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To cite this article: Z A Vasilyeva *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **734** 012041

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Potential for development of innovative processes in the high-tech sector of the region's economy

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Abstract. The development prospects of innovative processes in the economy of the region, characterized by technological diversity and diversified specialization, are considered. The development areas were prioritized on the basis of the need to develop high-tech and knowledge-intensive sectors of the economy, which are the locomotives of growth for basic and infrastructural ones. Assessment of strategic opportunities was based on an analysis of the development trends of world commodity markets, taking into account the potential of the region and the competitive positions of industries. The development of world markets was considered in the aspect of “global challenges” and national trends in two types of challenges, which determined the possibilities for their development and impact on national and local markets. At the same time, the emergence of new conditions for the development of commodity markets, which must be taken into account in the evaluation processes. The phasing of the study is determined. The prospects for the development of a high-tech sector of the economy in the field of high production redistribution in the context of traditional and new markets are presented. A positioning map has been compiled and the transition from local (niche) competitiveness to international. Potential elements of the region’s scientific and technical system in the form of R&D, production and consumption centers that accompany the process of technological development along the entire life cycle are identified.

1. Introduction

For a long time, studies have been conducted with varying degrees of intensity to search for non-resource-based growth opportunities in the economy of regions where there is a resource potential for innovative development that can create high-tech products [1-2].

In the Krasnoyarsk Territory, the manufacturing sector, which has high-tech and high-tech industries in its structure, occupies a share of 31.4% in the gross regional product, while the high-tech and high-tech industries themselves account for 13.6% of the region’s GRP, having decreased by 18.6 since 2013 % This situation determined the average-strong level of the region in the ranking according to the conditions and results of innovative development, noted in the National report "High-tech business in the regions of Russia" [3]. In 2016, the region held the 11-th position of a “strong innovator” (table 1).

Table 1. ating of the Krasnoyarsk Territory for 2014-2018 [6].

Year	Rank	Score indicator	% of average	Rating position change	Group
2018	20	0.48	122.6	-4	Medium Strong



					Innovators
2017	16	0.50	130.6	-5	Medium Strong Innovators
2016	11	0.54	141.6	8	Strong Innovators
2015	19	0.45	119.3	-1	Medium Strong Innovators
2014	18	0.45	120.5	5	Medium Strong Innovators

A more detailed analysis of the situation on individual components of the innovation rating of the regions indicates a decrease in the positions of the Krasnoyarsk Territory in all areas:

- the level of research and development decreased by 12 percentage points;
- the greatest decline is noted in the sub-rating “Innovative activity of organizations” - by 16 percentage points;
- the situation on the socio-economic conditions of innovation has worsened by 10 percentage points;
- the innovative activity of the region decreased by 5 percentage points.

At the same time, the dynamics of the gross revenue received by the region from the high-tech and high-tech sectors was positive. Significant growth rates in the region’s GRP accounted for the activities of air and space transport (+ 291%), activities in the field of information technology (+ 112%), research and development (+ 72%), related to the high-tech sector.

Domestic research and development costs have increased 2.3 times since 2010. Per one researcher, this is 2.23 million rubles. in 2017. The bulk of funding was provided by budgets of all levels (83.4%) - an increase from 2010 also by 2.2 times. At the same time, own funds of organizations were invested (7%) - a 3.3-fold increase. The business sector has intensified. Its investments in the structure of domestic costs amounted to 4.66%, and growth since 2010 - by 1.9 times.

The potential of organizations performing research and development has grown - by 27.8%. Since 2010, the number of educational organizations and industrial production organizations involved in research and development has increased 1.8 times. The number of personnel in this sector of the economy increased by 11.7%. This mainly affected private companies (23.6%) and non-profit organizations (20%). At the same time, the number of people employed in the public sector decreased by 12.4% and amounted to 1,758 in 2017.

An analysis of the positions of the Krasnoyarsk Territory in the innovation rating indicates the need to increase the level of research and development that is correlated with the innovative activities of organizations. In this regard, the statistics shown in Table 2 are indicative, which characterizes the process of technological development, focused mainly on existing technologies, and the acquisition of new machinery and equipment to replace retired (48.7%). The acquisition of rights to patents and licenses is also extremely low (1.3%) and five times lower than in the Russian Federation.

