Arctic Shelf Projects as a Driver for Social and Economic Development of the High North Territories: International Experience and Potential for Russian Practice

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Introduction

In recent years, the most important tendency for states involved in the oil and gas production is to enforce geological exploration and production at the marine hydrocarbon fields.

Many scholars and experts see the key strategic task of the long-term sustainable development of the oil and gas industry in the balanced development of the offshore hydrocarbon potential of the continental shelf

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A. Likhacheva (ed.), *Arctic Fever*,
https://doi.org/10.1007/978-981-16-9616-9_19

and the transformation of the Arctic into the largest region of world oil and gas production. In this regard, the state and project operators face completely new organizational and managerial tasks, the solution of which should contribute to the progressive, cost-effective, socially oriented, environmentally balanced and safe development of offshore hydrocarbon fields on the Arctic shelf.

Strategic management of the oil and gas complex in the implementation of offshore projects is a multicomponent process that covers a number of considerable issues in geopolitical, economic, social, environmental dimensions. These problems are solved at the state level and should take into account the interests of coastal regions, related industries and services, the interests of society in terms of compliance with environmental standards and the creation of new jobs. At the same time, it becomes necessary to understand strategic management from the point of view of taking into account the interests of all stakeholders in the preparation and implementation of projects for the development of offshore oil and gas fields.

Taking into account the well-established interaction with oil and gas companies and public environmental organizations, the state should ensure an ecologically balanced model of sustainable nature management, taking into account the special vulnerability of the sensitive Arctic nature and solving the problems of maximizing the preservation of the natural habitat.

Despite the current macroeconomic conditions, the development of the Arctic shelf is still one of the promising areas for the global energy sector. Experts estimate that the Arctic shelf contains up to 25% of all hydrocarbons on the planet.

The Arctic continental shelf of Russia is one of the most attractive and promising areas in terms of hydrocarbon production potential. The resources of the Russian shelf are on average estimated at about 100 billion tons of fuel equivalent (Fadeev et al., 2019). At the same time, it should be taken into account that these estimates are approximate since the shelf study is still far from being ideal.

The Arctic region offers unique prospects for developing energy resources, even though the Arctic is characterized by a harsh climate—with extreme fluctuations in light and temperature, short summers, snowy and icy winters, and vast permafrost areas.

Back in 1970s, several hydrocarbon fields were discovered on the Arctic shelf, some of which are unique. This has largely changed the fuel and energy complex development paradigm: design and technological solutions for hydrocarbon extraction on the Arctic shelf began to be created. As an apogee of these activities, in April 2014, the first batch of arctic oil from the Prirazlomnoye field was shipped, which received its own brand—ARCO (arctic oil).

For Russia, the Arctic zone has always had a strategic character. It is appropriate to recall the expression of the famous Russian naval commander Stepan Osipovich Makarov who said that "Russia is a building with its facade facing the Arctic Ocean". The Arctic has always attracted the attention of explorers. Starting in the eleventh century, the exploration of the Arctic has not ceased, and today, we can state that the Arctic is at the service of humankind (Fig. 1).

Today, the Arctic is an unconditional imperative for the economic strategy of a number of Russian regions. At the end of the last century, deposits classified as unique in terms of reserves were discovered in the Arctic zone. Today, this region is becoming a new oil and gas province, designed to ensure energy security not only for Russia but also for many countries in the world in the long term. Today, the Arctic is a "storehouse of natural resources" capable of guaranteeing the energy security of humanity for decades to come.

At the same time, it is essential to develop a model of ecologically sustainable use of natural resources, which could provide effective and long-term sustainable economic development of coastal areas, as well as

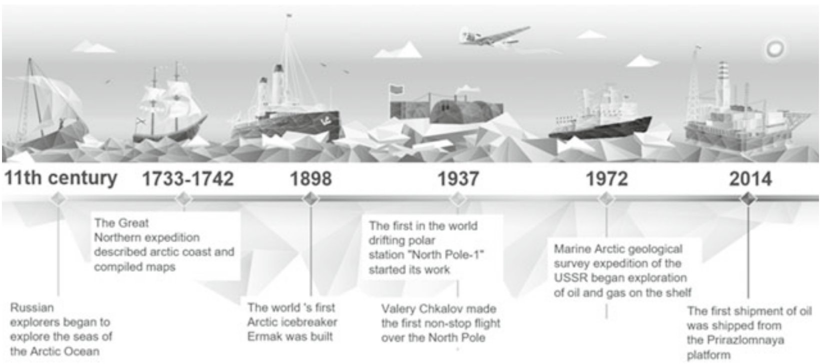

Fig. 1 History of Russian Arctic development (PJSC Gazprom Neft. Access mode: www.gazprom-neft.ru)

provide as possible comfortable living conditions for people in the coastal areas.

The implementation of hydrocarbon production projects in new producing regions can revive the general economic situation in most industries—primarily the heavy industry, construction, and transport sector, which in the regions is represented, as a rule, by small and medium businesses.

This chapter will focus on the role of offshore projects in the social and economic development of territories. The study consistently highlights the role of energy projects as an economic multiplier, foreign experience in implementing projects in the far North, the need to take into account the interests of the indigenous peoples of the North, the importance of preserving the sensitive ecosystem of the Arctic, the formation of an integrated, intersectoral approach to managing the activities of industries in the Arctic and, finally, ensuring the sustainable development of producing areas.

The authors attempt to identify the best international practices in order to project them on modern Russian macroeconomic conditions. The authors are convinced that the leading role of social and economic factors in the development of offshore fields, observed in countries and regions with a dominant role of the hydrocarbon production in the economy (Norway, Russia, Alaska, the northern provinces and territories of Canada), should become an absolute imperative in the implementation of offshore projects in the Russian Arctic.

Arctic Offshore Projects as an Economic Multiplier

Oil and gas projects can engage key industries related to other businesses through inter-industry process chains. Obtaining an order by major industries and, consequently, the output is a driving force for the development of related industries, which, in their turn, contribute to the development of domestic suppliers' capabilities, etc. These circumstances lead to the formation of multiplicative effects comparable to the effect of "self-excitation of economic growth". In this case, we are talking about encouraging the unwinding of the upward spiral of production demand, which would indicate investment and consumer demand on its basis. According to research statistics, domestic demand is the most significant and most reliable driver of economic and social growth (PJSC Gazprom Neft. Access mode: www.gazprom-neft.ru).

The multiplication index (multiplier) is a parameter characterizing the degree of particular industries' development. The multiplier value for developed countries is: Australia, 1.8–2.4; USA, 2.1; Norway, 1.6–1.7. According to experts' estimates, the "oil and gas" multiplier for Russia is 1.9, which fully corresponds to the level of multiplication of oil and gas producing countries of the world (Nikitin & Kibitkin, 1999).

