

UDC [332.1+338.1](985)(045)

DOI: 10.17238/issn2221-2698.2018.33.66

The prospects of the Northern and Arctic territories and their development within the Yenisei Siberia megaproject*

© Nikolay G. SHISHATSKY, Cand. Sci. (Econ.)

E-mail: nik@ksc.krasn.ru

Institute of Economy and Industrial Engineering of the Siberian Department of the Russian Academy of Sciences, Krasnoyarsk, Russia

Abstract. The article considers the main prerequisites and the directions of development of Northern and Arctic areas of the Krasnoyarsk Krai based on creation of reliable local transport and power infrastructure and formation of hi-tech and competitive territorial clusters. We examine both the current (new large mining and processing works in the Norilsk industrial region; development of Ust-Eniseysky group of oil and gas fields; gasification of the Krasnoyarsk agglomeration with the resources of bradenhead gas of Evenkia; renovation of housing and public utilities of the Norilsk agglomeration; development of the Arctic and northern tourism and others), and earlier considered, but rejected, projects (construction of a large hydroelectric power station on the Nizhnyaya Tunguska river; development of the Porozhinsky manganese field; placement of the metallurgical enterprises using the Norilsk ores near Lower Angara region; construction of the meridional Yenisei railroad and others) and their impact on the development of the region. It is shown that in new conditions it is expedient to return to consideration of these projects with the use of modern technologies and organizational approaches. It means, above all, formation of the local integrated regional production systems and networks providing interaction and cooperation of the fuel and raw, processing and innovative sectors. At the same time, the added value of the extracting and processing industries is localized in the area and will be mobilized for the purposes of high-performance technical and infrastructure base of the regional economy. The specified effect promotes economic development and leads to diversification of the monoprofile economy of the northern and Arctic regions. The provisions of the article and its suggestions can be considered as elements of the future development strategy for the Northern and Arctic territories of the Krasnoyarsk Krai. Results of the research can be used for adjustment and formation of long-term and medium-term investment programs at the state and municipal levels of management and also in development strategies of industrial, transport and power corporations.

Keywords: *northern and Arctic regions, macroregion "Yenisei Siberia", regional policy, strategic planning, investment projects, transport and power infrastructure, renovation of the Arctic cities, Arctic tourism, territorial and production clusters.*

Introduction

During the Krasnoyarsk Economic Forum (CEF-2018) in April 2018, the governor of the Krasnoyarsk Krai and the leaders of the Republic of Tyva and the Republic of Khakassia signed a cooperation agreement within the framework of the Yenisei Siberia megaproject on the joint development of territories. In May 2018, the Legislative Assembly of the Krasnoyarsk Krai approved the draft law on granting legal status to the agreement. The parliaments of Tyva and Khakassia have ratified similar bills. The agreement enters into force in five years. The project was initiated by the current Governor of the Krasnoyarsk Krai Alexander Uss in 2017. It is considered as a pilot

* For citation:

Shishatsky N.G. The prospects of the Northern and Arctic territories and their development within the Yenisei Siberia megaproject. *Arktika i Sever* [Arctic and North], 2018, no. 33, pp. 55–75. DOI: 10.17238/issn2221-2698.2018.33.66

project of a new concept of spatial development of Russia. In February-2018, the project of the macro-region was supported by the President of Russia V. Putin¹.

According to experts, the reasons for the selection of the Yenisei macro-region to be an integral management object are the following circumstances²:

1. The presence of stable interregional relations within the macro-region: migration; economic ties; communication business.
2. Formation of the Krasnoyarsk agglomeration as a nodal point of the macro-region and the center of economic growth at the federal level; as well as the center for the development of high-tech services.
3. The presence of a unified transport system, i.e., a mechanism for ensuring transport accessibility.
4. Interrelated investment projects in the three regions with a cost of more than 500 billion rubles. Among them:
 - “South cluster” (“Nornikel”);
 - “Development of infrastructure and resources of the Angar-Enisey economic area” (“Pole Krasnoyarsk”);
 - “Technological valley: Krasnoyarsk and Sayanogorsk” (Alluminium association);
 - “Intertatational transport, logistatics and industrial hub” (“ERA Group”);
 - “Modernization of Modernization of power facilities and optimization of the heat supply system of the city of Krasnoyarsk” (“Siberian Generating Company”);
 - “Siberia Agroindustrial Park” (“Unipro”);
 - “Construction of the railway Elegest — Kyzyl — Kuragino and the development of the mineral resource base of the Republic of Tyva” (“Tuva Energy Industrial Corps”) [1, Veselova E.Sh.].

The role of arctic and northern territories in the strategy of Yenisei Siberia

Among the announced projects of the macro-region “Yenisei Siberia”, one (contrary to its name) has a direct relationship to the Krasnoyarsk North and the Arctic — the “Southern Cluster”.

The Southern Cluster is a complex of long-term projects aimed at increasing the number of industrial sites and developing basic infrastructure in the Norilsk industrial region. However, the possibilities of increasing the efficiency of the spatial development of the Yenisei Siberia on the basis of this project remain unclear. Also, the potential for effective participation of the northern and Arctic territories in the megaproject “Yeniseyskaya Siberia” is not limited to this project. The northern and Arctic territories are internal for the Krasnoyarsk Territory and in this sense remain in the shadow of the main trends in the development of the macro-region “Yeniseiskaya Siberia”³. At present, the isolation, “island” nature of the territories of the North and the Arctic seriously restrains their de-

¹ Aleksandr Uss: «Enisejskaya Sibir'» kak novyj krasnoyarskij megaproekt podderzhan Vladimirom Putinyom». 13.02.2018. [Alexander Uss: “Yenisei Siberia” as a new Krasnoyarsk megaproject was supported by Vladimir Putin ”. February 13, 2018] URL: <http://www.krasnoforum.ru/news/aleksandr-uss-enisejskaya-sibir-kak-novyj-krasnoyarskij-megaproekt-podderzhan-vladimirom-putinyom/> (Accessed: 25 July 2018). [In Russian]

² Proekt «Enisejskaya Sibir'» budet uchtyon v Strategii prostranstvennogo razvitiya Rossii. [The project “Yenisei Siberia” will be considered in the Spatial Development Strategy of Russia]. URL: <http://news.sfu-kras.ru/node/20170> (Accessed: 25 July 2018). [In Russian]

³ The primary system (multiplicative) effects of an integrated development strategy for the territories of Yeniseiskaya Siberia are planned to be obtained by strengthening and developing interregional ties, primarily between the subjects of the Russian Federation - Krasnoyarsk Krai, the republics of Khakassia and Tyva.

velopment and the development of the mainland part of the Krasnoyarsk Krai and the macro-region “Yeniseiskaya Siberia”. The northern and arctic zone of the Krasnoyarsk Krai requires the high-tech competitive complexes for the development of natural resources, focused not only on the NSR but also on meridional transport links with the central and southern regions of the Krasnoyarsk Krai and the republics of Khakassia and Tyva. It will provide significant additional (both direct and indirect) effects for the Krasnoyarsk Krai and the macro-region “Yeniseiskaya Siberia” [2, Shishatsky N. G., Bryukhanova E. A., Matveev A. M.].

The project of integrated development of the northern and Arctic zones of the Krasnoyarsk Krai — a part of the macro-region “Yenisei Siberia”

The role of the northern and Arctic territories in the socio-economic development of the Krai and the country is dual and contradictory. On the one hand, their powerful natural resource, territorial and economic potential is a reserve for sustainable development. On the other hand, the extreme conditions of life and production complicate social and industrial processes. The development of the natural resources of the northern and Arctic territories is hampered by their weak geological distribution, low transport accessibility, and a shortage of electricity, which increases the cost of economic and life-support activities.

