Public-private partnership in implementing “mega-science” projects

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Abstract. The paper analyzes the legal aspects for establishing and operating unique scientific facilities of the megascience class. In particular, the paper considers the issue of financing megascience projects from budgetary funds and extra-budgetary funds. The mechanism of public-private partnership and the possibility of its application in implementing the “mega-science” class projects are analyzed. In addition, the main foreign and Russian megascience projects are briefly characterized.

1. Introduction

Today, scientific and technological potential and its implementation are becoming the most important resource for the development of any country. Rapid economic growth, improvement in the quality of citizens’ life and transformation of the state into a leader in terms of social indicators are possible only with the dynamic development of science and technology.

The current stage of the science development in Russia is characterized by the presence of both competitive advantages of the Russian Federation and unresolved problems that impede the scientific and technological development of the country, in particular:

• there is substantial potential in a number of areas of fundamental scientific research, what is reflected, among other things, in the framework of joint international projects, including the creation and use of unique scientific facilities of the “mega-science” class. However, the directions of research and development largely correspond to the directions relevant to the last decades of the last century,

• there are several hundreds of scientific and educational centers conducting world-class research and development. At the same time, there is a significant differentiation of scientific and educational organizations in terms of effectiveness and efficiency, concentration of research potential in only a few regions of the country,

• with the existing positive experience in implementing large-scale technological projects, including in the sphere of the state defense and security, there is still a problem with the economy and society remaining blind to innovations, which hinders the practical application of the results of research and development. So, the share of innovative products in the total output is only 8-9 percent; investments in intangible assets in Russia are 3-10 times lower than in leading countries; the share of exports of Russian high-tech products in world exports is about 0.4 percent. There is practically no transfer of knowledge and technology between the
defense and civilian sectors of the economy, which hinders the development and use of dual-use technologies,

- the weak interaction of the research and development sector with the real sector of the economy leads to the fact that public investment in human capital actually ensures the growth of the competitiveness of other economies, as a result of which the ability to retain the most effective scientists, engineers, and entrepreneurs, who create breakthrough products, is significantly reduced in comparison with leading countries in the field of innovation,

- the incoherence of priorities and tools to support the scientific and technological development of the Russian Federation at the national, regional, sectoral and corporate levels continues, which does not allow to form production chains for creating added value of high-tech products and services, to ensure the greatest multiplier effect from the use of emerging technologies.

The development of science is possible only with the broadest support not only of the state, but also of business. At the same time, the private sector of the economy should have an understanding of the importance of this process. This is the strategic task on which the state economy, social sphere and politics are based.

Since the beginning of 2000 the transition of Russia to an innovative economy has begun, which has been accompanied by a significant increase in the funding of science.

By Decree of the President of the Russian Federation No. 899 of 07.07.2011 “On the approval of the priority directions for the development of science, technology and engineering in the Russian Federation and the list of critical technologies in the Russian Federation” the priority directions for the development of science, technology and engineering in the Russian Federation were approved.

To conduct fundamental research, which allows scientists to obtain new knowledge that can drastically change the current state of affairs, it is necessary to establish unique scientific facilities that require an enormous investment of resources and time. These scientific facilities were called “mega-science”. At the same time, “mega-science” tends to be an international project combining the scientific potential and finances of several countries, although the history of our country offers many examples of creating unique national facilities in view of the need to ensure state security.

The Government Commission on High Technology and Innovation has set the task of developing a program to establish in Russia the national unique large-scale world-class research complexes “mega-science”, which gives direction to the consistent and coordinated international development and operation of global research infrastructures. The establishment of national mega-facilities demonstrates the level of scientific and technological development of the state, ensures the achievement of fundamentally new frontiers in fundamental science, provides new opportunities for international cooperation in breakthrough research directions, and serves as a guarantee of the Russian science competitiveness.

