Prospects for the arctic shelf development

Andrey Boyarinov*, *Olga* Litvinova, *Lyudmila* Teslyuk, and *Natalia* Dukmasova

Ural Federal University n.a. the first President of Russia B.N. Yeltsin, 620002 Ekaterinburg, Russia

Abstract. Nowadays development of the Arctic shelf and the continental slope resources is one of the most promising areas in the world oil and gas industry growth. Russia, unlike other countries with Arctic hydrocarbon reserves, implements only a few projects on the Northern shelf due to the difficult natural and climatic conditions and ecological vulnerability of the territory. The purpose of the article is to substantiate the feasibility of hydrocarbon resources development on the Russian Federation Arctic shelf in the long term. The article analyzes the external and internal factors affecting the decline in the rate of oil and gas exploration and production in this region in recent years. It considers state support measures reflected in the Strategy for the Russian Arctic Zone Development and Ensuring National Security – 2035, and a number of other laws and regulations developed and adopted after 2014. Special attention is given to the development of high-tech imports phase-out; specialists training; science, education and business integration; reducing the tax burden; environmental issues. The tasks facing state authorities, oil and gas companies, scientific and educational organizations have been identified that will lead to the successful Arctic shelf reserves development.

1 Introduction

According to the 2021 data [1] the share of non-renewable resources was 82.3% of the world fuel and energy balance, incl. oil - 30.9%, natural gas - 24.4%. Despite growing interest in alternative energy sources and increase in amount of based energy, oil consumption has increased by 6%, and natural gas - by 25% over the last 10 years. Therefore, searching, discovery and uptake of new deposits are important to cover the demand for non-renewable resources, used both for energy production and as raw materials in the petrochemical industry. Russian Federation Energy Strategy for the Period Up to 2035 [2] contains a complex of key measures, such as creation of long-term investment conditions for the accelerated development of the Arctic zone fields, incl. Barents, Kara, Pechora and Okhotsk seas continental shelf development. Nowadays only five countries have legal rights to develop the Arctic shelf: Russia, the USA, Canada, Norway and Denmark [3]. The Arctic shelf hydrocarbon resources exceed 100 billion tons of oil equivalent and almost two thirds of them are in the Russian Arctic. The Arctic oil and natural gas reserves distribution is shown at Fig. 1.

The Arctic shelf and the continental slope resources development is one of the most promising fossil fuel exploration areas on the planet. Now it develops much slower than other

* Corresponding author: au.boyarinov@urfu.ru

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petroleum bearing basins of the World Ocean, due to extremely difficult natural and climatic conditions and environmental exposure. Norway may be distinguished among the countries with oil reserves in the Arctic shelf as it achieved the greatest success in their development and usage [4].

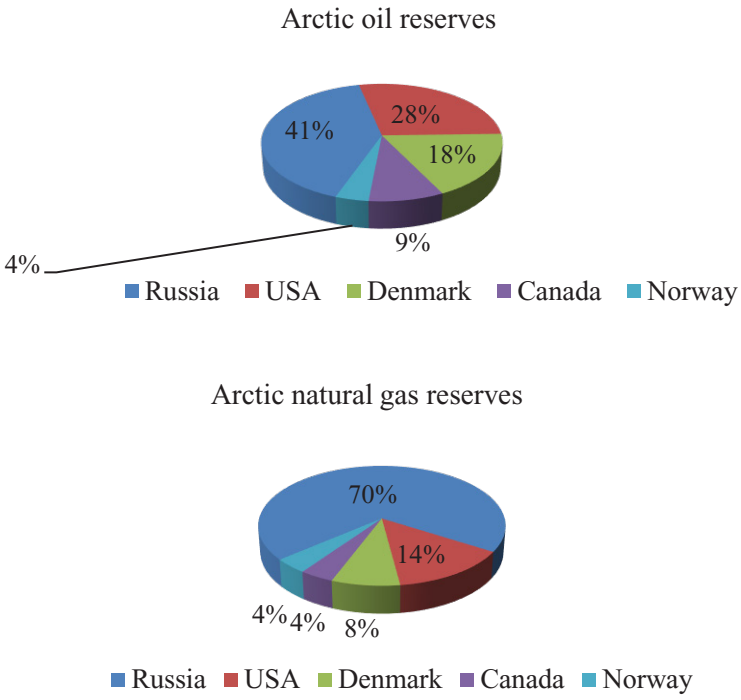

Fig. 1. Arctic oil and natural gas reserves (compiled by the author).