Problems in the quality and dynamics of innovative development of the region determined the purpose of this work, which is to identify those areas of technological development that will allow the manufacturing sector, high-tech and high-tech industries to take a leading position in the development of the region.

Table 2. The proportion of organizations engaged in certain types of innovation, in the total number of organizations engaged in technological innovation, %.

Region	The share of organizations (industrial production, services; agriculture; construction) carrying out									
	R&D	design	purchase of machinery and equipment	acquisition of new technologies	acquisition of rights to patents, licenses	software acquisition	engineering	staff training	marketing services	other new researches
	2017									
RF	39.5	6.7	53.9	8.7	5.6	27.1	16.0	15.2	4.3	13.6

SFR	32.8	7.7	52.4	8.5	5.1	27.3	19.6	12.8	4.3	18.2
Krasnoyarsk Region	32.9	6.6	48.7	6.6	1.3	36.8	18.4	11.8	2.6	145
2016										
Krasnoyarsk Region	34.7	2.8	45.8	4.2	-	36.1	16.7	12.5	-	12.5

2. Research description

The object of the study was the statistical indicators of the manufacturing sector of the economy of the region and its high-tech and high-tech industries, which are represented mainly by large and medium-sized enterprises of the Krasnoyarsk Territory, mainly located in the regions of the Krasnoyarsk agglomeration.

The information base of the analysis was the statistical materials of Kraistat, EMISS and SPARK Interfax, strategic documents on the scientific, technological and innovative development of industries and regions, scientific publications on this topic.

The research methodology is based on the systemic, strategic and network approaches proposed by Russian and foreign scientists, as well as the results of the authors' project work in the direction of the development of technological update processes in the regional economy.

The search for the problems of innovative development of high-tech and knowledge-intensive sectors of the economy was based on the criteria for choosing the directions of technological development and was carried out in the context of three main tasks (table 3).

Table 3. Stages of researching the priorities of the region technological development.

Stage	Result	Criteria of choice
Stage 1. Assessment of the ability of technologies to withstand the "global challenges" of the global economy and meet global trends in technological development	A list of priority technologies that can ensure the development of traditional sectors of the economy (resource and raw materials, infrastructure) and accelerate the formation of new sectors (high-tech, knowledge economy), taking into account the variety of technological solutions (materials, technologies, management systems) used in the production chain	- Compliance with the priorities of the technological development of the Russian Federation and global trends (digitalization, material revolution, etc.) - Ability to withstand global challenges
Stage 2. Assessment of the possibility of transition to a new technological structure, the formation and development of new markets	- Grouping of technologies in the sectors of the region's economy in accordance with technological development scenarios (Niche Leadership Strategy, Local Technological Competitiveness Strategy, International Technological Competitiveness Strategy) - Determining the potential for the development, production and use of priority technologies in the economy of the region based on the identification of existing elements of a scientific and technological system, production centers and consumption centers for technological products (materials, technologies, control systems)	- The ability of technology to shape and develop new markets - Obtaining results that have significant scientific novelty, ensuring the transition of the regional economy to a new technological structure
Stage 3. Assessment of the potential for the development and implementation of priority technologies in the region (by scenario; by sector of	Information on potential ways to develop priority technologies	Conformity of potential regarding production centers, consumption centers (markets), R&D centers (life cycle management)

Stage	Result	Criteria of choice
economy)		

This methodology made it possible, using approaches and tools of multisectoral economic development, “smart specialization” and spatial management, to determine the prospects for the development of high-tech and knowledge-intensive sectors of the region’s economy [4-6]. The article presents options for positioning technologies for the development of the “knowledge economy” sector in the space of strategic alternatives (table 4).

Table 4. Technology positioning for the development of the “knowledge economy” sector in the space of strategic alternatives.

