OTC 27353

Technical and Legislative Risks Associated with Arctic Development (Case Study - Russia and Norway)

[1]Riverson Oppong, [2]Amina Talipova, [3]Benson Lamidi Abdul-Latif

[1,2]Gubkin Russian State University of Oil and Gas, Moscow. Russia. [3]Saint Petersburg Mining University, Saint Petersburg. Russia.

This paper was prepared for presentation at the Arctic Technology Conference held in St. John's, Newfoundland and Labrador, 24-26 October 2016.

Abstract

Arctic territory today is the most perspective territory for oil and gas companies. It is not only resource based or in other words, Arctic boarding countries that should engage in arctic exploration as it requires completely new technological advancement, calling for intense attention to its field development. Following the USGC research developed in 2008 year, more than 80% of perspective Arctic territories are located in offshore. This fact inevitably conveys technical and legislative risks which are not experienced onshore or conventional offshore fields. Technical risks are associated with severe climate conditions, sensitive ecological situation and a lack of field development experience on these territories. Legislative risks depend on the arctic country in question. Legislative also include taxation system that directly affects the efficiency of field development. All this makes it actual to study technical and legislative risks associated with arctic offshore field development.

Practically, the work consists of two parts: analysis of influence of technical risks and legislative risks (including taxation system) on field development in different Arctic Seas and two cases in Russian Barents Sea and Norwegian Barents Sea were studied. Analysis of technical and legislative risks in these countries are determined by similar conditions of state participation and strategic meaning of Arctic territories for both countries. In the frame of technical analysis risk classification system according to different Arctic Sea conditions was worked out. Probability for each technical risk was assessed in expert way and included in the field development project evaluation, which in turn was made using real option valuation and stochastic modeling approaches. In order to receive synergetic effect, valuation

model of filed development with technical risks were then incorporated into economic model, which includes legislative restriction and taxation. These conditions differ according to territory in Russia which is the opposite in Norway, allowing us to create territories with similar climatic conditions and geological perspective, analyzing technical and legislative risks.

Introduction

Relevance of the research in the Arctic is due to the strategic importance of the northern waters for all neighboring countries. The Arctic and its natural resources today is called the resource base of the future not only for the oil and gas industry, but also for other minerals. The study of the development of the arctic and the risks related to adverse climatic conditions are also important in connection with the prospect of further development of the Northern Sea Route, the diversification of exports and the possibility of entering new markets, the creation of high-tech production.

To date, the level of depletion of traditional deposits is between 50% and above in Norway, and Russia, and one way to replenish the resource base and maintain the required level of production is just seen in the development of Arctic offshore fields. For Norway, the Arctic shelf is the main resource base. In Russia, about 70% of the territory of Russia, a promising oil and gas is in the server-latitudes, and 18% of the entire territory of Russia falls on the Arctic zone. The total area of the Russian continental shelf is 6.2 million square kilometers of which 4 million square kilometers - is the Arctic offshore.

The harsh climate and low level of knowledge do high-risk development projects, for such complex projects require a more thorough investigation of the risks. In this connection, as learning methods increases the need and risk analysis tools and their applicability to fields in evaluating the Arctic region. Thus, the object of study are the areas in the waters of the Arctic seas, as well as technological and legal risks associated with the development of the Arctic territories. In the world there are only a few projects in the Arctic sector of the US, Norway, Canada and Russia, each of which is unique and represents a strategic importance for both companies and for the state.

In view of this, the information base of the study served as open sources, including oil and gas companies’ data, summarized authors' calculations, published studies research centers and individual scientists. The main objective is to study the legal and technological risks, their analysis and the impact on offshore projects in difficult Arctic conditions.

The output is a recommendation on how to influence the project risks and to what extent, depending on the water area and its natural and climatic conditions. The result of the classification of risks, refer to the

Arctic fields, compiled by the authors, as well as shows the reaction scheme for risk. In this case, the author's personal opinions can not be interpreted as the only correct and are made based on research findings.

The Arctic Region

Commonly the Arctic region defined as the territory above the Arctic Circle at 66° 33’ 44’’ N. All other descriptions of the Arctic related to certain territories with specific ice and climate conditions, e.g. the areas in the Northern Hemisphere where the average temperature is below 10° Celsius in the warmest month. On land, Arctic regions are usually defined as lying north of the highest latitude where trees grow naturally. The main sea basins of the Arctic offshore are: the Barents Sea (including Pechora basin), the Kara Sea, Laptev Sea, the East Siberian Sea, Chukchi Sea, the Beaufort Sea, the Greenland Sea and the northern part of the Norwegian Sea.

Severe climate makes projects of resources development in the Arctic not only technologically sophisticated, but also environmentally and ecologically risky.

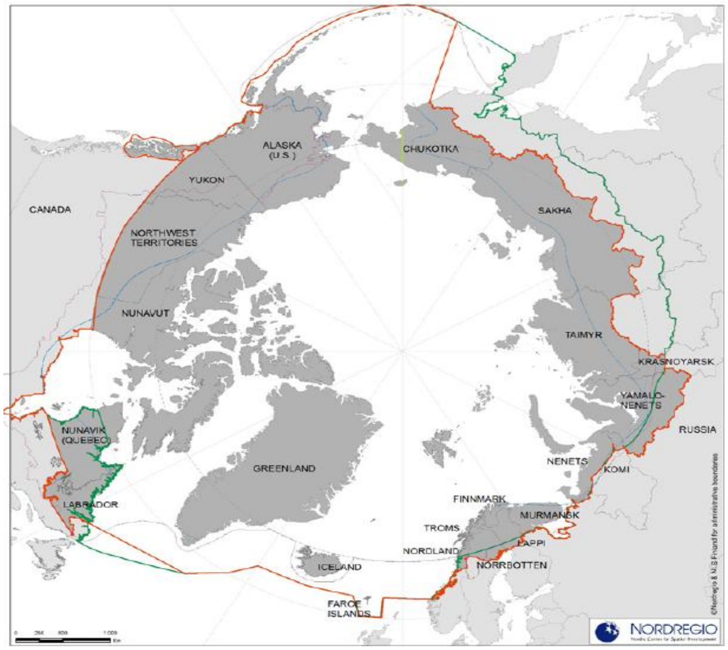


Figure 1: Arctic geographical definitions
Source: Definitions of the Arctic (Nordregio, 2013), available online at http://www.nordregio.se/en/Maps--Graphs/08-Urban-and-regional-divisions/Definitions-of-the-Arctic

The problem of ensuring the security of the oceans are currently on the importance and urgency goes to the level of problems such as disarmament, the settlement of regional conflicts and crisis situations. No country alone, even with the strictest control is not able to cope with the environmental threat.

Hence, international cooperation in long-term period should be in order to keep international environmental safety, take optimal environmental strategy, which includes both the concept and the program of joint actions of all countries. Future prospects for Arctic development in the near future will depend on key factors according to the personal author’s vision.

1. Technological factor. Resource development in Arctic and, in particular deep-sea production will depend directly on the development of subsea technologies and completion, ice protection, efficient transportation, the development of new transport routes, etc.

2. Price and economic factors. Development of complex Arctic fields depends on the price situation, as well as the demand for energy in the future. Under the price factors we understand market price and cost of production. Forecasting prices for resources for such a long period is difficult enough. The price of production will depend on the technological factor.

3. New gas markets and the distribution of production capacity. New gas market appearance will be due to the development of LNG technology. Although binding to the price of oil and, therefore, high uncertainty, LNG projects are now being implemented in almost all the continents both international and national companies. Further LNG competitiveness in each project will depend on the specific capital and operating costs. Only in the United States in December 2015 were approved 16 LNG projects. New LNG projects are planned in the Middle East, Tanzania, Angola, Nigeria, and Algeria.

4. Economic growth. Globally, the economy energy industry, population growth with overall economic growth and increase in income leads to an increase in energy consumption. In the next 25 years, energy consumption will increase significantly, mainly due to the economic growth of developing countries. Therefore, production will increase and the use of all existing industrial energy - coal, nuclear power, biofuels and other renewable energy sources, as well as hard to reach oil and gas resources.

5. Geopolitical and legislative factors. These two factors to our point of view are interdependent. There is no doubt that Arctic region is strategic territory for all bordering countries and countries already fixed it in national development program. On the other side, Arctic region is the shortest way to connect Europe and Asia through Northern Sea Route and all countries understands the importance for their national development. Arctic bordering countries try to optimize legislative base for their part of Arctic territory according to geopolitical interests. Legislative factor, in its turn, include also taxation system. Almost all projects in Arctic in current economic, politic and world market conditions are not profitable. The development of this territory will also depend on the tax and investment preference regimes each country will implement. Without appropriate legislative and tax regime companies will hardly go to the Arctic. All the above mentioned makes crucial to make deep research of technological and legislative factors and risks in Arctic associated with resource development.

Severe environmental conditions in the region significantly differs in terms of the water area and different nature conditions in around the Sea as temperature, open water days etc (Table 1). So, if the Russian Kara and Pechora Seas almost the whole year-round is ice-covered, the Norwegian part of the Barents Sea almost doesn’t freeze, which greatly reduces technological risks for projects in Norway in comparison with projects in Russian water areas.

In the future, development of the Arctic requires enormous financial resources, even considering the fact that the geopolitical situation is quite stable, and the state will retain tax and investment conditions in the Arctic. An important factor will be the future of the state policy regarding the admission of other companies on the Arctic shelf.

However, in the future will have to adhere to certain rules of the implementation of projects in the Arctic. In order not to deplete the Arctic, and not turn into a big pot of world reserves of precious ore in Davos on the 21 of February 2016 project «The principle of responsible investment in the Arctic» presented. The project based on ecosystem protection, the fight against corruption, the interaction with the locals and close cooperation between the investor countries.

Table 1. Comparison of nature climate conditions in Arctic water areas

Parameter	The Beaufort Sea	Kara Sea	North of Barents Sea	Center of Barents Sea	Pechora Sea
minimum temperature, t°C	-52	-50	-35	-24	-48
w maximum wind, m/sec	42	40	36	40	41
wave summit, m	6,3	5,7	10	12,5	6,2
stream velocity, m/sec	0,5	1,8-2	0,8	0,5	1
open water days	90	0-130	190	180-365	110
maximum thikness of ice without pressure ridge, m	2,1	1,8	1,8	1	1,3
rafting thikness, m	4,6-6,1	3,6	2	2	2,6

Source: S.Loeset, K.Shkhinek, O.T.Gudmestad, P.Sgrass, E.Michalenko, R.Frederkins, T.Karna. Comparison of Environmental conditions of some Arctic Seas in Basics of Offshore Petroleum Engineering and Development of Marine Facilities with Emphasis on the Arctic Offshore, Stavanger/Moscow/St.Petersburg/Trondheim, 1999.

Main territory and resource potential is divided between Russia, Norway, USA, Canada and Denmark (Greenland). There are several assessments of resource potential in Arctic: IEA, USGC, Ministry of Geology of Russian Federation, scientists etc. According to A. Kantorovich assessment of the World Ocean resource hydrocarbon potential, the richest region is Arctic – 58%.

One of the most famous research report on Arctic potential was provided by USGC in 2008. According to report, resources potential in Arctic assessed in 90 billion barrels of technically recoverable (undiscovered) oil, 1,670 trillion cubic feet of technically recoverable natural gas, and 44 boe of technically recoverable liquids. It is about 22% of world technically recoverable resources. 13% of undiscovered oil, 30% of natural gas and 20% of liquids in the world are expected to locate in Arctic where more than 80% of resources more likely to be on the offshore.