The main oil production areas in Norway are the North Sea fields: Statfjord, Troll, Uzeberg, Ekofisk, Gullfax, Maria, Johan Sverdrup. About 90% of oil and 96% of natural gas produced in the country [1] is sent for export to the European and other countries' markets. Share of oil and oil products in Norway's export in 2021 were: Canada - 1%, USA - 2%, China - 3%, Finland - 1%, Sweden - 7%, Germany - 19%, France - 7%, UK - 30%, Spain - 2%, Ireland - 1%, Belgium - 6%, Nigeria - 1%. Export share of gas via pipelines comprised 10.8% of world supplies (110 bln m^3). Norway has started development of Arctic hydrocarbon reserves in the 1970s and has accumulated significant experience in economically efficient production and transportation methods.

Nowadays only a few projects are being implemented on the continental shelf of the northern seas in Russia; therefore, Norwegian, Canadian, British and US experience in hydrocarbons development on the northern shelf is extremely useful for reducing technical, financial and environmental risks in order to achieve the socio-economic efficiency of large-scale investment projects, characterized by technological complexity and high capital intensity. But it should be noted that due to different natural and climatic conditions and hydrocarbon deposits characteristics at different fields, the use of such experience is possible only in the light of its specific features. Thus, experts note that Norwegian offshore area is the most comfortable in terms of conditions for oil production. On the contrary, Russian oil reserves are concentrated in hardly accessible places.

As noted in the work [4], based on the experience of implementing foreign projects, successful development of northern territories is impossible without active participation of

the Government. Legal regulations of offshore oil and gas industry differ in various Arctic countries while maintaining certain general approaches conducted by difficult weather conditions and high costs [5]. The Arctic development plays an important role in ensuring Russia's energy security in the long term. Russian Federation Arctic Zone Development Strategy and National Security Maintenance - 2035 [6] has a unified plan of actions that provide implementation of state policy foundations on the basis of coordinated actions of federal, regional and municipal authorities. Currently, there are a number of problems that complicate region development process:

- several counties may claim work in progress and the activity results;
- development requires large investments and technology spendings;
- viability of works performed in a difficult economic situation;
- cooperation with foreign companies during active anti-Russian sanctions.

The purpose of the article is to substantiate the long-term viability of hydrocarbon resources development in the Russian Federation Arctic shelf. The work analyzes factors that influence offshore investment projects realization, taking into account political, economic and environmental risks, and proposes measures to deal with them.

The article is based on Russian and international statistics data, Russian regulations of energy policy and Arctic development, instructional and methodological materials, domestic and foreign experts' works.

2 Estimation of the Arctic shelf development

The Arctic area is about 21 million km^2 from the North Pole to the Arctic Circle [3]. The Arctic region includes the territories of Russia, the USA, Canada, Norway, Denmark, Sweden, Finland, and Iceland. Onshore part of the Russian Federation Arctic zone includes four subjects (Murmansk region, Nenets, Yamalo-Nenets and Chukotka autonomous regions), as well as individual territories of the Arkhangelsk region, the republics of Karelia, Komi, Sakha (Yakutia) and Krasnoyarsk Territory, and all Russian islands of the Arctic Ocean [7]. Russia occupies 29.1% of the world Arctic territory. More than 2,415 thousand people lived there in 2017. The gross regional product share in the total gross regional product of the Russian Federation was 6.2%.

The Arctic zone contains over 97% of Russian platinoid reserves, 43% of tin reserves, a significant amount of nickel, titanium, apatite ores and rare earth metal ores. Russia has provided itself with reserves of almost 98% for the platinum procurement, 100% of titanium, zirconium, rare earth metal ores, apatite ores and more than 97% of nickel. About half of the copper and bauxite volume, up to 25% of total diamonds, gold and silver are being produced in the Arctic, iron ore and coal are also being mined [8]. The region produces over 80% of Russian natural gas and 17% of Russian oil (including gas condensate).

According to experts, the continental shelf contains more than 85.1 trln m^3 of flammable natural gases, 17.3 bln tons of oil [6] and is a strategic reserve for the development of fuel-energy base of the Russian economy. In terms of the total oil and gas potential, the Russian Arctic shelf sedimentary basins are comparable to the largest oil and gas territories in the world. According to the industry experts the Arctic shelf can provide 20-30% of world's oil production by 2050.

