



PROSPECTS FOR THE EXPLORATION OF HYDROCARBON DEPOSITS IN THE ARCTIC BASED ON SOCIO-ECONOMIC EVALUATION

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ABSTRACT

The article is devoted to analyzing, generalizing and systematizing the information on the current state and problems related to the exploration of the Arctic in Russia. Special attention is paid to identifying the factors that restrain the development of the Arctic territories. The main of them are technological, economic, natural, social and environmental factors.

When defining the feasibility and order of implementing projects on the exploration of hydrocarbons in the Arctic, it is offered to supplement the commercial evaluation of such projects' efficiency with the definition of their social and environmental potential. At the same time, it is reasonable to determine the social and environmental potential based on the offered evaluation indicators.

During the study, the authors used such methods as desk study, system and comparative analysis, PEST analysis, such statistical methods as data grouping, table and graphical methods that were applied to process the results of the study. Theoretically and methodologically the work was based on the official data of the Federal State Statistics Service of the Russian Federation, the US Geological Survey, analytical materials of the Ministry of Energy, industry research institutes, and works of national and foreign experts.

Key words: Arctic, shelf, hydrocarbons, commercial efficiency, innovation, technology, social potential, environmental potential.

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1. INTRODUCTION

The most important reserve for increasing the hydrocarbon production is the Arctic shelf that contains more than a quarter of the world's reserves and resources of hydrocarbons. At the same time, Russia's Arctic shelf has a large hydrocarbon potential and is currently considered as a region whose industrial development will compensate for the decline in oil and gas production in the country's old oil and gas production centers, provide a considerable part of energy needs, bring economic benefits, and solve numerous social problems [1].

Arctic hydrocarbon resources are a strategic reserve of the oil and gas complex of Russia that can ensure the country's energy security in the 21st century. The largest hydrocarbon reserves are located on the Russian shelf of the Arctic seas (about 85 % of the total area of the shelf of Russia are promising oil and gas bearing areas). The Russian Federation accounts for up to 41 % of oil reserves and 70 % of gas. Most of them are located on the Jamal Peninsula, on the shelf of the Kara, Barents, Pechora seas.

This determines the relevance of the exploitation of the Arctic shelf deposits, and is one of the main long-term areas for the development of the Russian energy policy.

At the same time, the Arctic territories are poorly studied and underdeveloped. The shelf resources are characterized as difficult to recover due to climatic, technological, as well as a number of other factors. Their exploitation requires the use of advanced innovative technologies, including those aimed at minimizing environmental damage, high investment and operational costs. Due to this fact, only a few projects are being implemented on the continental shelf of Russia.

Nevertheless, despite the ongoing economic crisis and low prices in the commodity markets, Russia has formed a plan for large-scale development of the Arctic region. According to this plan, about 150 projects will have been implemented up to 2050. About five trillion rubles will be spent for these projects. At the same time, the key problem in implementing this plan is, on the one hand, the possibility of implementing various alternatives in order to put hydrocarbon deposits into operation. On the other hand, there are a number of factors that restrain the implementation of projects related to the exploitation of hydrocarbons on the shelf.

As a rule, the decision on implementing a project is based on its commercial efficiency. However, due to the social importance of exploiting hydrocarbon on the Arctic shelf, the need to comply with the environmental safety of operations at all stages of the deposit development, as well as to determine top priority projects to be implemented, according to the authors, it is recommended to supplement the commercial evaluation of the projects' efficiency with the definition of their social and environmental potential.

2. METHODS

The hypothesis of the study is based on the assumption about the feasibility and prospects of involving the hydrocarbon raw materials from the Arctic shelf of Russia into industrial turnover. It is assumed that in the long term, the extraction potential of the Arctic shelf will compensate for the decreasing volume of oil and gas production from traditional deposits. At the same time, when evaluating the feasibility and order of implementing projects for the development of hydrocarbons in the Arctic along with the commercial evaluation of the efficiency of such projects, it is also necessary to determine their social and environmental potential.

The aim of the study was to analyze, generalize and systematize the information about the current state of developing the Arctic in Russia and the world, to define the factors that restrain the exploration of hydrocarbons in the Arctic, to study the methodological tools for evaluating

the socio-economic efficiency of projects, and to offer indicators for evaluating social and economic potential.

