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Technological development and patent activity in the Russian energy sector

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Abstract. The material provides an analysis of the number of organizations developing/using advanced production technologies, as well as the number of advanced production technologies developed and used in energy sector. The article concludes with data on the effects (or lack thereof) of the introduction of advanced production technologies by enterprises (statistical observation participants) and the obstacles to the successful implementation of advanced production technologies.

1. Introduction

Currently, the industry has implemented the division into three «branches»: generation, distribution, distribution; thus, along with naturally-monopoly activities (transmission of electricity, operations and dispatch control), there are potentially competitive spheres in it (electricity generation, distribution, repair and maintenance).

The key indicators for the energy sector are: electricity production and consumption; production by type of power plant; electricity consumption by consumer category (wholesale / retail, natural / legal persons, etc.)

The assumption is that the analysis of industry indicators will be based on all-Russian classification of types of economic activity; in this case it is 35.Provision of electrical energy, gas and steam; air conditioning. Not all forms of statistical reporting present a subdivision of different activities, therefore, with the necessary assumptions, the estimation will be based on the statistics for this code consolidated.

2. Materials and methods

The study is based on data from 2017 to 2020, including use of statistical data studies in the field of energy sector. In the preparation of the material an author used methods of analysis, comparison, conclusion, generalization.

Much of the information needed for analysis by Russian classification of types of economic activity can be obtained from statistical forms (aggregated and submitted by Federal State Statistics Service): N1-license «Information on commercial exchange of technologies...», N4-innovation «Information on



innovation activity of the organization»; N1-technology «Information on development and (or) use of advanced production technologies».

3. Results

The number of organizations developing advanced production technologies increased by 32 per cent in the energy sector during the period under review, which is only 2 per cent higher than the growth rate for the industry as a whole.

According to the statistics provided, organizations develop advanced production technologies with or without patented inventions; while in the Russian Federation the participation rate of patented inventions increased by only 13 per cent in the various branches of the economy, it increased by 125 per cent in the energy sector. It should be noted, however, that the sheer number of such technologies is very small (4, 9 organizations in 2017-19 and 2020).

Of particular note is the indicator of patent activity, i.e. the share of patenting technology organizations in the total number of organizations involved in their development: in 2017, the share in the energy sector was 16 per cent, while for all branches of the Russian economy it was 32 per cent; In 2020, the energy index was almost equal to the industry average of 27 per cent and 28 per cent respectively.

The share of technology patents in the economy as a whole was about 30 per cent, in the energy sector about 17 per cent and only in 2020 showed a tendency to increase to the average sectoral levels (figure 1). In 2020, the indicators for the industry and for the economy as a whole were equal.

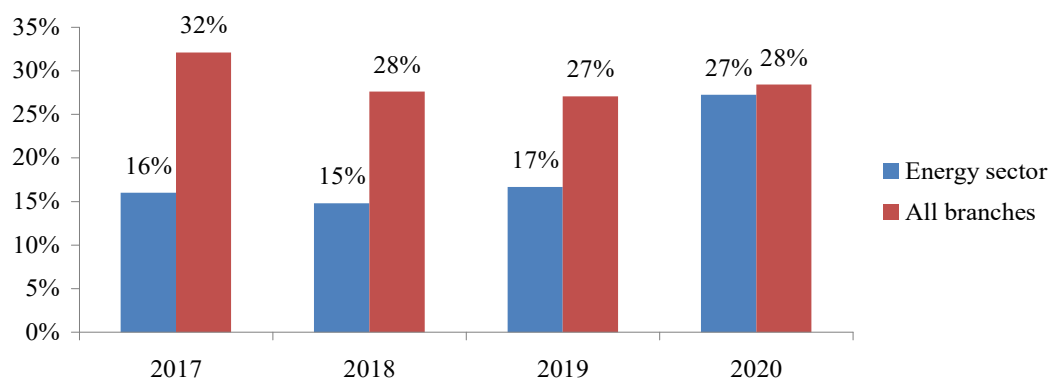


Figure 1. Level of patent coverage (patent activity) of organizations developing advanced production technologies, in general, by branches of the Russian economy / in the energy sector, %, 2017-2020.

Of the technologies developed, only a small number had fundamentally new characteristics for the Russian Federation. Thus, in 2017, there were 11.5 organizations developing fundamentally new technologies per one organization developing new technologies for the Russian Federation; in 2018 - 26, in 2019 - 0, in 2020 - 7.5. The distribution of organizations by category of development of innovative technologies is presented in table 1.

