries".

The following global trends favour the sustainable and successful development of the Arctic region: 1) eight Arctic powers (Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden and US) have a significant potential for bilateral and multilateral cooperation in numerous endeavors; 2) high cost of natural resources and their commercial potetial encourage increased investment in the Arctic region; 3) the NSR is not only playing a significant role in the transport system of the North, but it is also indispensable in the establishment of a single economic zone in Russia's Arctic region; 4) the accelerated growth in international trade will foster increased demand for shipping services through the NSR, particularly since it is a safe and economically viable sea route.

An intricate Arctic transportation system includes sea and river vessels; air, rail and road transport; and coastal infrastructure - sea ports, airports, navigational aids, hydrographic and hydrometeorological support, and communications. Obviously, in the future the main mode of transport for freight service in the Arctic will be by sea and river with the nuclear icebreaker fleet playing a central role in the Arctic transportation system.

There are several prerequisites for the sustainable development of the Arctic region, and the NSR in particular: 1) availability of an experienced and reliable Russian nuclear icebreaker fleet (six operating icebreakers); 2) technological advances in shipbuilding, allowing the construction of large vessels of high ice class, equipped for Arctic shipping; 3) new technologies in navigation, hydrographic and meteorological services, including satellite systems, ensuring accuracy and timeliness of the critical information; 4) construction of 37 rescue ships by the year 2015; 5) scheduled upgrades to Arctic ports; 6) overall ecological awareness (measures to prevent oil spills and handle gas to ensure maximum efficiency), as well as public financing of 2 billion rubles to remove waste from Arctic islands over the next 2 years.

2. Literature Review

There is a significant amount of literature as a result of international, multidisciplinary research such as the "International Northern Sea Route Programme (INSROP)" undertaken from June 1993 until March 1999.

The report by Ragner (2000) assesses the NSR's commercial potential and economic importance, both as a transit route between Europe and Asia, and as an export route for oil, gas and other natural resources in the Russian Arctic. The icebreaker fleet is examined by considering the status quo of the NSR infrastructure - icebreakers, ice-class cargo vessels and ports and by estimating its future capacity. The publication by Ragner *eds* (2000) incorporates the views of the international shipping companies and discusses the question of international shipping on the NSR more comprehensively than has ever before, not only as a matter of theoretical research but also as a practical matter, assessed in commercial, political and maritime terms. The researchers highlighted the high cost of icebreakers' services: an icebreaker tariff assumes a flat rate of around $5 per gross tonnage, that is 26% less than the extrapolated values estimated from the current guidelines (Ragner *eds.* 2000). Still, the tariffs are unjustified and overpriced, and this situation is currently being addressed by Russian policy-makers with an understanding of the inter-linkages between tariffs and cargo flow on the NSR. Annual cargo flow of up to 10 million tons determines the repayment of maintenance costs of the icebreaker fleet with the average icebreaker fee of $5-$7/ton (Ragner *eds.*2000).

Valsson (2007) points out that the planning theory maintains that on all levels the amount of transportattion has a decisive impact on where settlements and economies can prosper.

3. Data and Methodology

This research is supported by a unique database of potential investment projects in all sectors of economy and, in particular, infrastructure development projects (transport, communications, social infrastructure, etc.) in all regions of Russia until the year 2020. The database has been compiled over the course of a structured request to Federal authorities, regional authorities and business in Russia.

The research methodology consist of: 1) qualitative methods, including comparative economic analysis, and case studies based on investment projects' database, and structured interviews; 2) mapping and geographic analysis techniques (MapInfo); and 3) quantitative methods.

First, based on the thorough study of Russia's national development priorities as well as the Arctic regions' social and economic development priorities, the urgent need to modernize the NSR is discussed. Secondly, analytical maps with an indication of transport infrastructure (including the NSR), investment projects and the advanced development zones are provided. Thirdly, Arctic shipping development prospects are forecasted by evaluating the total freight cargo, including transit cargo on the NSR. And finally, the required number of the nuclear icebreakers is assessed.

4. Northern Sea Route within the Framework of Strategic Planning in Russia

4.1. Northern Sea Route

For decades the key role of the NSR was to connect the European and Far Eastern ports as well as to ensure that the state transport system continued to function in areas with extremely difficult access like remote archipelagoes, islands, seas and coasts of the Arctic, and central regions of the Eastern and Western Siberia. For example, more than 70 settlements receive supplies through the "northern delivery". The NSR also serves the large river ports, such as Igarka, Dudinka, Dixon, Tiksi, Pevek, by connecting the great Siberian rivers and sea trade routes to a unified transport system suitable for shipping "cabotage" and export cargoes.

