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TECHNOLOGICAL INDEPENDENCE AND IMPORT SUBSTITUTION IN THE IMPLEMENTATION OF ENERGY PROJECTS IN THE ARCTIC

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Abstract. Existing macroeconomic challenges, existing sectoral restrictions, including a ban on working with Russian energy companies for most Western equipment manufacturers and suppliers, the proclaimed course for the full-scale development of the Arctic have led to the emergence of a number of industrial and technological challenges, the successful overcoming of which largely determines the possibility of independent implementation of ambitious projects . The efficient and safe implementation of projects in the Arctic requires science and industry to create fundamentally new technical and technological solutions, often comparable in complexity to technologies for the space industry or nanotechnologies. Currently, there are about 30 smart fields in Russia, which already provide almost a third of all hydrocarbon production. Maintaining leadership positions in the development of Arctic resources requires the state to pursue its own technological policy and develop a national standardization system, which will lead to a change in the engineering culture in the country. It is obvious that the implementation of programs aimed at avoiding import dependence as soon as possible and achieving technological sovereignty requires the consolidation of actions at all levels of government: from the executive and legislative authorities to energy companies, industry associations, unions and business communities.

Keywords: Arctic, import substitution, technological sovereignty, institute of oil and gas technological initiatives, shelf, hydrocarbon resources

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ТЕХНОЛОГИЧЕСКАЯ НЕЗАВИСИМОСТЬ И ИМПОРТОЗАМЕЩЕНИЕ ПРИ РЕАЛИЗАЦИИ ЭНЕРГЕТИЧЕСКИХ ПРОЕКТОВ В АРКТИКЕ

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Аннотация. Существующие макроэкономические вызовы, существующие отраслевые ограничения, включая запрет на работу с российскими энергетическими компаниями для большинства западных производителей и поставщиков оборудования, провозглашенный курс на полномасштабное освоение Арктики привели к возникновению ряда производственных и технологических вызовов, успешное преодоление которых во многом определяет возможность самостоятельной реализации амбициозных проектов. Эффективная и безопасная реализация проектов в Арктике требует от науки и промышленности создания принципиально новых технических и технологических решений, зачастую сравнимых по сложности с технологиями для космической отрасли или нанотехнологиями. В настоящее время в России насчитывается около 30 интеллектуальных месторождений, которые уже обеспечивают почти треть всей добычи углеводородов. Сохранение лидерских позиций в освоении арктических ресурсов требует от государства проведения собственной технологической политики и развития национальной системы стандартизации, что приведет к изменению инженерной культуры в стране. Очевидно, что реализация программ, направленных на скорейший уход от импортной зависимости и достижение технологического суверенитета, требует консолидации действий на всех уровнях власти: от исполнительной и законодательной власти до энергетических компаний, отраслевых ассоциаций, профсоюзов и бизнес-сообществ.

Ключевые слова: Арктика, импортозамещение, технологический суверенитет, институт нефтегазовых технологических инициатив, шельф, углеводородные ресурсы

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Introduction

The introduced sectoral restrictions and the current macroeconomic and foreign policy challenges led to the start of the implementation of alternative substitution programs by the Russian Federation, aimed at the speedy avoidance of import dependence and the achievement of technological sovereignty in the energy sector. Import substitution is understood as the creation of domestic goods, works and services produced (provided) with the help of Russian equipment and technical and technological solutions with the involvement of Russian personnel to perform the work. Special attention also deserves the possibility of localizing foreign production in Russia with the possibility of R&D (Saitova et al., 2022).

The goals of implementing import substitution programs are to ensure the technological independence of the energy industry, develop healthy competition between domestic equipment manufacturers, and reduce the capital intensity of ongoing projects (Bolsunovskaya and Sentsov, 2016).

Technological solutions in the oil and gas sector, especially those used in Arctic projects, almost always belong to the "high-tech" category, which, on the one hand, is most dependent on imported solutions, and on the other hand, has significant potential for the development of Russian industry (Didenko and Cherenkov, 2018). Among the examples of high-tech solutions that currently have the potential for development at Russian facilities, the following can be distinguished: equipment and technologies for completing wells with multi-stage hydraulic fracturing and related software for modeling these processes, telemetry and logging instruments, rotary steerable systems, pumps high pressure (Brazovskaia et al., 2021; Larchenko et al., 2019; Volkov, 2020).

