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Arctic economics: What is missing? The case of the Northern Sea Route[1]

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Abstract. Traffic on the Northern Sea Route has been growing steeply in later years with the completion of the Yamal LNG project. More LNG development is likely to take place within the next few years. It is now planned to send LNG directly to Asia all year going east on the NSR. Presently, parts of the NSR are for practical purpose unnavigable for several months each year. To use the whole sea route also in the coldest winter months will require presence of a series of new icebreakers. A construction program is being implemented. A comprehensive analysis of the costs vs. the benefits of opening a whole year route has not been published. The purpose of this paper is to review various cost estimates available from open sources and estimate what traffic volumes and tariffs would be required to cover operational as well as capital costs for the new icebreaker fleet.
Keywords: *Northern Sea Route; icebreakers; Rosatom; Lider; Novatek; LNG; costs; Arctic; investments*

Introduction

Development of Russia's Arctic Zone has high political priority. This is repeatedly stated in official documents and declarations. The Northern Sea Route is a key component in this effort.

In later years a considerable growth in destination traffic has taken place, first with construction materials and equipment for the construction of the port and LNG plant at Sabetta, and since the start-up of Yamal LNG in December 2017 with the regular sailings of LNG carriers both westwards and eastwards. More LNG development is likely to take place within the next few years and it is projected that growing volumes will be sent eastwards.

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For this to happen it is necessary to provide all-year navigation, whereas presently major parts of the NSR is unnavigable for several months each year. The official expectation is also that trans-Arctic transit traffic between the Pacific and the Atlantic will increase. To use the whole sea route also in the coldest winter months will require presence of a series of new icebreakers. A construction program is now being implemented.

A comprehensive analysis of the costs vs. the benefits of opening a whole year route has, however, not been published. The purpose of this paper is to review various cost estimates available from open sources. It will then try to estimate what traffic volumes and tariffs would be required to cover operational as well as capital costs. Finally, it will be discussed how the conclusions arrived at can be interpreted.

The analysis entails big challenges with regard to data quality as well as assumptions, but the data sources are made as transparent as possible. Nevertheless, further research and discussion will be necessary.

Cost estimates for NSR development

I have found few, if any, comprehensive analyses of cost vs income potential from transit shipping on the NSR. But several authors discuss the issues. For instance, Besrukov argues that expectations for international transit traffic is insufficiently justified and that it is unlikely to serve as an impulse for resurrection and modernization of ports [Безруков, 2017]. Also Lukin is clearly sceptical about the economic potential of the sea route [Лукин, 2015]. Inozemtsev has in several articles strongly criticized investments in the NSR, arguing that they are uneconomic [Иноземцев, 2015].

It is evident that the Russian authorities have been struggling with the economics of the NSR. In 2015 “A complex plan for development of the Northern Sea Route” for the period 2015–2030 was confirmed by the Russian government[2]. The document was not published, with reference to sensitive information, but according

[2] Справка о Комплексном проекте развития Северного морского пути. 8 June 2015. http://government.ru/orders/selection/405/18405/

to the Ministry for Development of the Far East, the plan did not include a financial or economic model for the sea route[3].

The president gave that ministry the task and in late 2015 it issued a tender for a study to develop "The conceptual basis for a competitive model for development of the Northern Sea Route"[4]. The tender was won by the Analytical centre of the Russian government, who carried out the project in cooperation with the consulting company McKinsey [Севморпути…, 2016]. The report was not made public, but Rossiyskaya gazeta published an article in August 2016 with references to the conclusions [Деньги… 2016].

According to the article, international container traffic was seen as having a large potential for development of NSR. However, in April 2019 vice premier Trutnev announced that the Ministry for Development of the Far East and the Arctic, Rosatom and the Ministry of Transport would prepare a new economic model for development of NSR within 2–3 months[5].

In June 2019 Rosatom announced that a draft plan for infrastructure development of the NSR until 2035 had been submitted to the government, but not published[6]. Trutnev criticized the plan for being too focused on icebreakers, referring to Rosatom's new broader responsibility as logistics operator of the NSR since end 2018.

Rosatom, on its side, maintained that the plan was complete, but would have to be adjusted in light of the new version of the strategy for development of Russia's Arctic zone, expected in December 2019 [План Росатома.., 2019]. Finalization of the strategy was postponed to 20 March 2020, but in the meantime the government confirmed a plan for infrastructure development on the NSR until 2035 [Арктический… 2020]. It has so far not been published, but according to an article in Rossiyskaya gazeta, as

[3] Финансово-экономическая модель развития Северного морского пути будет представлена в июне 2016 г. – Минвостокразвития. Morskie vesti Rossii, 9 March 2016. http://www.morvesti.ru/detail.php? ID=52960

[4] https://www.bicotender.ru/tender40566843.html

[5] Юрий Трутнев провёл заседание президиума Государственной комиссии по вопросам развития Арктики. 10 April 2019. http://government.ru/news/36350/

[6] Трутнев потребовал от «Росатома» план развития Северного морского пути, *RBK*, 25 July 2019. https://www.rbc.ru/business/25/07/2019/5d39b88f9a794786fdfbd469?from=from_main

well as an overview given by Trutnev[7], it seems that the document focuses on infrastructure, resource projects and requirement for new vessels, including icebreakers and does not contain a comprehensive economic model.