The implementation of “mega-science” projects becomes a catalyst for activating the processes of institutional, organizational and informational transformations of Russian science, without which it is impossible to overcome a certain isolation of Russian science from advanced research. Projects “mega-science” at the same time cause an increased demand in the country for high-tech industry, the creation of high-tech equipment, the achievements of which can later be used in conventional production.

In the Address of the President of the Russian Federation to Federal Assembly on March 1, 2018 given by V.V. Putin it was noted that, relying on the backlogs of previous years, including in the research infrastructure, we need to reach a whole new level. In Gatchina and Dubna the projects of modern research facilities of the “mega-science” class are already being implemented. Recently, the Council on Science and Education has decided to create a powerful synchrotron accelerator in Akademgorodok in Novosibirsk and a new generation accelerator in Protvino near Moscow.

1 Code of Laws of RF, 2011, No.28, Article 4168.
According to the Decrees of the President of the Russian Federation “On National Goals and Strategic Tasks of the Development of the Russian Federation for the Period up to 2024” and the Strategy for Scientific and Technological Development of the Russian Federation, it is noted that:

- Science is one of the priority directions for the implementation of national projects for the period up to 2024,
- By the year 2024, the Government of the Russian Federation needs to create an infrastructure for research and innovation, including the creation and development of unique scientific facilities of the “mega-science” class,
- By the year 2024, the Government of the Russian Federation has been tasked with ensuring the presence of the Russian Federation among the five leading countries of the world carrying out research and development in priority areas of scientific and technological development,
- It is necessary to ensure attractiveness of work for Russian and foreign leading scientists.

In this regard, within the framework of the Main Activities of the Government of the Russian Federation for the period up to 2024 [1], it has been established that international research will be launched on unique scientific facilities of the “mega-science” class.

In order to implement these acts, the legal regulation issue of establishing and operating unique scientific facilities of the “mega-science” class, as well as their financing from budgetary and extra-budgetary sources, has become urgent. It is important to note that the current legislation of the Russian Federation does not contain a concept of the category of a unique scientific facility of the “mega-science” class.

2. Unique scientific facilities of the “mega-science” class: concept and features

Unique scientific facilities of the “mega-science” class tend to be international, which are designed to conduct fundamental research, allowing to obtain the latest technologies and developments, combining the scientific potential of several states with the participation of leading scientists from different countries and the establishment of international scientific collaborations.

Currently 360 unique scientific facilities with varying degrees of uniqueness are registered in the Russian Federation [2]. According to Article 2 of the Federal Law No. 127-FZ "On Science and the State Scientific and Technical Policy" of 08.23.1996 defines a unique scientific facility. A unique scientific facility is defined as a complex of scientific equipment functioning as one:

- created by an organization engaged in scientific or scientific and technical activities,
- aimed at obtaining scientific results, the achievement of which is impossible when using other equipment,
- having no analogues in the Russian Federation, what makes it be much in demand by other organizations implementing scientific or scientific and technical projects.

The concept of “mega-science” in world science began to be widely used in the beginning of the 21st century. In Russia, the term "Scientific mega-projects" was first officially recorded in the decision of the Government Commission on High Technology and Innovation of July 5, 2011, protocol No. 3, which approved the List of criteria for classifying research facilities as international scientific mega-projects.

The first document, where the term “mega-science” was adopted, was the Strategy for Scientific and Technical Development of the Russian Federation for 2017 - 2025, approved by Decree of the President of the Russian Federation No. 642 of December 1, 2016, paragraph 32b. As part of it, an Action Plan for the implementation of the Strategy for Scientific and Technological Development of the Russian Federation in 2018 was developed, which provides for the formation of a Program for the establishment and development of a network of unique scientific facilities of the “mega-science” class on the territory of the Russian Federation. In turn, the Ministry of Science and Higher Education of
the Russian Federation has created a special interagency working subgroup that developed proposals for the criteria and requirements for future mega-projects.