For work on the shelf, first of all, it is worth noting such areas and technologies as underwater production complexes and drilling equipment, ships and equipment for seismic exploration, as well as generating equipment (Carayannis et al., 2017; Sheveleva, 2022).

The domestic oil refining industry also needs today compressors for technological processes, pumps for technological processes of oil refineries, additives for oil refining and petrochemicals, as well as hydroprocessing catalysts (Chanysheva and Ilinova, 2021; Tsukerman et al., 2019; Veretennikov et al., 2018).

All this necessitates the consolidation of resources at all levels of management, active interaction between energy companies both among themselves as part of the consolidation of demand for high-tech products, and with Russian industrial enterprises. It is necessary to create "uniform rules of the game" in the field of standardization of equipment and technologies for the oil and gas complex.

Materials and Methods

Most modern energy companies have chosen the digitalization of their activities as an unconditional production priority (Pezzella and Pliushch, 2022). In addition to the presence of “smart fields” controlled on the basis of digital interpretation of a lot of received data, unmanned aerial vehicles, digital twins are becoming widespread, Russian fields are already using underwater production complexes and robotic drilling rigs that allow hydrocarbon production without the direct participation of the operator (Katysheva and Tsvetkova, 2019, 2017; Samylovskaya et al., 2022; Tsvetkova and Katysheva, 2017).

The growth of manufacturability of solutions in the oil and gas sector can be clearly seen, including in the context of the constant increase in sea depths, on which exploration and production wells are being built today for oil and gas production.

One of the technological solutions that allows increasing the oil recovery factor is the construction of wells with horizontal outlets. Currently, wells on the Arctic shelf are being built not only at impressive vertical sea depths, but also with horizontal diversions for kilometers (the world record is 15 km).

Energy project operators working in the Arctic face the following key challenges (Tsvetkova and Katysheva, 2017):

– Harsh climatic conditions and remoteness;
– Lack of developed service infrastructure;
– The need to promote legislative initiatives;
– Technological support of projects;
– The need to preserve the sensitive ecosystem of the Arctic zone.

At the same time, additional threats and risks should be taken into account: challenges associated with conflicts of national interests of circumpolar countries and regions; the geopolitics of the world powers and their integration and military-political alliances, the economic and military-political interests behind them; expanding the range of claims for participation in the "Arctic pie" of countries that do not have access to the Arctic territories and seas; expansion and intensification of the global competition of transnational capitals and corporations for the wealth of the Arctic shelves (Dmitrieva and Romasheva, 2020; Romasheva and Dmitrieva, 2021; Vasilev et al., 2020).

The issues of technological support for the implementation of projects in the Arctic are particularly acute (Romashkina et al., 2017). Along with this, it is important to take into account the high heterogeneity of water areas in the Arctic: if the Barents-Kara region is characterized by relatively favorable conditions for exploration and mining (due to the warm Gulf Stream), then the water areas of the eastern Arctic are characterized by extreme natural and climatic conditions. Accordingly, for the southern part of the Barents Sea, the Kara Sea, proven exploration and development technologies exist and are used (floating and jack-up drilling rigs, subsea facilities, fixed platforms, artificial ice and gravel islands, fixed ice-resistant platforms, extended reach drilling, ships using ice management systems) (Dudin et al., 2016; Fadeev et al., 2022). For the northern part of the Barents Sea, the central and northern parts of the Kara Sea, new technologies are being developed to enable operation in multi-year ice, including autonomous underwater drilling complexes (Abramov et al., 2021; Biev, 2019; Romashkina et al., 2017).

Thus, the main areas of import substitution in the implementation of offshore projects include:

– support vessels for offshore projects
– equipment for marine seismic surveys
– floating drilling rigs
– spare parts and components for offshore projects
– generating complexes for offshore projects
– drilling equipment for offshore projects
– equipment and technologies for oil spill response
– underwater production complexes.

Results

Obviously, the implementation of high-tech projects requires the creation of a number of solutions aimed at avoiding import dependence.

Speaking of sanctions, it is worth noting that they did not have the critical impact on the implementation of Russian projects in the Arctic that their creators were counting on. It is possible that the sanctions have made the implementation of projects a little less convenient for Russian energy companies, but thanks to the measures taken to reorient supplies from West to East, as well as the development of import substitution programs, companies are able to implement already launched projects in accordance with their plans.