Promising technologies by fields of activity and market potential	
Traditional markets	New markets
I. Sources of new knowledge - Creating your own maternal technology and innovative professional competencies	
<p>Local technological competitiveness</p> <p>Designing “smart” machines equipped with control and management tools; Production and efficient use of energy biomass; Ensuring the safety of power plants and maintaining an efficient fuel cycle; Accumulation of electric and thermal energy; Production, storage and use of hydrogen; Transportation of fuel and energy over long distances</p>	<p>International technological competitiveness</p> <p>Development of geographic information systems for city life management (monitoring and infrastructure management); Optimization of processes with “flexible” behavior based on digitalization and intellectualization of various systems management (for example: transport, traffic, resource efficiency of engineering infrastructures, buildings (“energy-efficient house” and “energy-efficient city” (SMART GRID))); Creation of multimodal transport and logistics systems of freight and passenger transportation; Development of space, aviation and suborbital systems; The development of drugs, methods of treatment and health promotion and the development of human physical abilities based on the processes of bioinformatics, genomics, proteomics, nanobioprocesses</p>
II. Sources of new knowledge - Import of technology and professional competencies	
<p>Niche leadership</p> <p>Industrial automation and control of production processes (robots); Development of electronic components for power and low-current electronics for use in intelligent energy systems, including for energy conservation</p>	<p>Niche leadership</p> <p>Intelligent systems for monitoring, diagnostics and automatic control of energy systems of enterprises based on sensor networks and smart sensors; Video surveillance to ensure public safety; Distance education (open on-line courses; electronic educational resources)</p>

The prerequisites for the development of the “knowledge economy” sector in the Krasnoyarsk Territory are the ongoing urbanization processes in the region and the prevailing extremely difficult situation in the field of transport and energy logistics, the rapid rise in the cost of operation and the limited means to maintain the safety of systems with high wear indicators (for example, power grids and water supply systems) .

The technological basis of the “knowledge economy” is computing power (system intelligence), wireless means of transmitting data and control signals, dynamic electronic models and simulators. That is, one of the priorities for the development of the region’s economy is the development of “SMART - technologies” [6].

The potential for the development, production and use of priority technologies in the high-tech and knowledge-intensive segments of the region’s economy for use in basic and infrastructural directions was determined based on the identification of existing elements of the scientific and technological system in the form of R&D centers (they combine the potential of research, innovation and technological structures and structures for building competencies), production (combine manufacturers

of intermediate and final products, involved in value-added cycle) and consumption (industrial consumers include groups forming the demand for innovative products) (table 5).

Table 5. The potential of the region's innovation and technology system for implementing technological development strategies.

R&D, production and consumption centers that determine the potential for technological development	
Traditional markets	New markets
<p>Local technological competitiveness</p> <p>Production Centers:</p> <ul style="list-style-type: none"> - industrial enterprises - subjects of national production technological chains; - medium and small innovative technological enterprises - subjects of the high-tech sector of the economy <p>Consumption centers (existing markets):</p> <ul style="list-style-type: none"> - enterprises in existing markets that produce new products of a new generation through the use of technological innovations, increase production efficiency <p>R&D centers:</p> <ul style="list-style-type: none"> - R&D centers (scientific research institutes of the Russian Academy of Sciences, industrial research institutes, SAE SFU) - Industrial R&D (corporate engineering and research centers); - Industrial and technological consortia (design and research organizations); - Technology transfer centers (service and design organizations focused on technology exports); - Financing centers (RTP, NTP, NTD); - Centers for innovation infrastructure (design centers, nanotechnology centers, industrial parks: Zheleznogorsk, p. Podgornoye, KRITBI) - Centers of professional competencies (universities of the Krasnoyarsk Territory, Siberian Federal District, and the Russian Federation) 	<p>International technological competitiveness</p> <p>Production Centers:</p> <ul style="list-style-type: none"> - medium and small innovative technological enterprises - subjects of the high-tech sector of the economy <p>Consumption centers (new markets):</p> <ul style="list-style-type: none"> - Enterprises in the markets of promising technology (ICT, biotechnology, nanotechnology), manufacturers of innovative products; - foreign companies (export); - population
<p>Niche leadership</p> <p>Production Centers:</p> <ul style="list-style-type: none"> - FPG extractive industries; - Large companies - subjects of national programs for the production of high-tech products <p>Consumption centers (existing markets):</p> <ul style="list-style-type: none"> - The state, industrial consumers of the Krasnoyarsk Territory, the Russian Federation; - foreign companies (export); - population <p>R&D centers:</p> <ul style="list-style-type: none"> - Industrial R&D (corporate engineering and research centers); - Technology transfer centers (service and design organizations focused on technology imports); - Financing centers (RTP, NTP, NTD); - Centers of innovative production (PIR 2. GK); - Centers of professional competencies (foreign research laboratories, universities, business schools, the largest industrial universities of the Russian Federation, Krasnoyarsk Territory) 	<p>Niche leadership</p> <p>Production Centers:</p> <ul style="list-style-type: none"> - Large companies - subjects of national programs for the production of high-tech products; <p>Consumption centers (new markets):</p> <ul style="list-style-type: none"> - enterprises in the segments of the region's innovative economy that produce new products based on a new technological platform