Due to this, during the study, the following methods were used:

1. The desk study that included collecting, analyzing and processing information about the current state of the exploration of the Arctic shelf deposits. The sources of primary and secondary data included the official data from the Federal State Statistics Service of the Russian Federation (Rosstat), the US Geological Survey, analytical materials from the Department of Energy, industry research institutes, and works of national and foreign specialists.
2. The systematic and comparative analysis that was used to identify the peculiarities of implementing projects related to the exploitation of shelf hydrocarbons, comparing various approaches to defining social and environmental indicators for the socio-economic evaluation of projects.
3. The PEST analysis that made it possible to identify the factors contributing and restraining the exploration of hydrocarbon deposits in the Arctic.
4. The statistical methods, such as data grouping, table and graphical methods that were used to process the results of the study.

3. REFERENCES REVIEW

Over the recent decades, there have been a lot of studies on the Arctic and its development. Studies on evaluating the oil and gas potential of the region are extremely important among scientific publications on the Arctic. The hydrocarbon potential of the Arctic territories is most deeply evaluated in the publications of the US Geological Survey [2], as well as Wood Mackenzie [3]. The works of the National Petroleum Council [4] not only describe the hydrocarbon potential of the Arctic, but also analyze other aspects of the reserves' exploration (technology of hydrocarbon production, logistics, ecology, climate, etc.). [5] analyzes the hydrocarbon resource base of the Arctic in terms of economic profitability and prospects of its exploration by using scenario forecasting methods.

The countries possessing the Arctic territories develop instruments for exploring them at the legislative level. Thus, the Russian Federation has developed the "Strategy for Exploring the Arctic Zone of the Russian Federation and Ensuring the National Security for the Period up to 2020". The United States of America have developed the "National Security Presidential Directive on Arctic Region Policy". The documents introduce the mechanisms for the exploration of the Arctic territories, and define the volumes and sources of financing the strategies.

A lot of scientific works, including those of such authoritative organizations as the World Wildlife Fund [6] and Greenpeace [7], [8], are devoted to the environmental vulnerability of the Arctic territories and analyzing the current environmental problems. The Arctic Sustainability Research: Past, Present and Future [9] considers aspects on ensuring the sustainable development of the Arctic. [7] Identifies not only environmental, but also social risks of implementing projects on exploring hydrocarbon reserves in the Arctic territories. [10] Generalizes studies of various specialists in the area of social impacts arising during the exploration of the Arctic, and shows the main areas of such impacts. [11] states social and environmental problems on developing the Arctic, describes the challenges faced by governments of various countries, and emphasizes the need in coordinating and cooperating in order to establish environmental and social guarantees. [12] Describes environmental and

social risks of exploring Arctic deposits, and evaluates them by using the Monte Carlo method based on calculating standard indicators of commercial efficiency.

Thus, governments of various countries adopt legislative acts and program documents related to the development of the Arctic territories. Many organizations and authors pay great attention to the prospects of exploring hydrocarbons in the Arctic. At the same time, works of Russian and foreign researchers note that its large-scale exploration can cause both positive and negative social effects, as well as negative environmental consequences. However, only some scientific works, as well as some recommendations indicate the need and make an attempt to take into account such effects and consequences when evaluating the efficiency of investment projects.

Thus, the Methodological guidelines for evaluating the efficiency of investment projects [13] based on the Unido methodology [14] and applied in Russia contain general provisions for evaluating the public efficiency of projects. However, the authors think that social and environmental indicators recommended for the calculation must be extended and supplemented.

The project analysis methodology adopted by the World Bank [15] contains socio-environmental standards and provisions to them that establish mandatory requirements for the Borrower. The compliance with them is a decisive factor in taking financing decisions. These standards show the need for a social and environmental evolution, but its essence is reduced to defining a number of social and environmental risks, while there are no recommendations on evaluating these risks.

4. RESULTS

4.1. Analysis of the Resource Potential of the Arctic Territories

The Arctic continental shelf has considerable resources of oil and natural gas. However, they are poorly studied. According to the National Petroleum Council, the Arctic accounts for up to 25 % of all unexplored hydrocarbon resources of the planet. Potential resources are evaluated at 525 bln. BOD, including 99 that are explored and 426 are unexplored. The potential resources of the Arctic seas shelf are evaluated at 390 bln. BOD. Russia accounts for 316 bln.boe (60 %) of the potential resources of the Arctic, including 235 bln.boe (45 %) on the shelf, and 81 bln.boe (15 %) by land (Table 1).