It is indicative that according to preliminary calculations carried out by experts at the stage of the feasibility study of the Shtokman gas condensate field development project, the income of the Russian side on the "engineering" (through placing orders with Russian contractors, suppliers of goods and services) could almost double (!) the similar income from gas production and processing. Increased production and subsequently maximum utilization of production capacities of enterprises are going to allow the majority of regional enterprises to equalize the current economic situation, pay off the existing loans and improve their financial situation.

At present, the contribution of small businesses to the country's total GDP does not exceed 20%, while this indicator in several other countries engaged in offshore oil and gas production is about 50–60% (PJSC Gazprom Neft. Access mode: www.gazprom-neft.ru).

The global experience of the leading countries in offshore development, such as Norway, demonstrates that work in the oil and gas complex opens up significant prospects for developing regional enterprises in the regions of operation, creating jobs and improving living standards. In particular, one of the most experienced companies working offshore today is Equinor ASA (formerly Statoil ASA [2009–2018], StatoilHydro [2007–2009])—has been actively involving regional business in the process of implementing large-scale projects for the development of hydrocarbon deposits on the Norwegian continental shelf almost since the start of work on the shelf. This fact is a driver of socio-economic development of the regions where Equinor ASA operates in Norway and beyond (Kutuzova, 2006).

Foreign Experience of Project Implementation in the North

The key positions of the state at all stages of field development is one of the most important features of developing hydrocarbon resources in the Far North of foreign countries. This state participation considers and details the interests of the individual municipalities and provinces affected by oil and gas development.

Among these regions and countries, Norway is the undisputed leader (Dodin, 2007). In 1966, after the demarcation and signing of the relevant agreements on the division of the North Sea bottom with Denmark and Great Britain, oil prospecting drilling on the Norwegian continental shelf has begun. It is interesting to note, that the first drilling rigs in Norway were converted whaling vessels operated by foreign-contracted companies. The Ekofisk field is the first major discovery on the Norwegian continental shelf made by the US company Phillips in 1969.

Norway, having no experience in exploration and development of oil and gas fields and the necessary financial resources, has shown the ability to develop an effective state policy of integrated management of oil and gas resources and attract private capital capable of developing fields at a high technical, technological, and social level (Fadeev et al., 2011). The industrial basis, formed in Norway, made it possible to equip the most advanced oil and gas complex, including the world's largest offshore drilling rig, to organize hydrocarbon production using subsea production complexes, to lay underwater pipes at sea depths of over one thousand meters as well as to build the world's northernmost gas liquefaction plant. Since the start of the oil and gas complex, more than 60 fields have been discovered on the Norwegian continental shelf, and about 3000 production wells have been drilled (Steinar, 2006).

It is noteworthy that the volume of oil produced on the Norwegian continental shelf has begun to exceed the government demand since 1975, which determined, among other things, the specifics of the Norwegian approach to the development of oil and gas resources, including for the future.

Hydrocarbons are a non-renewable national resource—a basic principle underlying the use of Norway's oil and gas resources. For this reason, the development of hydrocarbon resources should be conducted with maximization of possible multiplicative economic effects both for the present generation and taking into account the interests of future generations of

Norway. In the field of oil and gas resources use in Norway the following main objectives of state policy can be outlined (Steinar, 2006):

(a) Ensuring a stable level of welfare and employment while creating the highest possible value of work in the development, exploitation, and production of hydrocarbons;
(b) Internationalization of the Norwegian oil and gas service industry to develop this sector of the economy and at a time of declining production at the fields;
(c) Leadership in energy supply and impeccable environmental standards.

According to the current Norwegian legislation, companies operating on the Norwegian continental shelf have to pay almost 80% tax to the state, which, however, does not prevent them from developing even in times of crisis. Today Norway ranks 10th in the world in terms of daily oil production, and when it comes to supplying gas to Europe, it has become one of the main suppliers, ranking on a par with Russia and Algeria (Steinar, 2006).

It is noteworthy that more than 90% of the hydrocarbons produced by Norway are exported, thus providing almost 70% of the volume of foreign trade (Steinar, 2006). At the same time, the state's domestic energy needs are largely covered by the efficient operation of hydro and wind energy. More than 500 billion kroons a year are received for industrial development and replenishment of the National Stabilisation Fund, which is supposed to ensure stable state development for many years ahead (PJSC Gazprom Neft. Access mode: www.gazprom-neft.ru).

While using international cooperation as an efficient economic and technological development tool, Norwegian companies have taken the lead in almost all areas of oil and gas service, production of equipment for hydrocarbon production, transportation, and processing. To promote Norwegian services technologies abroad, INTSOK was founded. Today it plays a major role in the Norwegian oil and gas sector.

Involvement of the state and increased regulation of the oil and gas industry as a whole has become a major challenge for Norway to strengthen its position through increased domestic presence.

To ensure the long-term socio-economic impact of these resources on the country, the Norwegian government is continuously adjusting policies in the oil and gas sector. To improve efficiency and reduce costs in the oil and gas industry, a new Petroleum Act was adopted in 1996, which is a modernization of the existing regulations in the oil and gas industry and is aimed at addressing many issues, such as the assignment of oil and gas-bearing areas of the shelf.

The greatest source of wealth for the Norwegian economy is the hydrocarbon resources of the country's continental shelf. Today, Norway's oil and gas complex has strong technological links with other sectors of the economy: shipping, finance, information technology, etc. The multiplicative economic effects of the oil and gas complex are very significant for Norway. Thus, the number of people employed in the oil and gas complex in Norway is about 220,000 (all over Norway) (Kutuzova, 2006).

Creating conditions for sustainable development of the territories where hydrocarbon projects are implemented is one of the top priorities of the operating companies operating in Norway. Since the establishment of the Norwegian company "Statoil", there is an active process of involvement of regional business in the implementation of large-scale projects for the development of hydrocarbon resources, which has significantly contributed to the growth of socio-economic development of the territories, which are the regions where "Statoil" is present (Kutuzova, 2006).

Norway has successfully met the strategic challenge of transforming hydrocarbon resources into a technological state superiority, an outcome that was not predetermined. It is interesting that, for example, the experience of the UK in developing the resources of the North Sea, which relied on international technologies instead of developing domestic ones, did not show a similar result. Unlike Norway, which now has a high-tech oil and gas industry, the UK has not achieved a similar result. The Norwegian experience is currently being adopted by other countries: the Chinese oil and gas service market, for example, is developing according to this scenario today.

