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REGIONAL PROBLEMS
Integrated Development of Russia's Arctic Zone

Problems and Perspectives of Innovative Development of the Industrial System in Russian Arctic Regions

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Abstract—This article has studied the specific role of the northern regions of Russia in the processes of modernizing the economy, which is defined by the fact that their industrial system is aimed at the raw production sector, as well as at a large investment potential. We have shown several lines of improving the innovative policy determined based on expert assessments.

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INTRODUCTION

The development of the modern economy and sustainable economic growth is largely driven by the processes of innovation creation, which are inextricably connected with need to modernize the Russian economy.

We can assume that, under the conditions of intense competition on external markets, the development process of production enterprises primarily aimed at providing for a very high-capacity internal market of the country, which is in part based on import substitution, is the most successful. It is necessary to create conditions that ensure that the leading sectors (in Russia, resource sectors are currently leading) simultaneously play the role of cluster-forming links by creating orders and pulling the supporting sectors and enterprises (machinery, metallurgy, electronics, chemical plants, etc.). On one hand, the latter will be provided with some preferences as part of state programs; on the other hand, they will inevitably have to improve their technical level while competing with foreign manufacturers. This is exactly how we see the concept of re-industrialization of the Russian economy.

CHARACTERISTICS OF INNOVATIVE PROCESSES IN ARCTIC REGIONS

In the process of new industrialization, Arctic regions will reside in a specific place. In these regions, engineering and machinery plants will not be built because it is cost-ineffective due to increased expenditures in the specific conditions of economic management; however, the efficiency of the resource and raw production sector should grow due to the set of measures for improving the level of extraction and depth of raw material processing. The important thing is that, in the first phase of industrialization, extractive industries and corporations that possess powerful financial assets can and must be the strategic customers buying machinery and technologies from raw-material processing enterprises [1].

According to the data on Arctic subjects of the Russian Federation listed in Table 1, the regional structure of gross value added indicates a high non-uniformity of economy. Thus, by developing raw processing industries, Arkhangelsk oblast stands out, showing an even higher value than the average across the country. Speaking of the extractive industries, more than half of gross value added in the regions is produced in Nenets Autonomous Okrug and Yamalo-Nenets Autonomous Okrug. An indicator of investment activity is increased specific weight of the construction sector, which is characteristic of almost all regions except for Murmansk oblast. In Murmansk oblast, just like in Arkhangelsk oblast and Sakha (Yakutia) Republic, education is well-funded, which adds innovation capabilities to the investment factor.

For all regions of the Arctic zone of the Russian Federation (AZRF), an industrial model of economy is inherent, which is distinguished by a high level of specific weight of industrial production. In AZRF, large resource systems of the country are concentrated. The dynamics of industrial production indices is shown in Table 2. During the recent years, a number of AZRF regions have shown a decrease in the index and volume of production, which affects the economy growth rate in the country. Arctic regions account for almost 40% of the combined GDP production, 17% gross output of the industrial production, 33% of fixed

Table 1. Gross value added by types of economic activities in Arctic regions of the Russian Federation in 2013 (in current prices, as percentage of total)

Type of economic activity	Russian Federation	Murmansk oblast	Arkhangelsk oblast	Nenets Autonomous Okrug	Yamalo-Nenets Autonomous Okrug	Sakha (Yakutia) Republic	Chukotka Autonomous Okrug
Agriculture, hunting, and forestry	4.2	0.7	4.3	0.3	0.2	2.3	1.5
Fishing, fish farming	0.2	7.4	1.6	0.6	0	0	1.4
Mining	11.2	16.5	1.7	71.0	52.0	42.9	35.2
Manufacturing	17.3	13.3	19.3	0.3	1.2	2.0	0.2
Production and distribution of electric power, gas, and water	3.8	6.0	3.8	0.7	2.0	3.8	11.5
Construction	7.1	4.8	8.7	8.7	8.5	10.0	11.1
Wholesale and retail trade; repair of vehicles, motorcycles, household goods, and personal items	18.2	9.6	11.7	5.7	11.9	7.0	10.0
Hotels and restaurants	1.0	1.3	1.1	0.3	0.6	0.6	1.2
Transport and communications	10.4	8.6	17.5	5.6	9.5	10.6	4.8
Financial activity	0.6	0.2	0.3	0	0	0.3	0
Real estate operations, lease and services	11.9	8.3	7.5	2.5	8.1	4.4	1.1
State management and military security; social security	5.6	10.5	10.0	2.0	2.3	6.4	11.4
Education	3.1	3.9	4.3	0.9	1.3	4.4	4.2
Healthcare and social services	4.0	7.5	6.8	1.1	1.8	4.0	5.3
Municipal, social, and personal services	1.4	1.4	1.4	0.3	0.6	1.3	1.1