Thus, in 2020 not only has the number of development organizations increased, but also the diversification of technologies into categories, which is likely to contribute to realization of «target» directions, development of projects on technological specialization, clustering etc.

In contrast, the number of organizations using advanced production technologies declined by 36 p.p. in the energy sector, while the decline was only 4.4 per cent for all sectors of the Russian economy.

Table 1. Number of organizations developing advanced production technologies in the energy sector by type (new), 2017-2020.

Organizations developing different categories of innovative technologies	2017	2018	2019	2020
Total	2	1	-	4
4004 - Geographic Information Systems (GIS)			-	2
5001 - Enterprise Resource Planning (ERP)			-	1
6001 - Big data technology			-	1
500 - Communications and Management		1		
501 - Programmable Logic Controllers		1		
Separate equipment (machinery) (HQ/HSC/CN) (2.01)	1			
Enterprise LAN (5.03)	1			

Furthermore, while the decline in the number of organizations using patented inventions in the Russian Federation as a whole was 11.3 per cent for branches of the economy, 56 per cent for the energy sector.

Patent coverage also declined during the period under review, by 1 per cent for the energy sector (compared to 0.2 per cent for the Russian Federation as a whole).

Table 2. Number of organizations using advanced production technologies, 2017-2020.

Title	2017	2018	2019	2020
Number of organizations using advanced production technologies				
- total by industry	21909	23744	20935	20935
- by sector of energy	3523	3837	2249	2249
Number of organizations using proprietary advanced production technologies				
- total by industry	662	592	564	587
- by sector of energy	110	52	36	48
Level of patent coverage (patent activity)				
- total by industry	3,0%	2,5%	2,7%	2,8%
- by sector of energy	3,1%	1,4%	1,6%	2,1%

In this context, the following comparisons are interesting:

- The number of organizations using advanced production technologies for the Russian Federation as a whole was higher than the number of organizations developing advanced production technologies by 28 in 2020, 29 in 2019, 38 in 2018, 37 in 2017;
- The number of organizations using advanced production technologies in the energy industry was larger than the number of organizations developing it, by 68 in 2020, 94 in 2019, 142 in 2018, 141 - 2017. Thus, in the energy sector the degree of «concentration» Technology developers have proved to be much larger than the industry as a whole.

Further:

- The number of organizations using advanced production technologies «with participation» of patents, in general, by industry was greater than the number of organizations developing them, by 3 in 2020, by 3 in 2019, by 3 in 2018, by 4 in 2017;

- For similar organizations in the energy industry exceeds - 5 in 2020, 9 in 2019, 13 in 2018, 28 - 2017.

And finally:

- The level of patent activity (the share of organizations using patented PTT) was higher for the industry as a whole than the share of organizations developing such advanced production technologies), by 26 per cent in 2020, 24 per cent in 2019, 25 per cent in 2018, 29 per cent in 2017;
- In the energy sector, the share of organizations using patented advanced production technologies was higher than the share of organizations developing them, by 25% in 2020, 15% in 2019, 13% in 2018, 13% in 2017.

The latter indicator and its evolution are highly visible in the area of technology patenting in the energy sector (figure 2). There is a significant gap in the coverage of patents by advanced production technologies -using organizations: the level of innovation culture in the industry is well below the industry average, which may be due to the reasons identified above (high degree of monopolization, long payback periods for the introduction of innovative technologies, etc.)