Famous Russian scientists noted the project of integrated development of the northern and arctic territories should proceed from the new modern development model adequate to the global and Russian challenges. It should also provide for the advanced development of geological exploration, transport, energy and social infrastructure, based on the use of the most progressive and modern technological and organizational decisions [3, Kryukov V.A. ; 4, Pilyasov A.N., Kuleshov V.V., Seliverstov V.E.; 5, Pilyasov A.N.; 6, Resursnie regioni Rossii ...; 7, Siberia and the Far East in XXI Century...].

The megaproject “Yeniseiskaya Siberia”, in our opinion, provides new opportunities for such approaches. Four main blocks should be fundamental: transport, energy, industrial and social.

Transport

The core of the transport infrastructure of the northern and Arctic zones of the Krasnoyarsk Territory should be a network of latitudinal and meridional railways, including:

- Salekhard — Korotchaevo — Igarka — Norilsk railway line under construction;
- the project of the North-Siberian highway Ust-Ilimsk — Yarki — Lesobirsk — Bely Yar — Nizhnevartovsk;
- meridional railway on the right bank of the Yenisei from Igarka to Leso-Siberian.

Such a network will connect the southern and central regions of the Yenisei Siberia, as well as Western Siberia, with the mineral deposits of the northern and Arctic territories of the Krasnoyarsk Territory, providing access to the Northern Sea Route (Fig. 1).

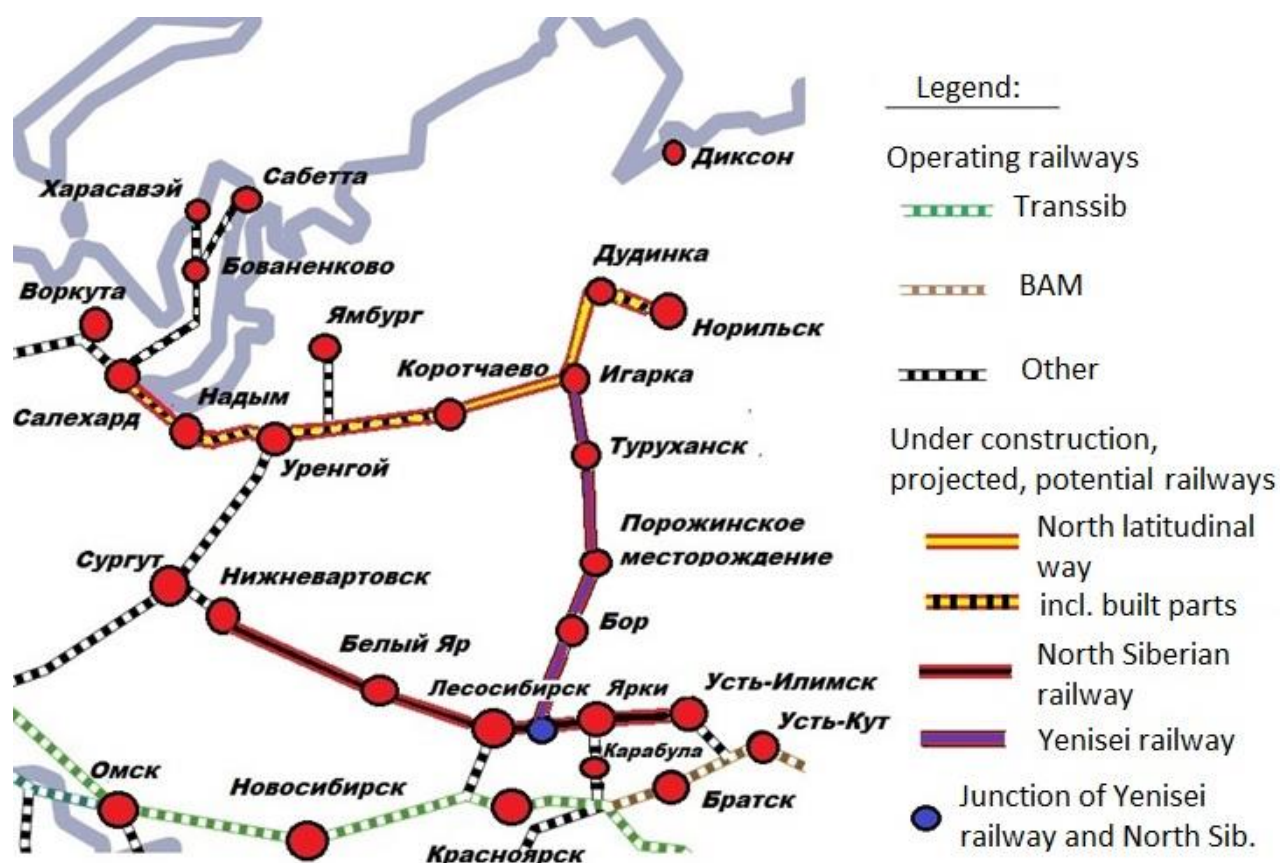


Fig. 1. Scheme of railways in the northern and arctic territories of the Yenisei and Western Siberia (possible perspective)

At present (albeit slowly), the phased construction of the sections of the Northern latitudinal railway line Korotchaevo — Russkoe (122 km), Russkoe — Igarka (482 km), Igarka — Norilsk (285 km) is being carried out. The project is being implemented jointly by the Government of Russia, the Government of the Yamal-Nenets Autonomous District, PJSC Gazprom, Russian Railways OJSC. In February 2017, the construction was announced to be completed in 2023, the project cost was estimated at 236 billion rubles (265 million rubles / km). For the first time in Russian railway practice, construction is carried out on a concession basis.

North-Siberian Railway (SevSib)

The SevSib project appeared in the 50s. last century. In the 1980s it was assumed that the railway will pass through Nizhnevartovsk (Khanty-Mansi Autonomous Okrug) — Bely Yar (Tomsk Region) — Lesosibirsk — Karabula (both — Krasnoyarsk Territory) — Ust-Ilimsk (Irkutsk Region).

In 2007, the Ministry of Transport of Russia, considering the positive expert opinion of the Institute of Environmental Protection of the Siberian Branch of the Russian Academy of Sciences, included the SevSib project (Nizhnevartovsk — Bely Yar — Ust-Ilimsk (1,892 km)) into the Strategy for the Development of Railway Transport in Russia until 2030. However, at present this document largely lost its relevance, although some point shifts in its progress took place.

In the Krasnoyarsk Krai, the Karabula-Yarki railway line (44 km), which is sometimes called the first section of SevSib, was built. It was constructed under of the Investment Project of the Nizhnee Priangarie. Another section of SevSib is the High Mountain Bridge over the Yenisei in the

Lesosibirsk region, which will become part of the future railway. The design of the power station has been completed (unfortunately, only in the mobile version), the decision on the sources of funding for this project (about 10 billion rubles) has not yet been made, but the authorities of the Krasnoyarsk Krai are actively promoting it. A systemic flaw in the SevSib project is the closeness of the main line in the west direction. All the multiplicative effects of SevSib can only appear a part of a single railway, which also includes the Barentskomur and BAM.

