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EXPERIENCE OF STATE EXPOSURE ON INNOVATION ACTIVITY IN POWER MACHINERY

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Innovative activity is more or less inherent for any production company as one of the fundamental factors of effectiveness in a competitive environment. Economic and political aspects of the present time impose demands on the knowledge-intensive and technologically complex products, such as power-generating equipment. The products' obsolescence, change of requirements of consumers and behavior of participants of the market sooner or later necessitate the development of new types of production and production technologies, application of new approaches to organizing the processes in the internal and external environment of the company. Competitive conditions in the international markets also force the enterprises to increase efficiency of their activity. Special measures have to be taken and conditions have to be created for ensuring the required level of product competitiveness and, as a result, economic efficiency of the manufacturing company. Innovative activity can ensure long-term competitiveness. The problem of knowledge management is equally urgent. R&D is an important method of a company's scientific and technical development. The article considers management of innovative activity in scientific and production companies. Knowledge-intensive types of equipment require the most financial resources and have to be developed using a variety of government assistance. We present an overview of state regulation and support approaches in the USA, China, Russian Federation and European countries with respect to innovations in power engineering as one of the most high-tech industries. We have also analyzed the international experience of the participation of public authorities in determining the priority technologies and providing the conditions for implementation of R&D and creation of new equipment.

Keywords: innovations; industry; government assistance; R&D

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ОПЫТ ПРИМЕНЕНИЯ МЕХАНИЗМОВ ГОСУДАРСТВЕННОГО ВОЗДЕЙСТВИЯ НА ИННОВАЦИОННУЮ ДЕЯТЕЛЬНОСТЬ В ЭНЕРГОМАШИНОСТРОЕНИИ

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Инновационная деятельность в той или иной степени присуща любой производственной компании, в том числе как один из основополагающих факторов эффективного функционирования в конкурентной среде. Экономические и политические аспекты современности предъявляют высокие требования к наукоемкой и технологически сложной продукции, такой как энергогенерирующее оборудование.

Моральное старение выпускаемой продукции, изменение требований потребителей и поведения участников рынка рано или поздно приводят к необходимости разработки новых видов продукции и технологии производства, применения новых подходов к организации процессов во внутренней и внешней среде компании. Конкурентные условия на международных рынках заставляют предприятия повышать эффективность своей основной деятельности. Требуется принятие специальных организационных мер и создание условий для обеспечения требуемого уровня конкурентоспособности продукции и, как следствие, экономической эффективности разработчиков и производителей оборудования. Инновационная деятельность – один из способов обеспечения конкурентоспособности в долгосрочной перспективе. Проблема управления знаниями (компетенциями) стоит не менее остро. НИОКР являются неотъемлемым условием научно-технического развития компании. Однако создание «прорывного» продукта требует обеспечения постоянного проведения исследований, поддержания инновационной активности конструкторских и технологических подразделений, организации эффективного взаимодействия с внешней средой компании. Рассмотрен актуальный вопрос обеспечения инновационной деятельности научно-производственных компаний. Наиболее требовательными к финансовым ресурсам являются наукоемкие виды оборудования, разработка которых может быть осуществлена в полной мере при разностороннем государственном содействии. Представлен обзор механизмов государственного регулирования и поддержки инновационной деятельности в США, Китае, странах Европейского Союза, России применительно к энергетическому машиностроению как одной из наиболее наукоемких и высокотехнологичных отраслей промышленности. Проведен анализ зарубежного опыта участия органов государственной власти в определении приоритетных направлений развития техники, обеспечении условий для реализации исследовательских программ и создании нового оборудования.

Ключевые слова: инновации; промышленность; государственное содействие; НИОКР

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Introduction. Innovative activity is largely unique. In addition to the need for human, financial and material resources, the innovation process requires intellectual resources such as knowledge and extraordinary ideas. For this reason, modern economy is called intellectual, i.e., based on constant technological improvement, development of knowledge-intensive products with a high added value. The flow of new innovative solutions is the main indicator of the functioning of the innovation economy or what is commonly called the knowledge economy, in which the efficiency of an innovative project is determined by the commercialization efficiency, that is, the involvement of scientific and (or) scientific and technical results in economic turnover [1].