During the entire period of geological prospecting work on the Russian Federation Arctic shelf, fields were discovered with current recoverable reserves of oil AB1C1 - 120.8 mln tons and 509.7 mln tons on B2C2, gas - 3692.3 bln m^3 on AB1C1 and 2972.1 bln m^3 on B2C2, condensate AB1C1 - 80.0 miln tons and for B2C2 - 58.7 mln tons:

- five oil fields (four in the Pechora Sea and one in the Laptev Sea);

- two oil and gas condensate fields (one in the Pechora sea and one in the bays and bolsters of the Kara sea);
- one oil and gas field (in the Kara Sea);
- five gas fields (three - in the Barents Sea, two - in the bays and bolsters of the Kara Sea);
- five gas condensate fields (one - in the Pechora Sea, two - in the Barents Sea, two - in the Kara Sea, three - in the bays and bolsters of the Kara Sea).

The State Balance Sheet of 01.01.2019 includes prepared D0 resources in the amount of 2344.5 mln tons of oil and 11546.9 bln m^3 of gas.

According to the Russian law, only state-controlled companies (the Government must own at least 50%) with at least five years of shelf experience can apply for the Arctic shelf development. A moratorium on the new permits issuance for offshore fields is active in Russia since 2016. At the moment, only PJSC Gazprom (operates in 29 Arctic areas, another 5 at PJSC Gazprom Neft) and PJSC Rosneft (has 31 areas) are allowed to work at the shelf [9]. The only active Arctic shelf field is Prirazlomnoye that PJSC Gazprom Neft commissioned in 2013 [10]. Hydrocarbon production dynamics in 2013-2018 (Pechora Sea) are shown in Fig.2, 3 [11].

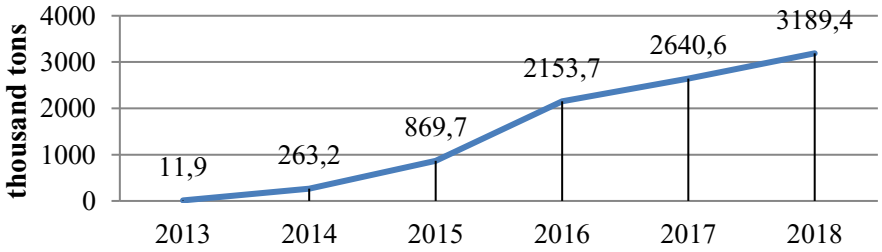

Fig. 2. Oil and gas condensate production dynamics (compiled by the author).

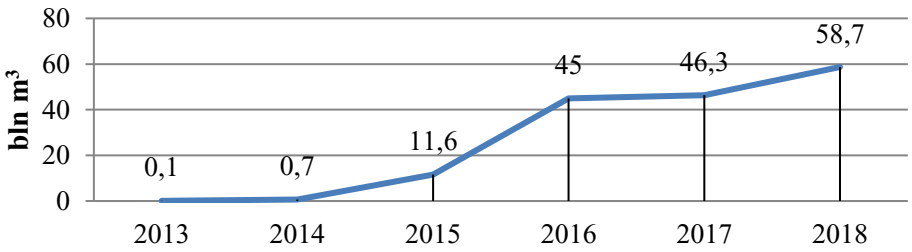

Fig. 3. Natural gas production dynamics (compiled by the author).

3 Problems and prospects for the arctic shelf development in Russia

In recent years, the rate of Arctic fields' development has noticeably decreased due to several reasons. The first reason is the oil-price drop caused by technology development and decreased costs of extracting hard-to-recover hydrocarbons, primarily shale, that made energy resources supply on the world market exceeding the demand. Thus, the US oil production volume increased from 396 Mt in 2012 to 745 Mt in 2019 [12] (by 88%), while Brent crude price during this period decreased from $111.4 to $66.33. with a minimum of $44.0 in 2016. The prices for Brent crude oil dynamics is shown in the Fig.4.

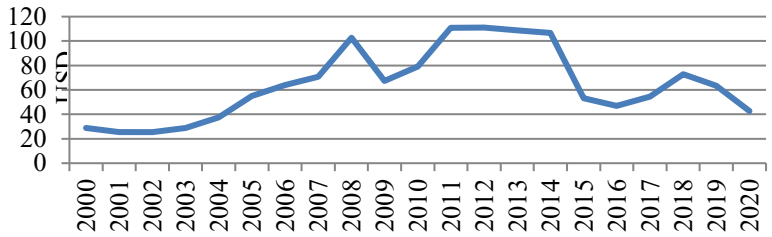

Fig. 4. Brent oil price (compiled by the author).