The meridional railway Lesosibirsk — Igarka (about 900 km)

This project is the least developed and is the most problematic. In the 1960s–1970s, the construction of a meridional railway from Leso-Siberian to Norilsk was considered one of the priorities for solving the transport problems of the northern and Arctic regions of the Krasnoyarsk Krai. *“The weak link of the transport system of the region (Krasnoyarsk Krai) is the insufficient connection of the southern (developed) and northern (resource) territories. Therefore, for more than a decade, the building a railway line connecting Norilsk with the country's railway network has been studied. According to the calculations of IE OPP SB RAS, due to the lack of a reliable transport connection with the Norilsk industrial hub, the national economy losses amount to more than 150 million rubles per year.*

The construction of the meridional railway will provide transport-railway approaches to the northern hydropower plants, to large industrial hubs, primarily to Norilsk, to dozens of iron ore, copper-nickel, polymetallic, ilmenite, manganese, phosphorus, coal, oil and gas and other deposits.

The Lesosibirsk-Norilsk railway can significantly speed up the exploration and development of mineral resources in this region. Also, without a railway, it is impossible to develop highly productive forest exploitation territories with total timber reserves of up to 3 billion m³.

The presence of shipping routes from the Yenisei river to 8 sections of limited shipping routes to another 25–30 sections of the planned railway route will allow it to be built simultaneously from dozens of lines with lower transport costs than on the Urengoy-Norilsk line. This project should consider the commodity soil, stone, rubble and sand and gravel along the meridional railroad.”⁴.

The feasibility of building a meridional railway from Igarka to the Porozhinskoe deposit is confirmed in the Territorial Planning Scheme of the Turukhansky District, developed by the Krasnoyarskagroproejkt in 2008. The document notes: *“During an estimated period (up to 2030), construction of a meridional railway along the right bank of the Yenisei river “Igarka — Turukhansk — Porozhinskoye field” with a further exit in the south direction to the North-Siberian transport way. Constructions of these routes can be completed only with the development of new resource zones*

⁴ *Nauchno-tekhnicheskij doklad po prognozu ispol'zovaniya prirodnih resursov i razvitiya proizvoditel'nyh sil Angaro-Enisejskogo regiona v period do 1990-2000 gg.* [Scientific and technical report on the prediction of the use of natural resources and the development of the productive forces of the Angara-Yenisei region in the period up to 1990-2000.]. Akademiya nauk SSSR, Komissiya po izucheniyu proizvo-ditel'nyh sil i prirodnih resursov pri prezidiume AN SSSR. Moskva. 1980. pp. 82-88. [In Russian]

in the central part of Evenkia - Turukhansk area (Nizhnee Priangare and the southern zones of Evenkia)”.⁵

In modern conditions, the meridional railway from Krasnoyarsk to Dudinka and Norilsk will be able to connect territories of the Yenisei Arctic not only with southern and central areas of Yeniseiskaya Siberia but also with countries of northeast Asia (China and Korea). The search for rational river and land transport routes is not an alternative to the development of the Northern Sea Route, and it allows you to expand the possibilities of optimizing transport and logistics access to the resources of the northern and Arctic areas of Russia, in which the business of these countries is interested (Fig.2)⁵.



Fig.2. Integrated transport and logistics network in Eurasia, providing freight traffic on the Northern Sea Route

The high competitiveness of the NSR, including the use of river routes along the Yenisei River, compared to other Asia-Europe transit routes, has been confirmed in studies by Korean experts [8, Moon D.S., Kim D.J., Lee E.K.].

The construction of a meridional railway in the Yenisei traverse will only increase the attractiveness and transport and economic connections of the countries of Northeast Asia with the territories of the Yenisei North and the Arctic. Their priority is confirmed in studies of Korean experts compare to the other transit routes Asia-Europe [8, Moon D.S., Kim D.J., Lee E.K.].

⁵ Maritime Challenges and New Opportunities in the Arctic, 30 August 2017 Jong-Deog KIM (co-author : Sung-Woo LEE) Korea Maritime Institute Republic of Korea The VII International Meeting of State-Members of the Arctic Council, State-Observers to the Arctic Council and Foreign Scientific Community.

It is obvious that the construction of the meridional railway in the Yenisei traverse will only increase the attractiveness and scale of the transport and economic relations of the countries of Northeast Asia with the territories of the Yenisei North and the Arctic.

Energy

The priority and at the same time, the most challenging element in the formation of a powerful energy system of the northern and Arctic territories of the region is the Nizhne-Tungus hydropower station.

The Nizhne-Tungus HPP is a new socially, environmentally and economically active project for the construction of a powerful HPP in the Nizhnyaya Tunguska alignment.

Previously developed projects for the construction of similar hydroelectric power plants (known by the names Turukhanskaya (in the 1980s — 1990s) and the Evenki Hydroelectric Power Station (2005–2012) were rejected by the people and the public of the Turukhansk region and Evenkiya, as well as authoritative scientific experts.⁶

However, it should be noted that the construction of a large hydropower station on Nizhnyaya Tunguska remains an important project with high socio-economic efficiency. At the same time, its relevance is particularly increasing in connection with the formation and transition to the implementation of the strategy of integrated socio-economic development of the macro-region of the Yenisei Siberia.

The following arguments are in favor of this statement:

1. hydro-potential is the most important and, at the same time, insufficiently mastered development resource of Siberia and Russia (Fig. 3, Fig. 4, Fig. 5);

⁶ Design and preparatory work for the construction of the Turukhansk HPP began in the late 1980s but by the early 1990s. They were stopped both because of the protests of environmentalists, who at that time enjoyed significant public support, and because of the deterioration of the economic condition of the country, accompanied by a drop in energy consumption. In the 1990s, various types of hydropower plants were considered, differing in pressure and, consequently, power and output -e.g., a variant of hydropower plants with a capacity of 6300 MW and an output of 29 billion kWh with a head of 140 m, an option with a capacity of 14,000 MW and others. In 2005–2012, the project for the construction of hydroelectric power plants (now called the Evenki Hydroelectric Power Plant) has again become urgent. In 2008, the Evenk Hydroelectric Power Plant (with the concurrent Nizhne-Kureiskaya Hydroelectric Power Plant with a total capacity of 8,150 MW and a production of 46 billion kWh) was included in the General Layout Scheme of the Russian Energy Facilities until 2020. According to the developed project, the hydropower plant capacity was taken at 12 000 MW and had to be transferred to the European part of Russia to cover the deficit of the power system. The project of the Evenk Hydroelectric Power Plant was supported by the administration of the Krasnoyarsk Krai. However, due to the negative attitudes, the project was again rejected. In the last General Scheme of the location of energy facilities in Russia for the period until 2035, approved in 2017, the construction of the Evenki hydropower station is not provided.

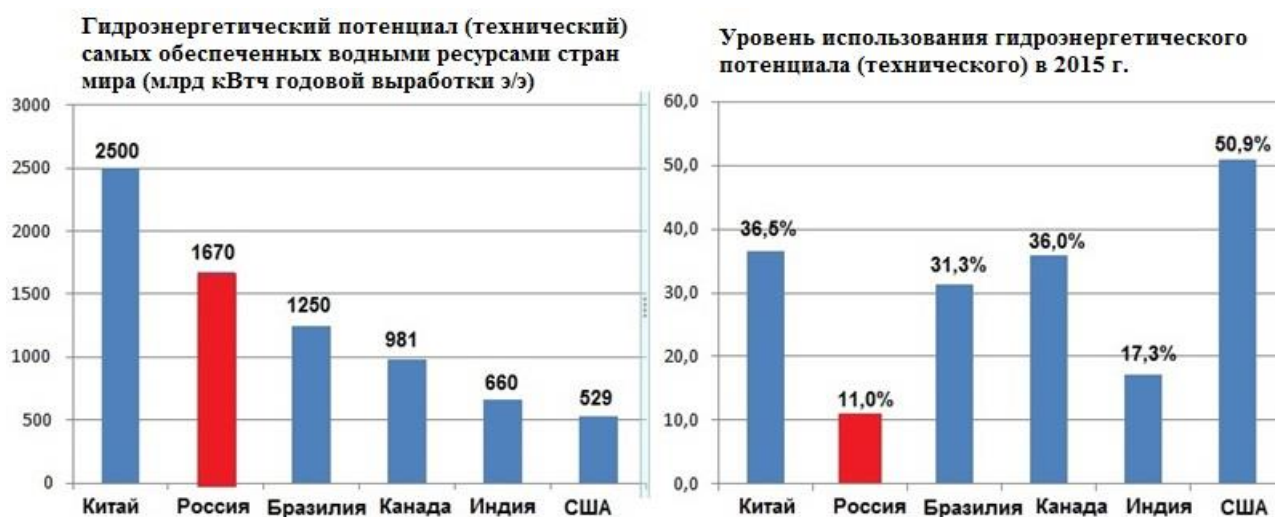


Fig. 3. Hydropower potential of the most water-rich countries in the world, billions of kWh, and the degree of its use.⁷
Countries from left to right: China, Russia, Brazil, Canada, India, the US