Features of unique scientific facilities of the “mega-science” class:

- are large unique scientific complexes, within the framework of which fundamental experimental scientific research is carried out, which is aimed at gaining new knowledge about the basic laws of the structure, functioning and development of man, society, and the environment,
- functioning is aimed at obtaining innovations and technologies that contribute to the solution of any global problem,
- activities to establish and operate unique mega-science scientific facilities are the subject of international cooperation between countries and the merger of relevant resources,
- the scale of scientific tasks and the high cost of facilities, the uniqueness of the intellectual resources and technologies used in the establishment and operation of such projects,
- another important function, educational, is connected with the uniqueness of the scientific knowledge, obtained during the implementation of scientific projects of the “mega-science” class. As a rule, an educational infrastructure is created based on scientific projects of the “mega-science” class pursuing the goal of training specialized personnel,
- international cooperation and its resources lead to the creation of unified sets of scientific equipment that have no analogues in any country in the world.

Scientific results (knowledge, technology, products), obtained during the implementation of such projects cannot be reproduced using other equipment.

Thus the unique scientific facilities of the “mega-science” class are a unique system complex of scientific equipment, created with the involvement of the resources from different countries and are based on international cooperation in order to obtain fundamental knowledge, technology or products of global significance, the obtaining of which is impossible when using other equipment complexes.

3. Foreign and Russian “mega-science” projects

Currently, several large-scale scientific projects of “mega-science” class are being implemented in the world, including CERN (Switzerland), ITER (Italy), FAIR (Germany).

3.1. ITER (International Thermonuclear Experimental Reactor)

One of such mega-projects is a “mega-science” project ITER (International Thermonuclear Experimental Reactor) which will be the first thermonuclear facility of fundamental science, producing industrial-scale thermal energy at the level of an industrial power plant, as well as the main world platform for further research and development in the field of thermonuclear energy.

ITER project participants are the European Atomic Energy Community People's Republic of China, Republic of India, Republic of Korea, Russian Federation, United States of America and Japan.

The ITER project is being realized with the participation of the Russian Federation (in particular, ROSATOM). Russia makes a contribution to ITER (9.1%) in kind by manufacturing and supplying equipment, namely twenty-five different systems for installing ITER.

According to paragraph 2 of the Order of the Government of the Russian Federation of September 4, 2006 No 1234 “On signing the Agreement on the establishment of the ITER International Organization for Thermonuclear Energy for the joint implementation of the ITER project and other international treaties aimed at the implementation of this Agreement” when forming the draft federal budget for the corresponding year, the Ministry of Finance of Russia must provide funds to ensure Russia's financial obligations to the ITER International Organization for Thermonuclear Energy, including the payment of a contribution of the Russian Federation to the fund of the specified organization, as well as for the manufacture and supply of equipment for the implementation of the ITER project.

5 Code of Laws of RF, 11.09.2006, N 37, Article 3912
3.2. *International acceleration complex FAIR*

In Darmstadt, Germany, an international acceleration complex FAIR (Facility for Antiproton and Ion Research), one of the largest research projects in the world, is being constructed.

On October 4, 2010, representatives of nine countries: Finland, France, Germany, India, Poland, Romania, Russia, Slovenia and Sweden signed the international Convention on the construction and operation of the Facility for Antiproton and Ion Research. The UK joined the project as an associate member.

It is a multinational project involving about 3,000 scientists from more than 50 countries.

The construction and operation of FAIR is carried out by the limited liability company Facility for Antiproton and Ion Research (FAIR GmbH), in collaboration with the GSI Helmholtz Centre for Heavy Ion Research (GSI Helmholtzzentrum für Schwerionenforschung GmbH) acting under the laws of the Federal Republic of Germany. The State Atomic Energy Corporation Rosatom participates in the project on the part of Russia.

FAIR main goals and objectives are:

1. Creation and study of the fundamental properties of cosmic matter in the laboratory, which will allow scientists to create matter in laboratory conditions, which usually exists only in the depths of space.
2. Obtaining new knowledge about the structure of matter and the evolution of the Universe from the Big Bang to the present, which will allow scientists to conduct experiments in the parametric field, inaccessible to research conducted on other facilities.