In the early 2020, the oil price abated significantly - to less than $32 per barrel. It was caused by OPEC+ inability to agree on a new oil output cuts and oil demand decrease due to the global coronavirus pandemic.

Arctic projects are undoubtedly expensive. The northern seas shelf development is associated with high capital and operating costs, and also requires efficient technologies development in the context of the region specifics, taking into account the personnel safety and the environmental pollution elimination. According to the Russian ex-Energy Minister Alexander Novak's statement at the International Arctic Forum "The Arctic - Territory of Dialogue", the offshore development profitability can be achieved at an oil price of $70-100 per barrel [13]. Only in that case companies' activities will be profitable and commercially viable, however, it is impossible to make such oil prices forecasts for the next 2-3 years. It should also be taken into account that profit is influenced not only by prices, but also by the costs of production and transportation. Firstly, difficult natural and climatic conditions require development of new complex technologies for underwater drilling (including deep water) that will result in large financial investments. Secondly, the creation of specific sea- and land-zone infrastructure close to the fields. Thirdly, it is necessary to take into account current financial and economic conditions of the Russian economy and the oil and gas sector in particular, especially an increased tax burden on oil and gas companies. Fourthly, active US and European sanctions and restrictions on the Arctic shelf development forbid attracting foreign partners, financing and equipment.

In 2014-2021, 534 Russian organizations fell under sanctions, including 134 energy companies and 117 banks [14]. The first sanctions list of 2014 included such Russian state-controlled banks as Sberbank, Vnesheconombank, VTB, Gazprombank, etc., as well as the largest oil companies: Rosneft, Gazprom Neft, Transneft. American creditors were prohibited from providing medium and long-term financing to these companies. Considering that interest rates on loans in European and American banks are much lower than in Asian ones, these bans have led to the costs increase for Russian oil and gas projects.

Restrictions on the offshore equipment and technology exports to Russia were also imposed. According to [15], the import share of the offshore equipment was 80-90% in 2014. At the beginning of the Arctic shelf development, it was planned to actively use advanced foreign technologies and attract international companies with successful experience of working in such conditions. After the Western sanctions were imposed some joint Arctic shelf projects were frozen, the rest are being implemented independently, without foreign partners' participation [16]. PJSC OC Rosneft, PJSC NOVATEK and PJSC Gazprom are considering the need to reorient towards the Asian innovative technologies and equipment market in the future. Oil-service companies from South Korea, India and China may become such partners [17].

Western technologies and equipment export ban has set certain tasks for Russian oil and gas companies, engineering and the Government. They have to create new high-tech means

to meet the energy industry's needs. For the optimum development and implementation of Russian equipment, the authors in [18] proposed to promote imports phase-out in the Arctic shelf development based on the facet method assuming division of several objects into independent groups in following directions: geological exploration, equipment and materials delivery, hydrocarbons production and transportation. In 2015, the Action Plan for Imports Phase-Out in Oil and Gas Machine-Building Industry of the Russian Federation was approved. There are more than 200 enterprises in Russia [16], that have already achieved some success in this direction; however, due to the general backwardness from technically-advanced countries additional measures are required to support development of domestic potential [19].

Along with financial, info-consulting, foreign economic support for the Russian production development, great importance should be given to the human resources development – training specialists for work in various areas in extreme Arctic conditions, including geological exploration, oil and gas production, Arctic transport, etc. It is recommended to involve leading Russian scientists and oil companies' specialists to take part in educational process and scientific research carried out to develop innovative offshore projects in the Arctic.

The oil industry has the highest tax burden in Russia - 52%, while the average for the economy is 11% (data for 2018). Share of oil and gas revenues in the country's budget was 46%. The tax regime has great importance for achieving Arctic projects' economic efficiency in situation of unfavorable macroeconomics and low oil prices, which helps to save costs [20]. In the spring of 2020, Putin V.V. signed a law amending the Tax Code for Arctic and offshore oil and gas projects. The mineral extraction tax (MET) rate is 5% for oil and 1% for gas for the first 15 years from the start of commercial production. This applies to the new offshore fields development in the northern part of the Okhotsk Sea, the southern part of the Barents Sea, the Pechora, Japan and White Seas [21]. Also, preferential conditions have been approved within the borders of the Krasnoyarsk Territory, the Sakha Republic (Yakutia) and the Chukotka Autonomous region. Tax incentives will not lead to quick-selling operations and increased interest from companies, but will contribute to the development of Northern territories in general.