The experience of projects on the Canadian continental shelf is also useful for Russia in terms of benchmarking. The first major hydrocarbon field being developed in the coastal waters of the Canadian province of Newfoundland is the Habernia project (Steinar, 2006).

The northern coastal conditions require advanced technology that makes the Habernia project unique in terms of technics, policy and enhancement. Implementation of this project at the cost of $7.3 billion (with reserves of 400 million tons) made it possible for Canada to become one of the world's leading countries in offshore oil production. This project, which cost $7.3 billion (with reserves of 400 million tons), made it possible for Canada to become one of the world's leading countries in the field of offshore oil production.

Discovered in 1979, the Habernia field is located on the east coast of Canada. It is important to note that it took more than a decade for agreements between the governments of Canada and the Province of Newfoundland and oil companies to be finalized to allow development to begin.

A general agreement involving joint management of hydrocarbon development was entered into the federal and provincial governments in 1985. The Canadian government, which partially financed the project, hoped to not only recoup its investment in the long term but also to reduce its budget by eliminating its subsidy to the province of Newfoundland. In the opinion of many Canadian experts, the Habernia Project was prioritized over regional development objectives before commercial returns from hydrocarbon production.

In the implementation of the Habernia project, the state was one of the guarantors of compensation for increased risks in the implementation of this project, as well as the role of an arbitrator and guarantor of property rights. To increase investment attractiveness and reduce risks, the Government of Canada was directly involved in the financial support of the project. The main significant forms of support were the following (Dodin, 2007):

(a) 0.25% reimbursement of pre-operational costs to the project operating companies, amounting to $1.05 billion;
(b) 0.40% guarantee of up to USD 1.68 billion of pre-commissioning loans. That is, the operators will transfer to the state the corresponding share in the project in case of impossibility to repay the loans;
(c) an interest-free loan in the event of oil prices falling below $19 per barrel up to $300 million;
(d) if the cost of the pre-commissioning phase exceeds $5.2 billion, additional loan guarantees are provided to cover 40% of the costs.

Increasing the employment and professional competence of the Canadian population was one of the goals of government support for the project. As a result, 66% of the jobs were filled by Canadian nationals, and the combined share of Canadian contractors and suppliers in the implemented project was about 60%. The use of regional labor and local contractors was facilitated by adequate financial support from the state. Analyzing the total costs of the project, it can be stated that $5.8 billion are investments of the operating companies, and $1.5 billion are investments of the state (Dodin, 2007).

In Canada, a special "Habernia Development Act" was enacted to address the pioneering nature of the project. The state was able to resolve the complex issues of work funding and revenue sharing, and a compromise was found to resolve jurisdiction over coastal waters. Thanks to political will and government support, the Habernia project has become one of the largest in the world.

For the Russian Federation, the Norwegian, Canadian, and English experience is very useful in implementing large-scale projects in the public interest, which, in addition to their technological complexity, are also highly capital-intensive.

As foreign experience shows, the implementation of projects solely within the framework of approaches focused on pure commercial efficiency is impossible without considering the social and regional conditions. ***None of these projects, implemented in Norway, Greenland, Canada, or the USA, took place in isolation from the solution of socio-economic development problems of the territory***. For example, the launch of the Soviet field development project in the Norwegian sector of the Barents Sea was largely due to potential regional effects.

The previously discussed features of foreign projects implementation imply active participation of the state (both at the federal and regional levels), as well as the application of procedures and approaches based on the program principle.

In the author's opinion, the implementation of Arctic offshore projects should be based on the following:

(a) formation of a unified offshore exploration program;
(b) creation of a common service infrastructure, as well as a coordinated technological scheme for the development and exploitation of closely located sites (cluster of locations);

(c) ensuring sustainable social and economic development of the region of operations;
(d) creation of organizational structures for project implementation, operating companies, as well as a system of state monitoring and support for the implementation of Arctic projects.

When implementing the projects on the development of hydrocarbon resources of the Russian Arctic shelf, the main priorities of state regulation of the oil and gas complex should be aimed at the formation of conditions for "participation" of the fuel and energy complex in solving a wide range of socio-economic problems of the state (Fadeev, 2013; Kryukov & Tokarev, 2007).

Indigenous Minorities of the North and Their Interests in the Implementation of Energy Projects

The Russian Federation is the largest multi-ethnic country in the world. There are 193 nationalities living on the territory of Russia. The legislation of the Russian Federation singles out small peoples as a special group that needs special protection and support. A total of 47 small peoples of the Russian Federation are included in the unified list of small peoples.

According to the definition, small-numbered indigenous peoples include such groups of the population, which live in the territory of the traditional settlement of their ancestors, maintain traditional lifestyles, economy and trades, number less than 50 thousand people in the Russian Federation, and recognize themselves as independent ethnic communities (C3 RF, 1999).

Of the 47 small-numbered peoples in the Unified List, 40 peoples have the status of small-numbered indigenous peoples of the North, Siberia, and the Far East of the Russian Federation (SZ RF, 2006).

The Indigenous Minorities of the North (IMN), Siberia, and the Far East include the Aleuts, Alutorians, Veps, Dolgans, Itelmen, Kamchadals, Kereks, Kets, Koryaks, Kumandins, Mansi, Nanai, Ngansansans, Negidals, Nenets, Nivkhs, Oroks (Ulta), Orochi, Saami, Selkups, Soyots, Tazy, Telengits, Teleuts, Tofalars, Tubalars, Tojin Tuvans, Udegeis, Ulchi, Khanty, Chelkans, Chuvans, Chukchi, Chulymtsy, Shorians, Evenks, Eveny, Enets, Eskimos, Yukaghirs. These peoples are settled on the territory of 28 subjects of the Russian Federation (the Republics of Altai, Buryatia, Karelia, Komi, Sakha (Yakutia), Tyva, Khakassia; Altai, Transbaikal, Kamchatka, Krasnoyarsk, Primorsky, Khabarovsk territories; Amur, Vologda, Irkutsk, Kemerovo, Leningrad, Magadan, Murmansk, Sakhalin, Sverdlovsk, Tomsk, Tyumen regions; Nenets, Khanty-Mansiysk-Yugra, Chukotka and Yamalo-Nenets Autonomous Areas) (Shtyrova, 2013).

Having centuries-long experience of living in the northern territories, people do not always adapt successfully to the emerging market relations and new forms of socio-economic relations. The current experience in the implementation of natural resource extraction projects has shown that the interests of indigenous minorities have often been neglected, leading to the deterioration of living and working conditions of the indigenous population, disturbance of the balance of territories, alienation of traditional use lands for industrial use, withdrawal of reindeer pastures from circulation, contamination of spawning grounds of valuable fish species.