Table 1 Allocation of the Arctic Hydrocarbon Resources by Countries

Type of resource		USA		Canada		Russia		Greenland		Norway		Total
		Land	Shelf	Land	Shelf	Land	Shelf	Land	Shelf	Land	Shelf	
1		2	3	4	5	6	7	8	9	10	11	12
Oil, bln. bl.	explored	9.9	21.9	1.4	11.3	12.6	17.9	0.8	15.3	0.1	4.5	96
	unexplored	1.4	0.7	0.4	1.5	4.6	0.5	0.0	0.0	0.0	0.9	10
Total		11.3	22.6	1.8	12.8	17.2	18.4	0.8	15.3	0.1	5.4	106
1		2	3	4	5	6	7	8	9	10	11	12
Natural gas, trillion cubic feet	explored	91.3	138.8	11.9	76.5	166.2	977.8	6.2	129.9	1.2	112.2	1,712
	unexplored	99.7	28.1	12.3	11.1	183.7	177.4	0.0	0.0	0.0	7.9	520
Total		191.0	166.8	24.2	87.5	349.9	1,155.3	6.2	129.9	1.2	120.1	2,232
Condensate bln. bl.	explored	2.4	3.4	0.2	.3	4.4	23.1	0.4	8.8	0.0	1.0	45
	unexplored	0.0	0.7	0.0	0.0	1.0	0.5	0.0	0.0	0.0	0.1	2

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Total		2,4	4.1	0.2	1.3	5.4	23.6	0.4	8.8	0.0	0.0	47
Total, bln. BOD	explored	27.5	48.4	3.7	25.3	44.7	203.9	2.2	45.8	0.3	24.2	426
	unexplored	18.1	6.1	2.4	3.3	36.2	30.6	0.0	0.0	0.0	2.3	99
Total		45,6	54.5	6.1	28.7	80.9	234.6	2.2	45.8	0.3	25.4	525

Data of Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources

Over the recent decades, the Arctic shelf has been considered as the main region of hydrocarbon production in the future due to the exhaustion of reserves in traditional mining sites, the shift of production to the seas, and availability of large reserves. At the same time despite the poor knowledge of the Arctic and the low industrial exploitation of its oil and gas deposits, some countries have already achieved some success in the development of the Arctic shelf. Russia also makes attempts to develop hydrocarbon deposits of the shelf that, however, are more likely to be point-like than systemic in nature [16].

In 2013, Deutsche Bank published the study that evaluated and compared the potential of various countries in terms of their abilities to develop the Arctic regions (Table 2). When ranking, countries were assigned one of the following estimates according to various criteria: very favorable conditions (1), favorable conditions (2), not the most favorable conditions (3), unfavorable conditions (4), and very unfavorable conditions (5).

Table 2 Rating of the Countries' Attractiveness in Terms of Using Opportunities for the Development of the Arctic Regions

Indicator	USA	Canada	Greenland	Norway	Russia
Access to resources	3	3	2	3	3
Competition for resources	4	3	3	3	3
Level of expenses	5	5	5	4	3
Existing infrastructure	4	5	4	4	4
Access to infrastructure objects	1	5	5	4	3
Access to markets	3	3	3	1	3
Prospects of opening new large deposits	1	3	2	3	1
Prospects of revealing the economic potential of deposits	4	5	2	2	3

Data of the *Ernst&Young* Company [17] based on researching markets by Deutsche Bank ("Is the Arctic the future of Russian oil?"), 2013

Table 2 shows that Russia does not have high potential in terms of the possibility to develop the Arctic. It is substantiated by a number of both subjective and objective factors that restrain the efficient development of the region (Table 3).

Table 3 Factors Constraining the Development of Arctic Hydrocarbon Resources

Political factors	Legislative factors
1. Introduction of sectoral sanctions by governments of many countries 2. Limited opportunities for international cooperation (attracting foreign investors) 3. Limited access to the Arctic hydrocarbon resources for Russian companies	1. Insufficient legislative support for small and medium businesses 2. Gaps in tax and environmental legislation
	Economic factors 1. Oil price volatility 2. Capital and operating costs for project implementation 3. Limited access to foreign markets
	Social factors

<ol style="list-style-type: none"> Partially negative perception of the Arctic projects' development by the society Full dependence (at the initial stages of developing the Arctic territories) of economic activity and the population's sustenance on the supply of fuel, food and essential goods from other parts of the country Insufficient number of highly qualified personnel for the development of the Arctic 	<ol style="list-style-type: none"> Lack of the required domestic technologies <p>The need for considerable infrastructure expansion</p>
Natural factors	Environmental factors
<ol style="list-style-type: none"> Severe climatic conditions Short navigation period that is safe for the assembly, transportation and installation of platforms 	<ol style="list-style-type: none"> Complex ecosystem of the Arctic Activation of environmental organizations opposing oil and gas activities in the Arctic

Despite these factors, taking into account the geopolitical interests of Russia, the development of hydrocarbon resources in the Arctic is a priority for the development of the country's oil and gas complex in accordance with a variety of programs and legal documents.