Source: [3].

Table 2. Industrial production index, percent of the previous year

Subject	2007	2008	2009	2010	2011	2012	2013	2014	2015 *
Arkhangelsk oblast	105.9	102.6	100.4	102.3	82.1	95.8	70.8	89.6	103.8
Murmansk oblast	100.2	98.2	94.4	104.0	98.7	98.6	97.8	99.8	107.0
Yamalo-Nenets Autonomous Okrug	95.2	99.4	92.5	107.3	102.0	97.8	97.5	100.0	103.4
Sakha (Yakutia) Republic	100.2	103.5	92.8	117.5	110.5	106.3	104.4	104.9	105.9
Chukotka Autonomous Okrug	88.8	177.4	114.6	93.8	93.6	98.3	134.2	138.5	88.0
AZRF	98.1	116.2	98.9	105.0	97.4	99.4	100.9	106.6	101.6
RF	**106.8**	**100.6**	**90.7**	**108.2**	**104.7**	**102.6**	**101.7**	**101.7**	**96.7**

Source: [4].
* October 2015, percent of the corresponding period of the previous year.

capital investments, and almost 60% of export of primary natural and fuel & power resources with the respective proportion of currency earnings [2].

As is shown in Table 2, there are regions in the Arctic zone, which surpass all of Russia by the growth rate of industrial production (Sakha Republic). However, Arctic territories in general show overall lower values. An exception is the crisis years of 2008 and 2009, during which they demonstrated high stability underpinned by the specifics of raw production markets.

The strategy of innovation-oriented development in the region is based on three conditions, i.e., the enhancement of strategical management and cluster development of engineering, scientific, and production potential, as well as the improvement of market mechanisms of financial and business operations. Arctic regions require elaboration of a clear innovative strategy of development aimed at the implementation of progressive engineering practices, the application of stimulation tools for the innovative advancement, and the formation of an efficient infrastructure using the latest communication and information technologies [5].

AZRF regions possess a significant innovation potential, which is not yet realized in practice. Its effective use implies focusing resources on maintaining a relatively high education level, developing a network of universities, academic institutions, and other state scientific organizations, and forming a new engineering framework. This should contribute to the creation of a system of knowledge generation, stimulation of business activities, and finally organizing production of globally competitive goods and services.

Official Russian statistics data indicate an insufficient level of innovative activities. Practically, for all values related to innovative activities and the adoption of novelties, Arctic regions generally fall behind the Russian Federation as a whole (Table 3). At the same time, in terms of the scientific potential, the values of Arctic regions surpass the average Russian level.