The most active user of the NSR is "Norilsk Nickel" company, having no other route to transport its products. In the past the NSR was the national transport corridor primarily used for bringing natural resources out, and for bringing deliveries in to the many settlements in the Russian Arctic. Perhaps more importantly the future of the NSR will be linked to the international transit of cargo vessels with tonnage exceeding 100,000 tons. Today, the NSR is rapidly becoming a transit Arctic shipping route that can provide an alternative to the

existing intercontinental shipping routes between the Atlantic and Pacific Oceans through Suez and Panama canals.

Having studied the recent Government plans to modernize the NSR and its infrastructure (including most notably the fleet of powerful nuclear icebreakers), most of the ports and towns will benefit from the development of navigation on the NSR, for example material procurement will be improved, port infrastructure will be updated, new jobs will be created. In addition, the NSR is the key to emerging areas of human activity on the northern borders and the continental shelf.

Overall revitalization of the NSR will require: 1) icebreaker fleet renewal; 2) rescue and hydrographic fleet renewal; 3) construction and modernization of onshore infrastructure (administrative buildings, wharehouses for equipment storage) to upgrade search and rescue in the Arctic; 4) modernization of the Arctic ports (Khatanga, Tiksi, Pevek, Dudinka, Dikson); and 5) dry cargo fleet and tanker fleet renewal to name but a few.

4.2. Strategic Planning of Socio-Economic Development of the Arctic Regions

The development of specific sectors of the Russian economy and regions must be considered within a strategic planning framework. Transport in itself is not the final objective; it must also promote regional development and international economic cooperation. Navigation on the NSR should be efficient, safe, and reliable thereby increasing accessibility to northern regions and their involvement in international trade. Given the NSR's role in establishing a single economic zone, it should become a permanent and continuously operating transport route.

It is generally accepted that the Arctic region is extremely rich in hydrocarbon, mineral and other resources (Map 1).

- - - Northern Sea Route

Territories of Natural Resources Production:

■ extraction of fuel and energy mineral resources rials

■ precious metals and precious stones extraction

■ extraction of widely-spread resources

■ extraction of other resources

Map 1. Natural Resources Development Territories, Transport Corridors, and Advanced Development Zones in Russia until the year 2020

Source: Author.

4.2.1. Oil and gas

First and foremost, it has been proven that the territories of the Far North have great potential energy reserves. The main Arctic fuel and energy province for decades to come in Russia is Yamal. Approximately 87% of Russian gas is produced in Yamal-Nenetsky Atonomous Region, and the Yamal Peninsula is the future of the domestic oil and gas industry. The Ministry of Energy of the Russian Federation estimates hydrocarbon reserves of the Yamal Peninsula as 50 trillion cubic meters. Up to 65 million tons of gas will be supplied to the Asian-Pacific markets after the construction of several liquefied natural gas (LNG) plants in the territory of Yamal Peninsula, and there is already a project to develop the

Bovanenkovskoe oil and gas condensate field. As such "Gazprom - Oil" is considered to be one of the potential users of the NSR.

Large hydrocarbon deposits are located in the Barents Sea and the Kara Sea. At present more than 10 oilfields and gasfields have been discovered in the Barents Sea, including one unique deposit – Shtockman; seven large deposits – Ledovoe, Ludlovskoe, Murmanskoe, Dolginskoye, Prirazlomnoye, Medinskoye-Sea and Severo-Gulyaevskoye; two medium size deposits - Pomorskoye and Severo-Kildinskoye; and one small deposit - Varandey-sea. Among the above-mentioned oilfields and gasfields, there are four gas deposits, two gas-condensate deposits, four oil deposits, and one gas and oil deposit.

The Pechora Sea (south-east of the Barents Sea) is a region of intense hydrocarbon development. Exports from the famous Varandey terminal by tankers equal 7.5 million tons per year, and in the coming years this amount will increase further. Prirazlomnoye oil field development – where oil platforms will be installed will add 7-7.5 million tons. As a result of oil transportation from this region, the volume of freight traffic on the NSR may be increased by 19-20 million tons by the year 2015.

