The impact of innovative transformation of industry on the socio-economic development of the Russian Arctic

V Tsukerman¹, A Kozlov¹², E Goryachevskaya¹ and A Teslya²

¹ Federal Research Centre «Kola Science Centre of the Russian Academy of Sciences», Apatity, Russia
² Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia

tsuksman@iep.kolasc.net.ru

Abstract. The goal of the study was to analyze the impact that innovative transformation of industry has on the socio-economic development of the Russian Arctic and to formulate proposals for accelerating and enhancing innovative processes in the industrial sector of the country’s Northern territories. We have established that, given the internal and external threats, challenges, restrictions and sanctions of Western countries, innovations and R&D should be stimulated, as these activities, primarily connected to impact of industrial transformation on socio-economic development of the Arctic, are particularly important not only from a scientific but also from a practical standpoint. We have considered the external and internal challenges and restrictions that hinder innovative development in the Arctic. We have confirmed that while growth of industrial production in the Arctic is ahead of the average indicators in the Russian Federation, it is largely due to extensive factors connected to intensified development of natural resources, rather than to generating and implementing innovative technological projects and usage of information technologies. We have analyzed the potential to increase the number of organizations implementing technological innovations to 50% by 2024 (as established by the Decree of the President of the Russian Federation No. 204 of May 7, 2018), confirming that it would be difficult to achieve the target indicators without special policies and measures, given the current trends and rates of innovative development of the Arctic regions. Considering the integral estimate, we have found that the Arctic regions have low susceptibility to innovation. We have established that the financial capabilities of Arctic enterprises for generating and implementing innovative projects are limited. For example, only one of the thirteen enterprises studied is capable of technological innovation.

1. Introduction
Innovative transformation of industry, primarily connected to orientation to mineral resources, exerts a number of effects on socio-economic development of the Arctic Zone of the Russian Federation; this means that a whole range of problems have to be solved in the foreseeable future. Deteriorating situation in the global markets for raw materials, as well as external threats, challenges and sanctions of Western countries, both observed and forecast, should give impetus to intensified innovative industrial activities. There is really no viable alternative for the Arctic except the path of technological and innovative development.
In the current climate of limited budgetary resources, with external and internal restrictions imposed, fundamental research, which should ultimately be new, original and significant not only from a scientific but also from a practical standpoint, has to be carried out into strategic directions of science-driven innovative technological development in order to deal with the accumulated and newly emerging unsolved problems of socio-economic development of the Arctic.

While the Arctic is rich in natural resources, their exploration carries a few issues associated with objectively diverse strategic goals of socio-economic development, and with searching for ways to reconcile the conflicting interests of the state, regions and extracting enterprises.

The issues of establishing and maintaining territories of advanced socio-economic development in the Arctic are of crucial importance. Creating these territories, primarily in Arctic single-industry towns, is aimed at ensuring the region’s overall growth. In this regard, finding new promising mechanisms for reconciling the interests of industrial enterprises and local communities, with a view to improving socio-economic performance, has a high practical significance [1].

Escalating global competition, diversification of the structure of economy and resource consumption drive the engineering of fundamentally new approaches to industrial activity in the Arctic [2]. The industrial sector of the Arctic economy should be innovatively active, stable, dynamic and cost-effective in order to meet the modern challenges.

Studies into the mechanisms for achieving equally balanced socio-economic development of different industries and enterprises in order to facilitate transition to progressive industrial relations in the Arctic dictate that the state should adopt science-based decisions in implementing economic policies. Innovative development is a key factor for maintaining competitive advantages, securing labor resources and generating acceptable conditions for the livelihood of the population, including for the indigenous small-numbered peoples of the North. Important tasks are accumulating the technologies to support import substitution, ensuring sustainable development of specially formed spatial systems of various purposes and scales.

Innovative technological transformation of the Arctic requires, aside from huge resources, developing mechanisms for management by objectives with a view to making a transition to sustainable development, which involves increased socio-economic efficiency and security, shift to the 5th and 6th waves of innovation, as well as ensuring state interests in the system of international cooperation [3, 4]. Thus, our goal has been to study the impact that innovative transformation of industry has on the socio-economic development of the Russian Arctic and to formulate proposals for accelerating and enhancing innovative processes in the industrial sector of the country’s Northern territories.

2. Existing literature; analysis of specifics of innovative technological processes in the Arctic regions

Simon Kuznets considered the relationship between innovation and economic growth [5], discussing new methodological approaches within the framework of innovation theory that elaborated on Schumpeter’s and Bernal’s ideas [6, 7].