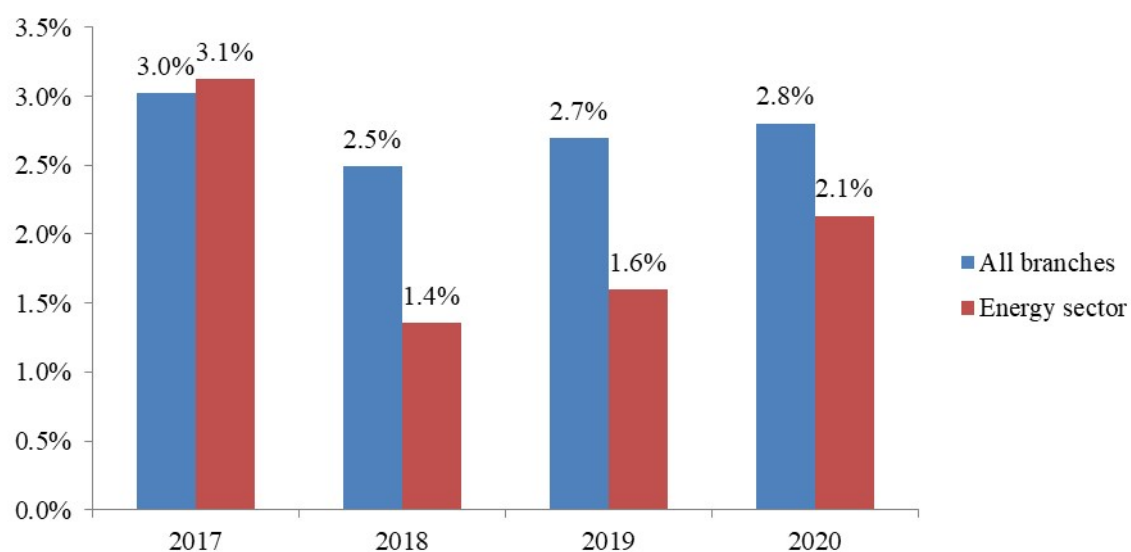


Figure 2. Patent coverage rate (patent activity) of organizations using advanced production technologies, %, 2017-2020.

Only a small number of technologies implemented in the production process had fundamentally new characteristics for the Russian Federation: thus, in 2017, one organization using new technologies for the Russian Federation accounted for 14.5 organizations developing fundamentally new technologies; in 2018 - 33, in 2019 - no data, in 2020 - 10.8.

Thus, in 2020 not only did the number of organizations using advanced production technologies increase (by 28, or by 90%) but also the diversification of technologies by categories, which confirms the above-formed conclusion on the creation of conditions for the «target» technology transfer in the energy sector.

The number of advanced production technologies developed in the energy sector during the period under review increased by 28, or by 90 per cent, while in all branches of the Russian economy growth was 587 units or 41 per cent (table 3).

Furthermore, the growth rate of the number of advanced production technologies developed with patented inventions increased by 34 per cent, or 7 per cent, for the Russian Federation's entire economy, while the growth rate for the energy sector increased by 8 per cent, or 160 per cent.

Patent coverage fell by 9 per cent per branch of the economy during the period under review, but increased by 6 per cent in the energy sector.

Table 3. Number of advanced production technologies developed in the energy industry and in general by branches of the economy of the Russian Federation, 2017-2020.

Title	2017	2018	2019	2020
Number of organizations using advanced production technologies				
- total by industry	1 402	1 565	1 620	1 989
- by sector of energy	31	34	45	59
Number of organizations using proprietary advanced production technologies				
- total by industry	485	497	530	519
- by sector of energy	5	5	6	13
Level of patent coverage (patent activity)				
- total by industry	35%	32%	33%	26%
- by sector of energy	16%	15%	13%	22%

The trend in the coverage of patents by developed advanced production technologies favours technologies developed in the energy sector over the industry average: by 2020, for example, only 4 per cent of the industry average is lagging behind, while in 2017 this indicator differed more than twofold (figure 3).