3. Conclusion

Based on the results of the study, a circle of potential business representatives of the Krasnoyarsk Territory was identified that could influence the development of innovative processes in the high-tech sector of the region's economy and the development of production of high-value products, including through the formation of cluster systems (table 6).

Table 6. Potential participants for the formation of cluster systems in the high-tech sector of the economy of the Krasnoyarsk Territory until 2035

Priority technology	Production centers	Consumption centers
2.1. Production of mixed uranium-plutonium oxide fuel or MOX fuel	FSUE FYAO "MCC"	Production of fuel assemblies for fuel supply of BN-800 NPP
2.2. Reprocessing and storage of spent	FSUE FYAO "MCC", LLC "SIET"	Countries developing nuclear

Priority technology	Production centers	Consumption centers
nuclear fuel based on nanostructured separation systems		energy, but not their own SNF management structure
2.3. Technologies for a phased transition to a new technological platform based on fast neutron reactors and a closed fuel cycle	FSUE FYAO "MCC", LLC "SIET"	Countries developing nuclear energy, but not their own SNF management structure
2.4. Technologies for managing genetic resources of agricultural plants, animals and microorganisms	LLC Orgtekhstrom, LLC PIK, LLC SIBAGRO, SPK Solontsy, LLC Educational-experimental farm Minderlinskoye, LLC APK Ustyansky, ZAO Agro-industrial holding Agroyarsk, LLC NPK BioSib, LLC Emelyanovskoe	Livestock farms of the Krasnoyarsk Territory
2.5. Organic waste processing technologies, production of organic fertilizers	LLC Orgtekhstrom, LLC PIK, LLC SIBAGRO, SPK Solontsy, LLC Educational-experimental farm Minderlinskoye, LLC APK Ustyansky, ZAO Agro-industrial holding Agroyarsk, LLC NPK BioSib, LLC Emelyanovskoye, LLC Energorezerv	Livestock farms of the Krasnoyarsk Territory; production of organic fertilizers (Berezovsky, Emelyanovsky, Shushensky, Nazarovsky, Mansky districts)
2.6. Development of integrated technologies for the utilization and dehydration of tailings for the processing of non-ferrous and precious metal ores processing of secondary raw materials based on electric steelmaking technologies as part of the development of mini-factories	FGAOU VO SFU: Institute of Mining, Geology and Geotechnology, LLC Tekhnoros, LLC Gorevsky GOK, GK Prognoz	Enterprises of the heat and power complex of the Krasnoyarsk Territory

Further research should focus on:

1. Assessment of the potential development opportunities of the basic high-tech and knowledge-intensive sectors of the region's economy and the formation of cluster systems;
2. Definition and assessment of the necessary conditions for the formation of cluster systems, taking into account the positioning of the regional economy in the international system of division of labor;
3. Development of a matrix for positioning potential cluster systems in the region, taking into account the resource, scientific, technical and human potential;
4. Formation of mechanisms for managing technological development (organization, coordination, support) of the regional economy (roadmap for action) of the Government of the Krasnoyarsk Territory;
5. Modeling the system of regional innovation infrastructure and the process of managing communication services of innovative activity of business entities;
6. Assessment of the potential of small and medium-sized innovative businesses in the production and technological chain of clusters;
7. Modeling the structure of the region's economy under the influence of technological development.

The conducted studies require improvement of the statistical reporting of enterprises. The approaches proposed in the article are developed in accordance with the needs of regional authorities and development institutions in the territories and are presented in a generalized form. However, the authors are open to discussion of methodological issues.

Acknowledgments

The project «Formation of mechanisms for selection and support of competitive high-tech businesses for structural changes in the economic system of the resource region and promotion in the world commodity markets» was funded by Krasnoyarsk Regional Fund of Science.

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