This approach leads to the loss of traditional livelihoods, cultures, and native languages, negatively impacting the health of people, and creating objective difficulties in employment. These indigenous minorities of the North are among the most vulnerable groups of the population that need maximum care from the state.

It is worth noting that if operations on the Arctic shelf is really a new page in the history of Russian energy companies operations, then operations in the Arctic for Russia is, without a doubt, a traditional and familiar habitat that has already proven its effectiveness. And the indigenous peoples living on the Arctic territory make a significant contribution to ensuring the well-being of the Russian Federation. By engaging in traditional crafts that have developed historically, as well as working on large industrial and energy projects implemented today in the Arctic zone of the Russian Federation, indigenous peoples make a tangible contribution to strengthening the economic well-being of the state.

The industrial presence in the Arctic is constantly increasing. 2/3 of the territory of the Russian Federation are permafrost areas. Not so long ago in Russia, a law was adopted, which officially defined the status of the subjects of the Russian Federation, related to the Arctic. Today the Arctic Zone of the Russian Federation (AZRF) produces up to 15% of the gross domestic product of the country and about 25% of its exports (Fig. 2).

It is important to keep in mind that the Arctic is an area the development of which cannot be determined by the laws of the market economy

Fig. 2 Contribution of enterprises located in the Arctic zone to GDP and Russian exports

only. Considering the established cooperation with oil and gas companies and public environmental organizations, the state should provide an ecologically balanced model of sustainable nature management, taking into account the special vulnerability of the harsh Arctic nature and solving problems of maximum conservation of the natural habitat.

Ensuring Environmental Safety in Hydrocarbon Extraction and Transportation in the Arctic

Due to the enormous reserves of hydrocarbon resources in the Arctic zone, as well as the increasing role of factors and conditions underlying the political and energy security of the leading industrialized countries of the world, many states now consider the Arctic as a strategic region. Development of the Arctic territories involves the development of transport, extraction of biological resources, and, of course, intensive exploitation of hydrocarbon resources on the shelf. In this connection, the implementation of a rational multiproduct, ecologically balanced model of sustainable nature management, as well as the particular vulnerability of the harsh Arctic nature, make it necessary to study and solve problems of maximum conservation of the natural habitat (including within the framework of international cooperation).

The Arctic ecological system is susceptible to external impacts and has a prolonged recovery rate in negative impacts. The environmental problems of the Arctic zone arouse considerable interest on the part of specialized specialists. Even though the Arctic is characterized by a harsh climate, extreme fluctuations in light and temperature, short summers, snowy and icy winters, and vast areas of permafrost, this is where there are unique prospects for the development of natural resources. Some flora and fauna found in the Arctic have adapted to the harsh conditions of the Arctic zone. Still, this adaptation has, in some cases, made them more susceptible to anthropogenic impact.

The impacts on the environment, ecosystems, and marine organisms in offshore operations begin with the geological and geophysical investigation phase of the seabed. Seismic surveys, based on seismic wave generation and recording of vibrations reflected from the seabed surface, are most commonly used to determine oil and gas-bearing capacity. Such studies allow us to judge the structure and oil and gas content of the sedimentary rocks of the sea shelf.

The effect of a water hammer of up to 150 atm causes damage to organs and tissues of adult fish, fry and even their death. Seismic surveys have the potential to disrupt salmonid fish migration routes in the exploration area. Organizing and conducting seismic surveys generates specific noises that disrupt communication between marine organisms, making it difficult to detect other sounds and, consequently, to find food. Whales are the most afflicted animals in this case. Attracted by unknown sounds, animals can suffer serious, even fatal, injuries from the powerful water shocks.

Some organisms and marine animals are restricted to certain habitats, leading to mortality due to lack of adaptability and subsequent failure to establish themselves in the new environment (Fadeev, 2011).

Seismic activity has been used in the oil and gas industry since the middle of the last century. Since the 1950s, explosives have been used to map the seafloor, causing considerable damage to the ecosystem; twenty years later, air guns were used for this purpose. Seismic surveys have been shown to cause significant damage to fish eggs and larvae that are located in close proximity to the effects of the air gun. It is still a pending issue whether seismic surveys are actually harmful to fish and marine animals impacted within a 2–3 km radius of the vessel. The result of such human activities for fish may be a change in spawning and migratory routes.

Well Drilling and Associated Environmental Risks

The extraction of hydrocarbon resources on the shelf is accompanied by a large amount of emissions of substances into the atmosphere, the marine environment, etc. It is noteworthy that environmental risks remain in the area of the field even after the production of hydrocarbon resources there has been terminated.

If seismic surveys indicate the presence of oil and gas bearing structures, well drilling begins at the exploration stage. The formation of liquid and solid waste accompanies virtually all phases and operations of oil and gas exploration and production. For each passed well, the volume of emissions in the form of the worked-out drilling agents and cuttings (representing the rocks drilled in the borehole) can reach 5000 m^3 (Fadeev, 2011).

Special drilling fluids and acids are used as part of the drilling process. In addition, the drilling process generates liquid wastes containing large amounts of toxic impurities, clayey slurry, and heavy metals that accumulate from rock excavations, which increase water turbidity in the areas of operations. The use of petroleum-based drilling fluids poses the greatest risk. Drilling cuttings impregnated with such a solution act as the main source of the organization's oil contamination and carry out drilling operations.

Discharge of formation water from wells is another significant source of pollution. The composition of such produced water is characterized by abnormal salinity, which is usually higher than sea water salinity, and high content of petroleum hydrocarbons and heavy metals. In the area of formation water discharge this fact may cause disturbance of hydrochemical regime. In addition, when in contact with seawater, natural radionuclides precipitate and form local microscopic deposits. It is worth noting that the volume of produced water increases during the operation of the field. Today, some technologies return produced water to the sea with pretreatment and allow it to be injected back into the wells.

Existing legislation prescribes the accumulation of spent drilling mud as well as other wastes with subsequent transport to shore for further treatment or special treatment. A portion of the waste may be discharged overboard, subject to the presence of contaminants. It is worth noting that the measures prescribed by law are not implemented by all operators and contractors. Moreover, efficient refining technologies for petroleum products in Russia are just being adapted.

According to experts, none of the existing technologies can provide 100% purification of formation water. Therefore, complete prevention of the release of hazardous substances into the marine environment has not been guaranteed to date. The problem of exploitation of old fields containing much more produced water than hydrocarbons directly is topical. As an example, the Tampen area in the North Sea, where the amount of oil produced is half the amount of produced water, is appropriate.