The picture is somewhat clearer when it comes to investment plans. The recent "Complex plan for modernization and extension of main infrastructure in the period until 2024", adopted by the Russian government in September 2018 includes a Federal project on the Northern Sea Route which stipulates measures to improve emergency communication, navigation infrastructure, construction of rescue capacity – both boats and bases, development of some port infrastructure, notably an LNG terminal for Arctic LNG 2. (The Plan for infrastructure development on the NSR until 2035 discussed above is supposed to be a realization of measures in the Federal project[8].)

The Federal project also includes construction of four LNG powered icebreakers for Atomflot, but a specific budget for them was not given (see also below)[9]. General port development in the Arctic is included in a separate project and the NSR project does not include construction of nuclear icebreakers or long distance diesel-electric icebreakers.

Total expenses for the listed items in the Federal project on the NSR for the period 2019–2024 were given at 587 bill. roubles in the plan released in September 2018. However, in the revised estimate from January 2019 the sum had increased by 25 per cent to 734 bill. roubles. Only 37 per cent of this is planned to be covered by the federal budget, the lion's share should be financed by users and other investors[10].

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[7] Трутнев раскрыл детали плана развития Северного морского пути. RIA-Novosti, 12 December 2019. 30 December 2019. https://ria.ru/20191212/1562324555.html?in=t

[8] Медведев утвердил план развития инфраструктуры Севморпути до 2035 года, RIA-Novosti, https://ria.ru/20191230/1563007104.html

[9] Комплексный план модернизации и расширения магистральной инфраструктуры на период до 2024 года, Утвержден распоряжением Правительства Российской Федерации от 30 сентября 2018 г. № 2101-р. http://static.government.ru/media/files/MUNhgWFddP3UfF9RJASDW9VxP8zwcB4Y.pdf

[10] Проект Северного морского пути подорожал почти на 150 млрд руб. *RBK*, 1 February 2019. https://www.rbc.ru/business/01/02/2019/5c52ffe49a79475910e538d3

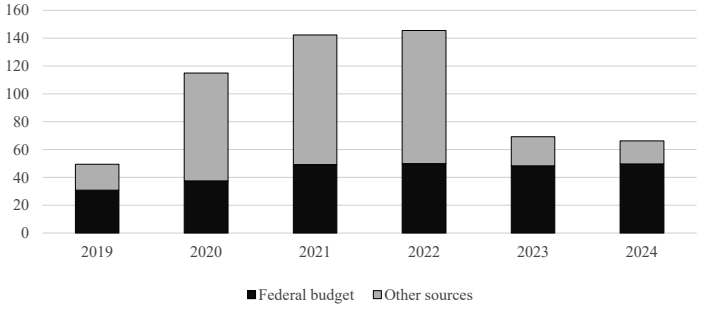


Figure1. Financing of the federal project "Northern Sea Route" (bill. Roubles).

Source: Распоряжение Правительства Российской Федерации от 30 сентября 2018 г

Nuclear icebreakers

Icebreakers is a key component of Russia' Arctic infrastructure. But it took a long time to decide on construction of a series of three 60 megawatt icebreakers to replace the existing fleet, which was gradually being decommissioned. When the decision was made in 2011 it was still unclear how the program should be financed[11].

The icebreakers were estimated to cost some 37 bill. roubles each (appr. USD1.2 billion at the time). The Ministry of Finance insisted that the federal budget should only cover 30–40 per cent of the construction costs, leaving the rest to users of the sea route. However, it turned out to be impossible to obtain such external financing and the government promised to fully finance all the three new icebreakers. In 2014 a state program for development of the nuclear energy-industrial complex was adopted. In the program

[11] The start of construction and the financing of the Arktika 60MW series is detailed in Arild Moe and Lawson Brigham: Organization and Management Challenges of Russia's Icebreaker Fleet, *Geographical Review*, Vol 107, No 1, 2017, pp. 48–68. Can be downloaded from https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1931–0846.2016.12209.x

121 bill roubles were assigned for construction of the three new icebreakers in the period 2012–2020[12].

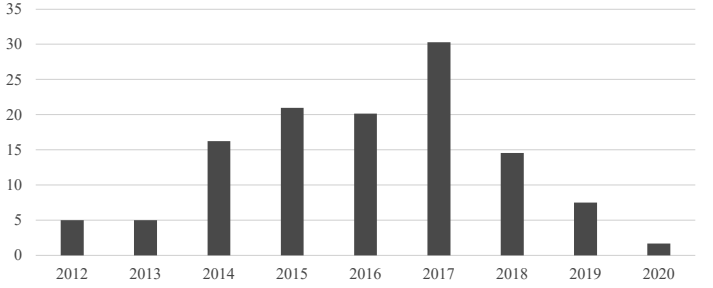


Figure 2. State investments in three new 60 MW nuclear icebreakers (project 22220), as expected in 2014 (bill. roubles).

In addition to the construction costs, the program also contained a budget line for various measures to keep operating nuclear icebreakers in a safe condition.

