

# Modern forms of project interaction of science, business, and government in the coal industry

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**Abstract.** The fuel and energy complex (FEC) of Russia is going through hard times. The problems of development and investment are particularly acute in the coal sector, where demand and prices have fallen particularly hard due to the financial crises of 2008 and 2014, unstable energy prices, sanctions and the transition of a number of countries to “carbon-free energy development”. In these circumstances, only the transition to flexible technologies, which are able to quickly adapt to changes and extinguish the external negative shocks, within the framework of close cooperation of science, government and business can save the Russian coal industry. The purpose of this article is to analyze the currently available project forms of cooperation between science, business and government for the benefit of the innovative development of the coal industry and to summarize the experience of implementing such project forms of cooperation at the Federal Research Centre of Coal and Coal Chemistry of Siberian Branch of the Russian Academy of Sciences (FRC CCC SB RAS), Kemerovo region.

## 1. Introduction

The fuel and energy complex (FEC) of Russia has always been and still is a key sector of the Russian economy. The characteristic feature of this sector is capital intensity and a long period of return on investment. This hinders the attraction of investment in the fuel and energy sector and limits the possibilities for innovative development. These problems are particularly acute in the coal industry, where demand and prices have fallen particularly hard due to the financial crises of 2008 and 2014, unstable energy prices, sanctions and the transition of a number of countries to “carbon-free energy development”. Unfavorable conditions for development and investment in related industries (coal engineering, transport and coal generation) also had a negative impact on the coal industry. While until 2008 infrastructure projects for the coal industry were actively financed from the budget, state funds, special programs of direct state support, etc., during the crisis, these sources of direct and indirect support for the coal industry decreased considerably.

The coal industry is seriously affected by the worldwide transition to new technologies within Industry 4.0: digitalization, robotization, modern big data processing systems, and the development of the industrial Internet, which displace people from all stages of the production process, including transportation and logistics, and further reduce the investment cycle in all sectors, making long-term investments in coal mining and coal energy even less attractive. In these circumstances, only the transition to flexible technologies, which are able to quickly adapt to changes and extinguish the



external negative shocks, within the framework of close cooperation of science, government and business can save the Russian coal industry.

The purpose of this article is to analyze the currently available project forms of cooperation between science, business and government for the benefit of the innovative development of the coal industry and to summarize the experience of implementing such project forms of cooperation at the Federal Research Centre of Coal and Coal Chemistry of Siberian Branch of the Russian Academy of Sciences (FRC CCC SB RAS), Kemerovo region.

## 2. Data and method

When preparing the article, the authors used the data of the Ministry of Energy of the Russian Federation and the Federal State Statistics Service. The principle research methods were the descriptive method and case-study.

## 3. Discussion of the problem

### 3.1. Forms of project interaction of science, business, and government in the coal industry and in related industries

As of the beginning of 2017, there were 181 coal mining enterprises in Russia, including 66 mines and 115 open-cuts. Coal processing was carried out at 65 coal washing plants, as well as at the sorting facilities existing in the majority of coal companies (table 1).

**Table 1.** The number of coal enterprises in the Russian Federation in 2016–2018.

Year / indicator	Total number of coal enterprises	Number of coal mining enterprises		Number of coal washing plants
		mines	open-cuts	
2016	191	60	131	63
2017	181	66	115	65

Currently both in Russia and in the world much attention is paid to project forms of interaction of science, government and business in the fuel and energy sector and related industries. The analysis of the world energy sector allowed the authors to conclude that the priority directions of joint projects in the energy sector are: (1) the development of modern technologies for the production of complex and hard-to-recover geo-resources in small fields with the use of low-waste technologies; (2) the support of independent companies (IC) and the promotion of national (local) markets; (3) the development of flexible transport systems and logistics; (4) the support of extensive cooperation of the independent oil and gas companies (IOGC) with the companies of related industries, service and engineering companies, created research organizations and major machine-building companies; (5) the formation of open branched fragmented value chains within large vertically integrated companies (VICs); (6) the creation of conditions for the localization of supporting and related industries, providing a comprehensive and balanced development of the territories where VICs and ICs are located.