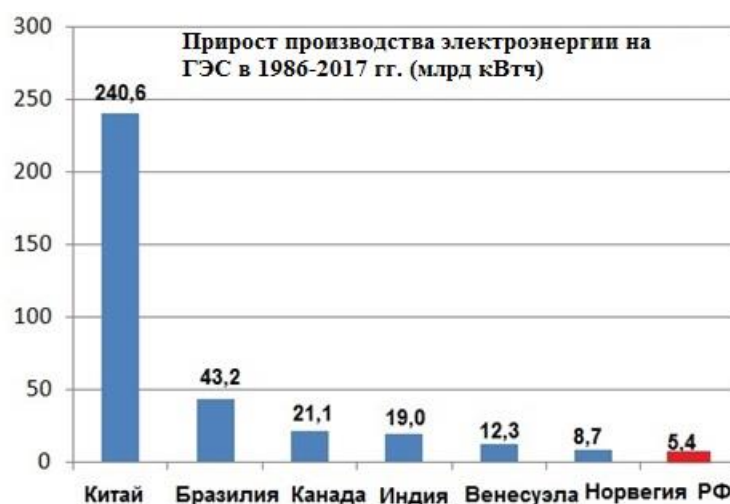


Fig. 4. Increase in electricity production at hydroelectric power plants in 1986–2017, billions of kWh.⁸
Countries from left to right: China, Brazil, Canada, India, Venezuela, Norway, Russia

⁷ Author's calculations based on data [9, Bogush B.B. et al., p. 4].

⁸ Author's calculations based on data from the BP Statistical Review of World Energy 2018. URL: <https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf> (Accessed: 25 July 2018).



Fig. 5. The degree of development of effective hydropotential of Russia ⁹.

European part of Russia – about 38% (incl. Ural); Siberia – about 30%; Far East – 8%; Russia is second in the list of hydro energy owners in the world after China; Russia's effective hydropotential \approx 853 billion Kwh (\approx 8.3% of the world HP); Russia is significantly behind the leading countries by the effective development of hydro resources.

2. The Lower Tunguska is one of the most favorable rivers of the world for hydropower construction. The narrow canyon-shaped riverbed allows us to implement various technology solutions and provide acceptable environmental damage. At the same time, both regarding area and volume, the reservoir of the future hydroelectric station should become the largest in the world. Such a significant size of the reservoir allows for deep multi-year flow regulation.

3. The zone of territorial influence of hydropower plants (within a radius of 500–800 km) is rich in mineral resources, has a favorable economic and geographical position and is a territory with a high potential for industrial development and consumption of electric power. Realization of this potential is constrained by a shortage of electricity in the western part of the Lower Angara region, in Turukhansk, Yenisei and North-Yenisei districts. The construction of a large hydropower station on Nizhnyaya Tunguska will not only remove the energy barriers to the development of these areas but also increase the environmental and economic efficiency of the energy sector by refraining from constructing the planned Nizhne-Angarsk (Motygin) hydroelectric station.

The construction of the Nizhne-Tungusskaya HPP (8150–12150 MW along with the counter-regulating hydropower plant) and the Nizhne-Kureiskaya HPP (150 MW), as well as the necessary facilities, will ensure reliable electricity supply to existing and introduced consumers in the

⁹ Author's calculations based on data [9, Bogush B.B. et al., p. 5].

territory of the new economic development The Russian Federation (up to 10% of modern energy consumption of the whole country). It will allow uniting the Taimyr-Norilsk energy system with the country's unified energy system and ensure the creation of a deep-water river master. It is in line with the Lower Tunguska and decides to fresh drinking water problems in the region. For its implementation, the project of the Nizhne-Tunguskskaya HPP should significantly improve performance compared with the previously proposed plans of the Evenki (Turukhansk) HPP.

The main directions for developing the project and increasing its socio-economic attractiveness (see Box 1):

- The project should be considered not only as a sectoral (hydropower) but above all as a socio-economic (transport, water, social, infrastructure, etc.).
- The project should prioritize consideration of regional socio-economic effects, primarily of the Turukhansk and Evenk districts.
- Environmental adverse effects and risks should be eliminated.
- Nizhne-Tungusky waterworks can be the beginning of the development of the Yenisei-Lena deep-water main¹⁰.

Box 1. Resolution of public hearings on the issue "On the construction of the Evenki HPP"

(Appendix to the Decree of the Legislative Assembly of the Territory of June 10, 2010, No. 10-4776P)

Noting the magnitude of the problems identified, realizing civic responsibility towards present and future generations, defending their right to live in an environmentally safe environment, participants in public hearings:

1. It is considered that the assessments of the socio-economic feasibility of building the Evenk hydroelectric station on the Nizhnyaya Tunguska river and assessing its environmental impact submitted for public discussion do not give answers to the problematic issues raised during open discussions. The official position of the potential investor of the project of JSC "RusHydro" on the problems identified was not presented at the public hearings. The lack of a comprehensive assessment of all possible consequences of the implementation of the construction of the Evenk Hydroelectric Power Station on the territory of the Krasnoyarsk Krai does not allow to form a definite opinion of the public concerned about the possibility and feasibility of continuing the project.

2. Recommend:

2.1. To the Government of the Russian Federation:

- *when deciding on a project to build the Evenk Hydroelectric Power Plant along with an assessment of the technical, financial and economic efficiency of the project to solve macroeconomic problems, development prospects of the territories, consider the consequences of dam construction for local communities, lifestyle of indigenous small peoples of the North, their health, social relations and culture, and large-scale environmental risks, irreversibility of changes in all components of the ecosystem of the Far North;*
- *return to consideration of alternative solutions to the task of ensuring the energy balance of the Russian Federation to increase the welfare of society, based on the equal importance of economic, financial, social and environmental factors;*
- *take the necessary measures to ensure the legislative regulation of issues related to the flooding of underground nuclear explosions, aimed at guaranteeing the ecological safety of the environment;*

2.2. To the Ministry of Energy of the Russian Federation:

- *clarify the long-term forecast of the fuel and energy balance of the Russian Federation (Siberia) in order to*

¹⁰ Rechnaya Doktrina RF [River Doctrine of the Russian Federation]. Moskva. Institut demografii, migracii i regional'nogo razvitiya, 2015.

substantiate the need to build the Evenki hydroelectric station on the Nizhnyaya Tunguska river from the perspective of the socio-economic development of Siberia and the Russian Federation as a whole in terms of the implementation of state policy in the field of increasing energy efficiency and energy saving;

- *to submit for public consideration to the interested public and state authorities of the Krasnoyarsk Territory updated indicators of the forecast balance of the power industry and relevant justifications;*
- *to consider the issue of choosing alternatives to the construction of the Evenk Hydropower Plant of the power supply options for the Russian economy during the preparation of proposals to the Government of the Russian Federation on the adjustment of the General Layout of Electric Power Facilities until 2020;*

2.3. FSUE "VNIPIpromtekhnologiya":

- *provide state authorities of the Krasnoyarsk Territory with full information on the condition of wells of underground nuclear explosions, on the radiation situation in the adjacent territory, as well as on environmental risks and environmental impact assessment of possible depressurization of underground atomic explosions cavities due to the construction of the Evenki Hydroelectric Power Plant ;*
- *prepare and send proposals to the authorized state authorities on radioecological monitoring of the state of underground nuclear explosions at the floodplain of the Lower Tunguska;*

2.4. The Governor of the Krasnoyarsk Territory is to inform the Legislative Assembly of the Krasnoyarsk Territory about any changes in the state of affairs of the Evenki HPP construction project.