Proposals to construct a new 120 MW icebreaker – twice as powerful as the Arktika series – have been under discussion for some time[13]. It is designed to break 4.3 m ice and open a channel 50 meters wide, which means it would be capable to go through the whole NSR any time of the year and escort very big ships.

In 2018 it was announced that the construction costs for "Lider" would be 99 bill roubles (including mva, first fill-up with fuel, bank guarantees and insurance during construction period)[14]. By August 2019, it was clear that the icebreaker would be built, but it

[12] Об утверждении государственной программы Российской Федерации «Развитие атомного энергопромышленного комплекса». Постановление Правительства РФ от 2 июня 2014 г. N506–12. http://government.ru/docs/12959/

[13] Дмитрий Рогозин поддержал проект создания атомного ледокола «Лидер, *PortNews*, 7 December 2015. http://portnews.ru/news/211157/

[14] Российский бюджет наткнулся на айсберг. News.ru, 15 October 2018. https://news.ru/economics/rossiya-ledokol-arktika-stroitelstvo/

was reported that the cost of the first 'Lider' was estimated to be 120 bill. Roubles, according to Rosatom's president[15].

In January 2020 a government resolution set aside 127 mill roubles for the construction, fully financing the vessel from the federal budget[16]. It will be built at the new giant "Zvezda" yard in the Far East. Rosatom expects the vessel to be delivered by 2026–2027[17]. According to "Zvezda", steel will be cut in 2020[18]. In the federal budget for 2020 and the plan period 2021–22, 25, 21 and 15 bill. Roubles have been set aside for the project in the respective years[19].

Atomflot has stressed on several occasions that one "Lider" is not enough. "Really, according to the calculations of our specialists, of such icebreakers as "Lider" there should be a minimum of three"[20]. A formal decision to build two additional "Lider" has not been taken, but they are referred to as "planned" by Zvezda[21]. No implementation period has been announced, but Rosatom has presented a sketch, indicating that they should be delivered in 2032 and 2034 respectively[22].

Different financial schemes have been discussed for the second and third "Lider". One idea is to take up bank loans and combine them with funding from Rosatom and federal government money, another proposal is to establish a concession system, where the

[15] Постановление правительства уточнит все нюансы строительства ледокола «Лидер», Sever-press.ru, 23 August 2019. https://sever-press.ru/2019/08/23/postanovlenie-pravitelstva-utochnit-vse-njuansy-stroitelstva-ledokola-lider/

[16] Ледокол «Лидер» введут в эксплуатацию в 2027 году. Strana Rosatom, 27 January 20120. http://strana-rosatom.ru/2020/01/27/ледокол-лидер-введут-в-эксплуатаци/

[17] Росатом и «Звезда» в ближайшее время подпишут контракт на строительство ледокола «Лидер». *Morskoy transport*, 18 July 2019. http://morvesti.ru/detail.php? ID=79685

[18] Константин Лаптев: «Звезда» сама сможет полностью построить ледокол «Лидер». Ria-Novosti, 5 September 2019. https://ria.ru/20190905/1558341817.html

[19] Federal budget for 2020 and the plan period 2021–2022, item 041222508. See also "На создание ледокола «Лидер» направят 60,5 млрд руб. на ближайшие годы». *Korabel.ru,* 30 September, 2019. https://www.korabel.ru/news/comments/na_sozdanie_ledokola_lider_60_5_mlrd_rub_na_blizhayshie_gody.html

[20] «Атомфлот» рассчитал потребность России в ледоколах «Лидер». Sudostroenie Info, 21 June, 2017. https://sudostroenie.info/novosti/19660.html

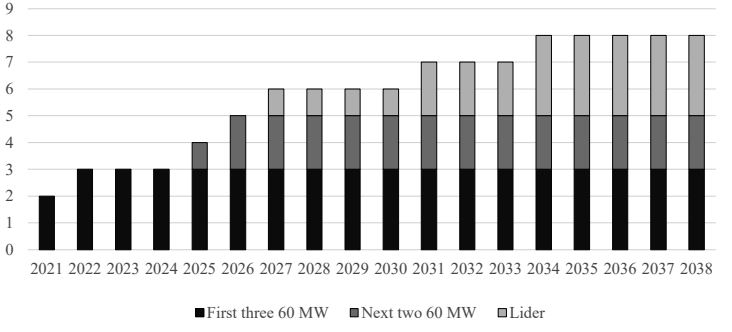
[21] Верфь «Звезда» сможет полностью построить ледоколы типа «Лидер». Ria-Novosti, 5 September 2019. https://ria.ru/20190905/1558353192.html

[22] K. Yu. Knyazevskiy: Развитие атомного ледокольного флота для обеспечения крупнейших национальных Арктических проектов. Atomflot, Presentation, St. Petersburg 20–21 June 2019.

concessionaire – Rosatom – is responsible for construction as well as providing icebreaker escort services [«Росатом» намерен.., 2019].

Whereas such solutions will relieve the federal budget of direct expenses, it can be argued that at the end of the day the difference for the Russian state economy will not be huge, especially since Rosatom is a state corporation. But obviously, the concession model would give Rosatom more control of the project and probably more incentive to economize as well as earning money from escorts. It seems unlikely though, that Rosatom will be able to decide on where the icebreakers will be built.