In this regard, the authors offer to take into account the environmental and social potential of implementing projects, when taking decisions on the feasibility and order of developing oil and gas projects in the Arctic, and defining their commercial efficiency (Figure 1).

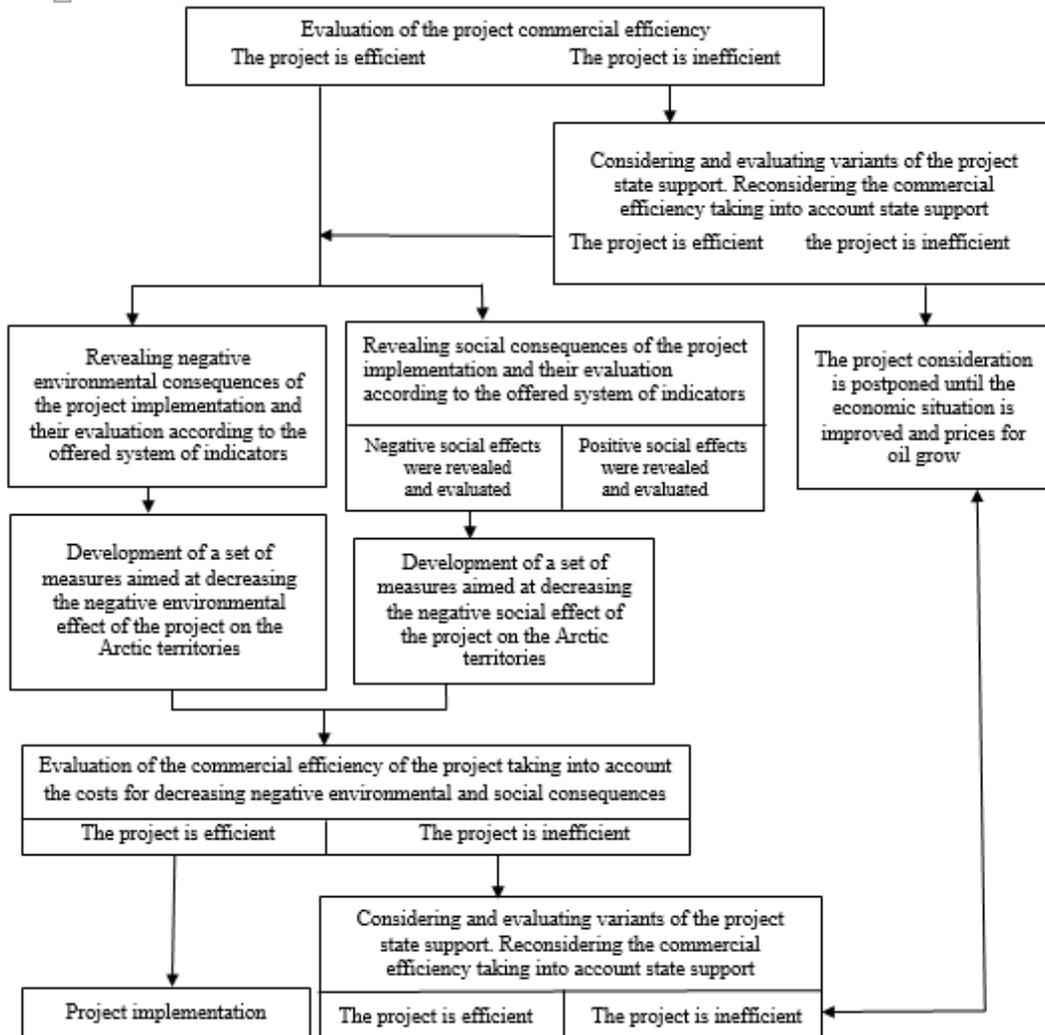


Figure 1 Evaluation of the Commercial Efficiency of Projects on Developing Hydrocarbon Resources in the Arctic, Taking into Account the Environmental and Social Consequences

When evaluating the social and environmental potential, it is offered to use the below indicators.