3. Offer:

3.1. The Russian Academy of Sciences - to prepare a comprehensive scientific examination of the project for the construction of the Evenki dam on the river Nizhnyaya Tunguska;

3.2. JSC "RusHydro" and JSC "Lengidroproekt" - to provide an opportunity for a comprehensive assessment of the construction project of the Evenki hydropower station, including an assessment on social and economic issues, as well as strategic environmental assessment using international practice in this area.

Industry

Primary industrial projects:

A) Construction of a mining and smelting complex in the Norilsk industrial region

Establishment of a world-class production of platinum group metals based on the Norilsk-1 and Chernogorskoe deposits, located near the city of Norilsk. The project in the Norilsk industrial region is the third in the world regarding the number of platinum group metals involved in the development. The processing of ores from the Chernogorsk and Norilsk-1 deposits is envisaged at two enrichment plants with a capacity of 9 million tons and 18 million tons per year, respectively. The output of platinum group metals will be more than 70 tons, most of which from the ore of the Norilsk-1 deposit, as well as nickel, more than 24 thousand tons, copper, about 60 thousand tons, gold - about 2 tons. At the Norilsk site, only mining of ore and production of concentrate is planned, the placement of metallurgical production is considered in Finland, Norway, Australia or South Africa. The company is also ready to find the option of accommodation in the Krasnoyarsk Krai (e.g., in Lesosibirsk), provided with the appropriate infrastructure and to use the Yenisei River as a link (300 thousand concentrates per year). Krastsvetmet is a priority option for refining platinum and gold (Krasnoyarsk)¹¹.

¹¹ Stenogramma press-konferencii «Russkoj platiny» 21 noyabrya 2012 g v Krasnoyarske. [Transcript of the Russian Platinum Press Conference on November 21, 2012 in Krasnoyarsk] URL: <http://russian-platinum.ru/press/news/93> (Accessed: 25 July 2018). [In Russian]

5) Forming center for oil and gas industry development

The following centers for the development of the oil and gas industry in the northern and Arctic regions of the Krasnoyarsk Territory can be distinguished:

- Vankorskiy Cluster (development of the Vankorskiy, Suzunskiy, Tagulskiy and Lodochnoe deposits);
- Evenk Cluster (development of the Yurubcheno-Tokhomsky and Kuyumbinsky deposits);
- Ust-Yenisei Cluster (development of Payakhsky and North-Payaysky deposits, and then - Baikalsky and Ozerneye deposits).

The projects will make it possible to increase the annual volume of oil production to 30–40 million tons, gas — more than 10 billion cubic meters by 2030.

The Vankor oil is transported via the Vankor-Purpe pipeline (Yamal-Nenets district) and further to the Transneft system, the gas-Vankor-Khalmerpayutinsky (Yamal-Nenets district) and further to the EGS Russia.

Transportation of Evenk oil goes via Kuyumba — Taishet oil pipeline for filling ESPO; associated gas — injection into the reservoir. The option of transporting gas to Boguchan is possible to obtain LNG for the gasification of Krasnoyarsk thermal power plants. Using gas from the Yurubcheno-Tokhomsky and Kuyumbinsky fields is the utilization of helium, which must be solved at the federal level using federal funds (see Box 2).

Box 2. Construction of the Boguchansky GPP and gasification of thermal power plants central and southern regions of Yenisei Siberia

The environmental improvement plan in Krasnoyarsk considers gasification of the city as one of the most critical activities. According to the general scheme of gas supply and gasification of the region, developed by Gazpromgaz at the end of 2016, it is planned to build the Proskokovo (Kemerovo region) - Achinsk - Krasnoyarsk - Kansk - Balagansk (Irkutsk Region) gas pipeline in the Krasnoyarsk Territory).

Connecting the area to the existing gas transmission system of Gazprom will allow gasification of 10 cities and 16 districts of the region.

The cost of gasification of the Krasnoyarsk Territory is estimated at 180–250 billion rubles and the re-equipment of urban thermal power plants for gas will require up to another 18 billion rubles. Considering that the Proskokovo - Achinsk - Krasnoyarsk - Kansk - Balagansk (Kovykta) gas pipeline with a tie - in to the Power of Siberia gas pipeline is unlikely to be built earlier than in 7-10 years and will require significant investments of 180-250 billion In this variant, the bad ecological situation in Krasnoyarsk will not change until 2025–2030. Another disadvantage of the official version is that the region will be gasified using West Siberian oil, while the Krasnoyarsk Territory has its significant reserves of natural gas. A more rational and attractive regarding time and costs is the gasification option of the Krasnoyarsk agglomeration, as well as the central and southern regions of the macro-region “Yeniseiskaya Siberia” proposed by the Ecological Center for Natural Resource Development (EC ROPR) (Krasnoyarsk). This option provides for the use of local gas resources for gas transportation of Krasnoyarsk and other territories of the Krasnoyarsk Territory (by-pass oil of the Kuyumbinsky and Yurubcheno-Tokhomsky fields).

According to estimates by the Department of Subsoil Use of the Central-Siberian District, industrial reserves of associated gas from the Kuyumbinsky and Yurubcheno-Tokhomsky fields amount to about 94 bil-

lion cubic meters. m, that is, they can meet the demand of the Krasnoyarsk agglomeration and the adjacent central and southern regions of the Yenisei Siberia for 15–25 years.

In general, in the Angara region and the south of Evenkia, recoverable reserves are at least 1 trillion cubic meters of natural gas.

The option involves the construction of a gas pipeline from the fields to the village of Bogu-Chany (in the traverse of the existing pipe), a gas processing and gas-liquefying plant in the area of the village of Boguchany with the subsequent transportation of liquefied gas (about 2-3 million tons per year) by rail Karabula - N. Poyma - Krasnoyarsk.

PJSC Rosneft is interested in building the YUTZ-Kuyumba-Boguchany gas pipeline, as the law prohibits the burning of associated petroleum gas, and the company has to invest significant funds in its injection technology. With the provision of appropriate benefits from the state, Rosneft PJSC is able to build the Kuyumba-Boguchany gas pipeline and gas processing facility in the Boguchany settlement area (cost estimate is 90–100 billion rubles). The growth of industrial gas reserves in Priangar'e (Agaleevskaya area, the Abakan deposit, etc.) is expected in 2024–2025. The construction of the Boguchany-Krasnoyarsk gas pipeline with a capacity of up to 10 billion cubic meters per year can become economically feasible.

Problem. Boguchansky GPZ should provide helium extraction. Considering that helium is a strategic resource of the state, the cost of additional equipment of the Boguchansky gas processing plant for the separation of helium with subsequent injection into the helio-depository should be financed from federal sources.