In parallel it has been decided to build two more Arktika class 60 MW icebreakers (project 22220). They will, like the first three in the series, be built at Baltiyskiy zavod in St. Petersburg, who received the order in August 2019. The federal budget will cover 45 bill. roubles, and Rosatom and Atomflot the rest. Total costs will be "more than 100 bill. Roubles", according to Rosatom. Construction will start in 2020 and delivery dates are December 2024 and December 2026[23]. They are intended to replace two of the operative icebreakers – Taymyr and Vaygach – which should be taken out of service by then.



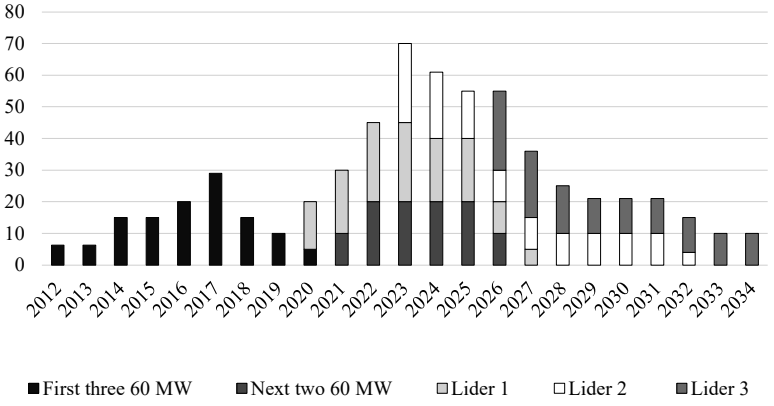
Source: Atomflot, 2019.

Figure 3. Completion year of new icebreakers and composition of fleet (number), according to decided plans and projections.

[23] Росатомфлот подписал договор на строительство третьего и четвертого универсальных атомных ледоколов проекта 22220. Rosatom press release, 23 August 2019. https://www.rosatom.ru/journalist/news/rosatomflot-podpisal-dogovor-na-stroitelstvo-tretego-i-chetvertogo-universalnykh-atomnykh-ledokolov-/?sphrase_id=828033

Adding up investments

Summing up the expenditures for icebreaker construction discussed above is a risky enterprise. The numbers include both already committed sums, planned expenses, as well as uncommitted budget allocations and estimated costs. Most of the sums have been announced in the period 2017–19 and we keep the original numbers as input. The budget for the first three 60 MW icebreakers was made in 2014, but the price of the second and third of them has been revised by Rosatom. The price increase is only 11 and 17 per cent respectively, however, less than what one would have expected given the depreciation of the rouble.



Sources are cited in the text. Implementation schedules according to projections from Atomflot. Distribution of budgets over years, where not cited in the text, has been calculated by author.

Figure 4. Projected budgets for construction of nuclear icebreakers (bill. 2019 roubles).

Altogether this icebreaker construction program amounts to 597 bill. 2019-roubles. But how much of this can be said to be additional expenditures for an extended navigation season?

When the construction program for the three first 60 MW Arktika series was launched, the argument was that new icebreakers were long overdue and necessary to replace operating icebreakers

approaching the end of their service life and avoid a *ledovaya pauza.* Indeed, the nuclear resource in three aging icebreakers was renewed to permit continued operation until the three new icebreakers were expected ready around 2018–2020.

Icebreaking needs for Yamal LNG and the Novy Port oil project was a key issue. Initially, representatives of Novatek and Yamal LNG announced a modest need for icebreaking, mainly confined to keeping a channel open to the port of Sabetta. Need for icebreaking assistance in the open sea westwards (December-June) and eastwards (July-November) was not envisaged given the icebreaking capacity of the new fleet of LNG carriers[24]. The arrangement made for icebreakers keeping a channel open along the coast of the Yamal peninsula meant, however, that the icebreaker fleet, including the three new 60 MW vessels would be more or less fully occupied – but also sufficient for that purpose. In this scenario we would not have included the three new icebreakers in the estimation of additional costs to provide for year-round traffic.

However, Atomflot later launched plans for construction of a series of 40 MW icebreakers powered by diesel and LNG (LK40), mentioned above, which they intend to deploy in the waters around the Yamal peninsula and up to Dudinka[25]. According to the company these icebreakers have to be completed before 2028[26]. In the most recent plans for deployment of Atomflot's icebreakers fleet, the LNG powered icebreakers take care of the western sector, including servicing the channel to Sabetta, whereas the three new nuclear icebreakers under construction are moved into the eastern sector of the NSR. Thus, also these three should be counted as part of the additional costs to secure all year transit navigation. Clearly,

[24] Tatyana Larionova, 'Krepkiy oreshek' ('A Hard Nut'), *Transport Rossii*, September 12, 2013, at http://www.transportrussia.ru/biznes-territorii/krepkiy-oreshek.html

[25] Various schemes for LNG powered icebreakers have been discussed overb the last years, including a proposal by Novatek to build their own fleet. The most recent plan is a cooperation between Atomflot and Novatek, where Novatek finances all or most of the vessels. Максим Акимов провёл заседание проектного комитета транспортной части Комплексного плана модернизации и расширения магистральной инфраструктуры до 2024 года, 17 July 2019. http://government.ru/news/37402/

[26] K. Yu. Knyazevskiy: Развитие атомного ледокольного флота для обеспечения крупнейших национальных Арктических проектов. Atomflot, Presentation, St. Petersburg 20–21 June 2019.