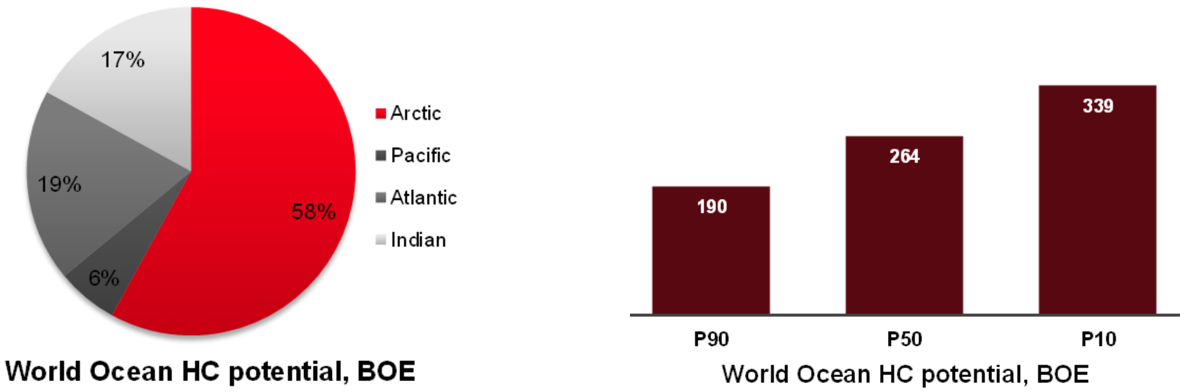


Figure 2. World Ocean hydrocarbon potential
Source: Open lectures of Professor A.B. Zolotukhin (based on the materials of A.Kantorovich)

Assessment in Arctic was based on 10% possibility (P10 according SPE PRMS) of technically recoverable (undiscovered) oil, natural gas and liquids. USGC report survey was also based on 33 sedimentary provinces researches. Transforming the data, totally 412 billion barrels of oil equivalent (boe) can be discovered in Arctic.

Another estimation is reported by IEA. According to this report, Russia shares 44% of the whole Arctic and 52% of oil and gas possible reserves. The estimation shows distribution of undiscovered oil and gas resources between Arctic bordering countries (Figure 3).

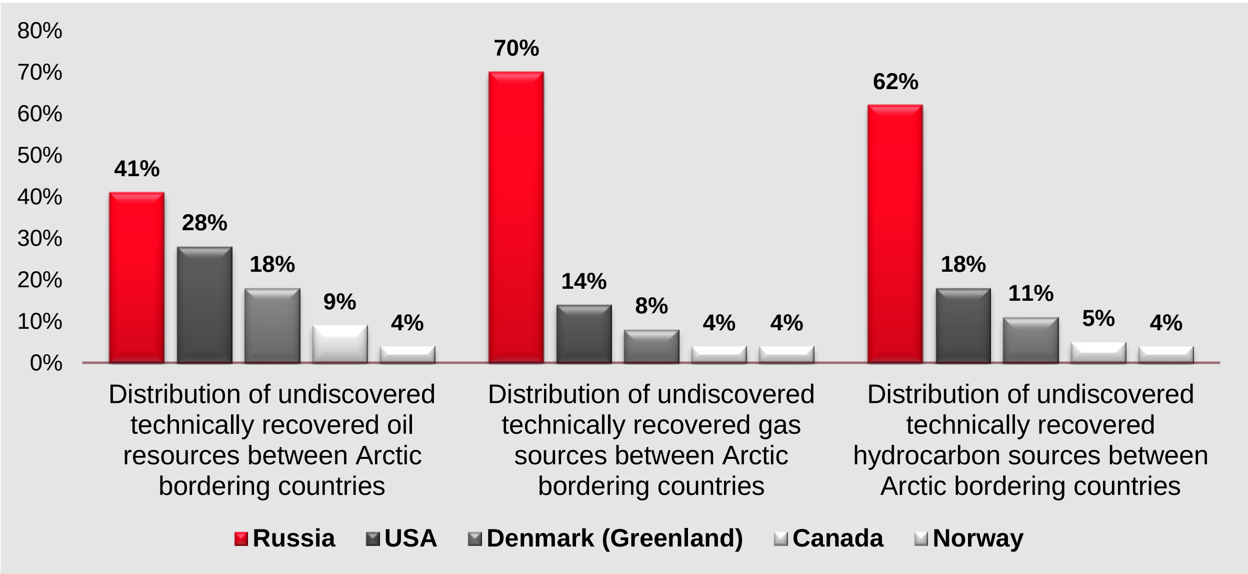


Figure 3. Resource distribution between Arctic bordering countries
Source: International Energy Agency

Interest in Arctic perspective reserves became active during past decade. In a greater degree it was driven by high oil prices. As the price for LNG is based on oil price, the industry observed LNG boom as well. Major companies as Shell, Statoil, and ExxonMobil started projects in Arctic water areas. In

Alaska (USA sector of Arctic) national surveys on resource potential was provided and planned territories for discover were identified (Figure 4).

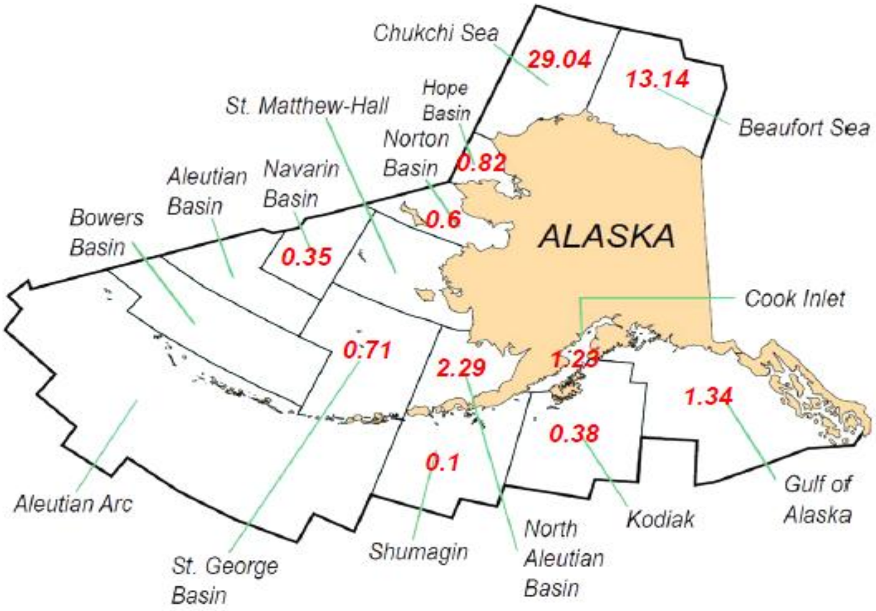


Figure 4. Undiscovered resource potential on Alaska continental shelf
Source: http://www.boem.gov/uploadedFiles/2011_National_Assessment_Factsheet.pdf

Experts in Russia estimate the total volume of recoverable reserves of 100 billion tons of oil equivalent, 80% of the gas, the remaining 20% crude oil. About 90% of these resources are concentrated in the seas. On the Russian shelf today opened 20 large offshore oil and gas provinces and basins, 10 of which - with proven oil and gas content. It should be noted that the assessment of the prospects of Arctic waters is carried out as a public company, and independent agencies. Estimates in this case differ widely (Figure 5). It may be caused by different seismic information, historical data and access to exploration.

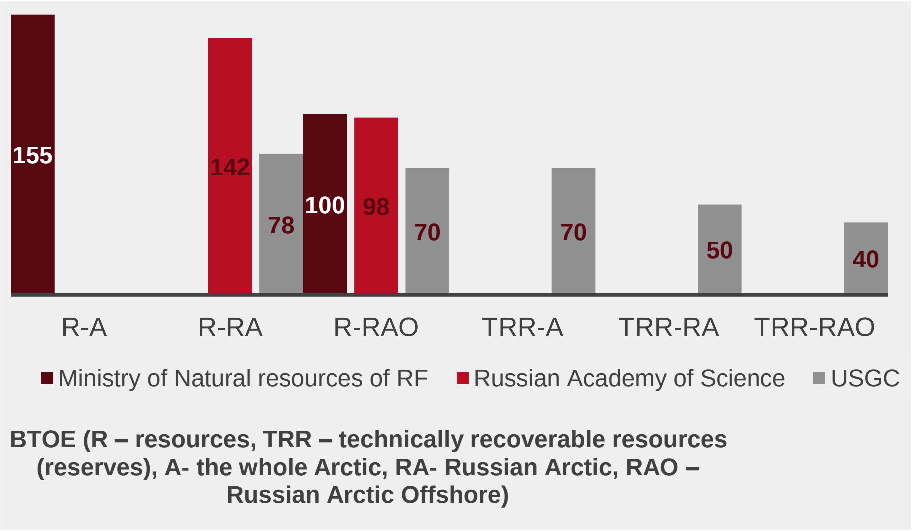


Figure 5. Arctic resources and technically recoverable reserves in, BTOE
Source: Open lectures of Professor A.B. Zolotukhin

Despite the harsh Arctic climate, as well as the associated capital costs and environmental risks, resource development has been conducted in Canada, the US, Norwegian and Russian sectors since the 20th century. Technology development have changed over time and depended on progress. In general, oil and gas fields' production technologies are divided into the following types: aerial, surface, underwater, underground (mine-tunnel), combined. Originally artificial gravial islands used in the Arctic surface. They were used in the Canadian and American sectors due to shallow depths (2 to 20m). Such a method is rather expensive and does not rule out the risk of technological operation at low temperatures. The islands were built in various ways: gravel islands, tidal islands, ice islands, etc. (Table 2).

Table 2. Type and costs of artificial islands for oil production in Arctic

Island type	Company	Location	Year	Sea Depth, meters	Cost, mln CAD
Artificial gravel island	Shell Sanopiper	Alaska	1985,1	8,2	40
	Shell Seal	Alaska	1981/82	7,9	40
	Exxon Beechy Pt.	Alaska	1980/81	6,1	20
	Shell Tern 1&2	Alaska	1981/82	6,1	15,5
	Shell Goose A	Canada	1982/83	2,1	16
Tidal islands	Esso	Canada	1976-1986	12-18	30/10/40
The island with slopes, reinforced with sandbags	Chevron Ellice	Alaska	1985/86	2	10
Ice islands	Amoco Mars	Alaska	1986	7,6	5,74
	Esso Angasak	Canada	1987	5,5	5,5
	Chevron Karluk	Alaska	1989	6,4	4,6
	Esso Nipterk	Canada	1989	6,9	7

Source: Masterson D.M., Bruce J.C., Sisodiya R., Maddock W., Beaufort Sea Exploration: Past and Future, OTC 6530, 1991

In 1987, within the framework of the deposit Endicott development (BP operator with the participation of Exxon Mobile), at a distance of 3.5 km from the coast of Alaska and at sea depth of 1 to 4 meters, two gravel island connected to the shore bulk highway were built. The construction of these islands demanded 5 million m^3 of gravel. Mine Endicott was the first offshore field of the Beaufort Sea, which entered into service.