4.2. Evaluation of the Social Potential of Projects on Developing Hydrocarbon Deposits of the Arctic

About four million people live in the Arctic. Some countries are entirely located in this region (Iceland, Greenland and the Faroe Islands). In other countries (Russia, Canada, the USA, Norway, Sweden and Finland), only a small part of the population lives in the Arctic regions [18].

According to forecasts, by 2035 the population of Alaska will have increased by 28 % up to 915,211 people, mainly due to the natural growth. The expected increase in the population of Yukon, a Canadian Arctic province, over the next 10 years will be 19 %. In 1990 the population of Greenland reached 55,000 people and, according to the forecast, it will remain at the same level in 2040. By 2060 the population of Iceland will have increased by 36 % up to 435,106 people. By 2040 the population of the Faroe Islands will be 53,000 people, and the number of people living in the Arctic territories of Norway will have grown by 31 %. The population of the Russian Arctic will have reduced by seven percent between 2010 and 2030, and will be about 1.8 million people as compared to 2.1 million in 2000 [18].

In general, the population of the Arctic will grow rather slowly from 4.050 million in 2010 to 4.127 million in 2020 and 4.197 million in 2030 (Figure 2).

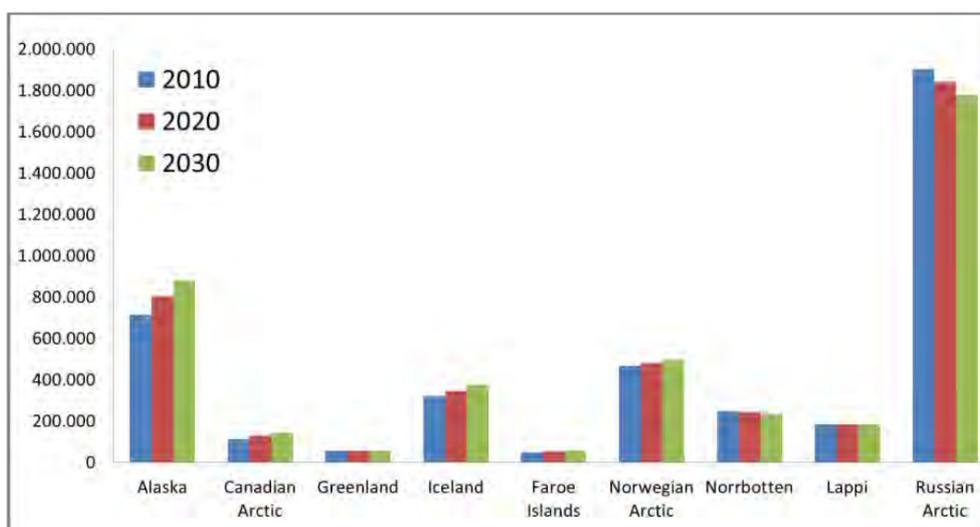


Figure 2 Forecast of Changes in the Population of the Arctic Countries [13]

A special group of indigenous peoples is distinguished among the population of the Arctic territories. The proportion of the indigenous population among the residents of Alaska is about 19 %, the Arctic territories of Canada – 50.8 %, Denmark – 88.1 %, and Russia – about 4 % [19].

To successfully implement projects on developing hydrocarbon deposits in the Arctic, it is necessary to continuously monitor the impact of the project on the population of the territories covered by the project, including the indigenous peoples.

To do this, it is necessary to identify local communities that have legal or traditional rights to use the territories and resources found in these territories and to analyze their interests.

The project on developing a hydrocarbon resource deposit must be evaluated taking into account the social potential of the project that is estimated by using the indicators in Table 4.

Table 4 Indicators for Evaluating the Social Potential of Project for Developing Hydrocarbon Resources in the Arctic

Area of the territory social development	Indicators
1	2
Human capital	Growth of the population in the Arctic territories
	Number of the local population who have undergone training or advanced training to work on the project implementation
1	2
Population's employment	Number of newly created jobs for servicing the project
	Number of newly created jobs in related industries
	The ratio of the number of jobs created to service the project as to the number of employable population
	Percentage of the local population in the total number of employees who serve the project
	Ratio of the salary to the average salary in the region
Infrastructure development	Amount of funds invested in the development of infrastructure by the company operator
	Number of health facilities constructed as a result of the project
	Number of primary and secondary education facilities built as the result of implementing the project
Economic development of Arctic territories	Amount of funds invested in the development of the territory by the operating company
	Growth of the regional gross product
Negative impact on local inhabitants	Area of alienated lands that have the status of hunting lands
	Area of alienated water bodies that were used by local residents for fishing
	Area of alienated forests that were used to pick berries and mushrooms

To reduce the nonfinancial risks of the project and to ensure a positive social effect throughout the whole project, it is necessary to monitor the developed indicators and analyze the perception of the project by local residents.