O. E. Darbinyan: Развитие атомного ледокольного флота для обеспечения крупнейших национальных Арктических проектов. Atomflot, 2018.

the cost of building them are mostly sunk costs, which could be an argument for treating them differently.

But since they have been replaced in their original area of operation, the Ob Bay area, by four new conventional LK40 icebreakers, it could be logical to see the cost of building the LK40 series as part of the costs for an extended navigation season to the east. A preliminary cost estimate from Atomflot is 17.2 bill roubles for each of LK40 icebreakers[27]. Nevertheless, we decide to include the three nuclear icebreakers in our calculation, and not the LK40s, since the nuclear ones are expected to actually help fulfil the goal of year-round navigation to the east.

Total costs

How can we estimate the annual capital cost of the icebreaker investments? We move forward to 2020 when the first of the new 60 MW icebreakers will start working. Investments in the new series have accumulated until then, but we start calculating the capital costs from that year. The accumulated investments are growing as new icebreakers are built – and put into operation.

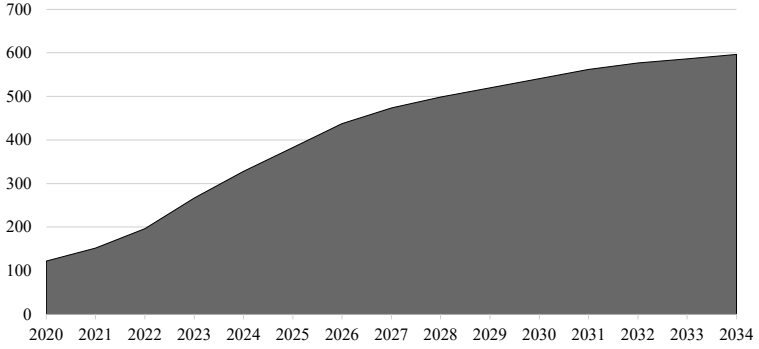


Figure 5. Accumulated investments in new nuclear icebreakers (bill.2019 Roubles)

[27] Вячеслав Рукша: «Росатом должен обеспечить российские мегапроекты в Арктике», Rosatom (source Novosti), 9 April 2019. https://www.rosatom.ru/journalist/interview/vyacheslav-ruksha-rosatom-dolzhen-obespechit-rossiyskie-megaproekty-v-arktike/?sphrase_id=840187

We assume an average service life of 30 years, over which period investments are depreciated linearly, i.e. 3.3 per cent per year, and we add a social discount rate (interest) of 3.2 percent, in line with recommendations from the literature [Kossova, Sheluntkova, 2016].

Finally, we come to the *operating costs* of the icebreakers, which are very difficult to assess. Numbers are not disclosed, and we infer from scattered information. Back in 2011 it was reported that the daily cost of operating the icebreaker Vaygach amounted to 3.3 million roubles[28]. If we assume a 40 per cent depreciation of the rouble since then, the sum equals 4,6 mill 2019-roubles. Around the time when the cost calculation was made, the average number of working days for the nuclear icebreakers was reported to be 158 (number reported was for 2009)[29]. We multiply the daily cost with this number of working days and arrive at average yearly operating cost for one icebreaker of 727 mill. roubles. (The number of working days has increased since then, it was 278 in 2017, but this does not affect our calculation of annual costs).

Also in 2011, the head of Atomflot reported that the cost of operating the icebreaker fleet was covered by revenues (whereas almost all of the state subsidies were used to take care of decommissioned vessels). That year revenues were calculated to be 1.9 bill roubles and subsidies 1.4 bill roubles [Moe and Brigham, 2017]. According to this reasoning the total current operating costs were probably around 2.5 bill. Roubles in 2011. At the time there were five operating nuclear icebreakers, thus with an average annual cost of 500 mill. roubles. If we assume an inflation or depreciation of the rouble since then of 40 per cent, the sum would equal 700 mill. 2019 roubles, thus very similar to the number calculated above.

Of course, it cannot be ruled out that both sums are based on the same flawed estimates or assumptions, and it must be stressed that we don't have specific estimates of operating costs for the new icebreakers. Some sources indicate they will be less expensive to operate than the old ones, because they require a much smaller crew.

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[28] Anna Yudina, 'Atomnye ledokoly khorosho zarekomendovali sebya na Baltike' ('Nuclear Icebreakers Recommended Themselves Well in the Baltic'), at http://www.sovfracht.info/?PageID=6674

[29] Мустафа Кашка: «Мы не можем допустить ледовой паузы», *Strana Rosatoma*, 11 March 2019. http://strana-rosatom.ru/2019/03/11/мустафа-кашка-мы-не-можем-допустить-л/

But in the absence of alternatives we apply a medium number of the costs calculated above – 713 mill. Roubles – as indication of the annual operating cost per new icebreaker. We multiply with the number of icebreakers in operation each year, as discussed earlier (Figure 6).