But the main advantage of the current macroeconomic situation is that the sanctions have made it possible to intensify the development of the national service supplier market. The imposition of sanctions has hit, among other things, foreign manufacturers: many foreign companies are forced to limit their activities in Russia. In this regard, niches appear on the market, which are occupied by domestic suppliers.

For the Russian industry, sanctions have created technological challenges, often associated with the development and production of new unique products, which require serious scientific and industrial work, government incentives and coordination with customers. However, Russia already has quite tangible successes in this direction.

Since 2014, the Ministry of Energy of Russia, in cooperation with the Ministry of Industry and Trade of Russia, as well as with other interested federal executive authorities and companies in the fuel and energy complex, has been working to reduce dependence on imported equipment, technologies and materials. The total amount of state support for import substitution programs amounted to billions of rubles, which led to the creation in Russia of fundamentally new technical and technological solutions that made it possible to completely get away from import dependence in a number of segments.

As an example, it is worth noting the creation of domestic autonomous bottom stations "Crab". This is a joint project of Gazprom Neft, the Ministry of Industry and Trade of Russia, OJSC Marine Arctic Exploration Expedition and LLC Marine Technical Center. "Crab" is a mobile hardware and software complex for marine seismic exploration and monitoring in transit zones and on the shelf. It was built on the basis of four-component autonomous bottom stations, which are serviced in container-laboratories of the complex. "Crab" is intended for seismic regional studies and exploration of offshore hydrocarbon fields. LLC "Marine Technical Center" also sells mobile hardware and software systems for marine seismic and monitoring in transit zones and on the shelf Flounder and Coral. The use of the aforementioned complexes has been implemented at the Yuzhno-Kirinskoye and Kirinskoye fields in the Sea of Okhotsk.

It is also important to note the creation of a Russian mobile complex for the extraction of hard-to-recover oil reserves (a fleet for hydraulic fracturing), which consists of 12 high-tech units. The unique Russian equipment was created by the Moscow Institute of Thermal Engineering Corporation with the participation of several dozen Russian enterprises in accordance with the decision of the President and the order of the Government of the Russian Federation as part of the import substitution program in the interests of the domestic oil and gas complex.

A very promising option is the creation of joint ventures and the localization of production capacities and R&D of leading foreign manufacturers in Russia. Among such strategic areas may be: equipment for offshore seismic surveys, support for directional and horizontal drilling, high-tech well completion; pumps and compressors for oil refining, catalysts for oil refining and petrochemicals, etc.

Obviously, the construction of all of the above must be provided by appropriate sites, shipyards and factories in the Russian Federation, created both by domestic contractors independently and in partnership with foreign high-tech partners.

Discussion

Since 2014 the majority of Russian energy companies have announced a course towards the implementation of their own corporate alternative substitution strategies aimed at creating new, previously import-dependent, nomenclature positions produced by Russian enterprises. Some companies created separate structural divisions, some simply appointed responsible persons, but often companies tried to work in the field of import substitution on their own.

Basically, such work began with a dialogue with Russian equipment manufacturers regarding the possibility of producing pilot batches of equipment. This was followed by pilot tests of the manufactured equipment and, in the event of a positive assessment of the results of such tests, new equipment manufactured in Russia could be purchased by an energy company.

As a rule, the time from the idea of implementing joint projects between industrial and energy companies to the possibility of organizing supplies within the framework of ongoing procurement procedures was at least a year (and sometimes several years). In addition, the system of attestation and accreditation of industrial enterprises by an oil and gas company also took a significant amount of time, often requiring considerable financial costs on the part of equipment manufacturers. At the same time, if a particular manufacturer had a desire to start work within the framework of the manufactured equipment with another energy company, then the entire process of confirming the released equipment to the stated requirements of the energy company had to be repeated. Taking into account the number of energy companies in Russia, the time required to pass compliance assessments, as well as the organizational and financial costs of organizing this process, this approach to ensuring process safety could hardly be called effective.

Recently, the American Petroleum Institute (API), which is a recognized world certification body, has stopped issuing its certificates to Russian producers (and in some cases there are revocations of previously issued documents). The need to consolidate efforts at the industry level has become obvious, including in the development of common standards for equipment and certification systems.

The Scientific and Technical Council for the Development of Oil and Gas Equipment under the Ministry of Industry and Trade of Russia became the main platform for joint discussion of issues and decision-making. Within the Council, more than 10 expert groups were created, whose activities covered almost all key target areas of import substitution for the oil and gas industry - from exploration and production to transportation and processing of hydrocarbons (Gruzinov et al., 2019).