Figure 6. Endicott project of artificial gravel island

Source: Matskevich D.G., Technologies for Arctic Offshore Exploration and Development, SPE Projects, Facilities&Construction, June 2007, p.1-6

To date, the underwater operation techniques have been used successfully when the extraction and preparation of the oil and gas is under water, and drilling is carried out by means of a floating vessel with subsea. Some projects with various arrangement techniques are presented in Table 3.

Table 3. Characteristics of projects in Arctic

Project	Company	Location	Year	Technology	Current Status
North Star	BP	Alaska	1999-2000	Artificial gravel island	In production
Oooguruk	Pioneer Natural Resources	Alaska	2008	Artificial gravel island	In production
Nikaitchuq	ENI	Alaska	2011	Artificial gravel island	
Liberty	BP	Alaska		Artificial gravel island	Stopped
Hibernia		Canada		Gravity platform	In production
White Rose	Husky Energy	Canada	2005	Gravity platform	In production
Hebron	Exxon Mobil, Chevron Canada, Nalcor Energy oil and gas	Canada	~2017		In construction
Snovit	Statoil	Norway	2007	Subsea complex	In production
Prirazlomnoe	Gazprom	Russia	2012	Gravity platform	In production

Source: Hall, J.D., Perry C.J., Oooguruk Project Field Development Concept and Execution, OTC 19526, 2008

Overview of Oil and Gas Reserves Potential and Rent Terms

Russia

Russia the world’s second largest producer of gas and third largest producer of oil is currently facing decline in its oil and gas production with its presently producing- but ageing – petroleum fields. It is therefore relying on its imminent shale oil exploration and production from remote East Siberian and Arctic offshore fields in order to meet its economic targets and stabilize its budget. It has also been seen that the government has been trying to adjust the tax regimes to buoy up production in remote fields. (USGS, 2008). Russia requires to develop these new fields in order to make up with the current decline in conventional oil and gas production and to sustain production at 10 mmbpd minimum beyond the year 2020.

Russia sees the Arctic Shelf development as a long-term production, however, strategic to be a vital source of production growth in oil and gas in the long term. The government is presently considering introducing adequate tax incentives in order to make shelf development a bit more economical feasible. Russia, since 1 January has a special tax package for Arctic offshore projects. State companies – Rosneft and Gazprom enjoy elite rights to the Russian Arctic offshore and as a matter of fact hold 80% of the continently shelf opened to exploration. Nonetheless, it is anticipated that these two companies, both been monopolized, would delay exploration and production activities. However, the current tax package still makes Arctic exploration economically attractive.

With ExxonMobil’s plans to join hand with Rosneft to explore the Arctic shelf in Russia in 2014, Rosneft was ready to spend nearly $40 billion in the shelf exploration in 10years, but ExxonMobil’s intention to withdraw from the JV after drilling its first successful exploratory well on the arctic shelf or Russia left Rosneft to tighten its relationship with Statoil and Italian’s ENI in order to order to tap their offshore technological expertise.

Norway

Norway, just as Russia faces similar situation with respect to decline in its oil and gas production with its presently producing- but ageing – petroleum fields in the North Sea and Norwegian Sea. Norway, over the past several year, has been able to attract over $9 billion capital in far northern fields. This is mainly due to its liable and steady regulatory environment for its oil and gas offshore deployments.

It must be noted that the future of Norway’s oil and gas exploration and production lies in the Arctic, however with respect to ice regime, the conditions do not correspond to the exact Arctic criteria. There will therefore be enough more activities if other Arctic regions were opened up for exploration and further development.

Over 40% of Norwegean’s continental shelf presently continue to be unavailable for exploration. Such “no-go” areas include the shelf covering the Lofoten, Vesteralen and Senja islands, which is estimated to carry 1.3 billion boe. Nonetheless, this very regions are located closer to the already existing infrastructure as compared to other regions in the Barents Sea. Decision is yet to be made by the government to allow these waters to be explored and allow for further developments.

With respect to taxes, 28% corporate tax and extra 50% derived petroleum profit tax. Norway is a bit flexible when it comes to taxes, as compared to Alaska, as federal property taxes are left totally in the hands of the local municipality. Just like Russia and other Arctic countries, Norway is obliged in a way to give incentives for its intensely remote, far northern fields.

Mutual Agreements between Russia and Norway

There is no doubt that collaboration between Arctic costal states could guarantee better responsibility and as well lead to best practices within its member states. Considering best practices, paramount environmental standards and high technology transfer among the Arctic member states can bring about further step of responsibility to the assurance of safe and accountable Arctic development.

Norway and Russia have in recent years been extremely active in formal collaboration in Arctic development by holding series of symposiums both in Russia and in Norway. Moreover, the maritime border agreement signed between the two counties in July 2011 has rather enabled them to tighten the corporation in the search for resources in the Barents Sea. And as said in the previous topic, Statoil and Rosneft signed a joint agreement few years ago to explore the offshore deposits. The two countries are also looking at signing a joint naval agreement in the continental shelf region.

Figure 7. USCG and Canadian icebreakers working in tandem to support American and Canadian Extended Continental Shelf claims.
Source: NOAA http://continentalshelf.gov/media/healy_louis_s_st-laurent_600.jpg.

Mutual agreements could be a bit more comprehensive and faster to attain as compared with multilateral efforts. Canada and Russia have had a longstanding debate over rights to the Lomonosov Ridge and Mendeleev Rise; Russia submitted a claim to the UN Commission on the Limits of the Continental Shelf in 2001 providing its recommendations on how the shared border should be delineated. However, with 51 sea claims currently before the UN Commission and only three examined each year, a timely resolution is unlikely. Bilateral agreements can resolve border disputes more quickly and avoid inefficiencies and delays.

Technical and legislative risk classification in Arctic

In this paper authors studied risks of fields' development in the Arctic region. Arctic has different natural and geological characteristics in different water areas and, therefore, different oil and gas production, transportation costs and risks. Oil and gas industry as a whole begins with risks that reserves may not prove. Unfortunately, the level of equipment and technology (rather its absence and unprofitable) today does not allow to develop most promising areas. However, to consider it as a risk is also not entirely right as no company will go into Arctic development without appropriate technical facilities.

Taking into account the natural characteristics of each water area, depth and ice conditions, we consider it appropriate to classify the risks of development of offshore Arctic fields depending on the climatic conditions. The proposed classification on the one hand divides risks into two large divisions: internal and external. External risks are further divided into two subsections: country risks and risks of the project participants (stakeholders). Internal risks are divided into financial and economic, technical and technological, marketing and logistics, and environmental. This division is due to the direct relationship of the classification followed by the model of analysis and risk assessment.

Then again, the above classification divides risks according to the area. In this paper risks in Kara Sea and Barents Sea were analyzed. In turn, the risks of each sea area are divided according to the four climatic factors:

1. water depth
2. ice conditions
3. period of open water
4. distance from shore

Such a classification allows for more precisely allocation of project risks according to different climate conditions, which is critical for the fields in the Arctic. This classification will allow us to understand the difference in the degree of influence of the same risks in the development of deposits in different waters, depending on the environmental conditions.

In connection with this, it is also necessary to note that it is incorrect to assume same cost of development of potentially fields in Arctic in different waters. Thus, the cost of field development in the Kara Sea, where the period of open water is only 2-3 months a year, will be completely different from the value in the Barents Sea, where the period of open water can be up to six months, and in some places, the sea does not freeze all year round. Within each zone in classification the combination of risk groups and the water areas of the risks have been identified. Table 4 shows the structure of the classification, where the horizontally arranged two groups of risks (internal and external) and sub-groups, and across the waters of the three considered and climatic factors within each area. Selection of the main risks was based on expert judgment and objectively existing risks. Each combination of horizontal and vertical band creates risks and uncertainties.

Technologies of Arctic development depend on the availability of territories and natural environments such as additional complexities that create natural factors: permafrost; subsidence and seismic activity; icebergs, hummocks; gas hydrates and bottom gases; ping and pockmark; weak bottom grounds; difficult terrain and landslides; faults; stormy atmosphere; coastal erosion. Ice load limits the applicability of the technology and cost increases (constant monitoring of the ice conditions). Russian Arctic shelf, as well as its land characterized by the presence of permafrost rocks. Permafrost zones and their power the most well studied only in the areas of oil and gas research.

Drilling has proven a wide range of the permafrost. According to GSC (geological survey of Canada) in a number of the Beaufort-Mackenzie areas it reaches 600 - 737 m. Permafrost is located on the shores of the Arctic seas and causes extensive destruction under the influence of heat and water exposure. Due to this, there is a high rate of retreat along the coastline reaching up to 2.9 m in the Kara Sea. The area of retreat is constantly growing, changing coastlines and threatening coastal strip destroying coastal facilities and shipping due to the appearance of previously unknown shoals. Norwegian sector of Arctic is characterized by open water Seas and more opportunities opens in this condition, because projects are realized without logistic problems and technological risks during exploration, drilling, completion and development are not so high. In addition, in Norwegian Arctic territory permafrost are not outspreaded so much. Another serious risk of resources exploitation is seismic situation, which is characterized by non-uniform distribution in the Arctic. The existing network of stations can be reliably identified in the Barents-Kara region earthquakes with magnitude more than 3.5 - 3.9, thereby an erroneous impression about the region aseismic created.

As with the development of conventional deposits on the offshore all projects begins with geological exploration and the main risks appear in this instance. In current Russian Arctic conditions the use of reducing geological risks mechanisms are very difficult or not at all mostly possible due to lack of information. In comparison with Russian Arctic and geological risks, Norwegian sector is highly explored and in new territories historical information can be used to reduce geological risks. Thus, in Russian sector according to the Tax Code, the costs of exploration can be transferred on other activities, but cannot tolerate losses in one structure between legal entities and there is a limit on the time and volume. Determining the optimum state's share in financing the exploration is a difficult task, because the entire Arctic shelf little studied and work is very capital intensive.

Another technological challenge the projects in Arctic will face is the supply of electricity. At small distances it is considered to be more efficient to produce it on the beach with a feed platform (well) on the cable. In world practice, there are other solutions, for example, produing electricity directly on the platform with the use of gas generators. A great risk for Arctic is transportation of underwater multiphase flow over complex terrain benthic ashore for further processing, as well as the long distance to the beach. In addition, it will be necessary to use antifreeze for the platforms when downloading from the platform due to the low temperatures at the bottom.

Transportation and technological risks in the development process for the most part related to the possibility of equipment failure, or to the lack of appropriate technology and experience transporting large volumes, as well as the lack of icebreakers and tankers. The choice of vehicles is due to the influence of a number of factors: geographical location of the sea, the depth, the volume of products for transport, transport distance, etc.

In the phase of development there is a problem of monitoring and maintenance of the pipeline situated in the waters during the period of six months covered by ice. There are three possible technical solutions: the creation of a class icebreaking service vessels, able to provide year-round access to the pipeline; construction of autonomous underwater technical means; duplication gas pipeline, located in the waters of the ice, which will provide the opportunity to maintain and repair it in a favorable period. The value of the transport line is not limited to one specific object, it can serve as the basis for the creation of infrastructure for the development of a number of other fields.

For areas with relatively small sea depths, acceptable and very severe ice conditions (Okhotsk Sea, Pechora and Kara Seas) is characterized by the specific risks of pipeline laying, associated mainly with overcoming quite an extended, freezing shallow zone and withdrawal pipelines on land in permafrost conditions. The complexity of this task is compounded by the fact that at shallow depths there is ice gouging bottom. As a result, there is a need for a significant deepening of the pipeline and the installation of additional automatic valve in case of damage. In the Arctic regions there is no communication with the coastal zone, or underdeveloped and it is additional risk.