Implementation of such projects is only possible with an adequate and efficient innovative infrastructure including sectoral research institutions, internal corporate mechanisms of organizational and methodological nature, and other auxiliary elements. However, an essential condition for carrying out any research and development is the availability of funding, in particular, this applies to knowledge-intensive products of the power engineering industry.

Analysis of the world experience confirms the special importance of material resources in the implementation of innovation policy. At the same time, the ratio of costs for the implementation of basic research to R&D is 1/10, while the ratio of costs for innovation is 1/100 or more.[1]

Purpose of the study. To analyze the world experience of state assistance in innovation, identify the key mechanisms, compare with the situation in the Russian Federation.

[1] Ofitsial'nyi sait Minpromtorga Rossii. URL: http://www.minpromtorg.gov.ru

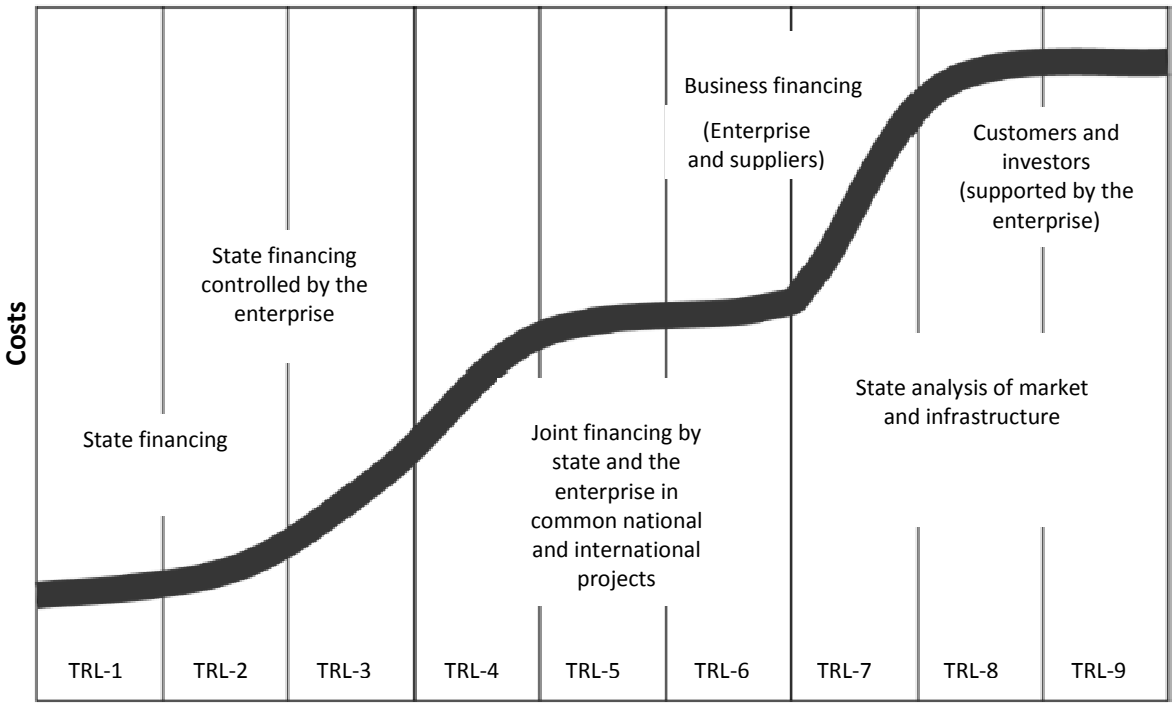

Fig. 1. Development dynamics and funding sources

Study methodology. As a clear illustration of the scale and dynamics of large project funding, we present the «Technological readiness level» model initially developed by NASA for space exploration. The model allows to decompose the development process of new products and technologies into stages and to forecast the costs. The model was later adapted by the US Department of Energy to evaluate its projects.[2] The process of developing a new technical unit or technology is divided into 9 technological readiness levels (TRL):

1 – initial phase of scientific research;

2 – intensive research, identification of practical application areas;

3 – applied analytical and laboratory studies;

4 – creation of basic technological components;

5 – integration of the main and supporting technological components, simulation of the operating conditions of the technical unit;

6 – development of the representative model of the unit (prototype), testing in real conditions;

7 – bringing the prototype to the required technical level, testing;

8 – successful completion of testing, certification;

9 – experimental operation of technology or technical unit.