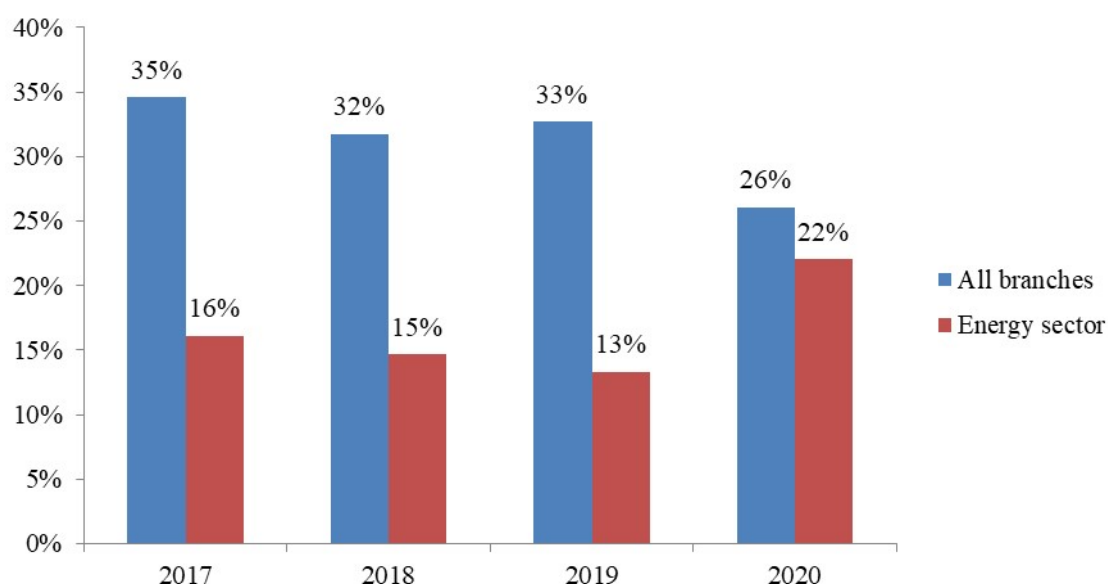


Figure 3. Level of patent coverage (patent activity) developed by advanced production technologies in general for branches of the economy of the Russian Federation / in the energy sector, %, 2017-2020.

4. Discussion

Of the technologies developed, only a small number had fundamentally new characteristics for the Russian Federation: in 2017, 1 out of 29. in 2018 - 1 out of 33, in 2019 – no data, in 2020 - 5 out of 54.

Thus, in 2020, there was already a diversification of technologies by category, as noted above, but also an increase in the number of technologies developed, giving some hope for the growth of innovative, patent, technological activity in the enterprises of the industry. The number of advanced production technologies used in the period under review increased by 6,583, or 72 per cent, in the energy sector, while in all branches of the Russian economy growth was 2,877 or 1 per cent.

With regard to the categorization of energy technologies, communication and management technologies are the absolute leader, but in 2020, due to the change in the nomenclature of the advanced production technologies, about 5% became industrial computing technologies and BigData in 2020. Sixty-one per cent of the technologies used in the energy sector were in the communication and management subsystems; 13 per cent were in the automated surveillance subsystem; and 10 per cent were in the production and information subsystem.

The 2020 statistical data collection forms provide information on the results of the implementation of the advanced production technologies: a list of the effects of the introduction of technologies and estimates of enterprises (expert opinions on whether the impact was high, medium, low or non-existent). The results of the advanced production technologies are presented. Unfortunately, no such estimates have been provided for 2017-2019, which makes it impossible to track trends. However, there are also indications that some conclusions can be drawn.

Thus, the «efficiency improvement of the production process (productivity growth)» was declared by the 393 organizations that implemented advanced production technologies, the «compliance with standards, technical regulations and norms» - 341 organizations, the «cost reduction» - 217, «acceleration of production process» - 199, «improvement of quality, reduction of marriage» - 176 organizations. All other factors were noted by a smaller number of organizations (1,802 industry entities in total).

More than half (54 per cent) of the organizations in the energy sector, however, concluded that there was no effect from the introduction of advanced production technologies. 20 per cent reported moderate exposure, 17 per cent reported low exposure, 9 per cent reported high exposure.

An analysis was also made of obstacles to the introduction of new technologies in the energy sector and, in general, in sectors of the Russian economy in 2020.

According to the representatives of the reporting organizations, such factors were: 1) low return on investment (long payback period) - 10 per cent each in energy / industry average; 2) Lack of technological organization of /enterprise - 10 per cent in the energy industry / 8 per cent in the industry average; 3) Difficulty in integrating new technologies into existing production processes; 8 per cent; 4) Difficulties in attracting public funding - 8 per cent/ 7 per cent; 5) Difficulties in recruiting qualified personnel - 7 per cent/ 8 per cent; 6) Difficulties in attracting private funding - 7 per cent/ 6 per cent.

5. Conclusion

At present, the issue of material incentives for innovators has not been resolved, nor have mechanisms been worked out to ensure that the developer or the employer have the right to enforce the technical solutions created. It is practicable to pay bonuses to inventors for a certain technological development; the additional profit obtained may be multiples of the size of such bonuses; however, it is often not possible to estimate the «effect of innovation in production». Consequently, the assessment of technologies as a whole is so difficult: conclusions on its effectiveness should be based on prognosis, estimation of implementation, etc.

It is clear that the identified problems of technological development and patent activity need to be addressed as soon as possible. However, the current structure of the Russian Federation economy creates the conditions that simple technological intermediation between the technology developer and its recipient, which is handled by most domestic entities, is doomed to failure.

A package of proposals was developed to improve the technological development and patent activity in the Russian Federation, which 100 per cent of the respondents to the expert study described as ineffective. Among the proposed measures are improvement of the legislative framework for the use of technologies, delimitation of powers in the organization of technological development and patent activity mechanisms and support of the activities of its subjects, development of algorithms (business models) of the organization of activities of technological development, etc.

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