Major contributions to innovation theory have been made by such economic theorists as Twiss, Jaffe, Lerner, Stern, Giarratana, Torrisi and Pagano, Arora and Gambardella, who confirmed in principle that economic performance of developing countries could be improved through innovation, identifying the factors of economic growth [8, 9]. One of these factors, stimulating economic development through innovation, is special education, which plays a crucial role in creating and implementing technological security. Great attention is paid to training highly qualified specialists in all developed countries with an established high-tech sector of economy.

As a rule, industrial enterprises in the Arctic fulfill their planned targets (Fig. 1).
The pace of industrial production has been, over the past five years, ahead of the average indicators in the Russian Federation; however, this is largely due to extensive factors associated with expanded development of natural resources rather than to implementing innovative technological projects.

Notably, organizations such as the Federal Council on Problems of the North and the Far East under the Government of the Russian Federation, as well as the State Committee for the North, dating back to the USSR and aimed at enforcing state policies in the Arctic, have now been abolished. The State Commission for Development of the Arctic was established in March 2015. The commission included representatives of the President of the Russian Federation, ministers, governors and heads of the Arctic regions, representatives of large corporations and scientific organizations. The Ministry for Development of the Russian Far East was renamed to Ministry for Development of the Russian Far East and Arctic [10] on February 26, 2019.

There are some positive examples of implementation of programs promoting scientific, technical and innovative activities in the Arctic. For example, programs providing financial support in the form of grants and subsidies to innovative companies have been launched in the Murmansk Region; programs of regional grants of the Russian Foundation for Basic Research have been adopted.

The external challenges and restrictions hindering innovative development of the Arctic have been formulated and the main problems typical for innovative development of the Arctic industry have been highlighted [11–14]:
- ineffective development of innovative economy;
- imperfect legislative support and legal mechanisms;
- ineffective interaction within the framework of the system encompassing science, education and innovations;
- lack of innovative system in the region;
- lack of mechanisms for innovative development of regional business structures;
- lack of system for insuring investment and innovation risks;
- unresolved issues of public-private partnerships;
- poorly developed small and medium-sized innovative business;
- badly depreciated fixed assets in the industry;
- declining working population;
- education system virtually not oriented to real demands of the regional economy.
Overcoming external challenges and restrictions should make it possible for the Arctic regions to solve internal problems, take leading positions in the key areas of technology and to achieve high rates of economic growth taking into account efficient use of natural resources as the main competitive advantage.

The Decree of the President of the Russian Federation No. 204 of May 7, 2018 set the task of increasing the number of organizations implementing technological innovations up to 50% of their total number by 2024 [15]. The data on the number of organizations engaged in technological innovations are given in Table 1.

### Table 1. Share of organizations implementing technological innovations, % from the total number [16]

| Region                              | 2010 | 2013 | 2014 | 2015 | 2016 | 2017 |
|-------------------------------------|------|------|------|------|------|------|
| Murmansk Region                     | 5.1  | 9.0  | 8.4  | 7.8  | 7.3  | 6.8  |
| Nenets Autonomous Okrug            | 4.5  | 4.8  | 2.6  | 5.9  | 5.6  | 4.6  |
| Chukotka Autonomous Okrug          | 15.4 | 17.6 | 33.3 | 26.1 | 14.7 | 10.7 |
| Yamalo-Nenets Autonomous Okrug     | 7.7  | 6.2  | 11.2 | 7.7  | 9.2  | 7.0  |
| Russian Federation                 | 9.3  | 9.7  | 9.7  | 9.5  | 9.2  | 7.8  |

In recent years, the Arctic has exhibited a negative trend in terms of the number of organizations implementing technological innovations. Moreover, the volume of innovative products produced in the Arctic regions has decreased (Table 2).

### Table 2. Share of innovative products in total volume produced, % [16]

| Region                              | 2010 | 2013 | 2014 | 2015 | 2016 | 2017 |
|-------------------------------------|------|------|------|------|------|------|
| Murmansk Region                     | 0.4  | 0.3  | 2.4  | 1.6  | 1.1  | 0.9  |
| Nenets Autonomous Okrug            | -    | -    | -    | -    | 0.0  | 0.0  |
| Chukotka Autonomous Okrug          | 0.3  | 1.5  | -    | 0.1  | 0.7  | 1.0  |
| Yamalo-Nenets Autonomous Okrug     | 1.4  | -    | -    | 0.2  | 0.1  | 0.0  |
| Russian Federation                 | 4.9  | 8.9  | 8.2  | 7.9  | 8.4  | 6.7  |

The volume of innovative production of industrial enterprises in the Arctic is about 13 times behind similar indicators for Russian Federation.