The main difficulties faced by oil and gas companies engaged in import substitution were:

– unification of product requirements by all consumers;

– search for objects and conducting pilot tests;

– mutual recognition of the results of pilot tests for accelerated scaling of production and implementation of emerging solutions in the procurement system of oil and gas companies.

The main problem that underlies all the indicated difficulties is the massive use of normative documents of foreign standardization systems. Established in 2015 The heavy dependence of the oil and gas sector on technologies created in the US and the EU in the implementation of projects both in the production and processing of oil and gas has led to the dominance of references to foreign standardization systems in design decisions and procurement specifications. References to international standardization systems due to problems with confirmation of conformity often become artificial barriers to the use of domestic equipment in projects - in the presence of comparable imported or even superior Russian analogues in terms of characteristics.

Additional restrictions under the sanctions policy arise when the manufacturer supplies equipment and materials to companies and projects under sanctions. Standardization systems may impose a direct ban on such supplies, and a possible strengthening of the sanctions regime creates the risk of an "institutional void" in industry standardization, that is, the loss of a quality benchmark.

In 2019, it became obvious that these issues need to be addressed not at the tactical, but at the strategic level. This idea became the prototype of the idea of combining the efforts of energy companies to address issues of import substitution and promote innovation by creating an appropriate industry organization.

As a response to these challenges, in 2020 four Russian oil and gas companies - Gazprom, Gazprom Neft, Sibur and Tatneft - became the founders of the creation of an autonomous non-profit organization Institute of Oil and Gas Technology Initiatives (INTI), whose main task is to develop and approve Russian industry standards for oil and gas equipment and technology and assessing the compliance of Russian enterprises with the developed standards.

The initiative to create a single organization, which is designed to ensure the development of uniform industry standards, was twice presented to the President of the Russian Federation Vladimir Putin and, following relevant instructions, nine other Russian energy companies joined the INTI project as observers. Russian energy companies were instructed, together with INTI, to ensure the transition to a unified industry standardization and conformity assessment system, as well as to consolidate resources and efforts in the field of import substitution.

At the same time, the founders set very ambitious tasks for the Institute: up to 2025. development and approval of at least 500 industry standards is required. For these purposes, the Institute is expected to attract more than 5,000 experts from the industry and professional community, and the number of conformity assessments carried out should exceed 3,000.

In 2020, INTI was also introduced to Mohammed Barkindo, the then Secretary General of the Organization of the Petroleum Exporting Countries OPEC. Having received a high appraisal of its activities, INTI began its international expansion. Currently, there are seven energy companies in the Institute as foreign observers: three from the CIS countries - SOCAR (Azerbaijan), KazMunayGas (Kazakhstan), Uzbekneftegaz (Uzbekistan), as well as four from the countries of the Opec + agreement - ADNOC (UAE), Kuwait Petroleum Corporation (Kuwait), Sonatrach (Algeria), Sonangol (Angola).

For equipment manufacturers, the presence of foreign companies in the Institute means the following: having received a conformity assessment at INTI, they gain the opportunity not only to work unhindered in the Russian market without the need to confirm the results of pilot tests or pass a specialized certification system, but also a barrier-free access to high-tech oil and gas markets companies that have joined the INTI project.

Obviously, the activities of the Institute of Oil and Gas Technology Initiatives create mutual benefits for both equipment manufacturers and energy companies. First of all, we are talking about technological development and independence through the consolidation of existing resources and competencies, as well as demand from oil and gas companies in order to develop innovative and import-substituting solutions for the needs of the oil and gas complex.

The creation of a unified Russian standardization system contributes to the accelerated introduction of products and technologies (including innovative and import-substituting ones) of domestic manufacturers of oil and gas equipment and developers, an increase in the share of purchased local equipment and technologies for their use in major investment projects and operating activities of oil and gas and energy companies, and an increase in the competitiveness of local manufacturers equipment and technologies.

An effective dialogue between oil and gas companies, manufacturers and engineering companies takes place on the INTI digital platform. Joint work allows more efficient and faster development and promotion of technologies and equipment of domestic manufacturers and developers in domestic and foreign markets through the development of common INTI standards and conformity assessment on them.