On the shelf of the Kara Sea, two gas condensate fields have been discovered - Rusanovskoye and Leningradskoye. Both of them are unique in terms of potential resources. In addition, OJSC "Gazflot" has discovered a number of gasfields in the Ob Bay and Taz Bay.

4.2.2. Non-ferrous Metals, Ferrous Metals and Other Ore Minerals

Arctic regions contain diverse mineral deposits, and their transportation depends on the nuclear icebreaker fleet. These mineral deposits consist of: 1) nickel, copper, and platinum (about 85% of nickel and 60% of copper reserves, and over 95% of platinum is concentrated in the Norilsk industrial region); 2) manganese ores and complex ores in Novaya Zemlya; and 3) ore minerals in Taimyr and Northern Yakutia.

The open joint stock company “Mining and Smelting Complex - Norilsk Nickel” is one of the largest shippers on the NSR. The development strategy of the business group proposes two scenarios for the development of enterprises in the Norilsk industrial district. These

scenarios propose either to maintain the current production volume or to reduce the current production volume.

Even the most conservative scenario for the Norilsk industrial district does not suggest a decline in the ore extraction and concentration. On the contrary, capacity of the Talnakh Concentration Plant will increase from the current 7.5 million tons of the processed ore to 10.5 million tons by 2013. As a result a decline in production volumes of high value added steel against the background of increased volumes of ore concentration is expected. In these circumstances it is possible not only to maintain the current volume of freight traffic on the NSR (in physical terms), but even to increase it slightly.

The nuclear icebreakers travel to the port of Dudinka year round. The need for the nuclear icebreaker fleet near Taimyr will remain as long as there is a need for freight traffic from the Norilsk industrial region.

Additional demand for the nuclear icebreaker fleet's services will be created as a result of the "Belkomur" project , a rail corridor that will connect the Ural and north-east of Volga regions through the Komi Republic to the port of Arkhangelsk. The main cargo traffic will consists of metals, fertilizers and other chemical products, timber and wood products, as well as pulp and paper products. The total projected amount of goods that will be shipped from the port of Archangelsk, is approximately 22 million tons. Transportation of these goods during the winter will require the nuclear icebreaker fleet's services.

In the long term, the advanced nuclear icebreaker fleet will allow for the development of other promising mining areas.

4.2.3. High Ice Class Vessels

The strategic planning in Russia until the year 2020 assumes the construction of modern shipping vessels. The overwhelming majority, 153 of 196 ice-class Arctic cargo vessels are registered in Russia.

In recent years the resource extraction companies have established their own fleet of high ice-class vessels. "Norilsk Nickel" company is operating five high ice class vessels, equipped

to overcome ice thicknesses of up to 1.5 meters. The “Norilsk Nickel” company still relies on the icebreakers for ice piloting of cargo vessels on Enisei river to guarantee regular and predictable deliveries. In all circumstances the resource extraction companies highlight the importance and necessity of the nuclear icebreakers on the NSR for rescue operations and safety provisions.

5. Nuclear Icebreaker Fleet in the Northern Sea Route

In Russia the icebreaker fleet consists of nuclear and diesel powered icebreakers. The diesel icebreakers operate only on limited routes in the Far East and Barents Sea. By contrast, the nuclear powered icebreakers are much more powerful than diesel icebreakers. One of the nuclear icebreaker’s key advantages is that there is no need for frequent refueling, which can occur while navigation in the ice. It is impossible to imagine the Arctic region and the NSR being used as a navigation route without the use of nuclear icebreakers. They clear the waterway, are indispensable in any emergency situations, and have extended the navigation period in the Eastern Arctic.

Currently, all the nuclear icebreakers are in the western region of the Arctic - Barents Sea and Kara Sea. In the near future at least one nuclear icebreaker will be based in the Far East.

In 2008, the nuclear icebreaker fleet was placed under the authority of the State Corporation "Rosatom" and is under the economic authority of Federal State Unitary Enterprise "Atomflot" (integral part of Rosatom, which, in its turn reports to the Ministry for Industry and Trade). The modern nuclear icebreaker fleet in Russia consists of: 1) six nuclear icebreakers (4 icebreakers of “Arctika-type”: “Rossia”, “Sovetsky Soyuz”, “Yamal”, “50 Let Pobedy” and two icebreakers of “Taymyr-type”: “Taimyr” and “Vaygach”); 2) the nuclear container carrier “Sevmorput”; and 3) five special vessels.