### 3. Results

The regions have been assessed for their capability of implementing innovations, i.e., susceptibility to innovation, which is the ability to quickly and efficiently absorb, stimulate, create and introduce innovations.

Calculation of susceptibility to innovation was carried out with respect to two major aspects [17]:
- scale of innovative activity (share of organizations implementing technological innovations; relative share of innovative products).
- intensity of innovative activity (expenses on scientific research and technological innovations compared to investments in fixed assets).

We used the method of ordered estimate, taking into account the comparison between the regions fully located in the Arctic, to assess susceptibility to innovation. The levels were compared and ranked based on calculating normalized partial estimates for the data at the beginning and at the end of the analyzed period, using the formula:

$$P_y = \frac{X_y}{X_{\text{max}}}$$

where P is the normalized partial estimate of the indicator of an i\textsuperscript{th} region;
i is the index of a specific indicator; 

j is the index of a specific Arctic region; 

$X_{\text{min}}$ and $X_{\text{max}}$ are the minimum and maximum values of the $i^{th}$ indicator.

Integral estimate of susceptibility to innovation revealed that this parameter is low for the Arctic regions (Fig. 2).

![Figure 2. Integral estimate of susceptibility to innovation of Arctic regions](image)

The analysis carried out for the potential to increase the number of organizations implementing technological innovations up to 50% by 2024 established that target indicators can hardly be reached without introducing special policies and measures, given the current trends and rates of innovative development of the Arctic regions [18].

Innovative transformation of industry as a basis for socio-economic development of the Arctic can be characterized not only by use of modern knowledge and practical application of innovative technologies; it is also closely related to improving the educational system and organization of personnel training for various industries, primarily in the scientific and industrial fields. Unfortunately, there has been growing shortage of personnel for systemic modernization of the Arctic economy for all positions, concerning managers at all levels, engineering and technical staff, as well as skilled workers. This problem is getting particularly urgent in view of ongoing digitalization of the economy in general and industry in particular. Digitalization and penetration of information and communication technologies impose new, higher demands on digital competences of the personnel. However, there are numerous barriers hindering the development of digital skills, including those evolving at the stage when these skills are acquired throughout higher education.

Counting on inviting specialists from regions outside the North to reduce the shortage of qualified personnel would be unrealistic, as confirmed by many years of experience, especially for graduates of leading educational institutions in Moscow and St. Petersburg. In this regard, educational organizations of the Arctic regions are the basis for training highly qualified personnel. Due to new economic realities, a network of higher educational institutions and university branches are established in small towns of the Arctic, which is a positive trend (successful experience of the Northern subarctic countries is proof of this). Reduction in state-funded slots in institutions of secondary and higher education in the Arctic has radically distorted the structure of educational services offered for specialist training, with the majority of branches of educational organizations closing in small towns.
Specific problems of innovative industrial development in the context of Northern studies should be given priority in addressing issues of integrated management of the Arctic economy.

Based on the existing problems, the regional policy of the Arctic should include development of incentive schemes to stimulate the inflow of qualified personnel, especially young professionals. New forms of economic and social incentives should be devised for attracting specialists to work in the Arctic.

Experience in development of innovative technologies in Western countries has proved that innovative economy can only function through comprehensive and effective reform of the scientific and technological sphere. The scenario where vigorous innovations stimulate the Arctic’s socio-economic growth is only possible by increasing innovative activity at all levels, since the indicators of innovative development are currently below the world average [19, 20].

Financing research and innovation is the main problem of innovative transformation of the Arctic regions. Assessment to determine the financial resources necessary for developing and implementing innovative projects was conducted for thirteen largest Arctic enterprises oriented towards minerals and raw materials. The assessment was performed by the method suggested by Gracheva and Anisimov [21]. As a result, it was found that only the Kola Mining and Metallurgical Company is capable of implementing innovative projects. The remaining twelve enterprises are characterized by a solvency crisis and, accordingly, it is unrealistic for them to plan innovative industrial development [22].

4. Conclusions
We have analyzed the key problems hindering innovative development of the Arctic regions, including imperfect transport and regional systems, extreme climatic conditions, inefficient social infrastructure, Western sanctions, shortage of necessary investments, low innovative activity and low competitiveness of organizations, insufficient state policy for import substitution. Substantial funds should be spent on production and on sustaining the livelihood of the population to solve these problems. Increased production of mineral resources, rather than innovative development of territories, remains the main driver of the Arctic’s economic growth. Despite the existing scientific and technological potential, development of the Russian Arctic regions lags far behind the level of other Circumpolar countries.

We have considered the main factors of innovative development of the Arctic regions in terms of innovative activity and its efficiency, susceptibility to innovation, financial capabilities of industrial enterprises related to impact of innovative transformation on the socio-economic development of the Russian Arctic.