INDUSTRIAL ENTERPRISES AND CORPORATIONS

Table 4 shows the ratings of large resource companies with their enterprises and branches operating in Arctic regions of the Russian Federation. PAO Gazprom permanently holds the first place among 400 leading joint-stock companies in Russia. It should be noted that 2014 was a favorable year for resource companies, resulting in profits due to growth in the ruble value, among other things. In 2015, resource companies' products were in high demand, which had an impact on all values and specifically at the level of capitalization. The assessed valuation of PAO Gazprom corporation exceeds 55 billions of dollars (it decreased twice compared to the previous year's value) at the level of profitability above 25%. It should be noted that, according to the specific weight of organizations introducing engineering innovations, AZRF regions are quite close to the average values of the Russian Federation. In this context, it should be kept in mind that predominant extracting companies in the AZRF are usually part of the corresponding corporations (vertically-integrated systems), whose research and engineering centers are situated in the zones of better climatic conditions. Furthermore, they still provide the activity of their resource and raw production links. The main resource base of PAO Gazprom is situated in Yamalo-Nenets Autonomous Okrug. The corporation is the largest gas company in the world in both the volume of extraction and the size of gas reserves; high expenses are considered to be its setback, which in turn are driven by objective conditions of extraction and transportation of the products.

In the Kola Peninsula, PAO Gazprom interests are associated with the Stockman deposit, the development of which is viewed as the world's largest Arctic project in scale (Table 5). Its explored reserves amount to 3.7 trillion cubic meters, which covers almost the same volume of gas to be extracted as all Norwegian deposits taken together. However, the difficulties of its development driven by a high occurrence depth

Table 3. Basic values characterizing the level of innovative development in AZRF subjects in 2013

Value	Arkhangelsk oblast	Murmansk oblast	Yamalo-Nenets Autonomous Okrug	Republic Sakha (Yakutia)	Chukotka Autonomous Okrug	AZRF	RF
Proportion of organizations developing engineering innovations, %	5.4	13.5	5.1	7.9	25.0	11.4	10.1
Proportion of innovative goods, works, and services, %	28.9	0.8		2.9	1.7	8.6	9.2
Number of submitted patent applications per 10000 researchers	0.9	0.7	0.5	1.5	1.2	1.0	3.0
Patents issued per 10000 researchers	0.7	0.9	0.6	0.8	0.8	0.7	2.3
Proportion of personnel involved in research and development, percent of the total number of employed people	0.2	0.6	0.0	0.5	0.1	0.3	1.1
Number of employees with an advanced degree within the overall number of personnel involved in research and development, %	14.1	22.5	18.3	31.6	10.5	24.4	14.9

Source: [3].

Table 4. Industrial corporations of AZRF

Company	Company					Volume of sales in 2013, billion rubles	Increment rate, %
	2010	2011	2013	2014	2015		
PAO Gazprom	1	1	1	1	1	5477	6.5
OAO Novatek	12	8	5	24	20	358	12.1
PAO Severstal	10	13	17	16	24	319	6.3
MMC Norilsk Nickel	14	15	20	17	17	456	24.5
JSC PhosAgro	75	76	79	82	73	123	17.1

Source: [6].

(around 500 m) and remoteness from the shore (over 600 km) resulted in indefinitely postponing the signing of the investment agreement in 2012. Furthermore, from an innovation viewpoint, this project was exceptionally promising for both the corporation and Russia's industrial system, due to the upcoming large orders for the newest technologies and equipment, including for the development of other deposits of the Arctic shelf. A particular role in postponing the realization of the project was also played by the division of disputed gray zone at the end of 2011 where Norway obtained additional potential sources of natural gas extraction.

OAO Novatek is the largest independent natural gas producer that performs exploration, extraction, processing, and sales of natural gas and liquid hydrocarbons. This company represents one of the main participants in the Integrated Project for Developing the Production of Liquefied Natural Gas in Yamal Peninsula (Yamal LNG) approved by the Decree of October 11, 2010 of Russian government, no. 1713-r. The Yamal LNG project will be implemented on the modern engineering basis in three phases. At each phase, capacities of 5.5 million tons per year will be introduced with reaching the project output of 16.5 million tons of LNG by 2025. Then, depending on the environment in the external markets, another

Table 5. Assessment of opportunities and problems of innovative development of the Northern regional economy