The costs of constructing the Modularized Start Version of FAIR are estimated at 1,027 million euros, of which Russia’s financial obligations amount to 178.05 million euros.

Russia is responsible for the development of many key elements of the FAIR project, this work is carried out by research centers and manufacturing facilities. NRC “Kurchatov Institute”, Joint Institute for Nuclear Research, NRNU MEPhI, Budker Institute of Nuclear Physics SB RAS, pilot plant JSC NIIEFA, JSC Chepetskiy Mechanical Plant and others are among them.

3.3. *CERN (Conseil Européen pour la Recherche Nucléaire)*

The most famous “mega-science” research project is CERN (Conseil Européen pour la Recherche Nucléaire), the European Organization for Nuclear Research.

The CERN Convention was signed in 1953 by the 12 founding states of Belgium, Denmark, France, the Federal Republic of Germany, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, Great Britain and Yugoslavia and entered into force on September 29, 1954.

Currently, the organization’s members are Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, Switzerland and the UK.

Cyprus and Slovenia are associated member states in preparation for membership. India, Lithuania, Pakistan, Turkey and Ukraine are associated member states.

A number of states and international organizations are endowed with observer status. In particular, the European Union, Japan, JINR, the Russian Federation, UNESCO and the United States of America have such status. Cooperation between the Russian Federation and CERN is currently regulated by the Agreement between the Government of the Russian Federation and the European Organization for Nuclear Research (CERN) on the further development of scientific and technical cooperation in the field of high energy physics, signed in 1993.

In accordance with this Agreement, the main areas of cooperation between the Russian Federation and CERN are “participation in the main major programs and / or projects aimed at further development of fundamental scientific research, including the accelerating-storage complex of protons, which is in process of construction in the Russian Federation, the modernization of the

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6 Collected Acts of the President and the Government of the RF, 18.10.1993, No 42, Article 4045
electron-positron collider at CERN, the development of linear electron-positron accelerators in colliding beams and LHC in the power transmission tunnel."

Within the framework of CERN, to conduct experiments at the Large Hadron Collider, a special organizational and legal structure was developed and tested and was named the LHC Collaboration [3].

Thus, according to various sources and in different monetary units, the total value of the LHC is estimated at about 4,332 million in Swiss francs [4], which equals 12 billion dollars [5], or 5.2 billion euros for construction and about 300 million euros annually for operation.

Currently Russia pays CERN about 8 million Swiss francs per year, but on the condition that almost all of this money goes to support the activities of the Russian scientists who work at CERN [6].

4. National project “Science”

The passport of the national project “Science”, approved by the Presidium of the Presidential Council for Strategic Development and National Projects, protocol No. 16 dated 12.24.2018, provides for the creation and development of a network of unique “mega-science” facilities in:

- International Center for Neutron Research based on a high-flux research reactor PIK;
- The complex of superconducting rings on colliding beams of heavy ions NICA;
- 4th generation Specialized Synchrotron Radiation Source SSRS-4 (ISSI-4) (first stage);
- Siberian Circular Photon Source SKIF (first stage).

4.1. International Center for Neutron Research based on the high-flux research reactor PIK

The International Center for Neutron Research based on the high-flux research reactor PIK is implemented at the Petersburg Nuclear Physics Institute named after B. P. Konstantinov of NRC “Kurchatov Institute”, Gatchina, Leningrad Region.

The PIK reactor is a powerful source of neutrons that slow down to the required energy, then are removed from the reactor through special channels and transported through the neutron guide system to experimental facilities for research. The PIK reactor surpasses all existing research reactors in its parameters and experimental capabilities [7].

4.2. Complex of superconducting rings on colliding beams of heavy ions NICA

The complex of superconducting rings on colliding beams of heavy ions NICA is implemented on the basis of the Joint Institute for Nuclear Research (JINR), Dubna. The NICA complex is aimed at the reconstruction and study of matter in extreme conditions of its phase transitions.