The benefits for equipment manufacturers are obvious: unification of customer requirements, reduction in production costs, assistance with conformity assessment, recognition of test results by consumers, product promotion and, of course, the introduction of manufactured equipment into purchases. For energy companies, cooperation with INTI opens up opportunities for developing competencies and exchanging experience, joint technological development, expanding the pool of suppliers, reducing audit costs and, as a result, leveling sanctions risks. The Institute invites all interested equipment manufacturers to take part in the development of standards approval. If the standard for manufactured equipment already exists, then manufacturers have the opportunity to pass an assessment of compliance with this standard, which allows them to work seamlessly with all energy companies that have joined INTI at once.

Currently, there are three digital services on the site https://inti.expert/ that provide the above tasks:

– INTI Docs is a service for the development and approval of INTI standards, which includes functions for the development of standards and a catalog of accepted standards.

– INTI Quality is a service for conformity assessment and testing of equipment and materials. Designed for local providers. With the help of this service, suppliers can undergo a conformity assessment.

– INTI Insights is a database of local equipment that meets INTI standards. Designed for equipment customers (oil and gas companies, licensors, EPC contractors). With the help of this service, it is possible to find the necessary equipment according to the specified criteria, get access to reports on the results of conformity assessment, and get acquainted with the available references.

Conclusions

The development of offshore hydrocarbon fields in the Arctic is a strategic task for the Russian Federation, the solution of which requires the consolidation of efforts at all levels of government.

Arctic resources are not only building up the resource base of the state, which, without a doubt, is a competitive advantage of the country, but also loading the most important industries, creating a significant number of jobs, increasing the tax base, stimulating scientific developments, as well as improving the demographic situation by attracting highly qualified personnel for work in the Arctic regions.

The current foreign economic and political challenges have created the prerequisites for a speedy departure from import dependence and for the Russian Federation to pursue its own technology policy, which should be based on the joint work of the state, energy companies, science and industry.

The development of the Russian system of standardization in the energy sector is a direct and effective tool for import substitution, aimed at the speedy achievement of technological sovereignty by the Russian oil and gas complex.

REFERENCES

Abramov V., Burlov V., Tatarnikova T. 2021. Digital Technologies Development for Maritime Activities Oceanographic Support in Arctic and Subarctic, in: IOP Conference Series: Earth and Environmental Science. IOP Publishing, p. 052075.

Biev A. 2019. The use of digital technologies for the Russian Arctic energy infrastructure assessment, in: International Conference on Digital Technologies in Logistics and Infrastructure (ICDTLI 2019). Atlantis Press, pp. 116–119.

Bolsunovskaya Y., Sentsov, A. 2016. Human potential as a strategic resource of the Russian Arctic sustainable development, in: SHS Web of Conferences. EDP Sciences, p. 01013.

Brazovskaia V., Gutman S., Zaytsev A. 2021. Potential impact of renewable energy on the sustainable development of Russian Arctic territories. Energies 14, 3691.

Carayannis E.G., Cherepovitsyn A.E., Ilinova A.A. 2017. Sustainable development of the Russian Arctic zone energy shelf: The role of the quintuple innovation helix model. Journal of the Knowledge Economy 8, 456–470.

Chanysheva A., Ilinova A. 2021. The Future of Russian Arctic Oil and Gas Projects: Problems of Assessing the Prospects. Journal of Marine Science and Engineering 9, 528.

Didenko N., Cherenkov V. 2018. Economic and geopolitical aspects of developing the Northern Sea Route, in: IOP Conference Series: Earth and Environmental Science. IOP Publishing, p. 012012.

Dmitrieva D., Romasheva N. 2020. Sustainable development of oil and gas potential of the Arctic and its shelf zone: The role of innovations. Journal of Marine Science and Engineering 8, 1003.

Dudin M.N., Ivashchenko N.P., Frolova E., Abashidze A.H., Smbatyan A.S. 2016. Innovative approach to the development of the logistics system of supply of the Arctic region space. International Journal of Economics and Financial Issues 6, 1965–1972.

Fadeev A., Levina A., Esser M., Kalyazina S. 2022. Transport and Logistic Support of Oil-and-Gas Offshore Production in the Arctic Zone, in: Arctic Maritime Logistics. Springer, pp. 45–62.

Gruzinov V.M., Zvorykina Y.V., Ivanov G.V., Sychev Y.F., Tarasova O.V. 2019. Arctic transport routes on land, water areas and airspace. Arktika: ekologiya i ekonomika 33.