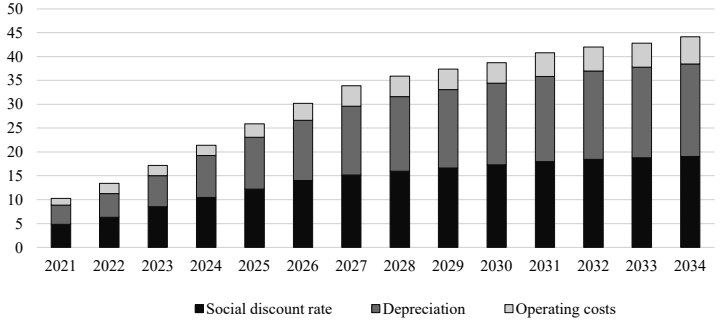

Figure 6. Composition of annual costs for new icebreakers (bill. 2019 Roubles)

Cargo scenarios and income expectations

Construction of additional nuclear icebreakers is tightly connected to the perceived need for an extended navigation season or even whole year use of the eastern part of NSR. This need was initially based on a vision of increased trans-Arctic transit traffic via NSR. Keeping the route open whole year would make it more attractive. However, the volume of future Arctic transit is very uncertain, and it will depend on a host of other factors as well. Rosatom does not expect transit shipping to any extent in the near-term perspective[30]. Building a series of expensive icebreakers in the *expectation* of increased user interest would seem too risky.

The argument has shifted to support for transport of resources out of the Russian Arctic – destination shipping. A crucial development, ensuring a solid cargo base in the eastern direction, was the revised

[30] Вячеслав Рукша: «Росатом должен обеспечить российские мегапроекты в Арктике», Rosatom (source Novosti), 9 April 2019. https://www.rosatom.ru/journalist/interview/vyacheslav-ruksha-rosatom-dolzhen-obespechit-rossiyskie-megaproekty-v-arktike/?sphrase_id=840187

logistical scheme for Yamal LNG and subsequent LNG projects from the same region. Whereas initially it seemed that the eastern route would be used much less than the western[31], now the ambition is to use the eastern route more extensively.

Export of LNG is not an independent factor driving demand for icebreaker services, though. Rather, there is interdependence between supply of icebreaking and demand. Increasing political interest in new icebreakers combined with a willingness to help finance a transhipment port on Kamchatka made the eastern route look more attractive. Announced plans to send LNG eastwards reinforced the argument for new icebreakers.

The increase in cargo flows on the NSR has already been substantial. In 2018, Atomflot escorted ships with a combined cargo volume of 12.7 mill. tons. This represents a steep growth since 2015, when the corresponding number was 2 mill. tons[32], the increase mostly caused by the start of Yamal LNG, which reached peak production in 2019.

In reports based on the document "Realization of the mineral resources and logistical potential of the Arctic" submitted by the Ministry of natural resources in April 2019, the cargo outlook for NSR is described this way: 80 mill. tons by 2024, in accordance with President Putin's *ukaz* from May 2018, is achievable with "punctual implementation of all planned projects, including infrastructure"[33].

Atomflot's scenario for cargo from projects needing icebreaker assistance by 2025 adds up to 70 mill. tons. Most of the projects represents firm contracts or very probable developments, see Figure 8. But in our context the main question is how much of the cargo will go eastwards, on a year-round basis, or rather *will have to* go eastwards.

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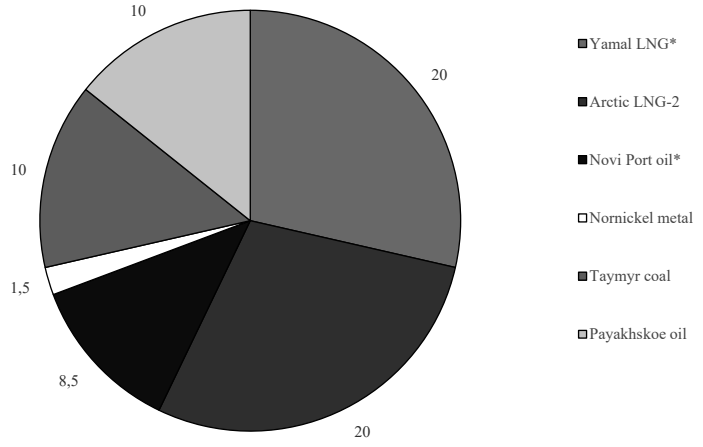
[31] Залечь на дно в Зебрюгге, *Znak*, 8 April 2014. https://www.znak.com/2014–04–08/sovladelcy_yamal_spg_mihelson_i_timchenko_stroyat_logistiku_proekta_na_zapade_nesmotrya_na_sobytiya_

[32] K. Yu. Knyazevskiy: Развитие атомного ледокольного флота для обеспечения крупнейших национальных Арктических проектов. Atomflot, Presentation, St. Petersburg 20–21 June 2019.