To solve the problem of transportation of oil in these conditions it is necessary for the construction of tanker loading terminals. And in order to provide year-round transportation of oil, for example, deposits of the Eastern Arctic seas, where the length of the ice-free period is limited to 1.5 - 2.0 months, it is need to use vehicles like tankers or icebreakers. In order to reduce environmental risks in the world practice liability insurance for causing harm is used.

When approaching the completion of field operations, there are risks associated with the wear and tear of equipment and infrastructure, leading to increased environmental risks for investors as this increase the likelihood of equipment failure, causing serious damage to the environment. There liquidation risks manifested in the possible absence of subsoil users and state funds for the implementation of works on liquidation.

	External risks				Internal risks			
	Country risks		Stakeholder risks		Financial and economic risks	Technological risks	Marketing and transportation risks	Ecological risks
	Rating lists	Geopolitical risks	Legislative and taxation risks	Investment risks				
Kara Sea (Russian) Sea depth Ice conditions Open water days Remoteness from the onshore	Risk reduction rating of the country and the withdrawal of investors Closing access to capital markets and high rates	Increased competition in the countries of the region Changing the internal policies of the countries in the region Increased interest on the part of the observer countries (China, India)	The uncertainty of the future tax treatment of customs duties and export after 2042. The risk of tightening access mode Changing the order of issuance of the license Change access to the shelf		Lack of own funds Penalties for non-compliance with license conditions Disruptions of the project due to the ice conditions Rise in price of the project The increase in the cost of technology	Lack of technologies for deep Lack of technology for drilling in ice conditions Technological complexity due to the short period of open water The impossibility of conveying technology	The complexity of the transport of materials for the project The complexity of the export product The uncertainty of the sales market The uncertainty of demand for the next markets	Breakthrough in the derivation of the pipeline to the shore Breakthrough or gas breakthrough Emissions from LNG production Gas seeps
Barents Sea (Norway) Sea depth Ice conditions Open water days Remoteness from the onshore	Reduction of current interest for cooperation in the partner countries due to unfavorable forecasts ratings	Risk of military conflicts because of dislocation on the Kola Peninsula		The risk of losing their company as investors due to the attractiveness of the Norwegian shelf		High waves and storms, a large distance from the coast The water depth is very large, complex development of technology open water period does not cause risk	Main Risk of Total and Eni current and planned projects, Lack of effective schemes of export products Lack of demand for the products of a given water area	Inhomogeneous bottom, the risk of laying the pipeline Earthquake in the region

Analysis of investment costs of offshore gas fields of the Arctic conducted by Krylov Shipbuilding Research Institute named after Krylov shows that the implementation of projects to develop offshore fields in Arctic will require significantly more investment than those that are spent on the development of fields in less harsh environments (Figure 7).

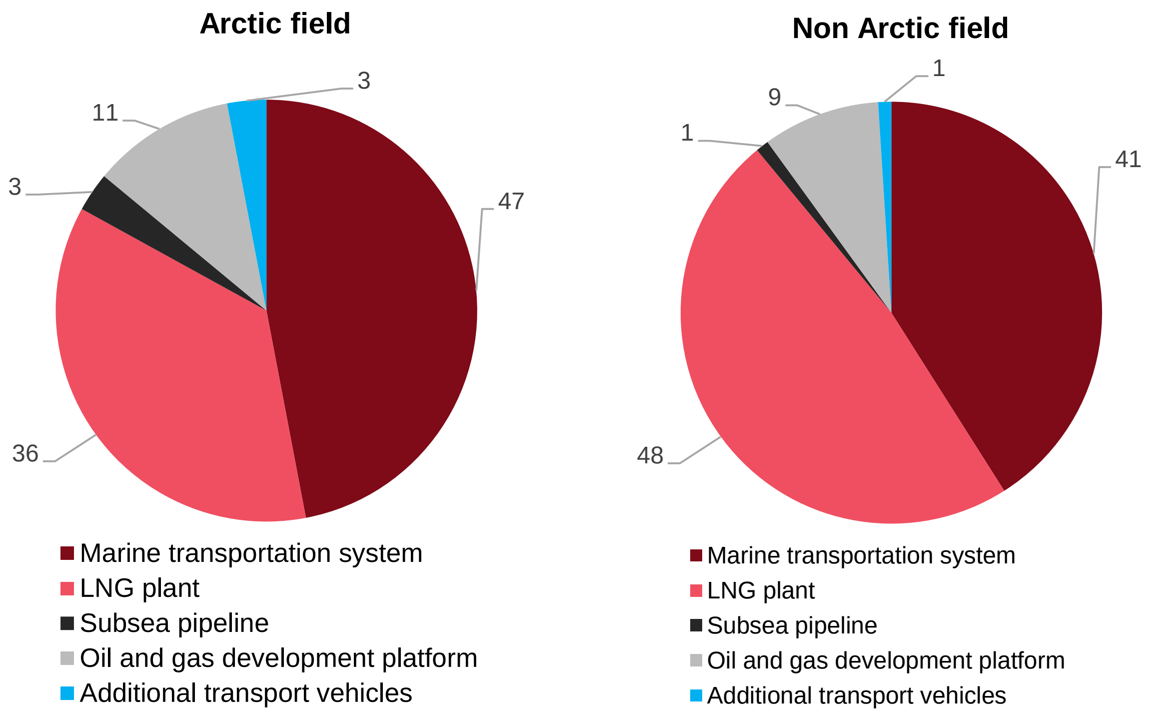


Figure 7. Costs distribution for Arctic and Non Arctic field

Source: the materials of Krylov Shipbuilding Research Institute

Applied solutions have direct impact on risks as well as cost of the risk, depending on the CAPEX. World practice shows that the average cost of underwater pipeline to the ice-free conditions is about $ 1 million per kilometer. For the Arctic seas, this amount is increased approximately 2-3 times. This fact is explained by the appreciation of both the pipeline and the cost of its construction in difficult ice conditions. Field development in the Arctic seas can increase the volume of investments by approximately 40% as compared with the fields being developed in less harsh environments. However, cross-over transport organization scheme for the liquefied natural gas can provide a reduction in investment costs, for example, at a ratio of 4.3%. It is noteworthy that the cost of the plant to liquefy gas slightly depending on the region in which it is located. Thus, the cost of the plant to liquefy 10 billion cube meters of gas will be about 2.1 billion dollars (including the cost of loading terminal in the composition of the gas storage and loading terminal and port fleet vessels). In developing the offshore Arctic gas liquefaction plant (taking into account the export terminal at the port fleet and the court costs) it is no longer prevalent in Arctic investment costs. Despite the fact that the cost of the plant remains unchanged, its share in the total cost falls sharply (from 48 to 36%).

However, the costs of all other field facilities such as offshore gas production platform, marine transportation system, subsea pipelines, auxiliary fleet increase substantially. According to the Krylov Shipbuilding Research Institute research in Russia, the specific investment costs per 1 thousand cubic m produced gas will amount to 23 dollars in production on the Arctic shelf. In the future, for the development of the Arctic requires enormous financial resources. Guggenheim Partners has estimated total global investments in the Arctic. They totaled 432.4 billion dollars. As experts say the company, required for $ 1 trillion for the sustainable development of the region, that is currently lacking an additional $ 567.6 billion. The polar hydrocarbons has already invested US $ 192.7 billion, in second place are the other minerals: 79.5 billion dollars, on the third place the renewable energy sources: they have invested 60.6 billion dollars. Melting ice means that the navigation period in Arctic is growing. The area of the Arctic ice will steadily decline. By 2050 they will be 30% thinner, and their volume is reduced during this time by 15-40%. In this case, extraction of hydrocarbons significantly simplify, some risks will disappear and reduce the cost of these several months container ship from South Korea to New York to pass all 5 thousand km instead of 12 thousand km, if you sail through the Panama Canal. In addition, a new relatively mild climate of the Arctic makes it a huge fish resources more accessible.

Legislative Systems

Legal regulation in the Arctic countries is very different. Two directions of legal regulation can be identified: the liberal approach (USA, Great Britain, and Canada) and the preservation of public participation (Norway, Russia, and Denmark). In countries with a liberal approach, it is not directly state legal regulation, and the state's share is limited or small installments or partial participation in the licenses. In countries where is legal regulation retained by the state, participation of non-governmental (private) company is impossible without the creation of consortium, where state regulation sufficiently high. In Norway, the state's share could vary depending on the issued licenses, some licenses are issued without the participation of the state. In Russia, under the laws of the State has direct or indirect control of 50%. Also, in contrast to the Norwegian legislation in Russia it is not allowed to issue a license for exploration without further development of resources. Taxes on the extraction of hydrocarbons in the Arctic regions within the neighboring countries include traditional oil and gas industry tax: royalty (or the tax on extraction of mineral resources), income tax, an additional tax on profits, bonuses, rent tax, etc. Differences in the legal regulation and taxation due to historical peculiarities of taxation of raw material extraction, production stage, the study of the region and the prospects of commercial reserves opening. Comparative analysis of the taxation systems shows that the lowest share of the state in respect of the hydrocarbons in the Arctic is in Russia, which is 30-35%, while in Norway, the state's share reaches 85%. However, in the Russian legislation with low tax rates introduced by the requirement of minimum five years of experience on the offshore for the admission to the Arctic. Together with the requirement of 50% participation of the state, the opportunities for access to the Arctic sharply limited the two state companies.

State regulation of access to resources and the establishment of preferential treatment due to high extraction of natural rent, which is typical for all resource industries, as well as the strategic importance of the Arctic region and the development of technology. Licensing in Norway is carried out under the control of the King and the Norwegian Petroleum Directorate. Licenses are available in two forms: an exploration and production on the basis of ongoing licensing rounds. Production license is issued after a careful examination of the candidate's experience in the offshore financial capabilities, technological expertise. Participation can only be registered in the Norwegian joint-stock companies or members of the European Economic Area agreement. The participants of the auctions are pre-qualified in the Norwegian Petroleum Directorate. Participants of the production on the Norwegian shelf are represented by more than 20 companies and 40 operating companies. During the period from 1971 to 2010 the existing system of state regulation and taxation of most income was received from the income tax (Figure 8).

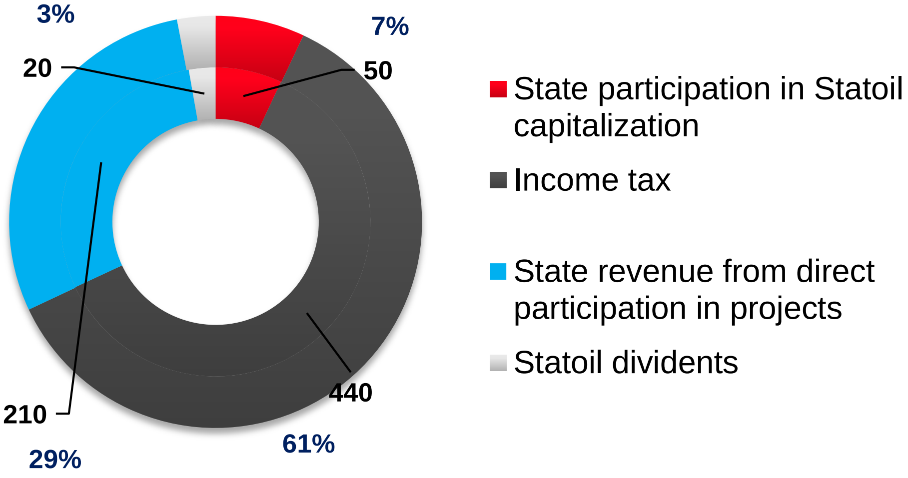


Figure 8. State participation in oil and gas industry

Source: Norwegian Petroleum Directorate (NPD) (www.ndd.no)

As a direct participant in the projects, Norwegian state invests in capital and operating costs in proportion to its share (Figure 9). This means that the state also assumes all risks associated with the projects to the proportion in which it participates. Participation takes place through the state-owned company Statoil (67% state share), which is an open joint-stock form of organization and through direct share. This mechanism was built to save the capital and resources of the state.