The structure of funding at each stage is not uniform, private and public involvement is expected (Fig. 1).

The distribution shown is confirmed by R&D funding statistics in the leading countries of the world economy (Tab. 1).[3]

The 2016 rating composed by the UNESCO Institute for Statistics that the leading countries retained their positions in the R&D funding volume, and that there is positive dynamics in a number of countries (Tab. 2).[4]

In accordance with international practice and depending on the industry, companies invest an average of 1–5 % of their annual income in innovation (R&D and foundations). In Russia, the figures are slightly lower, and amount up to 2 %.[5]

[2] Ofitsial'nyi sait Departamenta energetiki SShA. URL: http//:www.energy.gov

[3] National Science Board: analit. izd. Arlington, VA: National Science Foundation (NSB-2016-1). (2016) 45.

[4] Ofitsial'nyi sait Instituta statistiki Iunesko. URL: http//:www.uis.unesco.org

[5] Science, Technology and Patent Statistics: analit. izd. URL: http//:www.oecd.org

Table 1

R&D funding structure in the world in 2012–2014

Country	R&D funding, $ billion	R&D investment ratio, %			
		business	public	foreign	others
USA	457	60.9	27.7	4.5	6.9
China	334	74.6	21.1	0.9	3.4
Japan	162	75.5	17.3	0.5	6.7
Germany	103	66.1	29.2	4.3	0.4
South Korea	68	75.7	23.8	0.3	1.1
France	58	55.4	35	7.6	2.0
United Kingdom	42	46.6	27	20.7	5.7
Russian Federation	37	28.2	67.6	3.0	1.2
Poland	8	30	61	5.6	3.4

Table 2

Ratio of public and private investments in R&D

Country	R&D funding, $ billion	R&D investment ratio, %	
		private	public
USA	457	70.6	29.4
China	369	77.3	22.7
India	48	35.5	64.5
Russian Federation	44	59.6	40.4
Australia	22	56.3	43.7

The public policy on co-financing development has its own features in different countries.

1) The United States.

In addition to direct R&D funding (27–30 %), the state has also been developing mechanisms for protecting intellectual property rights, a strategy for technological development of the country, identifying promising areas for scientific research. Currently, there is a clear tendency to develop indirect methods of influence in the field of R&D.[6]

Special-purpose budgetary funding for research is carried out on a competitive basis. Budget contracts and grants are allocated to government laboratories and research centers, industrial companies and other private-ownership organizations. About half of all fundamental research is carried out by universities at the expense of the federal government. Most of the applied work under federal contracts is carried out by industrial companies.

Regarding the priorities of the US innovation development (Tab. 3), a noteworthy feature is the increase in the volume of long-term R&D funding in the energy sector, which has been observed since 2013.[7]

Industrial companies provide funding for more than 70 % of R&D (mainly, applied research), public research institutions are involved in fundamental research projects. Priority is given to projects covering several areas of science and technology that have commercial value in the long term.[8]

The Department of Energy (DOE) coordinates the implementation of the R&D program related to the energy sector through sector-specific agencies and national research laboratories under their jurisdiction. Government contracts can also be granted by one of the Federally Funded Research and Development Centers (FFRDC). Basic research is carried out by colleges and universities (53 %), business sector (20 %), FFRDC and laboratories (15 %), others (12 %). Laboratories have the financial capacity to employ third-party organizations on a competitive basis. Private research centers involved in performing such services often use the research equipment of national laboratories.

In addition to the above functions, DOE often acts as a link between the authors of new developments and venture funds (there are 26 large funds), provides funding for product prototype development, and organizes exhibitions of new projects.

2) The European Union.

Public support for innovation in the countries of the European Union (EU) shares a common approach in a number of key areas [7]:

– simplified procedure for setting up a business (a common EU database has been developed);

[6] Science and Engineering Indicators 2008: otchet Nats. soveta po nauke SShA. URL: http//: www.nsf.gov

[7] US Federal Budget 2017. URL: https://www.usa.gov/budget

[8] Small Innovative Company Growth: Barriers, Best Practices and Big Ideas. U.S. Small Business Administration. W., 2015.