Obstacle	Rating					Average rating
	1	2	3	4	5	
Absence of the need in collaboration for both parties, willing to do everything by themselves	2	3	9	6	5	3.36
Absence of information about potential opportunities of science and business interaction	3	4	6	8	5	3.31
Scientists having insufficient information about business demand for innovations	5	4	4	9	4	3.12
Unfamiliarity with forms and methods of cooperation	1	4	11	7	3	3.27
Low level of confidence in partners	3	3	5	6	14	3.81
Prohibitive cost of scientific developments for business	5	6	4	7	4	2.96
Low business demand for innovation	3	1	3	6	13	3.96
Insufficiently active position of the government regarding support of collaboration	1	3	4	7	12	3.96
Poor protection of ownership rights for innovative products	3	2	3	9	9	3.81
High risk	2	—	4	7	12	4.08

project will be implemented that was designed for the same output. It is characteristic that, under the conditions of western sanctions, OAO Novatek decided to build floating LNG plants (on platforms) that provide for full import substitution. For this purpose, Murmanskaya Verf enterprise will be created in the Kola Peninsula, and the first platform will be launched in 2019.

Thus, the gas extracting industry is secured with a resource and raw base for long-term prospects. The current industrial reserves will be developed at least until 2050, along with the explored reserves that evolved from the predicted resources. In the short-term prospects, deep horizons in the traditional areas of extraction will be developed, as well as reservoirs in isolated regions of Siberia and on the northern sea shelves. During the period until 2030, extended development of Yamal and Gidan will be implemented; then (until 2040s or 2050s), the Arctic, Far Eastern shelf, and Eastern Siberia provinces will be developed [7].

This edge will mark the transition to development of unconventional hydrocarbon sources, which currently include (a) gas-saturated low-permeability rocks of low gas recovery factor, (b) gas deposits in solid sand and shale formations as well as coal-bearing strata, (c) water-dissolved gas of the underground hydrosphere in developed provinces, and (d) solid gases (gas hydrates).

As a rule, preparation for the development of these sources represents a high-level engineering project, which is thus long and costly. For example, it took 20 years of exploration work (1960–1980) and at least 100 billion USD for the United States to arrange gas extraction from Devonian solid sandstones and coal beds. Another 20 years were spent on the development of shale formations to arrange the industrial-level extraction in 2005–2006, which, according to assessments, covered the country's demand for at least 15 years.

With regard to estimates by the International Energy Agency (IEA), natural gas is and will continue to be a resource of the highest demand for the next ten years. In Russia, a real goal has been set to achieve 900 billion cubic meters of gas production by 2020 and 1 trillion cubic meters by 2025. These volumes will allow one to achieve the defined targets of gas infrastructure development in the country and to increase gas exports by at least 1.5 times.

MMC Norilsk Nickel is the biggest corporation of the country that operates in the nonferrous-metals industry; its capital approaches 25 billion USD. Its main resource and production base is situated in in the Taimyr Peninsula and Murmansk oblast. The company represents the largest producer of nickel and palladium and the leading producer of platinum, copper, and cobalt. Besides, it produces gold, silver, radium, and some other metals. It has good research centers in St. Petersburg and Norilsk.

The regional industrial policy of the country is based on close production cooperation because the main extracting capacities are located in Krasnoyarsk Krai, and more than half of end products are made in Murmansk oblast. In the 1980s, this was the reason for transporting over 1 million tons of ore by the Northern Sea Route. The improvement of the engineering chain caused a reduction in sea cargo traffic by more than ten times.

In 2015, MMC Norilsk Nickel produced 285000 tons of nickel (4% growth compared to 2014); including: 219000 tons produced at Russian enterprises and 66000 tons produced at foreign sites. Copper production grew from 368000 up to 371000 tons (by 0.8%) [8].

Finally, the industry of phosphorus-containing fertilizers, the mineral and raw material base of which is situated in Kola Peninsula, is represented by the mining and chemical corporation, JSC PhosAgro, which sold its products amounting to 6 billion rubles in 2013. The assessed valuation of the company reached 4 billion USD at the level of profitability of around 23%. The raw material base of JSC PhosAgro comprises the world's largest deposits of apatite ores developed by AO Apatit being part of the corporation. The volume of ore extraction at the enterprise reaches almost 30 million tons, while it produces over 8 million tons of apatite concentrate. The enterprise's setback is high production expenses, including those caused by constant deterioration of extraction conditions and stiffened requirements for work safety.