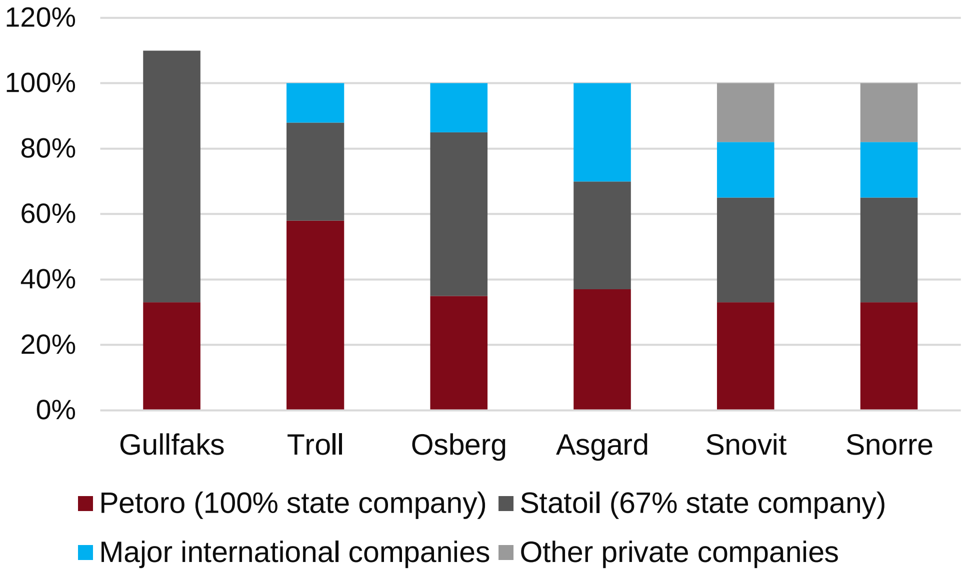


Figure 9. Forms of state participation in projects in Norway

Source: Norwegian Petroleum Directorate (NPD) (www.ndd.no)

According to the latest changes in the law «On Subsoil», state regulation in Russia carried out by the Ministry of Natural Resources, which issues licenses for exploration and production, as well as combinations of the license. Changes in the law also limited the maximum period of exploration on the continental shelf (including the Arctic) to 10 years and able to get only a combined license. As mentioned, the new law also required a 50% share of the state and 5 years of experience on the shelf. The only way now for the company is the creation of joint ventures. Table 5 presents a comparative analysis of state regulation systems in the Arctic countries.

Table 5. Comparison of legislative and tax condition in Norway and Russia

	Norway	**Russia**
Tax conditions		
Taxation basis	Profit based Corporate income tax, additional income tax on upstream activities	Revenue based Corporate income tax and royalty (MET)
Compensation bonus	No	Yes
Royalty	No	5%-15% MET dependent on the territory
Profit tax	28%	20%
Rentals and other resource taxes	50%	No
Loss carryforward/ carryback	Indefinitely/ 0 years	10 years/ 0 years

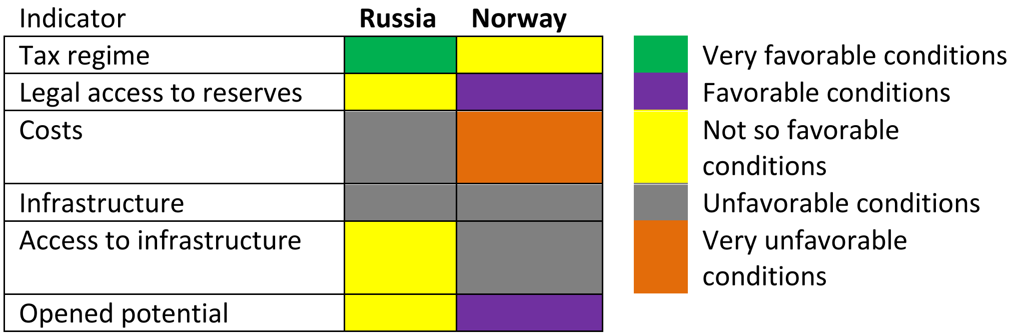
period		
Average level of overall fiscal burden on project's economics at 80$/bbl	78%	75%
Legislative conditions		
Compulsory state participation	No	>50%
Non-government companies participation	100% independent or consortium	Share in operating company without share in license
Qualifying requirements	Registration in the country, financial and technological abilities	5 years experience on offshore fields
Preliminary qualifying	Compulsory for all companies	Not applicable
Procedure for granting licences	Competitive selection	Non-competitive
Multi-client seismic access	For all open offshore territories	Prohibited

Source: prepared by authors and based on SPE174889

Tax system is part of the legal system. However, if the legal system as a whole does not often change, but the tax rate, the tax base are changed and improved in many countries. This is usually done for different purposes: to attract investors, reduce the tax burden in order to stimulate investment and modernization, improvement of the tax system, etc. Changing the tax system is typical for the Arctic territories in the countries where they are just beginning to get used to, whereas in countries with a developed infrastructure and activities of the state an effective tax system is already determined. If we compare the Russian and Norwegian system, it is possible to identify similarities and differences. The similarity is in the same strategic vision for the Arctic shelf of the two countries and, therefore, the need to control and participate in the development of the Arctic. The difference lies in the fact that Norwegian tax system has developed for a long time, as the development of territories began much earlier, and the tax system has undergone its historical changes.

The active development of Russia's Arctic territories started about 10-15 years ago, and, consequently, the tax system is changing and will continue to change. The Norwegian tax system from 1986 abolished royalty and other taxes from the gross production. Also applies linear depreciation for 6 years for the mining assets. In Russia, the mode of access to the shelf, including the Arctic, it is very hard in relation to the investor, subject to the same taxes as in traditional fields, except for some preferences in the form of zero or reduced rates. The legal basis is the government order № 443, according to which the royalty for the Arctic shelf were changed depending on the environmental conditions. The tax system in the Russian Arctic shelf can be considered quite favorable, as the royalty rates are quite low, abolished VAT and import duties on equipment and canceled the export duty on the extracted products. The final comparative analysis of the tax, legal and other parameters are shown in Table 6.

Table 6. Comparative analysis on tax, legal and other parameters in Russia and Norway.



Indicator	**Russia**	**Norway**
Tax regime	🟩	🟨
Legal access to reserves	🟨	🟪
Costs	▨	🟧
Infrastructure	▨	▨
Access to infrastructure	🟨	▨
Opened potential	🟨	🟪

🟩	Very favorable conditions
🟪	Favorable conditions
🟨	Not so favorable conditions
▨	Unfavorable conditions
🟧	Very unfavorable conditions

Source: prepared by authors.

Oil and Gas Regulations in the Arctic Region

There already exist several Universal rules and regulations intended to mitigate associated risks coming along with Arctic development. UNCLOS currently provides the elementary legal structure for the development of the arctic resources, granting the Arctic states the right to resource exploration and development on their respective zones. However, individual Arctic States have the obligation to preserve and safeguard the marine environment, taking into consideration all regulations governing the oil and gas development in the Arctic Region.

MARPOL 73/78 in accordance to the ICPPS requires all floating vessels and platforms to minimize pollution and ejections. And so does the OPRC commands all service and E&P companies to take on effective plans for mitigating and combating pollution. It must be noted that there are also International “lenient laws” such as AOOGG which is reviewed quite often and mostly influence arctic activities. The main aim of the guiding principles is to inspire the Arctic states to enforce ***legislation*** in order to warrant maximum environmental ethics and principles.

To keep Personnel much safer and Environment protected, the ISO 19906 “AOSS” standard however not compulsory is often implemented by operating companies. Throughout the “Barents 2020” project, Norway and Russia seem to seek standards for harmonized HSE protection for offshore operations in the Barents Sea.

In addition, due to the dynamic nature of the Petroleum Industry, possible things to regulate and realistic standards are repeatedly unstable. This normally makes the regulatory bodies outdates and out of touch with necessary updates. Another or additional supplementation to the regulatory methodology can be to pay more attention on performance criterion. The overall performance of a company, and not simply the primary activity therefore becomes the determining rod of its effectiveness and operational success.

It must be kept in mind that the deleterious consequences of accidents caused to the nature

(Environment) includes economical cost and a damage to the company in question's reputation. The "upshots" to BP for its Macondo accident in 2010 tells how much trust is lost by companies who fall under such unpleasant situations, fault being technical or operational.

It is believed that risk associated with company's reputation is most likely going to attract attention in the exploration and development of the Arctic Region as compared to onshore and conventional offshores. This is not only due to the fact that the Arctic Ecosystem is fragile, the unforeseeable challenges to spill response in cold regions, but as well as peoples' opinion concerning the destruction of an unspoiled wilderness. Any detriment to the aborigine and native population may intensify the effect, undoubtedly.

The development of measures to manage mobilization and capacities should there be accidents and spills appear to be an usual discussed topic within companies and also international cooperation. The Arctic Council initiated a special task force to assist in the development of an international instrument to combat Arctic marine spill and other related pollution. An evidence of unpreparedness for marine collaboration was revealed after the Macondo spill, whereby different companies and entities volunteered to assist, but looked impossible as coordination had to begin from the scratch. This sends a signal to the Arctic Council to organize a collaboration team among all E&P companies which will support fully best practices and techniques.

The Norwegian Clean Seas Association for Operating Companies (NOFO) is a good model for such a collaboration whereby the capability of member companies are synchronized to enhance performance and diminish cost on individual company. An Organization such as NOFO demonstrates a convincing case for "across arctic boundary" collaboration. The biggest issue is the cost sharing among companies in case of hefty accidents and of course spillages. It will therefore be ideal to create regional liability regimes which will guarantee companies' ability to make up for the probable environmental cost. The European Commission, for example, has proposed to all E&P companies to provide a structure for obligatory monetary security.

A significant attention must be paid to the impact the exploration activities may bring to our environment. The most noticeable instance of all is perchance climate change. Depending on geopolitical initiatives, it may be expected of the oil and gas industries to embrace management measures which will be more rigorous. If GHG emissions are considred, then E&P companies would need to take Carbon Capture and Storage (CCS) into consideration as one of the essential part of arctic development strategies.

Possible Regimes for Managing Development Risk in the Arctic

As discussed above, exclusive operational principles with respect to the environment and the interest of inhabitants MUST be integrated in the development strategy of the various E&P Companies. Risk managing regimes are basically grouped under two system, prescriptive and performance-based, whereas some companies combine both regimes.