"Arktika-type” nuclear-powered icebreakers are used to accompany cargo and other vessels on the NSR. Due to the use of Arktika type icebreakers the year-round navigation in the Western Arctic started in 1978 to supply the Norilsk industrial area with resources.

“Taimyr-type” low-draught nuclear icebreakers, namely "Vaigach" and "Taimyr", were designed and constructed to navigate on rivers and, in particular, serve the port of Dudinka located on the shallow waters of the Yenisei River.

All nuclear icebreakers, except for "50 Let Pobedy", were built before 1991. Among 6 icebreakers, only two of them - "Yamal" and "50 Let Pobedy" – have not yet reached the end of their service life. "Yamal" will reach the end of its service life in 2011. According to the Ministry of Transport of the Russian Federation, 12 out of 15 nuclear and diesel-powered icebreakers will have to be decommissioned by the year 2020. For instance, and icebreakers “Taimyr” and “Vaigach” will be pulled out of operation by 2018. Given that the nuclear icebreaker fleet is aging, it must be gradually replaced with new models. To continue successfully operating in the Arctic, Russia intends to develop and improve the nuclear icebreaker fleet, a key element of the NSR logistics and infrastructure system.

Calculations have shown that for the prospective transportation provision - instead of four or five nuclear-powered icebreakers of the "Arctika" - type - only three universal nuclear icebreakers with two varying draughts are sufficient. This approach will guarantee a savings in the cost of construction, and three new generation nuclear icebreakers have already been approved for construction by the Ministry of Finance.

6. Arctic Shipping Development Prospects Evaluation

6.1. Total Cargo Flow via NSR

In last decades the operations on the NSR has reflected the ups and downs of the Russian economy as a whole (Table 1).

Year	Freight Traffic Activity	Year	Freight Traffic Activity	Year	Freight Traffic Activity
1987	6,579 (max)	1996	1,642	2005	2,023
1988	6,295	1997	1,945	2006	1,956
1989	5,823	1998	1,458 (min)	2007	2,150

1990	5,510	1999	1,580	2008	2,219
1991	4,804	2000	1,587	2009	2,000
1992	3,909	2001	1,800	2010	1,800
1993	3,016	2002	1,600	*2011*	*3,000*
1994	2,300	2003	1,700	*2012*	*5,000*
1995	2,362	2004	1,718		

Table 1. Annual Freight Traffic Activity on the NSR (1933-2011), in thousand tons

Source: SOPS and Soyuzmorniiproekt. Cited as in "NSR is revitalizing Again", April 29, 2011 - for years 1933-2008

Author estimates - for years 2009-2012

The cargo flow on the NSR dropped from 6.6 million tons in 1987 to 1.4 million tons in 1998. The challanges and the crisis of the 1990s led to the deterioration of the Arctic infrastructure , and the Arctic transport system proved to be decentralized. The cargo flow started to increase again in 2000. In 2005-2007 the amount of cargo shipped in the Arctic region exceeded 2 million tons and kept growing.

In 2010, total cargo flow reached 1.8 million tons. The striking fact is that the annual cargo flow in the Western Arctic is significantly larger than cargo traffic in the Eastern Arctic – just 150 - 200 thousand tons. In 2011, cargo flow on the NSR will be around 3 million tons, including transit freight traffic of 800 thousand tons and domestic cargo an additional 200 thousand tons. The NSR's capacity is 9 million tons, six million of which is bound eastward, and three million westward (Forostenko, 2011). At present only 30% of the NSR's potential is used. The total freight traffic along the NSR is expected to exceed five million tons by 2012.

To accommodate the gas and oil field development projects in the Yamal Peninsula, and economic development projects in Siberia and Russia's Far East, the Arctic sea transport system will have to deal with increased shipping traffic on the NSR, which is projected to grow to 80 million tons by 2030.

Taking into account the forecast for domestic cargo as well as the forecast for the international transit freight cargo, the total annual freight traffic along the NSR may reach 20

million tons by the year 2015, 50 million tons by 2020, 75 million tons by 2025, and more than 100 million tons by 2030.