The radius of local impact of drilling waste from a single well extends to a radius of up to 5 km. If the number of wells being drilled is large enough, their negative impact may extend to entire field areas. The ecosystem of the North Sea being that poor, according to the Norwegian Institute of Marine Research, is precisely the result of oil and gas activities.

The Arctic region, with its highly fragile ecosystem, is particularly at risk of anthropogenic interference. Even a small spill of extracted hydrocarbons on the ice-covered shelf for most of the year can cause irreparable environmental damage. In 1989, the wreck of the Exxon Valdez oil tanker in Alaska resulted in one of the largest offshore environmental disasters in history. The result of this catastrophe was a dramatic decline in fish and marine animal populations. According to scientists, it will take at least 30 years to restore some of the Arctic's sensitive habitats. According to the court ruling, Exxon paid a fine of $4.5 billion (Fadeev, 2011).

Incidents and Accidents on Offshore Platforms and Facilities

Rapid development of emergency processes associated with hydrocarbon release and combustion in dense equipment is a distinctive feature of accidents at offshore facilities.

Due to insufficient attention to measures for identifying and mitigating safety hazards, the global history of continental shelf development has been marked by a number of accidents with disastrous consequences. The major incidents and accidents at offshore technical facilities and platforms of various types in recent decades are shown in Table 1.

In April 2010, an even larger environmental disaster occurred in the Gulf of Mexico offshore. The Deepwater Horizon, owned by British Petroleum (BP), sank off the coast of Louisiana after a 36-hour fire following a massive explosion on April 22, 2010. The oil spill caused enormous environmental and economic damage to the states of Alabama,

Table 1 Major accidents and incidents on offshore platforms and facilities (Fadeev et al., 2019)

Place and date	*Accident/Incident*	*Main causes and brief description*	*Damage and number of victims*
China Sea, November 25, 1979	Platform flooding	The platform was caught in a 10-point storm while being towed offshore. The platform overturned and sank as a result of flooding of the pump room	There were 72 fatalities Damage is the cost of the platform
Red Sea, October 02, 1980	Uncontrolled release of oil	An uncontrolled oil release followed by an explosion on the Ron Tappmayer platform. Oil spill into the sea in the volume of ~150 thousand tons and bags with bulk reagents	There were 19 fatalities Environmental damage—up to $800 thousand
Coast of Canada, October 15, 1982	Platform flooding	The Ocean Ranger jackup rig capsized and sank in stormy conditions. The main reasons are design flaws, unpreparedness and improper actions of the crew, and lack of sufficient rescue equipment	There were 84 fatalities Damage is the cost of the platform
North Sea, March 27, 1983	Explosion, fire, platform collapse	Alexander Kielland platform legs collapse with subsequent explosion and fire in stormy conditions. The main causes of personnel deaths are damage to rescue equipment	There were 123 fatalities Damage is the cost of the platform
Sea of China, October 25, 1983	Platform flooding	The drilling vessel Glomar Java Sea was derailed and capsized during the passage of a tropical typhoon; as a result, the vessel sank	There were 81 fatalities. Damage is the cost of the platform
North Sea, July 06, 1988	Explosion, fire, platform collapse	A series of explosions on the production deck of the Piper Alpha platform during the operation of the gas field, resulting in fire and destruction of the platform	The death toll was 164 people Damage is the cost of the platform

(continued)

Table 1 (continued)

Place and date	*Accident/Incident*	*Main causes and brief description*	*Damage and number of victims*
Atlantic Ocean, Brazilian coast, March 15, 2001	Explosion, fire, platform collapse	Damage to one of the base pontoons of a Petrobras oil production platform as a result of a series of powerful explosions. The platform sank and 125,000 tons of oil were released into the ocean	There were 10 fatalities Damage is the cost of the platform
Indian Ocean, July 27, 2005	Ship collision, fire, and platform collapse	A surf wave hit an auxiliary vessel standing next to the platform, resulting in a collision with the platform structure	There were 49 fatalities
Gulf of Mexico, October 23, 2007	A storm collision resulting in a fire	Platform oscillation due to gale force winds resulting in impact with the top of the fountain valve of the adjacent platform. There was an oil and gas leak, with subsequent ignition	21 fatalities
North Sea, May 24, 2008	Oil leak	Oil spill on the Statfjord A oil production platform; some of the oil leaked into the sea	No casualties 156 people were evacuated
Mediterranean Sea, June 15, 2008	Fire on the platform	Fire at the Norwegian oil production platform Oseberg A. The fire was contained	No casualties. Immediately after the fire, four helicopters evacuated 311 oil workers from the platform
Mediterranean Sea, September 17, 2008	Technical failures	Falling on the platform of a pipe that was to be lowered into the sea	There were 3 fatalities
North Sea, October 31, 2008	Oil leak	Oil spill on the Heather Alpha oil production platform	Fifty-six people were evacuated from the platform, a little over thirty stayed on the platform to eliminate the consequences of the accident. There was no fire

(continued)

Table 1 (continued)

Place and date	*Accident/Incident*	*Main causes and brief description*	*Damage and number of victims*
Sakhalin shelf, March 24, 2009	Oil leak	A release of 165 litresof oil onto the ice surrounding the Molikpaq platform as part of the Sakhalin II project, as a result of a malfunction in one of the units	The consequences of the accident were promptly eliminated, and there was no pollution of the sea
Gulf of Guinea, MAy 26, 2009	Platform attack	An attack by Nigerian fighters in a speedboat on a platform. Total oil platform security personnel repelled the attack	No casualties
Timor Sea, November 01, 2009	Fire at a mining platform	Fire at PTT Explo-ration&Production's Thailand oil platform off Australia's northwest coast. The fire broke out during oil spill response operations	No casualties. More than 28,000 barrels of oil spilled into the sea
Gulf of Mexico, April 22, 2010	Fire and platform flooding	The Deepwater Horizon platform belonging to British Petroleum (BP) sank off the coast of Louisiana after a 36-hour fire that followed a powerful explosion	There were 11 fatalities and 17 injured
Pechora Sea, September 18, 2013	Platform attack	Greenpeace activists made a new attempt to enter the Prirazlomnaya platform. Employees of the security service of Gazpromneft's oil platform repelled the attack	No casualties. The activists were detained by officers of the special-purpose unit of the Border Department of the Federal Security Service of Russia
Gulf of Mexico, July 2021	Underwater fire on a gas pipeline at a depth of 80 m	The incident took place off the coast near the town of Ciudad del Carmen (State of Campeche). Due to a gas leak from a 12-inch pipeline at a depth of 78 metres, 150 metres from the Ku-Charly platform	No one was injured in the fire

Mississippi, and Louisiana. The consequences of the accident cost several tens of billions of dollars and nearly bankrupted British Petroleum (Fadeev et al., 2019).