The prescriptive regime tends to recignised solutions which are considered to be safer based on their historical practices. This regime is seen to be a true equilibrium betweem risk vindication and costs associated with investment and operation. The challenge

A Prescriptive System
Gives the regulator possibility to specify exact requirements
Requires comprehensive and detailed inspection
Reduces operators’ responsibility to evaluate and manage risk
Depends on the industry’s willingness to give access to and share information
Can lag behind with regard to technological and social development

The perfomance-based regime practically explains the purpose to be met. In each instance, the operating company needs to choose the solution that coressopnds to the requiremts.

A Performance-Based System
Depends on dialogue and trust between the authorities and the industry
The companies themself need to aim for a good culture of safety
Tripartite cooperation and involvement
Transparency and openness with regard to reporting of failures and non-compliance
Requires a high degree of knowledge and competence

The main role of the government institutions using the performance-based regime will be to come up with regulations and make sure that the operarting companies implement organizational systems which conforms to the obkectives of the regime. Norway, Canada and the UK operates with performance-based regime, giving the operators high degree of freedom to operate so far as they prove to comply with regulation fuctional requirement. The performance-based regime is becoming popular paving way for high proactive approaches in terms of risk management and reduction, as well as improve safety.

Undoubtedly, the most suitable model for Arctic development will be a more safety system set on a performed-based structure. This will definitely take into consideration appropriate knowledge and understanding of the risk factors involved, identifying all applicable risk preventive and mitigation measures. In the meantime, a prescriptive approach can be adopted where enough pertinent experience exist.

Managing Risk

Managing risk aids to detect, classify, measure, highlight, and abate risks, and hence calls for reflecting complex connections between technology, organization and people, maintaining harmless and sound activities. With respect to this, extra measures need to be executed and even in some instances apply new technology (see table 7). However, in some circumstances, onshore experiences from Russia and Canada could be applied. Quite a few principles can be used to lessen risk below acceptable level, though based on logical cost valuation and risk mitigation benefits.

Table 7: Selected risk factors and mitigation measures needed for reducing the probability or controlling the consequence of an incident

Identified risk factors	**Mitigation measure**
Low temperatures have major impacts on the working environment and affect the structural materials used on ships and platforms; however there exists substantial experience from onshore operations.	• Personnel have to be protected by enclosing working areas. The enclosure should be properly designed to avoid introducing additional risk. • Correct material selection ensures proper material ductility.
Ice will be present for much of the year, in terms of drifting sea ice and icing on equipment.	• Additional strengthening and special designs to account for the loads from the ice.
Weather conditions in Arctic are not well understood and long-term developments are uncertain.	• Special design considerations if the long-term development leads to more severe conditions (e.g. waves).
Long-term human performance might be affected due to low temperatures, lengthy periods of darkness or light, noise and vibration from ice, and the psychosocial aspects of living in remote areas	• Selection and training of personnel in addition to adequate rehabilitation between working periods can help ensure a suitable workforce. • Appropriately designed living quarters give necessary relief during working periods.
A more vulnerable environment and in some cases insufficient awareness of how sensitive the environment is call for precaution.	• More safety barriers should be introduced; narrow operational windows or seasonal operations can be considered. • Probability of other risk factors should be reduced, to account for the possible increased consequence of incidents.
Oil spills in ice represent a major challenge, since no technology exists for oil recovery in ice. Detecting oil spills during the polar night is also demanding.	• Appropriate technology for detecting and recovering oil spill in ice is lacking, and should be developed.
Escape, evacuation and rescue of personnel is more challenging due to long distances, darkness	• Several alternatives for escape, evacuation and rescue should be implemented to ensure

and sea ice. No single solution exists today that is suitable for all conditions.	appropriate safety of personnel until a single solution can be developed.
Indigenous interests can be perceived as a risk for industrial activity in the Arctic due to the operators' lack of knowledge.	• Serious study of rights and cultures, including consultation processes. • Early involvement of indigenous peoples and other stakeholders.

The Risk-Acceptance Criteria

As at now, there isn't any clear goals for risk acceptance. Any risk acknowledged for decision is classified as "accepted risk". The risk management practice infers that risk is first of all examined, and then decided upon if the risk must be mitigated to satisfy the risk criteria. The risk-acceptance criteria thus outlines the levels using the quantitative approaches, that are unaccepted and or accepted based on exposure of personnel, environment, and other factors.

There are many methodologies used to formulate risk-acceptance criteria, including quantitative, qualitative, the type of risk parameters to be examined; individuals against population. It should be made clear that risk-acceptance criteria is mostly based on the idea of equivalence, considering the fact that any given activity can be a representation of a similar level of risk as a known activity which by familiarity is usually accepted. The constraint that arctic oil and gas development and other related activities will not surpass the risk experienced in likewise activities in the North Seas is such a likeness criterion.

There are as well different practices which tell the person to be responsible to define the risk-acceptance criteria. This criteria is globally set by the operating companies; for example, oil and gas activities on the Norwegian Continental shelf. Meanwhile for other activities such as production and manufacturing, the requirements are set by the government regulatory institutions in the form of prescriptive regime. The Norwegian Safety Authority, for example has in its regulations that E&P companies will set their own risk acceptance criteria. However, it is the responsibility of the authority to supervise and make sure that risks are managed accordingly.

The risk-acceptance criteria are the basics to risk-based safety practices, however, they need to be associated to an exact procedure that will reduce risk to as low as practically possible, or perhaps, for Arctic Development. Risk Management, according to ISO 31000, is referred to as "risk treatment". The regulations for Norwegian and UK offshore petroleum exploration and development, the above mentioned practice is required and all activities are documented.

The Case Analysis - Norway and Russia

In this paper, the authors propose to carry out on the basis of a three-level model of the risk analysis method «from top to bottom». Levels of analysis is consistent with the risk classification of the authors shown in Table 4. The first (top) level - the analysis of the country risk (which refers to the «external risks» section in the classification). Country analysis allows us to evaluate the rating of the country, for participants of the project is an important indicator. This stage involves two steps: geopolitical risks and risk rating. The second step is implemented through review of major leading rating agencies rating. Selection of international rankings carried out by experts. Moreover, this level may be changed at the discretion of the expert. It is carried out in the framework of project financing rules (PMI): Project rating may not be higher than the rating of participants of the project and can not be higher than the rating of the country in which the project is carried out. At the same time, how to assess the rating on all levels is not specified anywhere. Therefore, the proposed model of risk analysis and assessment developed by the authors based on subjective opinions. Thus, the lower the rating of the country, the more speculative capital will be in the external market for borrowers and, therefore, the higher the rate of Libor + and unattractive to the project. Rating country is changing mainly due to the unstable geopolitical situation in the country, the external environment and the country's participation in certain conflicts.

Analysis of external risks (hereinafter referred, under the external risks we mean external risks on the project) is qualitative and includes legal as well (including tax). This analysis has been selected for this model, as one of the key for the region. As one of the tools for the analysis of the legislative and geopolitical risks in the whole scenario method was chosen because it allows us to consider a variety of results. The methodology of scenario analysis carried out by the Shell method, which was presented in Nord University (Bodø, Norway). This methodology is in any case does not refute and reject classical analysis tools such as SWOT or the PERT, but only one more effective tool. In addition, classic design and prediction external analysis tools cannot always be realized. With this just may be encountered in the analysis of water areas of the Arctic, as there is no project-analog and no historical data on the basis of which could be carried out, for example, the statistical analysis.

The method is based on the «foresight, no prediction» (foresight instead of forecasting). The method is implemented by expertise and, of course, has its subjective side, depending on the professionalism of performers. Further, Table 8 presents the main differences of classical instruments and scenarios.

Table 8. The difference between the classical and the scenario approach

Classical approach	Scenario approach
Strategic thinking is based on the stringent analytical and quantitative methods	Strategic thinking is based on the idea of the future situation and ways invention, it can happen
For this approach, you must: • Understanding of external market forces • Identifying critical factors • Prediction of trends, forecasting	For this approach, you must: • future representation of the future • concept of company common vision • transition from vision to realization
Example: 5 forces Porter, a PEST analysis, statistical methods	Example: Scenario method

Source: International Arctic Petroleum Cooperation: Barents Sea scenarios Routledge Studies in Enviromental Studies, Oxon/New York 2015, Anatoli Bourmistrov, Frode Mellemvik, Alexei Bambulyak, Ove Gudmestad, Indra Overland, Anatoly Zolotukhin.

Scenario method effectively applied at the initial stage of the external evaluation, when there is no historical data for statistical prediction methods. Yes, and how to predict changes in legislative sphere inside countries or international geopolitical situation?

To develop scenario method the following sequence is used:

1. Make assumptions selection (global trends), which will be maintained in the long term;

2. The main uncertainties, which are allocated on a global scale;

3. On the basic assumptions «overlap» variations of uncertainties and obtained several scenarios. Scenarios are not positive or negative by nature, or, as is often done, drawn up three scenarios: optimistic, pessimistic and base. Again reservation that scenario are developments in response to changes in uncertainty either direction.

4. The final stage - the identification of so-called «wild cats», where in addition to the scenario assumes that happens quite incredible situation (usually considered a few) and is regarded as in this case, the events will develop. Schematically, the process shown in Fig.10.

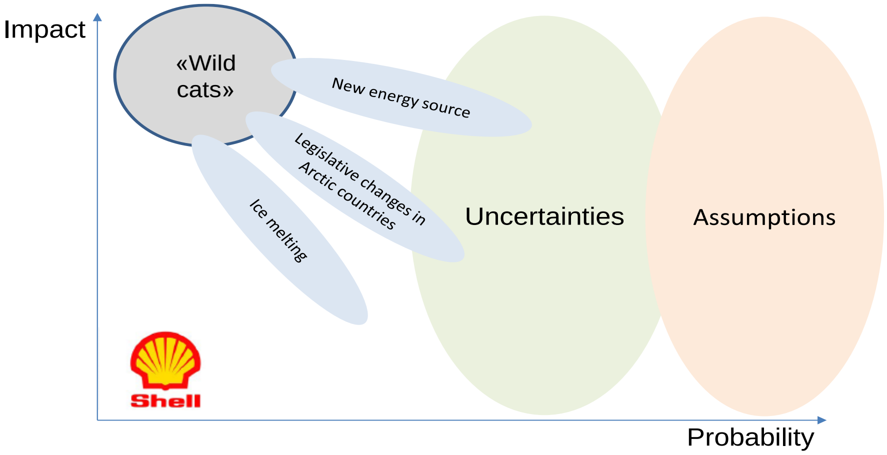


Figure 10. Scenario analysis layout.

Source: International Arctic Petroleum Cooperation: Barents Sea scenarios Routledge Studies in Enviromental Studies, Oxon/New York 2015, Anatoli Bourmistrov, Frode Mellemvik, Alexei Bambulyak, Ove Gudmestad, Indra Overland, Anatoly Zolotukhin.