Katysheva E., Tsvetkova A. 2019. Economic and institutional problems of the Russian oil and gas complex digital transformation. International Multidisciplinary Scientific GeoConference: SGEM 19, 203–208.

Katysheva E., Tsvetkova A. 2017. The future of oil and gas fields development on the arctic shelf of Russia. International Multidisciplinary Scientific GeoConference: SGEM: Surveying Geology & mining Ecology Management 17, 917–922.

Larchenko L., Gladkiy Y.N., Sukhorukov V. 2019. Resources for sustainable development of Russian Arctic territories of raw orientation, in: IOP Conference Series: Earth and Environmental Science. IOP Publishing, p. 012121.

Pezzella E., Pliushch E. 2022. Digital transformation of business: use of blockchain in the oil & gas industry. TECHNO ECONOMICS 3, 4–16.

Romasheva N., Dmitrieva D. 2021. Energy resources exploitation in the russian arctic: Challenges and prospects for the sustainable development of the ecosystem. Energies 14, 8300.

Romashkina G., Didenko N., Skripnuk D. 2017. Socioeconomic modernization of Russia and its Arctic regions. Studies on Russian Economic Development 28, 22–30.

Saitova A.A., Ilyinsky A.A., Fadeev A.M. 2022. Scenarios for the development of oil and gas companies in Russia in the context of international economic sanctions and the decarbonization of the energy sector. N. Mark. Form. Econ. Order 25, 134–143.

Samylovskaya E., Makhovikov A., Lutonin A., Medvedev D., Kudryavtseva R.E. 2022. Digital Technologies in Arctic Oil and Gas Resources Extraction: Global Trends and Russian Experience. Resources 11, 29.

Sheveleva A. 2022. Digital Technologies of Oil and Gas Companies in the Development of the Arctic Shelf, in: The Handbook of the Arctic: A Broad and Comprehensive Overview. Springer, pp. 1–17.

Tsukerman V., Fadeev A., Kozlov A. 2019. Algorithm for implementing the import substitution strategy when exploiting hydrocarbons on the Arctic shelf of the Russian Federation, in: IOP Conference Series: Earth and Environmental Science. IOP Publishing, p. 012111.

Tsvetkova A., Katysheva E. 2017. Ecological and economic efficiency evaluation of sustainable use of mineral raw materials in modern conditions. 17th International multidisciplinary scientific geoconference SGEM 2017 17, 241–248.

Vasilev Y., Tsvetkova A., Stroykov G. 2020. Sustainable development in the Arctic region of the Russian Federation. Proceedings of the International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Varna, Bulgaria 16–25.

Veretennikov N.P., Mikulenok A.S., Bogachev V.F. 2018. Management of the System for Russian Arctic Region Logistics and Information Support, in: 2018 IEEE International Conference" Quality Management, Transport and Information Security, Information Technologies"(IT&QM&IS). IEEE, pp. 271–273.

Volkov A. 2020. Methodological approaches to the study of socio-economic constraints on sustainable development of the Karelian Arctic region in modern conditions, in: E3S Web of Conferences. EDP Sciences, p. 05023.

СПИСОК ИСТОЧНИКОВ

Abramov V., Burlov V., Tatarnikova T. 2021. Digital Technologies Development for Maritime Activities Oceanographic Support in Arctic and Subarctic, in: IOP Conference Series: Earth and Environmental Science. IOP Publishing, p. 052075.

Biev A. 2019. The use of digital technologies for the Russian Arctic energy infrastructure assessment, in: International Conference on Digital Technologies in Logistics and Infrastructure (ICDTLI 2019). Atlantis Press, pp. 116–119.

Bolsunovskaya Y., Sentsov, A. 2016. Human potential as a strategic resource of the Russian Arctic sustainable development, in: SHS Web of Conferences. EDP Sciences, p. 01013.

Brazovskaia V., Gutman S., Zaytsev A. 2021. Potential impact of renewable energy on the sustainable development of Russian Arctic territories. Energies 14, 3691.

Carayannis E.G., Cherepovitsyn A.E., Ilinova A.A. 2017. Sustainable development of the Russian Arctic zone energy shelf: The role of the quintuple innovation helix model. Journal of the Knowledge Economy 8, 456–470.