Table 3

R&D Funding in the United States, $ billion.

Departments and agencies	year				
	2013	2014	2015	2016	2017
Department of Defense	63 838	63 856	65 547	70 872	72 825
Department of Health and Human Services	29 969	30 912	30 453	31 942	32 714
National Agency for Aeronautics and Space Research	11 282	11 667	12 145	12 410	12 043
Department of Energy	10 740	11 359	14 354	14 405	17 160
National Science Foundation	5 319	5 729	5 944	6 117	6 529
Department of Agriculture	2 116	2 418	2 452	2 674	2 923
Department of Commerce	1 360	1 632	1 524	1 913	1 888
Department of Veterans Affairs	1 164	1 174	1 178	1 220	1 252
Department of Transportation	829	853	885	924	1065
Department of National Security	684	1032	919	579	585
Environmental Protection Agency	532	560	523	516	530
Department of Education	319	323	279	242	248
Others	2 180	2 167	2 075	2 324	2 571
Total expenditure on R&D	130 332	13 3682	13 8278	14 6138	15 2333

– a set of measures to secure and protect the intellectual rights of the developers of new technologies;

– financial support mechanisms for small and medium-sized businesses;

– incentive mechanisms for innovative product developers and manufacturers (tax incentives);

– conditions that stimulate improving the educational level of employees.

Determining the priority areas for the development of the energy sector, planning, organization and funding of R&D in European countries is carried out, as in the US, through public-private partnerships [4]. The division of responsibility for determining the R&D areas is shown below for Germany (Fig. 2).

The Federal Government identifies the priorities for development. The Energy Research Program is developed under the guidance of the Federal Ministry of Economics and Technology (BMWi).

Private companies are bidding for receiving state grants with co-financing of the research with the involvement of educational and research organizations. The responsibility for holding competitive tenders and allocating funds rests with agencies in the relevant areas: the German Research Foundation (DFG), the German Energy Agency (DENA), the Federal Office for Radiation (BfC), etc.

3) China.

Since 1999, China has been implementing a state policy for industry modernization and technological development. In particular, the Program for the Technological Development of Enterprises has been adopted, aimed at increasing the profitability and adaptability of industries to the market economy conditions.

Developers and manufacturers of new machinery and technology have been offered a set of financial mechanisms, including direct government investments, state loans, investments of local governments, relevant industries and enterprises, preferential bank lending (the State Development Bank of China). Priority is given to investment projects with a long production cycle. Particular attention is paid to facilitating direct foreign investment for reforming and technological upgrade of the industry.

A number of measures are aimed at ensuring cooperation in the research sector. In particular, research centers have been exempted from paying duties for imported equipment and from sales tax in technology transfer, specialized investment funds for supporting scientific activities have been established.