6.2. Transit Potential of the NSR as a Nexus between Europe and Asia-Pacific Region

The transit routes through the NSR are also quite attractive for foreign cargo owners and have great potential to attract transit cargo in the Arctic. The trial passages performed through the NSR in 2010 demonstrated not only the possibility, but also the economic viability of this shipping route. In August 2010 a pilot transit of the Arctic ice class 1A Super (Arc5) tanker «SCF Baltica» on the NSR was successful. The tanker «SCF Baltica» ("Sovkomflot" group of companies) with deadweight 117,000 tons, delivered 70,000 tons of gas condensate of the "Novatek" company from Murmansk to Ningbo (China) via the NSR. An ice convoy of the tanker «SCF Baltica» through the Taimyr and Ayonskogo ice was carried out by the nuclear icebreakers "Taimyr", "Russia" and "50 Years of Pobedy."

7. The Proposed Scenario for the Nuclear Icebreaker Fleet Development until Year 2030

The proposed scenario is presented in phases of approximately five years, and will vary in accordance with the external conditions, which may result in an increased or decreased in the duration of each phase.

Key events for each phase are considered, including: provisions for service demands on the nuclear icebreaker fleet institutional change and organizational and technological developments.

It is assumed that demand for work and services for the State in terms of national security (military and naval operations, maritime security, contingency plans) remains at the current level for all scenarios.

Due to the fact that most of the time, the Arctic seas are ice-covered, assistance from the nuclear icebreakers is one of the main components of navigation safety on the NSR. To replace the outgoing ships, 4-5 new genearation nuclear icebreakers will be required in the

long-term (15-20 years). As such , in addition to the existing icebreaker “50 Let Pobedy”, at least 3 new generation nuclear icebreakers have to be put into operation by year 2025. Given the construction time needed, the icebreakers may be slated for delivery in years 2016, 2024 and 2028. These icebreakers will ensure a stable year-round pilotage along the entire NSR.

The design of the new generation nuclear icebreaker (LK-60 N) was completed in 2010. This icebreaker will have the overall power of 60 MW with variable draughts (from 8.5 m to 10.8 m), and will be able to replace an icebreaker of “Arktika-type” and “Taimyr-type”. In 2016-2017 there may be an “icebreaker pause” as a result of the expiration of the exploitation period for “Taimyr” and “Vaygach”. Given this possibility it is importance to put into operation nuclear icebreaker with two varying draughts, to eneable them to serve ports in Yenisei river mouth. Nuclear icebreakers with two varying draughts can be used all-year in the Western Arctic, and in the summer-autumn season in the Eastern Arctic. It should be noted that multi-functionality is built into the new generation nuclear icebreakers and diesel-electric icebreakers, which will allow them to convoy ships, as well as rescue people and vessels, and repair of oil spills at sea.

Development of the Russian nuclear icebreaker fleet is implemented according to the framework of the Federal Target Programs (FTP). The construction of three additional nuclear icebreakers with two variable draughts each and six diesel icebreakers have been planned as part of the FTP “Development of Transport System of Russia (2010-2015)”, using the Federal budget..

The proposed scenario for nuclear icebreaker fleet development until 2030 is presented in Table 2. In the first stage (2010-2015), one out of three additional nuclear icebreakers will be put into operation. In the second stage (2015-2020), an assessment of the number of required icebreakers for shipping provisions on the NSR is taken into account keeping in mind the life extension of nuclear and diesel icebreakers. The third stage (2020-2025), will see two additional universal nuclear icebreakers being put into operation. And in the fourth stage (2025-2030), the number of nuclear icebreakers will be maintained in accordance with

the demand for commercial services and guaranteed performance of public responsibilities by constructing new nuclear icebreakers.

<table>
<tr><th>Characteristics of the Nuclear Icebreaker Fleet Development Stages</th><th>Measures to be Implemented</th></tr>
<tr><td rowspan="6">Stage 1.
Years: 2010-2015
The annual total freight traffic along the NSR may exceed 5 million tons in year 2012, and 20 million tons in 2015.
Stage 1 is characterized by:
1) stabilization of commercial demand for nuclear icebreaker fleet services at a relatively low level,
2) growth of commercial demand for nuclear icebreaker fleet services is possible by the end of the period as recovery from the recession occurs,
3) services volume growth for State needs in terms of the geological, geophysical, hydrographic, cartographic, and other work on the preparation of materials for increased economic development in the Arctic zone of the Russian Federation.</td><td>1. Bringing the number of nuclear icebreakers in line with the present demand for commercial services and performance of public duties. Staff restructuring.</td></tr>
<tr><td>2. Construction of one additional new generation universal nuclear icebreaker with the overall power of 60 MW will be launched in 2012 and completed in 2016.</td></tr>
<tr><td>3. Activities deployment and utilization of decommissioned nuclear icebreakers.</td></tr>
<tr><td>4. Remedial maintenance, base modernization, and security equipment modernization (operations with radioactive waste and spent nuclear fuel).</td></tr>
<tr><td>5. Relationship restructuring between the nuclear icebreaker fleet operator – Rosatomflot – and the State.</td></tr>
<tr><td>6. Start of work on the formation of public-private partnerships (PPPs) to enhance logistic effectiveness for major customers.</td></tr>
<tr><td rowspan="2">Stage 2.
Years: 2015-2020
The annual total freight traffic along the NSR may reach 50 million tons by the year 2020.
Stage 2 is characterized by:
1) moderate growth in the demand for</td><td>1. Maintain the number of nuclear icebreakers in accordance with the demand for commercial services and guaranteed performance of public responsibilities by extending the life of nuclear icebreakers.</td></tr>
<tr><td>2. Activities on utilization of the decommissioned nuclear icebreakers.</td></tr>
</table>