The NICA complex includes a unique collider of heavy ions and polarized light nuclei based on the Dubna Nuclotron superconducting accelerator, which will be a source of beams for the collider.

4.3. 4th generation Specialized Synchrotron Radiation Source SSRS-4 (ISSI-4)

4th generation Specialized Synchrotron Radiation Source SSRS-4 (ISSI-4) is implemented on the basis of SIC "Kurchatov Institute", Protvino. The aim of the project is to create a fundamentally new specialized source of x-ray radiation, a 4th generation Specialized Synchrotron Radiation Source SSRS-4 with extremely high spatial coherence equivalent to laser radiation, with record brightness and temporal structure [7].

4.4. Siberian Circular Photon Source (SKIF)

Siberian Circular Photon Source (SKIF), where the first international scientific research was carried out, is implemented by the Federal State Budgetary Institution of Science Budker Institute of Nuclear Physics of Siberian Branch of the Russian Academy of Sciences.

The aim of the project is to create a modern national network infrastructure based on synchrotron radiation sources of new generation with a pilot machine at the NSC SB RAS (Novosibirsk), the head
machine at the Kurchatov Institute (Protvino, Moscow Region), and a synchrotron radiation source in the Far Eastern Federal District (Vladivostok).

5. Public-private partnership in the implementation of “mega-science” projects

Given the fact that international scientific cooperation is the most important condition for the implementation of “mega-science” projects, the financing of the creation and operation of unique Mega-science scientific facilities in Russia should be funded by Russian and foreign sources.

It is noted that the scientific organizations of Russia, when implementing domestic projects of mega-facilities, are able to accumulate wide international scientific collaborations. This primarily concerns organizations belonging to the “most significant institutions of science” and endowed with increased autonomy in this capacity, such as the Kurchatov Institute [8].

At the same time, it is understood that international cooperation in this area should develop and therefore foreign funding should increase.

To date, the main source of financing for Russian mega-projects is the federal budget. At the same time, there are no uniform rules enshrining the features of both budgetary and extra-budgetary financing of unique scientific facilities of the “mega-science” class at the expense of Russian and foreign sources.

Thus, along with budget financing of “mega-science” projects, other types of financing should be actively introduced through extra-budgetary sources in the form of public-private partnership (hereinafter - PPP).

The criterion for classifying such cooperation as PPP may be the performing by the business functions traditionally performed by the state. “The development and maintenance of infrastructure (in this case, educational and scientific) is the most typical example” [9].

Based on the foregoing, today the pressing issue is the implementation of the PPP mechanism in various fields, including the sphere of science, which the Russian state is developing with the help of targeted projects and programs, in particular, the issue of PPP in the implementation of “mega-science” projects.

The distinctive properties of PPP in Russia are recognized:
- lack of legislative regulation;
- little experience with the use of this institution.

In turn, the federal law On Public-Private Partnership, Municipal-Private Partnership in the Russian Federation and Amendments to Certain Legislative Acts of the Russian Federation was adopted on July 13, 2015 No. 224-FZ (hereinafter - the Law on PPP), in the framework of which the state (municipal) -private partnership is defined, its goals and principles, the status of a public partner and partners' obligations are disclosed, restrictions for private partners are indicated, the distribution of financial results and control behind them are established). It should be noted that the adoption of the Law on PPP indicates a positive trend in the development of cooperation between the state (municipal entities) and private investors.

It should be noted that the adoption of the Law on PPP indicates a positive trend in the development of cooperation between the state (municipalities) and private investors.

However, it seems that the Law on PPP can be considered as a “first step” on the way to developing an agreement in the field of PPP and a more detailed study of the legal framework in this direction at the level of by-laws, including the field of development of PPP and MPP in educational and scientific environment.

In Russia, PPP has been used relatively recently and mainly in the construction of roads, airports, water supply and sanitation systems, and heat supply. The plans include the implementation of PPP projects in the field of social infrastructure, including educational and scientific fields.