Consequently, the regional industrial policy of AO Apatit is aimed at enhancing the technical equipment and flexibility of production lines, which increases the energy efficiency of production, the integrity of using apatite and nephelinic ores that result in products with increased added value. It is planned to develop technology for extracting rare-earth metals from the apatite concentrate in cooperation with the Prayon company (Belgium). The creation of the technology will take approximately four to five years, after which the apatite concentrate will become more desirable and expensive. In this context, it is necessary to bear in mind that Khibini ore contains around 40% of all reserves of rare-earth metals in Russia (over 10% of the world's reserves) [9].

In 2011, an engineering and construction center was created as part of JSC PhosAgro, Gorno-Khimicheckii Inzhiniring, in collaboration with the Samoilov Science and Research Institute for Fertilizers, which comprised a powerful engineering base of the company. One of the primary goals of the center is modernization of the Pikalev production complex, which will enable an increase in the capacities of aluminum oxide production by more than 1.5 times, i.e., from 250000 to 600000 tons [10].

If we talk about the mechanism of industrial innovation policy in territorial systems, the program- and goal-oriented approach is a single option due to the limitation of assets. This is most appropriate for developing and implementing of integrated regional programs, where a resource-effective set of economic, technical and production, scientific and research, and management measures is defined, in which many economic entities and regional authorities should participate.

EXPERT ASSESSMENTS FOR INNOVATIVE DEVELOPMENT

In order to make assessments and predict the innovative industrialization, we conducted an expert survey of the participants of "The North and the Arctic in the New Paradigm of Global Development" conference (2014), which was held in Apatity on April 12–14, 2014.[1]

A large group of questions were dedicated to the opportunities and problems of the innovative development of the regional economy. For example, it was suggested that obstacles in the way of mutually advantageous cooperation between science and business should be assigned with a rating (five points corresponds the largest obstacle). The ratings are shown in Table 5 where it can be seen that they are highly differentiated.

In Table 5, places 1–10 are intentionally not put in order so as to show that the difference between the ratings is in fact very small, and all of the obstacles were practically rated higher than the average of 3. The only obstacle rated lower than the average (2.96) is the "prohibitive cost of scientific developments for business," which is still quite high. The first three obstacles with the highest rating and a small gap between them are: "high risk," "low business demand for innovation," and "insufficiently active position of the government regarding collaboration support."

Concerning the question "In your opinion, what are the main external obstacles to innovative activities of industrial enterprises in Murmansk oblast?" (you can choose several answers), we received the following distribution of opinions.

Distribution of Expert Opinions on External Obstacles for Developing Innovative Activities

Answer	Rating
1. No serious external obstacles for innovation	2
2. Insufficient demand for innovative products	16
3. Long payback period for innovations	7
4. Difficulty of attracting funds for implementation of innovative projects	18
5. Low incidence of state co-financing of innovations	13
6. Insufficient and/or inadequate tax incentives for innovations	14
7. Limited volumes of state procurement of innovative products	5
8. Low predictability of state industrial and innovation policy	9

[1] The list of the participated professionals consists of seven doctors of science, sixteen candidates of science, and five employees without an advanced degree; five of them work at higher educational institutions, nineteen work at scientific organizations, two work in production, and two more are employees of governmental authorities [11].