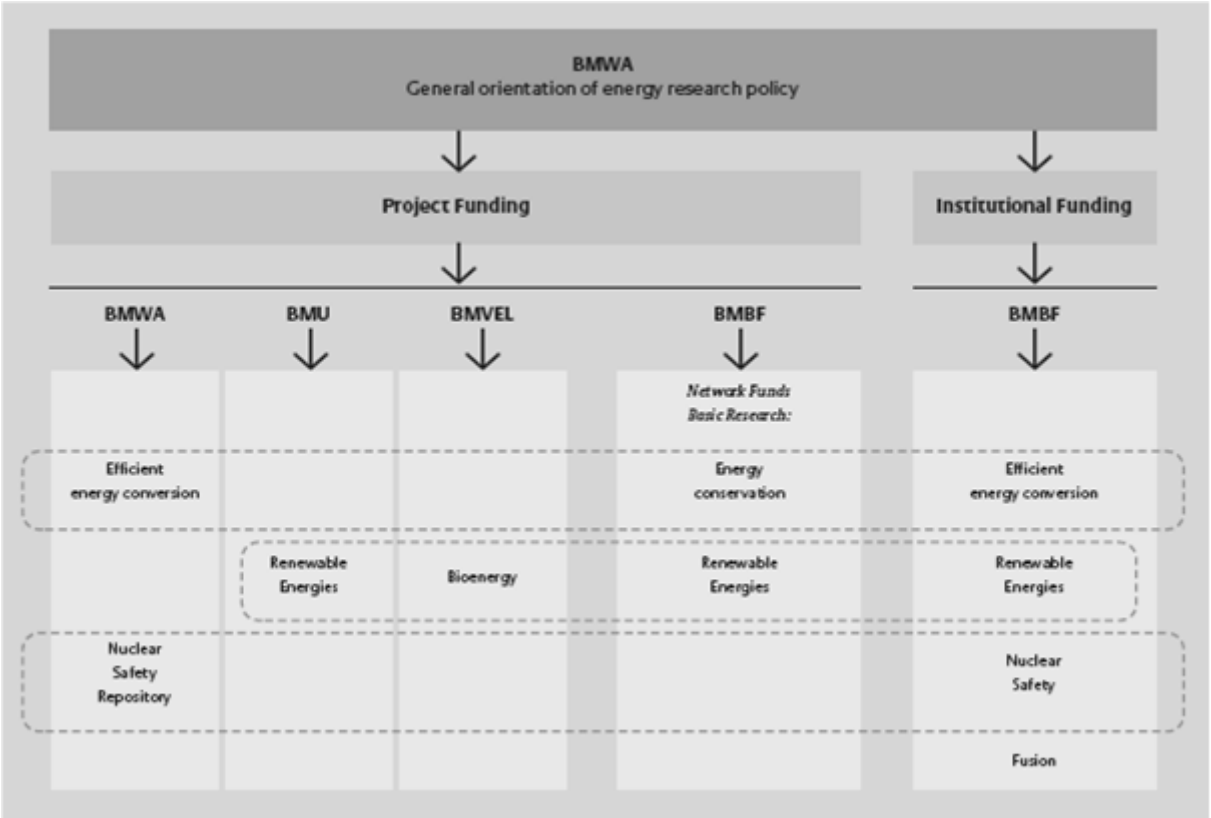

Fig. 2. R&D funding model in Germany

S o u r c e : BMWA – Federal Ministry of Economics and Labor; BMU – Federal Ministry of the Environment, Nature Conservation and Nuclear Safety; BMVEL – Federal Ministry of Consumer Protection, Food and Agriculture; BMBF – Federal Ministry of Education and Research.

In addition, when innovative companies are created at the expense of Chinese investors, restrictions are removed for individuals to acquire shares in the authorized capital of these companies [3].

Fiscal policy mechanisms include exemption from value added tax and customs duties on imported equipment and technologies for projects involving foreign capital; the state can also provide guarantees for foreign investment in projects approved by the government and appraised by state experts.[9]

In order to reduce the debt ratios of enterprises, there is an opportunity of «debt transformation into a share», which means that asset management is temporarily transferred to experts of a commercial bank.

The Foreign Trade Law of the People's Republic of China stipulates that the state uses such forms of export support as export credits, VAT refunds and other measures stimulating the development of foreign trade, including support for the activities of the Chinese Committee for the Promotion of International Trade, establishing exporters' associations, foreign trade development funds, etc. In order to protect domestic manufacturers, China uses almost all available means used by other countries (regulation of customs duty rates, import quotas and licensing, temporary or complete bans on the import of goods, the institute of special importers, imposition of anti-dumping duties, etc.).

In accordance with the Regulation of the People's Republic of China on the export and import of goods, the state performs insurance of export credits, provides information services to support enterprises in world markets. In particular, free information services are provided (MVTES of the PRC), databanks of the enterprises have been established to use the information by partners abroad, assistance in defending interests in conducting anti-dumping investigations abroad and applying discriminatory measures against Chinese manufacturers has been provided.

[9] 2014 Global R&D forecast. Battelle, R&D Magazine. December 2013. URL: http:// www.battelle.org