To date, in the Russian coal industry and the related industries there is a fairly well-defined range of available project forms of cooperation between government, business and science. The most common forms include:

- self-supporting infrastructure projects financed on the basis of self-sufficiency at the expense of the National Welfare Fund (infrastructure projects) and the Russian Direct Investment Fund,
- concessions,
- public-private partnership agreements (PPP projects),
- Federal target programs (FTP),
- projects implemented in the framework of the Decree of the RF Government No. 218 dated 9 April 2010 (Government Decree No. 218),
- special investment contracts (SPIC).

These project forms of cooperation differ in the scale of projects, the degree of innovation, the nature of management and the ways of involving the parties in cooperation, etc. It is important to emphasize that all these forms of cooperation are aimed directly at the development of the coal industry, their task is to remove barriers to its development through developing related industries (transport, energy, coal engineering, etc.). This practice is not exclusively Russian. All over the world, the companies operating in the industries related to FEC receive state support. Table 2 gives a brief description of these forms and a list of related industries in which they are most common.

**Table 2.** The number of coal enterprises in the Russian Federation in 2016–2018 [1-6].

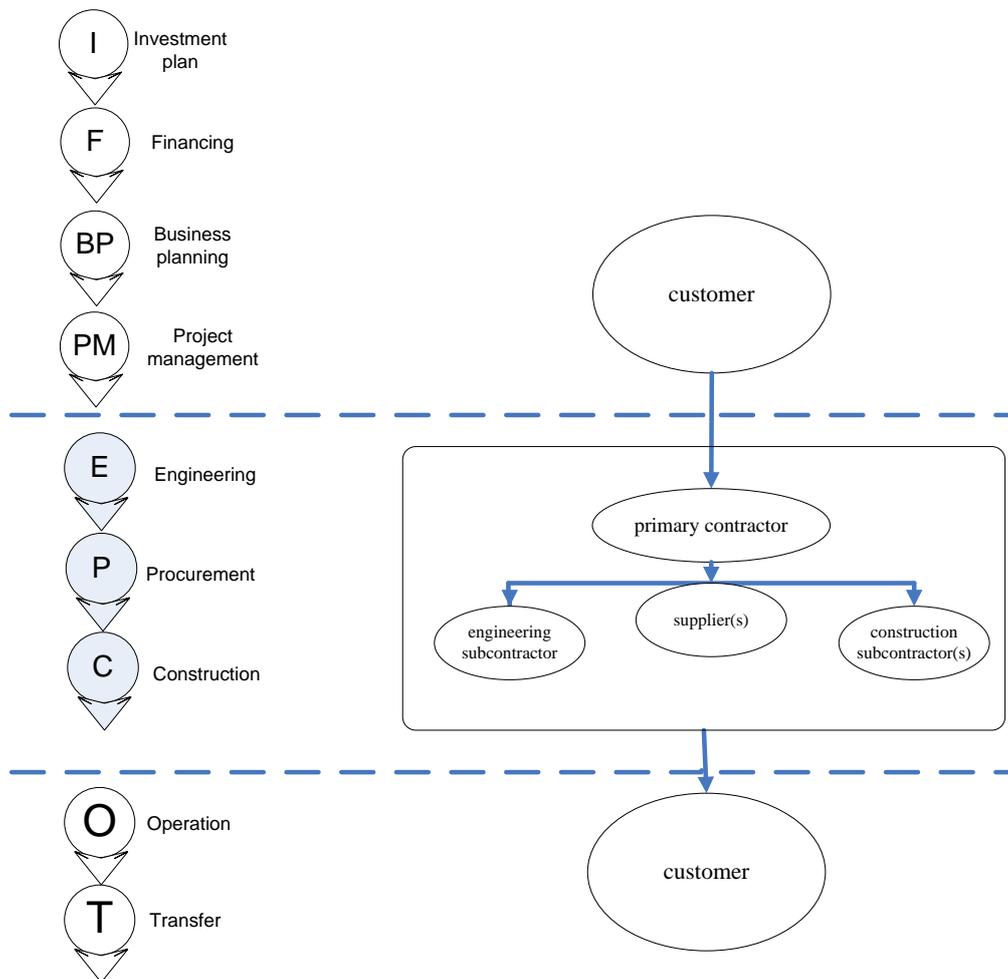
Form	Definition	Relation to FEC	Specifics of interaction between parties, and degree of innovation development
Infra-structural project	A major infrastructure project of particular importance for the development of the industry (region), included in the list of Federal (regional) projects financed by the National Welfare Fund.	Development of transport and energy infrastructure, development of new deposits	The state provides the funding on a return basis, the business implements the project The stage of mass production The scientific organization can be involved at the stage of development and implementation of the contract
Concessions	Agreements permitting, under certain conditions, to perform prospecting, exploration and (or) exploitation of mineral deposits owned by the state (or local authorities). Concessions are legally formalized through the contracts for the provision of rights, licenses, or lease.	Development of transport infrastructure	The business provides the funding and implements the project, the state grants exclusive rights to use the created or reconstructed objects The stage of mass production The scientific organization can be involved at the stage of development and implementation of the contract
PPP project	Cooperation of the public partner, on the one hand, and the private partner, on the other hand, which is legally formalized for a certain period of time and based on the pooling of resources and the distribution of risks	Attracting investments to infrastructure projects and programs for the development of new territories, including resource regions	The business creates or reconstructs the object, manages the object, and after the return of the invested funds returns the object to the state The stage of mass production The scientific organization can be involved at the stage of development and implementation of the contract
Federal target program	The program of budget funding of research, giving access to specific developments and products in the technological areas that are a priority for the Russian economy and contribute to improving its competitiveness through cooperation between business and scientific organizations.	Possibility of financing high-tech innovations for the benefit of fuel and energy complex and related industries on the basis of converting the results of scientific research into a market product.	The state provides funding to the scientific organization at the stage of R&D with the obligatory participation of business as an industrial partner, which undertakes the duty to introduce innovation and receives rights to intellectual property created during the project.