Transportation of Payakh and North-Payah oil (as well as oil from other deposits of the Ust-Yenisei oil and gas cluster — Baikalovsky, Ozerniy) is possible in two versions:

- northern option: by building an oil pipeline from the oil fields to the Tanalau oil terminal (100 km from Dudinka) on the right bank of the Yenisei River with further transportation by tankers along the Northern Sea Route;
- southern option: by building pipelines in a southerly direction and connecting them to the existing trunk network (Vankor-Purpe pipeline).

The northern option is preferable for the following reasons:

- provides an opportunity to preserve the Siberian Light brand of oil (in the pipeline system of the public joint-stock company Transneft, there is a mixture with heavy oil of the Volga-Ural oil and gas region and the Urals mixture is exported, which is traded at a discount of 10 percent);
- allows to expand the geography of sales markets (when transporting through the pipeline system Transneft, approximately 40 percent of the produced oil is exported, which reduces the profitability of developing deposits);
- due to the construction of an oil terminal in the Dudinka area, it allows you to create a base for the development of adjacent territories of Taimyr, where hydrocarbon deposits are located.

The use of produced associated natural gas is possible by an LNG plant in Dudinka (2–5 million tons) and the subsequent transportation of liquefied gas for export through the NSR.

B). Turukhansko-Lesosibirsk energy industrial region (complex)

The central and most important condition for the creation of the Turukhano-Lesosibirsk energy industrial region is the construction of the Turukhansk hydroelectric station and the merid-

ional railway from Abalakov to Norilsk. These objects are the most critical infrastructure elements not only for the macro-region “Yenisei Siberia” but also for the country's economy as a whole.

Development of the Porozhinsky Manganese Deposit

Manganese is a strategic raw material of the Russian Federation. Porozhinskoe manganese deposit is one of the largest in Russia. The organization in the territory of the Krasnoyarsk Krai of a complex for the deep processing of manganese ores can satisfy by 50% the needs of Russian ferrous metallurgy. The field is located 350 km north of the railway station Lesosibirsk, 12 km east of the Yenisei river. The total manganese ore potential of the deposit is 267 million tons. The project of the 1st stage of field development provides for the extraction of ore — 2.55 million tons, the production of concentrate — 711.4 thousand tons and manganese alloys (ferromanganese and ferrosilicomanganese) — 221 thousand tons. The commencement of commercial ore mining was to begin in 2013–2014. (CJSC “Turukhansky Meridian” (a subsidiary of the company OJSC “Prominvest”)).

The metallurgic ferroalloy production plant was planned to be organized in Sosnovoborsk (40 km from Krasnoyarsk). Delivery of manganese concentrate to the metallurgical plant was planned for river transport, for which the construction of the Porozhin River Terminal was supposed. Project postponed indefinitely due to financial difficulties. The creation of the energy base in the region and the construction of the railway to the deposit will significantly improve the financial performance of the project (due to the relocation of the metallurgical plant site to the Lesosibirsk region and reduce transportation costs) and reduce the time for its implementation.

“The main technical and economic indicators confirm that the effective implementation of the project for the development of the Porozhinsky field in the conditions of an undeveloped industrial infrastructure of the Turukhansk region is possible only with the organization of large-scale production and only in the case of the formation of a single mining and metallurgical complex uniting the entire production cycle raw ore prior to metallurgical processing of manganese concentrates within the local industrial territory”[10, Prirodnie resursi..., p. 146].

Copper-nickel plant based on the Norilsk concentrates

The idea of building in the middle course of the Yenisei of metallurgical plants for processing Norilsk ores is not new. It was formulated back in the 1960s.

“The analysis of actual and project indicators for Norilsk MMC confirms the impossibility of the normative recoupment of capital investments in the development of metallurgical capacities, as well as the cost-effective industrial use of all the components of the ore even during the primary development of the richest solid sulfide copper ores, if all the enrichment-metallurgical the redistribution will be located in Norilsk and on the Kola Peninsula. It is due mainly to the high energy intensity of nickel and copper production and, consequently, the high cost of energy supply to the Norilsk region.

In the early 1960s, it was recommended to take out the heavy fraction and feinstein from the Norilsk region and place part of the metallurgical production capacity in the Forest-Siberian

Industrial Center. Lesosibirsk Copper-Nickel Plant provides a drastic increase in production efficiency and solves the problem of bringing the air basin of Norilsk into sanitary norms.

With a concentration in Lesosibirsk of up to 40% of the total production capacity of Norilsk MMC for the production of commodity metals, it is possible to ensure the effective functioning of the created metallurgical facilities in Norilsk and Lesosibirsk for many decades.

A new copper-nickel plant in Lesosibirsk, in addition to the main processing of Norilsk, concentrates and semi-finished products, can consume copper-nickel and copper concentrates from new promising ore areas to the south and northeast of Norilsk, in particular from Igarsky, Kureisky, Priangarsky, and Maymecha-Kotuisky.

It guarantees not only long-term maintenance of the initial capacities of the Lesosibirsky combine but the need in effective expansion to the scale required by the material balance of the USSR with two times lower than in Norilsk capital and operating costs for metallurgical redistribution¹².

Phosphate fertilizer plant

Prerequisites for the creation of this enterprise:

- the need to reduce the overconcentration of apatite concentrate production within the Murmansk region and the development, in order to reduce the cost and increase the availability of phosphate tuk, new phosphate ore deposits located near agricultural regions of the country, including in Siberia;
- availability of sufficient raw material base of apatite and phosphorus ores in the Krasnoyarsk Territory (Tatar deposit of phosphate-niobium ores, Seiba deposit of phosphate-iron ores, Telek phosphate deposits), in the Republic of Khakassia (Obldzhansk phosphate deposits), and also in Irkut region (Beloziminsky apatite-metal deposit);
- the possibility of creating an effective sulfuric acid production based on the use of huge excess resources of elemental sulfur obtained from the disposal of industrial waste in the Norilsk region. The plant may be located in the Lesosibirsk region. The enterprise may operate from sulfur and phosphate raw materials imported from Norilsk, supplied from local deposits.

Development of gold deposits

The priority object is the development of the Olginskaya gold ore area (217 sq. Km) located in the northern part of the Yenisei Ridge (resource estimate of at least 388 tons of gold, the average gold grade in the ore is 3 grams per ton). The deposit may be developed openly. A side effect of field development gives the ability to harvest 3 million cubic meters. According to the developed project (CJSC Prim-Invest), it is planned to create a raw material base, to form an industrial infrastructure and to build the Olginsky GOK with a design capacity for the extraction of first gold of 9 tons per year. Cement Plant in the construction area of the Turukhanskaya HPP is intended to provide for the construction of hydraulic and industrial structures of the Turukhansk-Lesosibirsk

¹² *Nauchno-tekhnicheskij doklad po prognozu ispol'zovaniya prirodnih resursov i razvitiya proizvoditel'nyh sil Angaro-Enisejskogo regiona v period do 1990–2000 g.* [Scientific and technical report on the forecast of use of natural resources and development of productive forces of the Angara-Yenisei region in the period up to 1999-2000]/ Akademiya nauk SSSR, Komissiya po izucheniyu proizvo-ditel'nyh sil i prirodnih resursov pri prezidiume AN SSSR. Moskva. 1980. pp. 51, 55.[In Russian]

energy industrial region. Production capacity is 600 thousand tons of cement and concrete products per year. The project involves the creation of a raw material base of the cement industry in the Yenisei North, the development of limestone, marl and gravel deposits in the area of construction of hydropower plants and the lower reaches of the Yenisei.