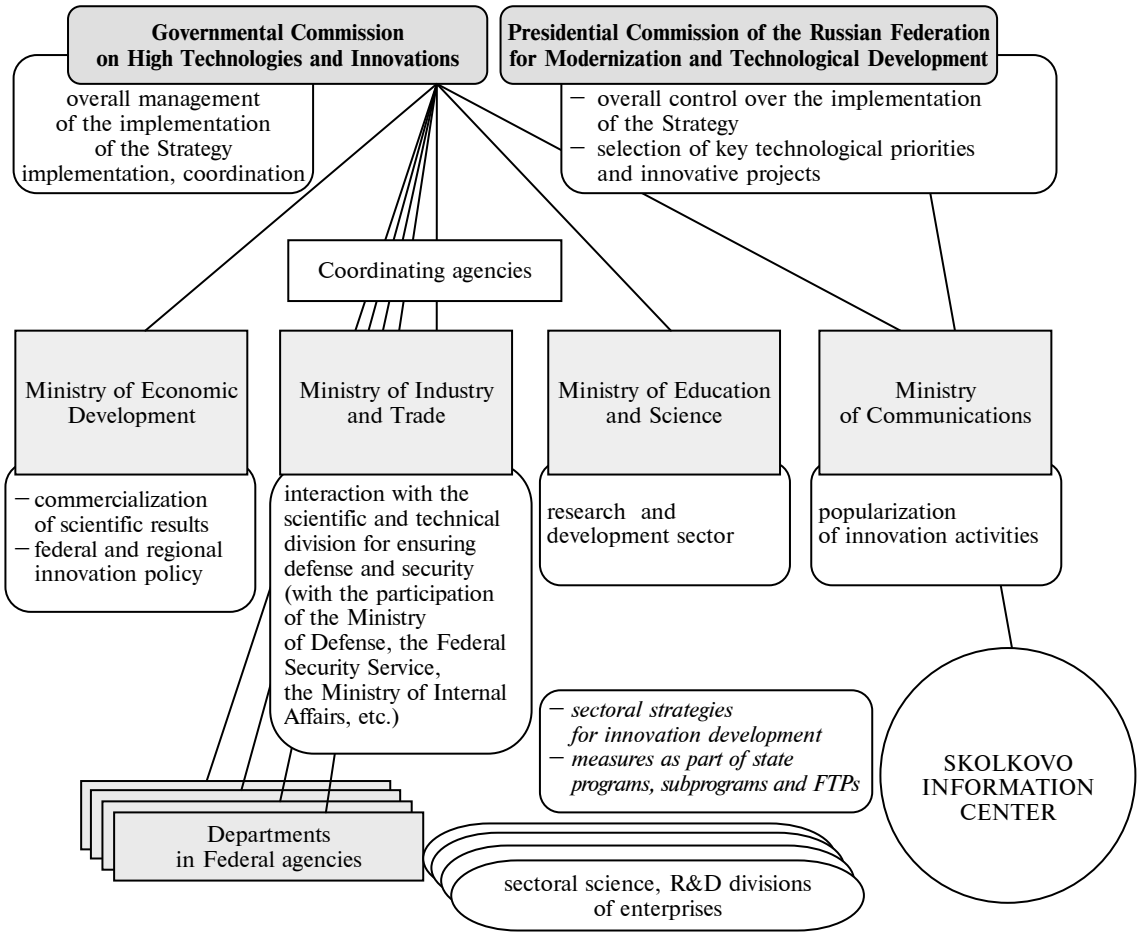

Fig. 3. System of government innovation management in Russia

4) Russia.

To date, a system of direct and indirect stimulation of innovation has been established in the Russian Federation. The mechanisms of direct stimulation are: budgetary funding of science, selection of priority areas of development (programs, strategies), government contracts, public procurement, subsidies and guarantees to private banks, creation of consortia, engineering centers, clusters, scientific and technological parks, science cities, etc. Tax preferences for participants of innovative activity (establishing the tax base and granting tax privileges), customs regulation, involvement of the existing industrial and innovation infrastructure in the economic circulation on the basis of industrial clusters are indirect support mechanisms.

The system of ensuring innovation at the state level is a multi-level system for determining the areas, funding and control of the participants of the process (Fig. 3).

There is a number of normative and legal acts regulating innovative activity (first of all, in companies with state participation), as well as determining the procedure and amount of research funding. In order to form a competitive and efficiently functioning sector of applied research and development, a list of research and development topics listed in the Federal Target Program «R&D for priority areas of the development of the science and technology complex of Russia for 2014–2020» has been established for each development area.[10] The annual amount of funding for the program's activities is more than 25 billion rubles.