[33] Минприроды направило в правительство более 100 проектов в Арктике, RBK, 18 April 2019. https://www.rbc.ru/business/18/04/2019/5c8f97429a7947cc518736b9



*= Firm contracts, others are under negotiation.

Source: Atomflot, 2019.

Figure 7. Arctic projects with icebreaker assistance 2025 (mill. tons.).

According to Rosatom, in the period 2025–30 cargo shipped eastwards will grow to 20 million tons annually, as against 60 mt. towards west[34]. This corresponds well with plans by Yamal LNG to send 20 mill. tons eastwards annually when the transhipment facility on Kamchatka will have full capacity, possibly by 2026 [Строительство СПГ-терминала… 2019]. According to Mikhail Grigoriev, this translates into 500 voyages (including return voyages in ballast), two thirds of which will require icebreaker support [Банки выстроились.., 2018].

After 2030 Atomflot believes cargo flows eastwards should increase to 70 mill. tons, reflecting expected increased icebreaking

[34] Вячеслав Рукша: «Росатом должен обеспечить российские мегапроекты в Арктике», Rosatom (source Novosti), 9 April 2019. https://www.rosatom.ru/journalist/interview/vyacheslav-ruksha-rosatom-dolzhen-obespechit-rossiyskie-megaproekty-v-arktike/?sphrase_id=840187

capacity, whereas westward flows should drop to 30 mt.[35], In other words, after 2030 volumes will not grow, but be redirected. Clearly these volumes will have to include cargo from several other projects than the ones listed in Figure 7.

Based on Rosatom's projections, we construct a timeline for cargo growth on the NSR in the eastern direction:

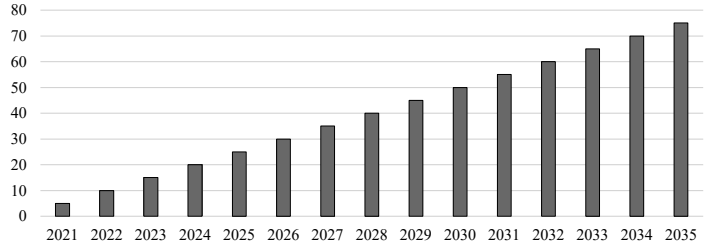


Figure 8: Rosatom's cargo scenario – eastern direction (mill. tons)

What would this mean in terms of income for the icebreaker fleet? This is not possible to answer. But we can try to estimate what the average income per ton *would have to be* to cover the costs identified in Figure 7.

The main message here is that the economy will improve if cargo volumes increase as projected, and the icebreaker fleet is increased.

The Deputy director of Rosatom has mentioned that 20–30 USD/ton would completely cover icebreaker costs as well as other maritime services[36]. He did not specify how many tons were needed. But looking at the income estimate per ton in USD, it would seem that the goal is achievable within not so many years, based on the cargo projections applied here.

[35] Numbers are taken from O. E. Darbinyan: Развитие атомного ледокольного флота для обеспечения крупнейших национальных Арктических проектов. Atomflot, 2018. This presentation deals with the period 2025–30, but a more recent presentation (Knyazevskiy, 2019) presents the numbers cited in the text here, referring to Ruksha. It is therefore assumed that Darbinyan's numbers have been 'postponed' to 2030–25.

[36] Вячеслав Рукша: «Росатом должен обеспечить российские мегапроекты в Арктике», Rosatom (source Novosti), 9 April 2019. https://www.rosatom.ru/journalist/interview/vyacheslav-ruksha-rosatom-dolzhen-obespechit-rossiyskie-megaproekty-v-arktike/?sphrase_id=840187

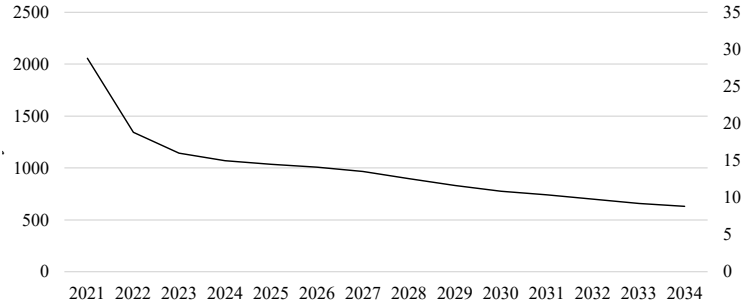


Figure 9: Average income per ton to cover full costs (USD/ton)

Even if the calculations above are correct, there are, however, several questions that can be raised about the income potential.

LNG is a core component in future cargo expectations. As reported by Vedomosti, referring to Novatek, transporting 21.1 mill. tons of LNG eastwards to Asian markets via the transhipment facility in Kamchatka represents an annual saving of USD225 mill. compared to the western route [Строительство…, 2019]. If we assume that Novatek is willing to pay close to what it saves from using the eastern route it amounts to some 10.3 USD per ton, totalling USD149 mil.