Due to the limited territory and difficulty of evacuation, accidents on offshore drilling platforms are usually accompanied not only by extremely serious environmental consequences, but also by a significant number of human casualties due to thermal impact of fire and toxicity of combustion products.

However, it is worth noting that analysis of statistical data on accidents at oil and gas production platforms shows a decrease in the number of accidents with catastrophic consequences in recent years. This is due to technological and structural improvements to the platforms, the use of modern safety systems, and the timely conduct of exercises.

Uncontrolled (emergency) oil spills. The implementation of hydrocarbon extraction and subsequent transportation projects is accompanied by the risks of oil or chemical spills. Equipment failure, "human factor" (personnel errors), and extreme natural conditions are the most frequent causes of accidents. When accidents occur near shorelines or in areas with delayed water exchange, the environmental consequences of accidental releases are particularly severe.

During drilling operations accidents are characterized by unexpected volley blowouts of liquid and gaseous hydrocarbons from the well in the process of drilling while penetrating zones with abnormally high formation pressure. An accident can have a long-term catastrophic nature with very large pressure differentials. Then it is possible to drill inclined wells to stop the emissions.

"Normal" (regular) accidents can be eliminated within several hours without arranging additional drilling. The danger of such emissions lies in their regularity and a long-term impact on the marine ecosystem.

Oil and petroleum product spills result in serious disturbance of marine life. The deterioration of the chemical composition of water and its physical parameters (transparency, temperature, etc.), forced change of migration routes, molting, nesting, spawning, as well as death of marine living organisms as a result of oil products getting on the surface layer of skin and plumage take place.

Environmental experts estimate that the implementation of oil extraction projects in the Barents Sea poses a risk of water area pollution of up to 100,000 km^2 and can affect the coastline of more than 4000 km in total.

Emissions to the atmosphere. Emissions of pollutants almost always accompany oil operations into the atmosphere. The flaring of associated gas and excess hydrocarbons during well testing and operations is the most common source of such emissions. Environmentalists estimate that up to 30% of flared hydrocarbons are released into the atmosphere, subsequently precipitating onto the sea surface and forming thin films around the drilling platforms.

The introduction of greenhouse gases into the atmosphere. By emitting large quantities of greenhouse gases such as CO_2 and CH_4, oil and gas activities contribute significantly to climate change. The large share of these emissions comes from the flaring of associated gas and from the combustion of oil or gas to produce energy that provides the production platform.

The combustion of associated gas in turbines required for power generation generates NO_X emissions. It is worth emphasizing the local nature of the impact of these emissions, which, however, can cause serious environmental damage to both marine and coastal ecosystems due to the possibility of "acid rains" containing large amounts of this substance.

The World Bank experts' calculations are interesting and revealing. According to them, 100 billion m^3 of associated gas flared annually is equivalent to ¾ of the volume of Russian gas that is exported or comparable to meeting the world's energy needs for 20 days.

nmVOC Emissions. Non-methane volatile organic hydrocarbons are produced due to the evaporation of crude oil during its storage or transshipment to terminals. When nmVOC interacts with NO_X, ozone is formed when exposed to the sun. Concentrations of elevated ozone that collects in the ground layer can be harmful to human health, as well as to vegetation and even buildings.

Increase in the level of seismic hazard. A significant increase in the level of seismological hazard of the region due to subsidence of rocks over vast areas may be observed during the long-term exploitation of hydrocarbon fields. This risk could result in the collapse of the upper layers of rock, leading to potentially high casualties, environmental consequences, and the propagation of a shock wave with possible earthquakes in regions remote from hydrocarbon production operations.

Today, there is no guarantee for monitoring weak earthquakes due to the remoteness of registration centers at 600–900 km from the fields in the Arctic seas. It is necessary to create seismic groups on Novaya Zemlya and Kolguev Island and other islands of the Arctic zone in order to achieve an optimal level of sensitivity and accuracy of the signals received. Kolguev, as well as other islands of the Arctic zone in order to achieve an optimal level of sensitivity and accuracy of the received signals.

Transportation of hydrocarbons by tankers. The creation of efficient transport and engineering infrastructure capable of operating in extreme natural and climatic conditions is inextricably linked to the development of offshore fields. Obviously, hydrocarbon production and transportation risks on the shelf are much higher than on the mainland. The nature of heat exchange of the ocean surface with the underlying water layers and the atmosphere, the spatial distribution of the Earth's magnetic fields, specific climatic conditions, the duration of daylight hours, as well as the bottom topography, types of shores, and shallow tides significantly reduce the natural self-regulation of the environment. For these reasons, the development of intensive shipping and the creation of offshore production facilities in the Arctic zone requires special attention to environmental safety.

The Rationale for an Integrated (Intersectoral) Management Mechanism for the Development of Arctic Offshore Hydrocarbon Fields

At the moment, there is already a number of economic entities in the Arctic zone, including its sea area. These are, first of all, transport, extraction of biological resources, extraction of aquaculture, and, finally, extraction of mineral and hydrocarbon resources. Taking into account the diversity of economic activities of these economic entities, each of which has its own geography and national–international system of regulation and management, there is often a conflict of interests, which can lead to very negative consequences for both the sensitive ecosystem of the Arctic zone and for the development of individual sectors of the national economy.

In other words, unlike harmoniously created natural ecosystems, human activity on the Arctic seas shelf has no systemic organization, separate industries (transport, bio- and aqua-resources extraction, hydrocarbons extraction, etc.) do not form a single systemic community.

The cumulative set of connections and economic relations at the present time does not have the character of interaction directed on formation of integrally focused useful result. In other words, the complexity of economic activities in the Arctic is not the final result, but a set of parallel processes in the development of sea areas and resources of the Arctic zone. For this reason, such concepts as "oil and gas complex", "fishery complex", "transport complex", "ship repair complex", etc. are present in the economic lexicon (Matishov et al., 2001, 2005; Matishov & Denisov, 2000).

Reasoning from the perspective of the economic postulates of a market economy, a greater number of market participants leads to more competition, which is an obvious advantage, crowding out inefficient participants from the market field. Thinking within the framework of the Arctic zone we are considering the competition between fisheries and hydrocarbon production as an example. There is reason to believe that with obviously lower profits, fisheries will be displaced as well as aquatic biological resources, which are not only the object of industrial fishing, but also an element of biological diversity, which determines, to some extent, the formation of hydrocarbon resources. Thus, the development of the oil and gas industry without the support of fisheries would be profoundly dangerous.