One of the obstacles is limitation of companies' access to the continental shelf development. In 2014, when Rosneft began to cooperate with ExxonMobil, sanctions prohibiting American companies from participating in Russian offshore JV were imposed, and the Russian corporation lost a partner. Still in 2014, Lukoil that had already worked as an operator on the Norwegian continental shelf, wanted to join the project. But federal authorities did not allow the company to operate on the shelf, as well as other private national companies and companies with foreign capital. The Arctic Development Strategy, signed in October 2020, allows increased participation of private investors in such projects while maintaining state control over their implementation.

The Arctic has a fragile ecosystem. There are many sources of hazardous situations under the influence of the region characteristics during the Arctic shelf development that may lead to irreparable environmental consequences of various scales, from local to subregional [22]. Due to the harsh natural and climatic conditions, the Arctic shelf development is a vulnerable zone for any economic activity associated with great risks to the environment. Exploration and well-drilling is damaging marine organisms and whole Arctic ecosystem. Seismic exploration generates noise pollution that negatively affects marine life. Drilling is accompanied by emissions into the atmosphere and discharges into the hydrosphere. Harmful substances in wastewater contain toxicants, high-density metals, clayey suspensions. The oil and gas fields' development and production is accompanied by danger of oil spill accidents. These accidents cause large-scale pollution of water objects and death of marine organisms. Serious environmental risks are associated with transportation of hydrocarbons. Another

huge problem is garbage and waste from production activities that need to be recycled. Otherwise, this territory will turn into a dumping ground, which is unacceptable for the Far North regions [23].

Moreover, the Arctic shelf is located next to the tundra, where low-numbered peoples of the North live. For thousands of years, these peoples have lived in ideal natural conditions. The pollutions named above affect the vegetation of the tundra: cup moss and lichens, which have antiseptic properties. Because of this, deer die. They play an important role in all the tundra inhabitants' life spheres (as transportation means, meat and skins source). Civilization brings all its diseases to the tundra, while local population has no immunity to them [24].

The necessity to preserve existing ecosystem complicates technical facilities' operations in the offshore zone and leads to an increase in the Arctic projects' cost. All countries that have the right to develop deposits on the Arctic shelf take an unbiased look at the high environmental risks of hydrocarbons exploration and development. They have their own strategies for their Arctic territories development, use and protection and have formed a whole raft of legislation in fields of resource management and environmental protection [5]. Since 2016, new offshore drilling operations have been forbidden in North America under the influence of low oil prices, the shale revolution and environmental protests [25]. Russia recognizes its responsibility for the Arctic environment preservation and protection, but it still has to create a legal and regulatory framework for regulating economic activities, taking into account the experience of other Arctic states and the characteristics of its own territories.

4 Conclusions

Vertically integrated oil and gas companies, the Government and the scientific community need the following to develop Arctic shelf reserves successfully:

1. The Government is to develop a complex program to stimulate the Arctic shelf development, which should include not only tax benefits but also offshore specialists' training system, support for scientific research and development in deep-sea mining in difficult climatic conditions. Under the terms of active sanctions, it is necessary to increase the localization quotient in the technologies for Arctic offshore oil and gas drilling and production from 20% to at least 60% [26]. The program should include financial, organizational and labor resources for the infrastructure creation near the land deposit.
2. Governmental Entities should allow all the companies, incl. private domestic and foreign enterprises, and not only state-controlled groups (PJSC Gazpromneft and PJSC NK Rosneft), to operate offshore projects. Successful development requires technology, personnel and financial capabilities of these companies.
3. Vertically-integrated oil and gas operators should actively invest their resources in the deposits development, especially those that are already licensed by the Government, despite long payback period and low profitability level at the moment. That would allow receiving significant competitive advantages and super profits in the future.
4. Due to significant environmental risks of offshore operations and lack of infrastructure the Russian Federation, the Parliament is to pass a number of legislative acts that would allow regulating the activities of oil and gas operators in order to limit their negative impact on the environment and prevent the occurrence of industrial accidents and disasters.
5. Preparation of an innovative program for oil and gas industry development that will include vertically integrated oil and gas companies and RAS institutes will provide an opportunity to implement new technologies and thereby significantly reduce the prime cost of offshore production. Offshore oil and gas fields' exploitation can and should be profitable at a price of $50 per barrel or less, similar to the shale oil production in the United States.

As a conclusion it can be claimed that the Arctic shelf development is a strategically important and economically justified activity area for the Russian economy growth.

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