However, the specially designed icebreaking LNG carriers for Yamal LNG and Arctic LNG-2 will not require icebreaking assistance for the whole year. And the cargo owner is unlikely to pay for the service in more or less ice-free periods, which of course impacts the economy of icebreaking in the eastern direction. If we use the assessment quoted above, namely that two thirds of the 20 mill. tons will require icebreaking assistance, the impact on required fees – or actually break-even rates – is substantial. In this scenario only 14 mill. tons of LNG need icebreaking assistance and consequently will pay for that service.

The same argument can be applied to other potential cargo owners. Whereas it can be attractive to use the eastern route to

reach Asian markets quickly and with less transportation expenses in the ice-free season, it may be less beneficial to use the route when the ice situation requires icebreaking assistance and payment of accompanying fees. Some cargoes are not time sensitive and may be stored until the ice melts. It is also not given that all the expected projects always will have a better market in Asia than in the Atlantic basin and that consequently more cargo will go west even if the eastern route is open. This was vividly illustrated in 2019, when a large part of the output from Yamal LNG was sold in Europe, and not in Asia as originally intended, because LNG prices were higher in Europe.

If we therefore reduce the expected cargo flows by a third and assume that all cargo owners are willing to pay the same as the LNG project owners, we get a picture of a revenue stream which we can compare with annual costs, Figure 12.

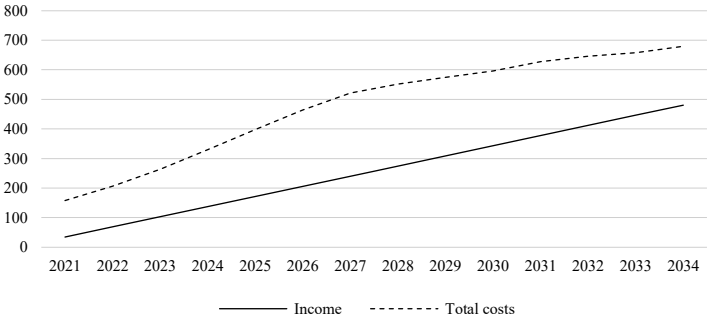


Figure 10: Income from assumed acceptable rates (USD10.3 per ton) in a scenario where 2/3 of expected cargo eastwards (data from Figure 9) need and is willing to pay for icebreaking assistance; total costs from Figure 7 converted to USD (1 USD=65 RUR)

The impression is that even in this relatively optimistic cargo scenario there is a substantial difference between what can be expected in income and the total costs of the icebreaker program.

What is missing?

In this paper I have tried to establish a picture of costs related to the ongoing nuclear icebreaker expansion program, based on publicly available information. The figures are taken at face value. The objective has been to discuss implications of decided or proposed plans, not to question the realism of cost estimates and implementation schedules. That being said, there is good reason to doubt cost assessments and plans. Historically it seems to have been the main rule that actual icebreaker construction costs are higher than planned, and that building icebreakers takes longer than expected. For Russian decision-makers the quality of investment cost assessments must be a major issue.

Operating costs are an even more uncertain exercise. Very little is available in the public domain. Again, clarification on this account should be an important input to decisions.

However, the most acute missing information are the income assessments. In all public documents inspected, income assessments are very superficial or missing altogether. Nevertheless, expected income plays an important role in the justification of the icebreaker program. More specifically, expected increase in gross cargo volumes are used as an argument for increased icebreaking capacity. The argument in this paper is that the relevant numbers is the additional income from an extended navigation season compared to the extra cost of making year-round navigation possible (i.e. build icebreakers that can do that).

As it looks in the analysis here, the implementation of the icebreaking program is set to amount to a substantial subsidy to Yamal LNG and subsequent LNG projects, since they may use the eastern route year-round, but are not likely to cover the full cost of the icebreaker program

Of course, this kind of reasoning is based on an implicit assumption that decision-makers want to see an economic return on state investments. Many would argue that this assumption is unrealistic, or even wrong, and that year-round icebreaking capacity has a value for Russia beyond the potential direct commercial

benefits, including military security and the ability to move anywhere in the Arctic, as well as supporting scientific research. It can also be argued that the icebreaking capacity should be regarded as general public infrastructure and that the existence of a year-round corridor will attract transit shipping in the future, which will increase the income base, even though it cannot be safely estimated today. Finally, increased icebreaking capacity in the eastern sector may also bring benefits to communities and industrial projects along the coast.

If we follow this way of thinking the cost of constructing new icebreakers is more like an expense, not an investment. An implication is that the focus will be on the annual operating costs compared to income. Indeed, that has been the usual approach in discussing "NSR economics". The calculations in this this paper indicate that operating costs will be covered even under a modest cargo scenario and even if they should be somewhat higher than estimated here.

The capital costs have largely been absent from public discussions, but they have been the focus of this paper. It has been shown that capital costs are the major icebreaker costs, overshadowing operational costs.

But looking at construction costs as an expense makes it appropriate to consider the numbers in the context of the annual state budgets. The sums are not trivial. According to the investment schedule presented in Figure 4, annual outlays in the next decade will hover between 20 and 70 bill 2019 roubles every year in the next decade.

Even if one supports the broader purpose of icebreaking, a clarification of the economic aspects should be worthwhile. That would make it clear what part of the investments are commercial, and what part has to be attributed to other purposes. It will be interesting to see if official documents will be published that bring such clarification.

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