Table 6. Ranking the factors of state support of innovations

Measure of support	Places (ranks) at the	
	federal level	regional level
Enhance the funding of science	1.8	3.2
Improve the general education system	3.7	1.6
Improve the training of technical specialists	2.3	2.8
Support businesses which develop scientific and engineering innovations	2.2	2.4

9. Insufficient stability of conditions for economic activities	8
10. Large bureaucratic barriers for innovations (certification, licensing, etc.)	10
11. High customs duties for imported equipment	4
12. Complexity and inadequacy of customs clearance processes	4
13. Adoption of new technologies will lead to formation (or enhancement) of the technological gap between partners in the production chain	–
14. Underdevelopment of innovation infrastructure (technology parks, technology transfer centers, etc.)	14

Here, we can point out two obvious leaders, i.e., the fourth (difficulty of attracting funds) and the second (same insufficient demand for innovative products) answer options. The following three external obstacles are also close to the top (options 6, 14, and 5), i.e., insufficient (inadequate) tax incentives for innovations, the underdevelopment of innovation infrastructure, and the low incidence of state cofinancing of innovations.

In this context, we can state with certainty that, regarding both questions (Tables 5, 6), we are not really talking only about innovations in Murmansk oblast. These problems are peculiar to all northern regions and, probably, for the entire country.

By the next question, we attempted to investigate if the experts consider that the Murmansk oblast's industrial system transitioning into predominantly innovative way of development possible. Only 43% specialists answered positively, 25% answered negatively, and the rest were unsure. As for the time frames of this transition, the majority of respondents who answered positively thought that the most likely year for the transition was after 2025. Furthermore, experts pointed out the main signs of innovative development, which were specific weight of produced innovative goods, the specific weight of organizations developing engineering innovations, and the number of issued patents.

As for the prospective value of these signs (indicators that characterize the transition into predominantly innovative dynamics), opinions were notably divided. Thus, as for the specific weight of innovative organizations, experts provided the following opinions (%):

Respondents	Specific weight
40	20
20	25
16	More than 25
12	10–15

Considering that, in 2013, this value was 7.9% for Murmansk oblast, the majority of experts state the need to increase increase it by two to three times. The most probable time of achieving this level is 2020 or later (80% respondents). The specific weight of innovative products produced in Murmansk oblast must grow even faster; 19% of respondents believe that the proportion of the produced innovative products should be 3%, while 33% believe that is should be 6%, 29% believe that it should be 9%, and 19% believe it should be more than 9%. Given that in 2013 this value was equal to 0.8%, tenfold growth is expected. In this case, 80% of experts defined a possible time frame for achieving this value that was beyond 2015.

In order to identify the critical lines of state support for innovative trends, we performed ranking based on the four factors provided in Table 6. The lowest rank (or place) corresponds to the highest significance. As is shown in Table 6, the most important measures of innovative policy at the federal level according to the experts are enhancing science funding and supporting business developing scientific and engineering innovations. As for the regional level, the need to pay more attention on the general education system has been pointed out.

CONCLUSIONS

Summarizing the data in this article, we can draw the following conclusions on the problems and opportunities of innovative development in the Arctic regions of the Russian Federation:

—Transitioning from the resource-export model of developing the economy to the innovation-resource model is the primary goal of the state policy while aiming at expanding the internal market.

—The need to accelerate technical and engineering transformations is driven by the sanction policy of the West. Import substitution, especially in the spheres of homeland security, is imperative.

—Resource and raw production industries of northern territories can become kind of a driving force of innovative development because they are in demand and possess financial potential.

The main problem of developing and increasing the efficiency of the industrial system of the North is highly dependent on imported equipment and technologies. However, it can decrease as early as in the next period with regard to a number of sets of mining and exploration equipment.

—Strategically, the industrial system of the northern regions will maintain the innovation demand using orders for high-tech materials and machines required to develop the Arctic shelf.

—The gas industry will be the most rapidly developing industry considering the provision for internal market and exports at a constant increase of LNG production based on the latest technologies and growth in the number of orders for domestic machinery building.

—According to expert estimate, the main problems of the innovative development of the North's industrial system with regard to management and economic tools are low business demand for innovation and insufficiently active position of the government regarding the support of collaboration between the participants of an innovation process.

—According to the experts, enhancing science funding is a prospective line of innovation state support at the federal level, and paying more attention to the general education system is a prospective line at the regional level. At both levels, the most important line is support of companies that implement scientific and engineering innovations.

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