We have analyzed the potential for increasing the number of organizations implementing technological innovations to 50% by 2024 (as established by the Decree of the President of the Russian Federation No. 204 of May 7, 2018). We have confirmed that given the existing trends and rates of innovative development of the Arctic regions it is unrealistic to achieve the approved targets without special policies and measures. The priority task is developing and implementing a set of measures related to stimulating technological activity of companies providing innovative products and services.

The mechanism for state regulation of innovative development in the Arctic should be based on economic forms and methods, used by government bodies to influence innovative enterprises, combining federal and regional levels. Additionally, government regulation should be aimed at improving socio-economic development through innovative transformations of production and business operations and cover the following directions:
- general support for stimulating innovative processes;
- improving financial support for research and innovation in industry;
- improving innovation-based diversification of business processes of enterprises;
- establishing, maintaining and improving innovative infrastructure.

Considering the foreign experience in state regulation of innovative development in the Arctic, we can conclude that the leading positions in technological and innovative development are taken by the countries that have managed to ensure high rates of economic development and improve the quality of life of the population through effectively using attracted resources and their own scientific and technological potential.

The experience of the Nordic countries indicates that Northern and Arctic territories hold great potential in the post-industrial era. Although these countries are very similar to Northern regions of Russia by their geographical, climatic, and demographic indicators, they are far ahead in terms of development.

We have established that innovative development of the Arctic regions should be aimed at enhancing the role and importance of education, industry and science.

References
[1] Gutman S et al 2018 31st International-Business-Information-Management-Association Conference Innovation management and education excellence through vision 2019 IV-VI p 3014
[2] Govorova N V et al 2018 Contemporary Europe-Sovremennaya Evropa B 1 156
[3] Martynova M Y et al 2018 International Journal of Civil Engineering and Technology 9-9 p 1992-2001
[4] Didenko N I et al 2018 International Conference on Information Networking January-April p 626-631
[5] Kuznets S 2005 Economic Growth of Nations: Total Output and Production Structure (Moscow: Modern economics and law) p 352
[6] Schumpeter Y A 1982 Theory of economic development: (The study of entrepreneurial profits, capital, credit, interest and business cycle (Moscow: Progress) p 400
[7] Bernal D 1956 Science in the history of society (Moscow: Foreign Literature) p 735
[8] Penman S H and Penman S H 2014 Financial statement analysis and security valuation (New York: McGraw-Hill) p 784
[9] Tan W and Tsai Y 2010 After the Ice Melts: Conflict Resolution and the International Scramble for Natural Resources in the Arctic Circle Journal of Politics and Law B 3-1 p 91
[10] Presidential Decree N 78 of February 26, 2019 "On Improving Government Governance in the Development of the Arctic Zone of the Russian Federation” Available from: http://www.consultant.ru/document/cons_doc_LAW_318976/ [Accessed 20th January 2019]
[11] Komkov N I and Kulakin G K 2018 Studies on Russian Economic Development 29-5 p. 558-572
[12] Komkov N I et al 2017 Studies on Russian Economic Development B 28-1 p 31
[13] Zharov V S 2017 North and the Market: the formation of Economic Order 3 p 68-77
[14] Zharov V S and Zharov N V 2018 Proc. of the 2018 IEEE Managing the development of large-scale systems (MLSD’2018). Eleventh int. conf. 1 - 3 Oct. 2018 (Moscow: IPU RAS) p 1-3
[15] Presidential Decree of May 7 2018 No. 204 “On the national goals and strategic objectives of the development of the Russian Federation for the period up to 2024” Available from: http://kremlin.ru/acts/bank/43027 [Accessed 25th January 2019]
[16] Regions of Russia. Socio-economic indicators 2018 (Moscow: Rosstat) p 1162
[17] Grodskaya G N 2008 Innovative competitiveness of the region: assessment and development concept (Samara: Ed. Samara State. University of Economics) p 163
[18] Ivanter V V et al 2016 Arctic space of Russia in the XXI century: development factors, management organization (SPb.: Publishing House “Science”) p 1016
[19] Ivanter V V et al 2016 Studies on Russian Economic Development 27-5 p 485-494
[20] Komkov N I et al 2017 Studies on Russian Economic Development B 1 (28) p 31
[21] Gracheva N L and Anisimov A Yu 2009 Economic analysis: theory and practice B 10 p 39
[22] Tsukerman V A et al 2017 Proceedings of the 2017 International Conference "Quality Management, Transport and Information Security, Information Technologies" (St. Petersburg. Publ. Saint Petersburg Electrotechnical University “LETI”) p 593