Society

Renovation of housing and communal services and economy of Arctic cities

The need for renovation

As it is rightly noted in the works of leading Russian scientists, “the cross-cutting principle of maximizing the use of infrastructure and human potential of existing settlements should be put in the basis of the state regional policy in the Arctic. At the same time, in the further economic development of the Arctic territories, exclusively rotational-expeditionary method should be applied”. [11, Fauzer V.V., pp. 45–46]. With respect to the Arctic territories, a number of systemic principles should be followed.

First, to introduce a regulatory ban on the creation of new settlements with a permanent population in the Russian Arctic or to transfer settlements from rotational to stationary ones. At the same time, it is necessary to maximize the use of the unique labor potential of the Arctic cities in the development of new territories of the Russian Arctic through the use of intra- and inter-regional monitoring. Among other things, it will contribute to the adequate behavior of workers in the Arctic natural environment, since they live there constantly.

Secondly, as a matter of priority, to direct budget investments to modernize the housing and communal services of the Arctic settlements. Already established settlements with a permanent population and elements of infrastructure should be considered as a result of previously produced considerable state investments and, accordingly, as a real asset and instrument of state participation in the economic development of the Arctic territories. To this it should be added that “human settlements are often the only element of the state presence, state “outposts” in the vast territories of the Eastern and Far Eastern sectors of the Russian Arctic, where industrial development is just ahead” [11, Fauzer V.V., pp. 45–46].

The housing fund of Norilsk is currently in a critical condition. The construction of housing in the city practically ceased more than 20 years ago, and most of the houses built earlier became useless. The conditions of the Extreme North - the harsh climate, the permafrost. Buildings in such conditions cannot serve as long as on the mainland. Active housing construction in Norilsk began in the 1960s. During the “Komsomol construction projects”, Khrushchev buildings were built, which today constitute the largest sector of residential buildings in Norilsk. Before this, “stalinks” were built in the city, and after Khrushchev houses, more modern homes appeared. And since all these types of houses were made each in its own time, they also became unusable, have served their time.

The situation has now reached a critical point: either the housing conditions of the Norilsk people will improve, or soon people will have to be relocated to the mainland. The second option is unpromising. Norilsk Mining and Metallurgical Combine masters the riches of Taimyr and people need to have decent living conditions.

Renovation problems

1. Restoration (on a rational scale) of its construction base during Soviet times, enterprises producing all construction materials necessary for the construction of buildings worked in Norilsk. They have not been working for a long time, and all that is necessarily has to be transported from the mainland by the Northern Sea Route. Naturally, in the conduct of large-scale construction, this creates additional difficulties and entails enormous costs. The development of the regional construction industry can improve the efficiency of renovation.

2. Financing. It is impossible to implement such a large project as the renovation of Norilsk (the minimum estimate of the cost of such a program is from 200 to 400 billion rubles, the real one is from 500 to 1,000 billion rubles). It should be financed from the federal, regional and city budgets with the participation of business. Negotiations and agreements on the possibility of co-financing with Nor-Nickel, the government of the Krasnoyarsk Territory, and the federal government are necessary.

3. Scientific support and maintenance. The renovation program is a multidisciplinary problem. It requires scientific substantiation and development not only in the field of construction and architecture and housing and communal services but also in the field of economics, innovative development, demography, sociology, etc. At CEF-2018, the administration of Norilsk signed an agreement with the SFU on cooperation, aimed at the participation of university specialists in the development of the urban planning strategy of the city of Norilsk: conducting a public examination of programs, plans, development projects and improving the infrastructure of the town.

Who can be involved in the Norilsk renovation program?

Federal center: the transformation of Norilsk into the center of the Taimyr-Turukhansk Arctic support zone;

Authorities of the Krasnoyarsk Krai: strengthening of Norilsk as the center of the Arctic and northern zone of the macro-region Yeniseiskaya Siberia;

Large business (Norilsk Nickel and Russian Platinum): to reduce labor costs (it is estimated that the joint project of Norilsk Nickel and Russian Platinum will require up to 10,000 workers and builders; creating improved living conditions in Norilsk will allow appropriate costs for their arrangement) and in improving the transport, logistics and financial and economic relations.

The development of the Arctic and North tourism: the Yenisei and the Arctic sea

Currently, regular sea cruises are organized from Murmansk (5–7 times a year) to the North Pole and back with a visit to the Franz Josef Land (or Spitsbergen). Despite the high cost of

participation in the polar cruise on the nuclear icebreaker “50 let Pobedi” (30–50 thousand dollars/pers.), they are very popular (table. 1).

Table 1

*Cruises from Murmansk to the North Pole on the nuclear icebreaker “50 Let Pobedi”
(capacity — 120 places)¹³*

	2015 г.	2016 г.	2017 г.
Number of cruises	7	5	6
Number of passengers	805	557	702

Inclusion in the program of polar Arctic cruises on the nuclear icebreaker “50 let Pobedi” ports of the Krasnoyarsk territory (Dixon and Dudinka), and territories of The Great Arctic Nature Reserve and the Northern Land (Fig. 6) can increase the tourist attractiveness of these cruises and the flow of tourists to the Arctic and Northern regions of the Krai.



Fig. 6. Routes of polar cruises Murmansk: the North Pole-Murmansk and the Arctic territories of the Krasnoyarsk Krai

The need to purchase a second atomic icebreaker in addition to the “50 Let Pobedi” may already be a problem when organizing combined cruises Murmansk — the North Pole — Dudinka and increasing the associated tourist flow. The practice of tourist cruises to the Arctic on Russian nuclear-powered icebreakers can be stopped, “if transit traffic continues to grow. Tourist flights pay off only if they are made two or three per season. One flight does not pay off. Two or three trips - this is already a plus. But if the cargo traffic develops, there will be no extra icebreakers (for tourists), — said A. Smirnov, Deputy Director of Atomflot in the interview¹⁴.

The composition of the atomic icebreaking fleet currently includes: two nuclear icebreakers with two nuclear power plants with a capacity of 75 thousand hp (“Yamal” and “50 Let Pobedi”),

¹³ Nacional'nyj park Russkaya Arktika. [The National park Russian Arctic] URL: www.rus-arc.ru (Accessed: 25 July 2018). [In Russian]

¹⁴ Rossijskie ledokoly prekrashchayut turistscheskie kruizy v Arktiku [Russian icebreakers stop tourist cruises to the Arctic] URL: <http://www.ecosever.ru/article/15542.html> (Accessed: 25 July 2018). [In Russian]

two icebreakers with a single-reactor installation with a capacity of about 50 thousand hp (“Taimyr” and “Vaigach”), a nuclear lighter carrier-container ship “Sevmorput” with a reactor with a capacity of 40 thousand hp and 5 technological service vessels. The atomic icebreaker “Soviet Union” is in operational reserve. In the coming years, Rosatomflot will include three universal nuclear-powered icebreakers (UAL), intended for pilotage of large-capacity vessels, year-round leadership of caravans in the Western Arctic. The two-draft design of nuclear-powered ships allows them to be used both in Arctic waters and in the mouths of polar rivers. The deadline for the UAL “Arktika” is 2019; the first serial atomic icebreaker “Sibir” — November 2020; the second serial atomic icebreaker “Ural” — November 2021.¹⁵

The organization of tourist polar cruises from Dudinka is impossible without resuming river cruises along the Yenisei on the route Dudinka — Krasnoyarsk — Dudinka for tourists arriving in Dudinka or departing from it to the North Pole and to Murmansk. And this is another problem.

The results of surveys of Russian and international tourist companies that specialize in organizing river cruises in Russia show a high demand for river cruises along the Yenisei on the route Krasnoyarsk — Dudinka — Krasnoyarsk. Despite the lack of offers, this cruise remains known and, no doubt, will be in demand by Russian and foreign tourists.