commercial services, 2) significant amount of services for State needs. Nuclear icebreaker fleet will participate in expanded use of the NSR for transit of international cargo between Europe and Asia.	4. Maintenance facilities modernization completion, including facilities for safety.
	5. Implementation of government orders for system improvemnents.
	6. Rosatomflot participation in the formation of transport and logistic systems in the Western Arctic in cooperation with PPPs.
Stage 3. Years: 2020-2025 The annual total freight traffic along the NSR may reach 75 million tons by year 2025. Stage 3 is characterized by: 1) strong growth in demand for commercial services in the Western Arctic, 2) gradual growth in demand for commercial services in the Eastern Arctic. The volume of services for the State needs will remain stable. Nuclear icebreaker fleet will take part in the development of the NSR for use in transit of international cargo between Europe and Asia.	1. Maintain the number of nuclear icebreakers in accordance with the demand for commercial services and guaranteed performance of public responsibilities by putting two new generation nuclear icebreakers into operation.
	2. Activities on utilization of the decommissioned nuclear icebreakers.
	3. Maintenance facilities (including facilities for safety) readiness for the complete maintenance cycle for the new generation nuclear icebreakers put into operation. Scaling up the use of maintenance facilities.
	4. Rosatomflot participation in the formation, of an integrated transport and logistic systems throughout the NSR in cooperation with PPPs,.
Stage 4. Years: 2025-2030. The annual total freight traffic along the NSR may reach more than 100 million tons by year 2030. Stage 4 is characterized by:	1. Maintain the number of nuclear icebreakers in accordance with the demand for commercial services and guaranteed performance of public responsibilities by constructing new nuclear icebreakers.
	2. Activities on utilization of the decommissioned

1) moderate growth in demand for commercial services in the Western Arctic, 2) increased demand for commercial services in the Eastern Arctic. The volume of services for the State needs will be reduced. Nuclear icebreaker fleet will be involved in the NSR's steady tranformation into a year-round transportation route.	nuclear icebreakers.
	3. Maintenance facilities (including facilities for safety) readiness for the complete maintenance cycle.
	4. Rosatomflot participation in the development of an integrated transport and logistic systems throughout the NSR in cooperation with PPPs.
	5. Rosatomflot contribution – on the condition of PPPs – to international cargo growth on the NSR.

Table 2. The Proposed Scenarios for the development of the Nuclear Icebreaker Fleet until the year 2030

Source:Author

8. Conclusion

To date the NSR remains a difficult and dangerous route, which is available for navigation for only 5-6 months a year. In addition to the existing fleet, at least three new generation nuclear icebreakers will be needed to make it possible to extend the navigation period of the NSR. The NSR will be critical in securing the transit of Arctic-produced oil and gas to European and Asia-Pacific countries, and to other regions of Russian regions via the shortest route for vessels with international cargo from the Western Europe to Pacific Rim countries.

Gas and oil company ventures in the Yamal Peninsula, coupled with the growing interest in the NSR from the national and international shipping companies, bode well for the transformation of the NSR into a very busy sea route; and the railroad projects will be followed by the other infrastructure catch- up projects.

Significant public financing and private investment are necessary for the further development of the NSR. Although the direct commercial return is not sufficient to finance the new generation nuclear icebreakers, the investment will certainly pay for itself through economic development of the Northern regions, and revenues from the transit of goods through the NSR. The "polar" vector of the economic development should exist and prosper.

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