In this regard, ***there is a clear need to find a balance between economic efficiency and the possibility of conserving biodiversity.*** Finding and ensuring such a balance is the main task of integrated cross-sectoral management.

It is worth noting that in the Russian Federation, the relevance of this problem has only started to be realized; the system of views and methods in this area is at the initial stage of formation, as the development of the Arctic shelf is a relatively new type of activity.

Nevertheless, Russia has accumulated considerable experience in exploiting oil and gas fields located onshore, so it seems promising to apply the management ideas developed for onshore fields to marine activities in the Arctic.

This aspect deals with the adaptation and practical application at sea of the following types of management activities: anticipatory and operational management. The above activities are closely linked and have the common goal of harmonizing management decisions aimed at the efficient and safe development of the Arctic.

Speaking about the mechanism of advanced management, it is worth noting that it is characterized by the composition of several actions performed in a certain sequence: the study of the current state of marine systems with subsequent analysis of human economic activity, modeling the upcoming anthropogenic changes in the system and their assessment, selection of optimal measures to mitigate negative consequences and, finally, implementation of ecological expertise of projects (Matishov et al., 2001, 2005; Matishov & Denisov, 2000).

The concept of integrated intersectoral management of offshore hydrocarbon field development consists of four main components:

1. Within a given water area, water column, bed and banks, all relationships and interdependencies between major ecosystem components (biotic and abiotic) are taken into account for management decisions;
2. The management actions taken should be planned and implemented in the context of the long-term development strategy of the management subjects under consideration;
3. The interrelationships among the various economic actors in the Arctic zone and the socio-environmental values and interests that are interlinked with them must be considered as a whole;
4. To achieve a strategic balance between the economic interests of corporations and the conservation of the sensitive Arctic ecosystem, all emerging territorial/productive conflicts and disagreements in economic issues must be resolved by transforming corporate interests into national ones.

The formation and development of a unified strategy and program of action for all business entities (sectors) is the foundation of integrated management methodology. However, in the case of intersectoral and traditional approaches to governance, the role of the public and the public in the process of development and decision-making is different. In the framework of traditional, branch approach to manage the population and the public are the external environment in relation to the branch. Approaches to sectoral strategic planning consider population as an external constituent, which forms the market and demand for products, or as an internal constituent, which forms the supply of labor. Thus, there is a "consumer" attitude towards society as one of the components of the profit chain. Speaking from the perspective of integrated intersectoral management, the population of the coastal region acts as an equal participant in all the processes taking place in the region. That is why the public and small indigenous peoples of the North should be involved in the procedure of decision planning, implementation, monitoring and control, i.e. to be full participants of the continuous process of interdisciplinary management both in the coastal zone and on the shelf (Matishov et al., 2001, 2005; Matishov & Denisov, 2000).

It is worth mentioning that the object of inter-branch management is a human being.

Thus, we can state that integrated intersectoral management is an impact not on the processes occurring in nature, but on the organization of human activity in order to harmonize with nature.

In cross-sectoral management, environmental principles are the main criterion for evaluating such activities.

Environmental management is undoubtedly one of the foundations of intersectoral management. It is worth noting that the rational use of natural resources within the framework of intersectoral management does not deny the possibility of exploitation of natural resources. Resources can and should be exploited by observing the following basic principles (Matishov et al., 2001, 2005; Matishov & Denisov, 2000):

(a) for renewable resources, the rate of consumption should not exceed the rate of renewal (recovery);
(b) for non-renewable resources, the rate of consumption should not exceed the rate of finding sustainable substitutes;
(c) the volume of pollutants and the intensity of their discharge into the environment during economic activities must not exceed the capacity of the environment to absorb and process these wastes.

The concept of interdisciplinary management of the Arctic offshore hydrocarbon field development differs from the generally accepted management activities in that it is based on taking into account and managing all the factors that are directly or indirectly related to the considered marine ecosystem and coastal zone.

The increasing competition for floor, coastal, aquatic and habitat space resulting from the multiple-use regime of territorial exploitation may make the sharing of ocean resources by different economic sectors incompatible. In order to solve this problem, an integral (comprehensive) assessment of the interests of economic entities, prioritization of their interests, as well as spatial zoning of water areas on a regional scale are envisaged.

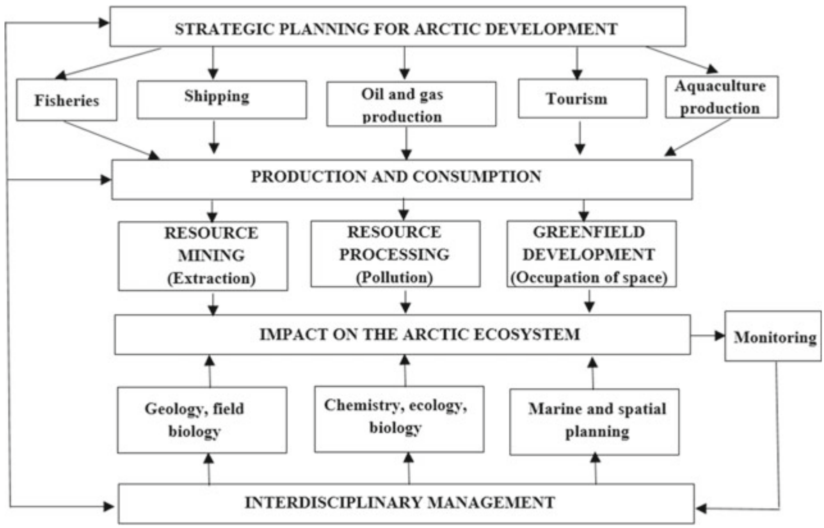

Fig. 3 Inter-sectoral management framework

The schematic diagram of inter-branch management is shown in Fig. 3 (Fadeev et al., 2019).

Sustainable Development of Coastal Regions in the Implementation of Projects on the Arctic Shelf

Sustainable development of the new oil and gas region involves the creation of mechanisms to ensure the necessary development, level of consumption, and social harmony in society, as well as sustainable development of the economy and sustainable functioning of the biosphere. The main direction of the oil and gas complex formation is to create such conditions that would contribute to the convergence of hydrocarbons' realized and potential values. The social value is understood as a set of (direct, indirect, and multiplicative) effects obtained from the development and use of hydrocarbon resources (Kryukov & Tokarev, 2007).