PPP can be created under the following conditions:
- lack of state financial resources;

7 Code of Laws of RF, 2015, No 29 (Part 1). Article 4350
guarantees of quality and terms of work by a private enterprise;
the ability of a private partner to implement an innovative approach.

At the same time, the legal and social aspects are based on PPP projects that limit the possibility of applying PPP to the following conditions:
legislative conditions that reduce the chances of attracting a private company that has the necessary characteristics for the implementation of the project;
lack of public opposition to attracting a private partner (job creation, etc.).

The following advantages of PPP are distinguished:
• attracting non-state financing for investments into federal property;
• reduction of government spending on the subsequent maintenance of these facilities;
• ensuring cost-effective project management by transferring managerial functions to a private investor;
• attracting modern high-performance technologies to the development of infrastructure;
• creation of conditions and the formation of the so-called "business environment" for profit by the state and private investors.

In turn, the following forms of PPP are included: universal and specialized.

PPP classification is based on the following criteria [10]:
• source of financing;
• ownership of the created infrastructure object;
• phase of the project, where a private company was involved.

There are two ways of financing PPP they are public and private. State financing involves the use of funds from budgets of various levels of the budget system of the Russian Federation, and a private investor pays for investments through the receipt of state subsidies.

With private financing, investments are paid back through the money of users of the created public good.

Based on the ownership of the infrastructure being created, the following classification of PPP can be distinguished (table 1).

**Table 1. PPP classification.**

| Ownership of the created infrastructure | Transfer of ownership to the state upon expiration of the contract |
|----------------------------------------|---------------------------------------------------------------|
| State property                         | Private property                                              |

If under the contract the object remains in state ownership, then return on invested funds to investors is guaranteed. This option is used in practice more often.

However, in practice there may be situations when the expectations of private partners from the implementation of joint projects with the state are not fully justified. This, what happened with the Olympics in Sochi, for example. It is noted that the problem is that the business, called upon by the authorities to participate in the construction of the infrastructure of the Olympic Games, "overestimated the preferences that this participation will provide" [11].

In this regard, it seems that the development and implementation of a PPP system in the field of science can become an important condition for achieving strategic goals in the field of scientific and technological development of our state, as the help of private business is timely for solving the respective problems.

At the same time, the complicated procedure for the implementation of the state order scares off a significant number of enterprises. The cost of compiling such documentation can reach up to 30% of the total project cost. At the same time, enterprises do not have guarantees that they will win the competition [12].
Despite the fact that so far we have to talk about the beginning of the formation of PPP, even in such situation it is obvious that it is impossible to implement global projects in the scientific field by the forces of one state and thus only with the help of the public and private sectors it is possible to achieve positive results in this area.

The main task of PPP is the equitable distribution of risks between private and public institutions and the provision of remuneration for each party, taking into account the accepted risk.

It is indisputable that recently in most states the scope of interaction between the state and the private sector in the form of public-private partnerships has significantly expanded, which, in turn, provide for "official relations or arrangements between public and private organizations" [13].

The advantages of participation in public-private partnerships for the state and private structures are revealed.

The positive aspects for the state include:

- ensuring high efficiency of the results of the partnership;
- ability to attract additional sources of investment;
- receiving a new joint "innovative product" from partnership and a new technology as a product of such an activity;
- creation of advanced infrastructure for the implementation of a "mega-science" project.

The benefits of participating in a public-private partnership for private business are:

- long-term use of state assets;
- security of own investments;
- the reliability of the results;
- additional sources for further development of private business.

6. Conclusion

To sum up, it is important to note that at the moment there is no system of normative legal acts defining organizational and legal forms in the framework of international and national scientific cooperation in the implementation of projects of the “mega-science” class as well as for the revealing of the features of budget and extrabudgetary funding of unique scientific facilities of the “mega-science” class for account of Russian and foreign sources.

Thus, along with ensuring the implementation of projects within the framework of the scientific and technological development of Russia, including “mega-science” projects, at the expense of budget funds, other types of financing should be actively introduced through the use of private capital in the form of public-private partnership.

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