To stimulate investment activity in Russia, legislative acts establishing a new mechanism, a

[10] O federal'noi tselevoi programme «Issledovaniia i razrabotki po prioritetnym napravleniiam razvitiia nauchno-tekhnologicheskogo kompleksa Rossii na 2014–2020 gody: Post. Pravitel'stva RF № 426 ot 21.05.2013 g. URL: https://www.consultant.ru

special investment contract, have been adopted.[11] The contract guarantees to the investor for the entire validity period:

– stable conditions for doing business (provided that the investors fulfill their obligations);

– tax privileges and relief from payment of customs charges;

– preferential lease terms payment for public and municipal property use;

– conclusion of long-term government contracts with an industrial enterprise as a single supplier.

There is a well-known positive experience of using such a mechanism in China. In 1991–1998, the annual volume of investments grew more than tenfold, from $4.4 to $45.5 billion.

Some other financial and regulatory measures to stimulate innovation are also being implemented. For example, in order to involve the existing industrial and innovation infrastructure of enterprises with a common industry affiliation or with common points in the production and technological cycle in the economic turnover, a legislative basis for the creation of industrial clusters has been created at the state level.[12] The associations included in the Register of Industrial Clusters of the Ministry of Industry and Trade of Russia have the right to receive public support for reimbursement of a fraction of the costs when implementing joint projects.[13]

The mechanisms for venture funding of projects are a separate category. Government involvement in providing venture funding of projects in the Russian Federation has been implemented since 2013 through 53 foundations and federal development institutions (the Skolkovo Foundation, the Assistance Foundation and the Internet Initiatives Development Foundation). The Russian Venture Company acts as the state investor and coordinator.

Analysis of the experience of applying the proposed mechanisms in research and development allows to identify a number of areas that require adjustments and revisions of approaches. A significant amount of funding for research and production companies with government involvement with limited subsidies and concessional lending to private entities are among the most significant ones. Taking into account the specifics of the Russian market of manufacturers and developers of power generating equipment, this approach leads to insufficient funding for projects in critical areas of the economy in conditions of stagnation and a drop in demand for products.

Results of the study

1. We have analyzed the foreign experience of state regulation of innovative activity in the field of power engineering.

2. We have considered the mechanisms of state influence on innovation activity in the Russian Federation in the case of the energy sector and identified the priority areas for development.

Conclusions. Analysis of global trends in the organization of funding for technological projects and introduction of new technologies has shown that the principle of independent provision of innovative activity in power engineering by private investors is a common myth. State support of knowledge-intensive industries is carried out in all technologically advanced countries. As a rule, the mechanism of public-private partnership is applied at various stages of development of technical units. The forms of funding are different: direct investments in research through authorized organizations (foundations, laboratories, research centers), direct funding for works (grants, concessional lending), tax and customs privileges, identification of priority areas for technological development, mechanisms to secure and protect intellectual rights, information and organizational support for innovative enterprises.

In Russia, to date, a system of state support and regulation of innovation activities has been established, which is widely used in the field of power engineering among others. The existing regulatory framework fixes the priority areas of industrial development, elements of the state infrastructure, as well as mechanisms for direct and indirect funding of research and development.

In the future, it would be appropriate to consider the ways of developing methods for assessing the effectiveness of funding innovation in public-private partnerships.

[11] O promyshlennoi politike v Rossiiskoi Federatsii: Feder. zakon RF № 488-FZ ot 31.12.2014 g. URL: https://www.consultant.ru; O spetsial'nykh investitsionnykh kontraktakh dlia otdel'nykh otraslei promyshlennosti: Post. Pravitel'stva RF № 708 ot 16.07.2015 g. URL: https://www.consultant.ru

[12] O promyshlennykh klasterakh i spetsializirovannykh organizatsiiakh promyshlennykh klasterov: Post. Pravitel'stva RF № 779 ot 31.07.2015 g. URL: https://www.consultant.ru

[13] Ob utverzhdenii Pravil predostavleniia iz federal'nogo biudzheta subsidii uchastnikam promyshlennykh klasterov na vozmeshchenie chasti zatrat pri realizatsii sovmestnykh proektov po proizvodstvu promyshlennoi produktsii klastera v tseliakh importozameshcheniia: utv. Post. Pravitel'stva RF № 41 ot 28.01.2016 g. URL: https://www.consultant.ru

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