In this paper, 3 development scenarios were drawn up according to the identified assumptions and uncertainties (risks) (Table 9):

Table 9. Assumptions and uncertainties (risks) to produce Arctic scenarios

Assumptions	**Uncertainties (risks)**
• Cooperation and international co-operation in the Arctic • • Population growth and increasing food problem • • The development of technology and innovation • • Growth in energy demand • • Economic growth in the world • • Increase of alternative energy sources in the total energy balance of the world • • Changing of the climate	• Legal regulation of the Arctic • Changes in the energy sector, the development of electricity storage technologies • Technological advances in the oil and gas industry • The emergence of new shipping lanes • Slow or fast growth • Deteriorating environmental conditions • Energy prices

Source: prepared by authors

We will not go on assumptions, as it is by expertise made global trends. Let us consider more uncertainties. The question arises why the country, private companies and other stakeholders still do not master the scale north? This can be explained by the uncertainties inherent in any activity, including business development or resource development in the Arctic:

1. One of the major uncertainties - this international legal relations in the region. Despite the fact that the current regulation of the borders and the territory of the North falls under the regulation of the International Convention on the Law of the Sea (UNCLOS), and all the country is satisfied, we do not know how can change the geopolitical interests of neighboring countries on the one hand, as well as observer states, on the other hand. China and India, as most developing countries with emerging economies and resource requirements may ask for more powers within the framework of their current status or change it.
2. Next uncertainty associated with the future - is the new energy sources. 21st century was marked by the increasing consumption of gas and alternative energy. Gas is not a new resource or renewable, but unlike oil, is environmentally friendly. Other alternative sources may not completely replace non-renewable, but only increase in the share of consumption.
3. There is also uncertainty in the future regarding the breakthrough, and completely new technologies. For example, in oil and gas technology it has recently seemed fracturing technology breakthrough technology, and today it has been used for all companies. But what are next new technologies and what kind of access they will be open to us in Arctic, is still uncertain.
4. Over the past few years, the world rocked two major crisis. It is not known how slow or rapid economic growth and economic recovery of the country will be shown in the future.
5. The same uncertainty remains with respect to oil and gas prices. However, these prices are difficult to predict in any attempts.
6. Another important factor that worries many experts - a new sea routes that could occur much sooner than expected. First of all we are talking about the Northern Sea Route. Although a small proportion of the world's shipments to date, these factors (eg, global warming) can make it available more quickly. If this happens in global trade and maritime transport much will change.
7. Speaking about the development of the North, we can not fail to note the negative impact of human activities on the environment. We're still not sure whether our activities in the North is so safe and responsible as we say it now.

Thus, all of the above indicates the presence today of uncertainties(risks) that will have a different impact on the development of the Arctic and from which future scenarios can be developed in different ways in order to mitigate or manage risks. It should be noted that the uncertainty - is also risk not receiving any planned result in the future. But the uncertainty can not be perceived as something negative, as it is inherent in any phenomenon, activity or project. We need to look at the uncertainty as to the possibility of new, previously unknown, and one way to see these opportunities - building scenarios. By the authors 3 possible scenarios of the Arctic region have been developed. The first scenario – «Territory of peaceful cooperation». This scenario assumes that the legal regulation of the Arctic is stable, and small economic growth in the world, there are no breakthrough technologies in the oil and gas industry and new sea routes. In this scenario, it is caused by including the remaining lower energy prices. As a result, the environment and other fields in the Arctic are stored, there is no cause for conflict and the country simply cooperate on other issues. There is a second scenario of development of the Arctic, which was named «Industrial development of the territory». In this scenario, we assume that energy prices were relatively high, at the same time is to stimulate the development of new technologies in the oil and gas industry and breakthroughs are made, allowing more efficient to develop resources in the Arctic. All this as a result leads to the appearance of new sea routes, which may lead to legislative disputes and cooperation will not be close as it is now. The third scenario «Territory of geopolitical interests» involves the development of a script to higher economic growth rates, as it is assumed that now the world is under the low economic cycle, after which will follow economic growth. In this scenario, there will be a high demand for energy and growth of the world's population, while alternative energy will not be able to completely replace the traditional sources and from other countries will be increased interest in Arctic resources. In this regard, the region becomes a zone of geopolitical interests and perhaps even legislative disputes. In all three scenarios assume a relatively average increase the share of renewable energy in the consumption structure. The development of scenarios is shown in Fig. 11: Red Line - the first scenario, the blue line - the second scenario, the gray line - the third.

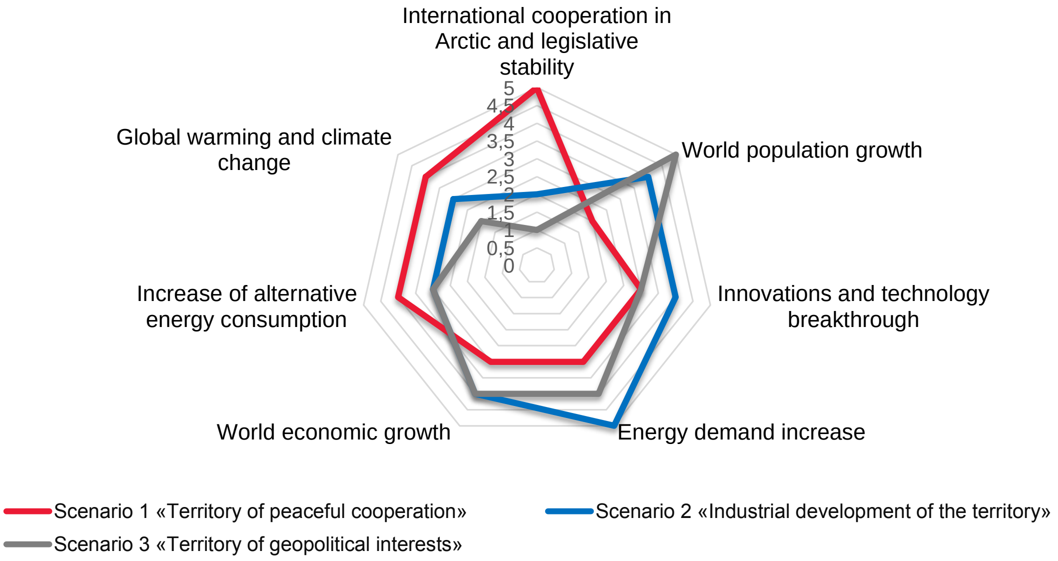


Figure 11. Scenarios of global trends and uncertainties (risks) and the impact on the Arctic

Source: prepared by authors

On these two stages of the risk analysis there are following conclusions. If the rating analysis shows that the implementation of projects both high-risk and capital-intensive in the Arctic may be unprofitable in the medium term, the expert analysis by scenarios helps us to see that the current situation can and will change, and many development scenarios are possible. Company must be based on a comprehensive risk analysis, which not only provides a vision of the current external situation in the study water areas, but also a vision of the future changes. Further, the analysis of legislative (including taxation) risks for the project stakeholders is provided. At this stage, the company determines how risky for is the process to enter the project in the Arctic region in terms of investment, tax and regulatory environment. To do this, a qualitative analysis is conducted and recommended that the first stage is investment climate analysis. It can be done in many ways up to company experts, including rating, evaluating the country codes in the degree of openness, transparency, corruption, ease of doing business and other counts by different international agencies. However, with reference to the Arctic region, we offer to evaluate the so-called country's involvement in international institutions and strategic positioning of the region in the international arena. In other words, investment attractiveness of the Arctic sectors for all bordering countries is determined by multilateral and bilateral agreements, ratification of international conventions and active participation in international institutions regulating the cooperation of the countries in the Arctic region.

This means that the more a country has approved the status of the region on the international political, diplomatic and legal arena, the greater the confidence in the project for Participant Company that its rights will be respected. Criteria for the selection of indicators for risk analysis are selected on the basis of an objective method of comprehensiveness. Participation and ratification of these agreements talk about an open position of the country, its involvement in the global economy and, consequently, the legal guarantees for companies operating in the area.

Once passed this stage, it is important to understand how domestic Participant acceptable in relation to the risk of the tax and legal climate. To do this, the analysis of legal documents in the country on the one hand, and the existing tax environment in relation to the analyzed region, on the other. Legal regulation of the Arctic paid a lot of attention, formed the legal and regulatory documents developed by the national development strategy. The issue is deeply described above (Tables 5-6). Nevertheless, we cannot say that the legal regime is completely formed. We believe that in the medium and long term, there may well be changes in the liberalization of the legal regime, admission of private companies, and in the direction of some strict measures, for example ecology. Therefore, legal environment in the Arctic region is still risky.

The second part of the analysis at this stage is, as has been stated in the examination of the existing tax environment in this region. This stage divided into 2 stages: comparative and analytical. In the comparative analysis of the stage tax conditions in Norway and Russia. The review also considered the tax environment parameters such as access to the shelf, the degree of liberalization of access. It should be noted that the development of the offshore is being for a long time and the main regulatory conditions in Norway developed as deposits reached capacity, and the basic infrastructure is already built (Table 5). Unlike Norway, in Russia the development of offshore companies is relatively recent. This is due to changing tax and legal environment, lack of technology, low level of liberalization and companies' access. Further on the basis of the analysis and comparison of other research companies tax conditions matrix was drawn up compared to the Arctic countries (Table 6). To sum up on this risk analysis stage:

- at the level of project participants held a two-stage comparative analysis on the country's participation of the project and the project in the region in the international multilateral agreements at the first stage, as well as a comparative analysis of the tax conditions, the conditions of access to the shelf and regulatory risks;
- results of the risk analysis for the project participants can be concluded that the Russian sector of the Arctic region under the international agreements (UNCLOS and the Arctic Council), and the country of the project has an open political vector of cooperation both with the Arctic countries, and with observer countries and other interested parties. On the legal side, however, the risk of changes in the legal regulation of the region within Russia, while difficult to say whether it will take place in the future towards the liberalization of access of companies to the region, or vice versa, tightening some of the rules;
- analysis of the tax conditions shows that according to the current regulations, they are attractive for the consideration of projects, but also remains the risk of changes in the overall uncertainty of the same conditions after the deadline specified in the documents (2032 and 2042);
- analysis and its results allow to further continue the third phase - the project risk analysis; on the basis of stages below shows a map of the risks and risk map (see Table 10-11).

After spending two stage analysis of stakeholders an assumption that this region has acceptable risk / long-term interests ratio is made. Then the next step is to determine, what Arctic water areas to enter the company, which is less risky to start projects. The main problem is the lack of information or confidentiality, available to other companies. Moreover, various evaluation resource capacity, as described above, and vary over a wide range.