In order to successfully interact with the population, it is required to conclude agreements with indigenous peoples on the procedure for controlling economic activities in the territory whose natural resources are owned or used by this indigenous community, to develop procedures for considering complaints and disputes with indigenous peoples, and to form information channels for local people to access information about the state and use of natural resources.

The damage incurred to indigenous communities must be compensated taking into account the loss of resources (for example, hunting, fish, berries and mushrooms, plants) or deterioration of their quality (for example, water).

4.3. Evaluation of the Environmental Potential of Projects for Developing Hydrocarbon Deposits in the Arctic

The implementation of projects for the development of hydrocarbon reserves in the Arctic may cause irreparable environmental consequences (Table 5).

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Table 5 Negative Environmental Impact of the Hydrocarbon Deposits' Development on the Arctic Region

Stage of developing the hydrocarbon deposit	Negative environmental impact
1	2
Mining geophysics	Effect of hydro shock up to 150 atm, formed during the marine seismic exploration, causes the death or damage of the organs and tissues of adult and baby fish.
	Violations of migratory routes of salmon fishes are possible during geophysical surveys.
1	2
	Noises created by seismic surveys prevent marine organisms from detecting other sounds, communicating with each other, and searching for food.
Oil production	Emissions in the form of waste drilling mud and sludge that reach 5,000 cubic meters for each completed well.
	Discharge of formation waters that come from wells to the Arctic waters. The composition of the formation waters is characterized not only by the high content of petroleum hydrocarbons and heavy metals, but also by anomalous mineralization that is usually higher than the salinity of seawater.
	Emission of greenhouse gases. The most of these emissions are results of burning oil or gas for producing the energy required for the operation of the production platform installed at the deposit, as well as the combustion of associated gas.
Transportation	Violation of the environmental situation when constructing trunk pipelines

The high "sensitivity" of the natural environment of the Arctic to any displays of the anthropogenic impact requires a preliminary environmental evaluation of projects (Table 6) and continuous monitoring of the environmental impact at all stages of their implementation.

Table 6 Indicators for Evaluating the Environmental Potential of a Project for the Hydrocarbon Resources' Exploration in the Arctic

Areas of the territory social development	Indicators
Emissions in the atmosphere	Volumes of CO ₂ emissions
	Volumes of NO _x emissions
	Volumes of nmVOC emissions
	Volume of flared associated petroleum gas
	Volume of utilized associated petroleum gas
Emissions in the hydrosphere	Volume of discharges of drilling fluids and sludge into water bodies
	Volume of discharges into water bodies of stratal waters coming from wells
Alienation of lands and reservoirs for industrial use	Area of lands alienated for industrial use
	Area of water territories alienated for industrial use
Allocating wastes	Waste disposal volume (indicators for wastes' hazard classes are given)
	Volume of recycled wastes (indicators for wastes' hazard classes are given)
	Volume of recycled wastes (indicators for wastes' hazard classes are given)
Financing ecological programs	Volume of funds allocated for the ecologization of hydrocarbon production
	Volume of funds allocated to solve the environmental problems of the Arctic Region

5. CONCLUSION

The extremely high “sensitivity” of the Arctic environment determines the need to develop and implement a methodology for prioritizing the exploitation of hydrocarbon deposits based not only on evaluating the commercial efficiency of projects, but also on defining the potential for the social development of the territory as a result of the project implementation, as well as minimal negative impact on the region’s environment.

In order to reduce the revealed negative social and environmental impacts when developing the hydrocarbon reserves of the Arctic regions, it is necessary to ensure the introduction of the best technologies aimed, inter alia, at reducing emissions (greenhouse gases) into the atmosphere and minimizing the amount of chemical wastes that come to the marine environment when exploiting oil and gas deposits.

The impact of the project in terms of the social and environmental aspects should be determined and analyzed by evaluating the offered indicators both at the stage of designing projects on developing Arctic reserves and their implementation.

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