Chanysheva A., Ilinova A. 2021. The Future of Russian Arctic Oil and Gas Projects: Problems of Assessing the Prospects. Journal of Marine Science and Engineering 9, 528.

Didenko N., Cherenkov V. 2018. Economic and geopolitical aspects of developing the Northern Sea Route, in: IOP Conference Series: Earth and Environmental Science. IOP Publishing, p. 012012.

Dmitrieva D., Romasheva N. 2020. Sustainable development of oil and gas potential of the Arctic and its shelf zone: The role of innovations. Journal of Marine Science and Engineering 8, 1003.

Dudin M.N., Ivashchenko N.P., Frolova E., Abashidze A.H., Smbatyan A.S. 2016. Innovative approach to the development of the logistics system of supply of the Arctic region space. International Journal of Economics and Financial Issues 6, 1965–1972.

Fadeev A., Levina A., Esser M., Kalyazina S. 2022. Transport and Logistic Support of Oil-and-Gas Offshore Production in the Arctic Zone, in: Arctic Maritime Logistics. Springer, pp. 45–62.

Gruzinov V.M., Zvorykina Y.V., Ivanov G.V., Sychev Y.F., Tarasova O.V. 2019. Arctic transport routes on land, water areas and airspace. Arktika: ekologiya i ekonomika 33.

Katysheva E., Tsvetkova A. 2019. Economic and institutional problems of the Russian oil and gas complex digital transformation. International Multidisciplinary Scientific GeoConference: SGEM 19, 203–208.

Katysheva E., Tsvetkova A. 2017. The future of oil and gas fields development on the arctic shelf of Russia. International Multidisciplinary Scientific GeoConference: SGEM: Surveying Geology & mining Ecology Management 17, 917–922.

Larchenko L., Gladkiy Y.N., Sukhorukov V. 2019. Resources for sustainable development of Russian Arctic territories of raw orientation, in: IOP Conference Series: Earth and Environmental Science. IOP Publishing, p. 012121.

Pezzella E., Pliushch E. 2022. Digital transformation of business: use of blockchain in the oil & gas industry. TECHNO ECONOMICS 3, 4–16.

Romasheva N., Dmitrieva D. 2021. Energy resources exploitation in the russian arctic: Challenges and prospects for the sustainable development of the ecosystem. Energies 14, 8300.

Romashkina G., Didenko N., Skripnuk D. 2017. Socioeconomic modernization of Russia and its Arctic regions. Studies on Russian Economic Development 28, 22–30.

Saitova A.A., Ilyinsky A.A., Fadeev A.M. 2022. Scenarios for the development of oil and gas companies in Russia in the context of international economic sanctions and the decarbonization of the energy sector. N. Mark. Form. Econ. Order 25, 134–143.

Samylovskaya E., Makhovikov A., Lutonin A., Medvedev D., Kudryavtseva R.E. 2022. Digital Technologies in Arctic Oil and Gas Resources Extraction: Global Trends and Russian Experience. Resources 11, 29.

Sheveleva A. 2022. Digital Technologies of Oil and Gas Companies in the Development of the Arctic Shelf, in: The Handbook of the Arctic: A Broad and Comprehensive Overview. Springer, pp. 1–17.

Tsukerman V., Fadeev A., Kozlov A. 2019. Algorithm for implementing the import substitution strategy when exploiting hydrocarbons on the Arctic shelf of the Russian Federation, in: IOP Conference Series: Earth and Environmental Science. IOP Publishing, p. 012111.

Tsvetkova A., Katysheva E. 2017. Ecological and economic efficiency evaluation of sustainable use of mineral raw materials in modern conditions. 17th International multidisciplinary scientific geoconference SGEM 2017 17, 241–248.

Vasilev Y., Tsvetkova A., Stroykov G. 2020. Sustainable development in the Arctic region of the Russian Federation. Proceedings of the International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Varna, Bulgaria 16–25.

Veretennikov N.P., Mikulenok A.S., Bogachev V.F. 2018. Management of the System for Russian Arctic Region Logistics and Information Support, in: 2018 IEEE International Conference" Quality Management, Transport and Information Security, Information Technologies"(IT&QM&IS). IEEE, pp. 271–273.

Volkov A. 2020. Methodological approaches to the study of socio-economic constraints on sustainable development of the Karelian Arctic region in modern conditions, in: E3S Web of Conferences. EDP Sciences, p. 05023.

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