Table 10. Description of country risks and risks of the project stakeholders, the probability of occurrence and impact

Risk	Description	Impact	Probability
A1	Risk of reduction rating of the country and the withdrawal of investors	High	0,9-1
A2	Closing access to capital markets and high interest rates	Above average	0,5-0,9
A3	Strengthening sanctions pressure	Average	0,5
A4	Strengthening non-Arctic countries interests in the region	Above average	0,5-0,9
A5	The requirement for approval of the observer countries of the legal status	Above average	0-0,1
Б1	Increased competition among the countries of the region	Average	0,5
B2	Increased military activity in the region	High	0-0,1
B3	The change of internal countries’ policy in the region	Below average	0,1-0,5
C1	The uncertainty of the legal, tax regime and customs duties in the Russian sector	High	0,5-0,9
C2	The liberalization of access to the Arctic offshore	Above average	0,5-0,9
C3	Legislation changes	Above average	0,5
D1	Reducing of partner countries credit ratings	Below average	0,5-0,9
D2	Formation of military enclaves in conjugate States	Low	0-0,1
D3	Preservation of the current geo-political control in the Arctic	Below average	0,9-1

Source: prepared by authors

Table 11. A risk map on the basis of risk analysis

	Low	Below average	Average	Above average	High
0,9-1	🟩	🟩 D3	🟨	🟥	🟥 A1
0,5-0,9	🟩	🟨 D1	🟨	🟨 A2 A4 C2	🟥 C1
0,5	🟨	🟨	🟨 A3 B1	🟨 C3	🟨
0,1-0,5	🟩	🟨 B3	🟨	🟨	🟥
0-0,1	🟩 D2	🟩	🟨	🟥 A5	🟥 B2

Source: prepared by authors

Other waters have different potential, but at the same time different climate conditions. Different natural conditions in the Arctic are of fundamental importance and represent different risks for projects and different impact. Building a conventional cash flow model gives negative results for such risky projects, which complicates the choice. The results of calculations for the two projects in Norway and Russia in the construction of cash flows are presented in Table 12. Therefore, classification of risks for offshore fields in the Arctic has been developed, as well as real options valuation (ROV) has been selected as a tool to assess the prospects of projects. Most available data is seismic that company has to buy or pay for it. These costs are mandatory and cannot be avoided. As a result, we get a rough estimation of the prospects into categories D2, D1 (Russian classification equal to probable according to PRMS). However, for the calculation of the prospects of projects to work with these estimates cannot be, since they are deterministic and do not account for the probability of failure to confirm this value. At this point, it uses the tools of simulation and real options method (calculated stochastically) to determine the function of the probability distribution of reserves. This tool is used for the project, the prospects of which the traditional methods of calculation, such as NPV is negative, but can bring a lot of value under certain conditions. Real options require that the project can bring significant profits, the greater the degree of uncertainty it is exposed. Calculation options held by Black-Scholes model:

$C\ (S,t)= S \times N(d1)-K \times ert \times N(d2)$ (11) [1]

$d1= (\ln(S/K)+(r+\delta\text{^}2)t)/(\delta\sqrt{}t),\ d2 = d1- \delta\sqrt{}t$

where: C (S, t) - value of the option, S-current value of the underlying asset, K - strike price, r-rate of interest, t-term performance, delta-standard deviation of the yield, N (d) - cumulative probability function normal distribution.

Table 12. Performance of projects on the basis of calculations of cash flows method

Criteria	A project (Norway)	B project (Russia)
Period of field development	till 2064	
Current gas price in Europe	180 $/thousand cubic meter	
CAPEX	22,4 $bln	27,2 $bln
OPEX	8,37 $bln	9,94 $bln
Discount rate	15%	
NPV	- 1 906 $mln	- 859,9 $mln
IRR	6%	1%

Source: prepared by authors

Black-Scholes model is just comply with the applicable conditions for field development projects where the cash flows generated by the option, due to the onset of certain events (the opening of the deposit, confirmation of inventory, commissioning). The costs incurred by the company before the start of search operations, recognized current expenditure of the company, because at this stage, reserves are hypothetical in nature and do not have a reliable estimate. Thus we come to the assessment of risk and the costs of prospecting and exploration, as well as evaluating the hydrocarbon potential. The input parameter for the option will be the EV value to be gained as a result of probabilistic estimates of reserves. The exercise price of real option, a limited probability of success - there is the cost of seismological, geophysical and other works. Taking into account the minimum information expected value is defined as the product of the probability of success on the net result for the product of the probability of failure at a loss in case of failure: EV = (probability of success × result in the case of success) - (probability of failure × loss in case of failure) .Modeling of a function of lognormal distribution supplies for input value EV calculation is performed stochastically to confirm the possibility of using the selected probability of 10% (P10) (Figure 12). Assuming that the territories are discovered reserves with a given probability of geologic success (0.2025, based on the source [3]) and value (P10) is not more than 290 billion cubic meters of gas for the project A and not more than 630 billion cubic meters of gas for the project B, at a cost to the stage of exploration and evaluation of at least $ 300 million. And for the project and at least $ 380 million. For the project B, we can determine the expected value (Table 13).

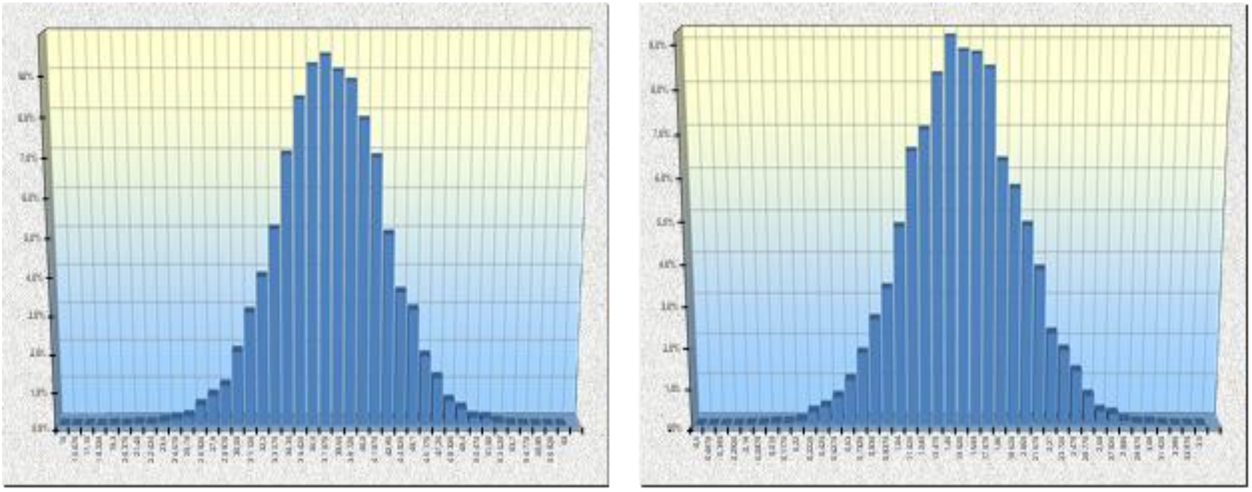


Figure 12. The function of the probability distribution of reserves

Source: prepared by authors

Table 13. Calculation of the expected value of the projects in Norway and Russia

Expected value (UM) for the initial investment for exploration	
A project	B project
EV= (290×180×0,2025) - (0,7975×) = 10 570 – 14,3 = 10 361 MMRUB	EV = (630×180×0,2025) - (0,7975×383) = 22 963 – 305 = 22 883 MMRUB

Source: prepared by authors

Of course, this assessment does not mean that the project will bring this particular profit, and the upper limit and suggesting whether the costs will pay off in the future for capital investments in the development in the case of success. Given that the cost of this stage will not exceed one-tenth of the total capital of the future costs of the project on the development stage, and the uncertainty will decrease, the decision will cost the company 300 and $ 380 million., Respectively, for projects A and B in case of success. This assessment does not mean that the project will bring this particular profit, and the upper limit and suggesting whether the costs will pay off in the future for capital investments in the development in the case of success. Table. 18 shows the options calculations on two projects that show what error rates to pay the company in case of failure and what benefit in the future will bring each project in case of success. As you can see, the project B has a higher value, it is due to the large value of the probability distribution of reserves. Further, at this stage it is necessary to determine where the company is willing to invest. Is B project really so promising, even though the risk of more severe climatic conditions and overrides any future benefit all of these risks.

Table 14. ROV calculation for the projects A and B

Designation	Definition	A project	B project
T	The term of the option implementation, years	5	
R	Risk-free rate	7%	
K	Strike price, MMRUB	18	18
S	Current cost, MMUSD	300	380
Δ	Market volatility	0,3	
E	The base of the logarithm	2,7	
d1=	Arguments of the normal distribution function	13,68	2,3560
d2=		13,16	1,6850
N(d1)=	The values of the normal distribution function	1,0095	0,9908
N(d2)=		1,0093	0,9540
V=	ROV	10 361	22 883

Source: prepared by authors

Conclusion

This article represents risks facing the Arctic shelf oil and gas development far beyond technical risks which operating companies may face. Risk that can arise due to International conflicts seems managed by mutual agreements between concerned states. However, less seems to be done with environment and human associated risks.

The international and local government institutions have demonstrated ineffectiveness when drawing detailed regulations is concern. With respect to Corporate Social Responsibility, it is advisable for operating companies to self-regulate by themselves. Further support could be received through a performance-based system.

In order to keep the same level of safety just like in the conventional offshore activities for that of the

North Sea, then is would be extremely essential to lessen the probability of incidents in order to mitigate the occurrence of accidents. Operating companies should thus be abreast with the expectation of the inhabitants in terms of level of accuracy to minimize risk associated activities in the Arctic region.

Different perceptions of risk need to be balanced by the society, as societal insight about risk is not always consistent with that of the industry. It is considered to be useful to have a better harmonization as well as joint cooperation on risk-acceptance criteria. It may be seem impossible as diverse states with respect to population, ethnicity, economy, and development state are involved. Nonetheless, adequate information can help link the dots. No matter how difficult it may seem, the operating companies must be able to create a solid risk-mitigation strategies only if they need to continue their operations in the Arctic shelf.

Abbreviations

AOOGG - Arctic Offshore Oil and Gas Guidelines
AOSS - Arctic Offshore Structure standard
CCS - Carbon Capture and Storage
E&P - Exploration and Production
IMO - International Maritime Organization
ICPPS - International Convention for the Prevention of Pollution from Ships
NOFO - Norwegian Clean Seas Association for Operating Companies
OPRC - Oil Pollution Preparedness, response and Co-operation
CSR - Corporate Social Responsibility
UNCLOS - United Nations Convention on the Law of the Sea
USGS - United States Geological Survey

References

1. Anatoli Bourmistrov, Frode Mellemvik, Alexei Bambulyak, Ove Gudmestad, Indra Overland, Anatoly Zolotukhin, International Arctic Petroleum Cooperation: Barents Sea scenarios Routledge Studies in Enviromental Studies, Oxon/New York 2015.
2. Arctic council, «ARCTIC OFFSHORE OIL AND GAS GUIDELINES», 2009, 98p.
3. Byers, M. (2013). International Law and the Arctic. Cambridge University Press. Shorter version «Cooling Things Down: The Legalization of Arctic Security»
4. Fridtjof Nansen Institute, «Arctic Resource Development: Risks and Responsible Management», ONS SUMMIT 2012 «THE GEOPOLITICS OF ENERGY».

5. Heininen L., Sergunin A., Yarovoy G. (2014). Russian strategies in the Arctic: avoiding a new Cold War. Moscow: Valdai International Discussion Club. Available at: http://www.uarctic.org/media/857300/arctic_eng.pdf
6. Henderson, J. and Loe, J. (2014). The Prospects and Challenges for Arctic Oil Development. OIES Paper: WPW 54, Oxford Institute for Energy Studies. Available at: http://www.oxfordenergy.org/wpcms/wp-content/uploads/2014/11/WPM-56.pdf
7. Jensen, L.C. and Skedsmo, P.W. (2010). Approaching the North: Norwegian and Russian foreign policy discourses on the European Arctic. Polar Research, 29: 439-450. Available at: http://www.polarresearch.net/index.php/polar/article/view/6073/6752
8. USGS World Assessment Team, 2000, U.S. Geological Survey World Petroleum Assessment 2000-Description and Results: U.S. Geological Survey Digital Data Series - DDS60 [http://pubs.usgs.gov/dds/dds-060/].
9. WEC (World Energy Council). 2007. Survey of energy resources 2007. http://www.worldenergy.org /publications/survey_of_energy_resources_2007 /default.asp
10. World Energy Overview: International Energy Agency, 2013, 668p.
11. www.gazprom.ru
12. www.rosneft.ru
13. www.statoil.com
14. www.russiancouncil.ru