With an average load of 120–150 passengers, for the summer navigation along the Yenisei, 1,100–1,350 tourists (up to 2 thousand people) can sail. The Yenisei cruise can be supported by charter flights from Moscow to Krasnoyarsk and Norilsk. It also combines well with the “Sayan Ring” route and with other future interregional routes, when tourists adhere to the principle “since you’re in Siberia, you better see the more you can”.

Cruise tourism on the Yenisei is not the most prepared tourist destination (an increase in navigation periods is necessary, experienced operators and the possibility of operating the vessel as a floating hotel in the off-season). At the same time, cruises on the Yenisei are not only a business direction, but also an important social project for the population of the northern territories, affecting such indicators as the employment rate of the population at working age, the living standard, the level of social tension, and the amount of tax revenues from the project.

The most appropriate solution for the resumption of river cruises on the Yenisei, apparently, is the purchase of a European vessel. According to OJSC “Passenger-Trans”, the cost of a European ship with a 10-year lifespan is € 8–10 million, and the service life of such a ship is 30 years. Design and construction of a new ship in the Finnish or German shipyard will cost from € 30 million. The service life of the vessel is at least 50 years.

Buying a ship (or better, two ships) for river cruises along the Yenisei requires public-private partnership and attracting private investment.

Participants of the Yenisei river cruises have a large package of diverse and interesting excursion programs and tours and some more can be developed (eco-tours to the Putoran plateau;

¹⁵ Atomnyj ledokol'nyj flot [Nuclear icebreaker fleet]. URL: <http://www.rosatom.ru/production/fleet/> (Accessed: 25 July 2018). [In Russian]

visits to ethnic settlements of Indigenous Minorities of Evenkia and Taimyr; restoration of monuments of Soviet history (Stalin building No. 503) — the former settlement of Yermakovo; the IV Stalin memorial complex in Kureik, Norillag); extreme taiga safari and fishing (the Kureika river, the districts of the Bor settlement, the Verkhneimbatskoe settlement, and the Bakhta settlement); pilgrim tourism (the Yeniseisk church ensemble and Turukhan crown trinity monastery); objects of archeological heritage (ancient camp of IV — I millennium BC at the mouth of the Podkamennaya Tunguska river); Permafrost Museum in Igarka, etc.). Today demand for these destinations is low due to the remoteness and inaccessibility of sites.

The organization of the cruise involves the provision of an excursion program in the parking areas (activities of tour guides, transport, catering, the realization of souvenirs, wild plants, museums, other objects of tourist display), the development of the aerodrome network, which allows for the delivery of tourists to the sites on airplanes, creating complementary short routes on high-speed vessels in the Eniseisk — Bor, Bor — Turukhansk — Igarka, etc.

When organizing a sustainable tourist flow (based on sea and river cruises), the demand for existing and new tourist offers may significantly increase.

Conclusion

Summarizing what has been said, it can be concluded that the implementation of large-scale development projects for the most precious natural resources of the North and the Arctic will require advancing development and creation of a reliable infrastructure: transport (system of railways, including (construction of large hydropower plants on the Lower Tunguska and other tributaries of the Yenisei).

Effective implementation of such a complex program is impossible without the use of innovative methods and the application of the newest ecologically and socially balanced technologies. In this development scenario, the raw material orientation of the economy can become a powerful stimulus for the formation in the North and the Arctic not only industrial but also high-tech innovation clusters. At the same time, this will require new forms of organization of industrial production based on locally integrated regional production systems and networks.

In modern conditions, this is possible only by a systematic approach in the preparation of decisions made. The provisions and proposals outlined in the article can be considered as elements of the future strategy for the development of the northern and Arctic territories within the “Yenisei Siberia” macroregion. The research results can be used to adjust and formulate long-term and medium-term investment programs at the state and municipal levels of government, as well as in the development strategies of industrial, transport and energy corporations.

Acknowledgments and funding

The article was prepared within the framework of the state assignment of the FANO of Russia, project XI.174 1.1. (0325-2017-0008) “The economy of Siberia and its territories under the

conditions of external and internal challenges and threats: methodology, trends and forecasts" № AAAA-A17-117022250133-9.

References

1. Veselova E.Sh. «Eniseyskaya Sibir'» — pervyy makroregion Rossii ["Yenisei Siberia" — the First Macroregion of Russia]. *EKO* [ECO journal], 2018, no. 6, pp. 20–37. DOI 10.30680/ECO0131-7652-2018-6-20-37
2. Shishatskiy N.G., Bryukhanova E.A., Matveev A.M. Problemy i perspektivy razvitiya Arkticheskoy zony Krasnoyarskogo kraya [Problems and Prospects of Development of the Arctic Zone of Krasnoyarsk Krai]. *EKO* [ECO journal], 2018, no. 4, pp. 8–28. DOI 10.30680/ESO0131-7652-2018-4-8-28
3. Kryukov V.A. Arktika — kakim prioriteta ot dat' predpochtenie? [Arctic — which priorities to give preference?]. *Problemy i gosudarstvenno-upravlencheskoe proektirovanie* [Problem Analysis and Public Administration Projection], 2014, vol. 7, no. 6, pp. 45–66.
4. Pilyasov A.N., Kuleshov V.V., Seliverstov V.E. Arctic policy in an era of global instability: Experience and lessons for Russia. *Regional Research of Russia*, 2015, vol. 5, is. 1, pp. 10–22.
5. Pilyasov A.N. Severnaya futurologiya: sleduyushchie dvadtsat' let [Northern futurology: the next twenty years]. *Arktika: ekologiya i ekonomika* [The Arctic: Ecology and Economics], 2014, no. 3 (15), pp. 62–71. (In Russ.)
6. *Resursnye regiony Rossii v «novoy real'nosti»* [Resource regions of Russia in the "new reality"]. Ed. by Kuleshov V.V. Novosibirsk. IE OPP SO RAN Publ., 2017. 307 p.
7. *Siberia and the Far East in XXI Century: Problems and Perspectives of Development: Scientific report*. Ed. by V. Efimov. Siberian Federal University Publ., Strategic Research Fund «Siberian Club». Translated from Russian. Krasnoyarsk, SibFU Publ., 2017. 182 p.
8. Moon D.S., Kim D.J., Lee E.K. A Study on Competitive-ness of Sea Transport by Comparing International Transport Routes between Korea and EU. *The Asian Journal of Shipping and Logistics*, 2015, march, pp. 1–20.
9. Bogush B.B., Khaziakhmetov R.M., Bushuev V.V., Voropay N.I., Bellendir E.N., Vaksova E.I., Chemodanov V.I., Podkoval'nikov S.V. Osnovnye polozheniya programmy razvitiya gidroenergetiki Rossii do 2030 goda i na perspektivu do 2050 goda [The main provisions of the program of hydropower development of Russia up to 2030 and visions to 2050]. *Gidroenergetika XXI veka: Rossiya i mirovaya integratsiya*, 2016, part 1, pp. 3–19.
10. *Prirodnye resursy Krasnoyarskogo kraya (entsiklopediya)* [Natural resources of the Krasnoyarsk Territory (encyclopedia)], Krasnoyarsk, KNIIGiMS Publ., 2007. 471 p.
11. Fauzer V.V. Demograficheskiy potentsial severnykh regionov Rossii kak faktor ekonomicheskogo osvoeniya Arktiki [The demographic potential of Russia's northern regions as a factor of the economic development of the Arctic]. *Arktika i Sever* [Arctic and North], 2013, no. 10, pp. 19–47.