Such effects can be expressed not only in monetary terms but also in the form of indirect and indirect benefits, such as an increase in the value of human capital. Human capital, in this case, is understood as a set of skills embodied in a person, including education, intellect, creativity, work experience, entrepreneurial ability, etc. Thus, during the development of oil and gas resources under the centralized planning and management system conditions, it was often focused primarily on achieving a certain level of production indicators, so the real value (at the regional level) was largely different from its potential level. Ensuring an acceptable level of the social value of hydrocarbon resources is only possible if there is a developed system of modern civil society institutions, as well as an effective specialized institutional system aimed at ensuring socially oriented development of the fields. The economy of oil and gas regions in general is based on the production of hydrocarbon resources and largely depends on the pace of field development. In the process of deployment of economic activity there are significant changes in the living conditions of the population, as well as observed structural shifts in the economy and social sphere of the region, the development of transport systems, changes in the environment, as well as the strengthening of migration influx. Large-scale industrial development of the oil and gas production area, significant changes in the economy and social sphere primarily concern the population living in this territory. At the same time, the process of oil and gas resources development is accompanied by a number of both positive and negative trends, which requires certain targeted impacts from the state to correct these trends. The factor of exhaustibility of hydrocarbon resources requires taking into account not only economic, but also social consequences of resource development and conditions of regional economy functioning at all stages of production.

The specified factors demand the complex approach to an estimation of consequences of oil and gas resources development in the region and full account of both features of oil and gas resources development, and its influence on social and economic system of the region. The experience of the leading oil and gas powers shows that over the past 20–30 years the world has developed and successfully implemented approaches to integrate the development of hydrocarbon resources with a wide range of socio-economic objectives. Such approaches involve a shift in emphasis from projects' solely financial and economic impact to their social and economic outcomes. Analysis of the policy of industrially developed countries, which are simultaneously major subsoil users (Norway, Australia, USA, Great Britain, Germany), shows that the liberal approach towards institutions in the sphere of property relations, related to the use of conventional assets, is supplemented by a branched system of rules, regulations, and procedures in the sphere of use of subsoil resources. These facts provide the state with the protection of its rights as the owner of subsoil resources, as well as form the conditions for the dynamics of the development and use of non-renewable resources effective from the point of view of public interests (Kryukov & Tokarev, 2007).

The balance of interests and minimization of contradictions between the state, oil and gas companies, and the local population largely determine the extractive region's progressive and balanced socio-economic development.

Ignoring or infringing the interests of any of the above entities will inevitably lead to a significant reduction in the so-called synergistic effect based on mutual cooperation. Achieving a balance of interests between business, the state, and the population living in a given territory is one of the key conditions for the sustainable development of regions when developing deposits.

In the development of hydrocarbon deposits, it is customary to distinguish the following macroeconomic effects of their development:

- significant volume of investment attraction;
- modern technologies' transfer;
- budgetary revenues' increase;
- indirect effects related to subcontracting by regional enterprises;
- domestic employment's increase.

Table 2 presents the main positive and negative consequences for the region of the development of oil and gas fields on its territory, affecting the formation of multiplier economic effects (Kryukov & Tokarev, 2007).

All these macroeconomic effects are components of the economic multiplier effect, which expresses the existing dependence between industries. It is customary to distinguish the extractive industry, the so-called "generator" of the investment wave, from which the economic influence is transferred to other related industries. The concept of "multiplier" (from Latin "multiplicator – multiplying") was introduced in economic theory in 1931 by British economist R. Kahn. Reviewing the impact of public works, which the Roosevelt administration organized to combat the economic downturn and unemployment, he noted that government investment in public works produced a "multiplier" employment effect:

Table 2 Objective positive and negative consequences for the region of the development of oil and gas fields on its territory (Kryukov & Tokarev, 2007)

Positives	*Negatives*
Rapid growth of industrial production in the region	Limiting the economic dynamics to the reserves of the field
Increase in taxable base	Reduced competitiveness of other enterprises in the region due to tax preferences
Improving the profitability of hydrocarbon-related business	Gravitation of the regional economic system to the mono-product type
Rising incomes	Population differentiation by income
Impetus for regional infrastructure development	Dramatic increase in pressure on the ecological system

not only primary but also secondary, tertiary, etc. employment emerged. In other words, the initial investment spending of budget funds led to a multiplication of purchasing power and employment. These notions were soon expressed in the Keynesian theory of the multiplier effect. The multiplier in Keynesian theory refers to the coefficient showing the dependence of changes in output and national income on changes in investment. The multiplier principle is based on the interrelation of different industries or productions in the economy. In general terms it can be formulated as follows: an increase in demand in one industry will automatically cause an increase in demand in other industries, which are technologically related to each other. Thus, the demand for oil and gas equipment causes the growth of demand for metal, components, and electric power. In turn, the metallurgical plant will increase demand for ore, power plants will increase demand for gas, coal, etc. Thus, a number of investment impulses arise, which is very favorable for the economic system (Ilyinsky et al., 2006).

Conclusion

An analysis of foreign experience in implementing energy projects in the Far North, including the shelf, shows that none of the projects is being considered and implemented in isolation from solving social and economic problems of the territory development. The principal feature of projects in new areas—the impossibility of solving the problem exclusively within the framework of approaches focused on the pure commercial efficiency of projects for the development of hydrocarbon deposits is no less important.

In the Russian Federation, the development of the Arctic shelf has entered the practical stage. Currently, it is extremely important to transform the rich natural potential of the Arctic into the social and economic well-being of the country inhabitants.

The solution for the most important problems of the state: raising of living standards of the population, the quality and accessibility of healthcare, education, science and culture, while strengthening the statehood, is directly related to improving the economic climate in the country. For a considerable period of time, industry has been a crucial area of strengthening and developing the Russian economy, so it should concentrate the main efforts of all branches of the country's government through the implementation of large-scale offshore projects in the Arctic.

Russia needs to study the accumulated international positive experience in the development of hydrocarbon fields. In this case, an effective modernization of the country's oil and gas complex can be successfully carried out, including the solution of a wide range of social and economic problems.

The development process of hydrocarbon resources of the new regions should have an openly declared socially oriented character. A comprehensive approach to solving the problems of resource territories, taking into account the peculiarities of formation, development, and functioning of the oil and gas sector in the region, is necessary.

Development of the Arctic shelf is a state task. The government's time horizon should be much broader than that of the commercial participants in the investment project. If an investor is concerned with getting back the invested funds as soon as possible without taking high risks, the state, first, is interested in launching a creative economic process to ensure sustainable development of territories.

The strategy of sustainable development of territories in the implementation of offshore projects in the Arctic should be based on the joint use of competitive advantages of the region and the specific project, which should form the basis of the oil and gas complex management strategy in the development of offshore hydrocarbon fields (Quint, 2019).

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