Government Decree No. 218	The program of development of cooperation between Russian higher education institutions, state scientific institutions and organizations implementing complex projects for the creation of high-tech production.	. Possibility of financing high-tech innovations for the benefit of the fuel and energy complex and related industries on the basis of converting the results of scientific research into a market product.	The state provides funding to the business at the stage of experimental industrial production with the obligatory participation of the scientific and educational organization
SPIC	The agreement between the investor and the state, which fixes the obligations of the initiator of the project to develop a new production of industrial products within the prescribed period, as well as the obligations of the Russian Federation and (or) its subject in terms of guarantees of stability of tax and regulatory conditions and the provision of support measures.	Possibility of financing the introduction of high-tech innovations for the benefit of the fuel and energy complex and related industries on the basis of converting the results of research into a market product and the creation (expansion) of markets for innovative products	The private investor undertakes to create or modernize and (or) master the production of industrial products in the territory of the Russian Federation, and the state (subject of the RF) undertakes to guarantee the sales market and tax benefits for the entire duration of the project. The stage of mass production The scientific organization can be involved at the stage of development and implementation of the contract

### 3.2. EPC contracts with the engineering firms

As foreign experience shows, the optimal choice of the project operator – the organization that cooperates with the regional authorities, business and scientific structures – plays a crucial role in the success of the project. The operator can be a private manufacturing company, a public authority or a private intermediary agency. However, specialized engineering firms are the best operators in fuel and energy projects. The modern market of engineering services is characterized by a complex, multistage structure, complex forms of interaction between the customer and the contractor, so EPC contracts (engineering, procurement, construction contracts) are often used in such projects. Figure 1 shows a detailed scheme of the EPC contract.

The EPC contract is a contract for the turn-key construction (reconstruction) of an industrial facility. The engineering firm acts as an EPC contractor that performs the bulk of the investment and construction project and assumes all the risks of its implementation from the moment of design to the moment of transfer of the finished object to the customer (including the fulfillment of warranty obligations), for which the contractor is financially responsible to the customer [8]. The advantage of EPC contracts is the possibility to reduce the project implementation period due to the possibility of parallel launching of works (the start of the next stage before the finish of the previous one, as it is not necessary to complete the design work to start the construction). Despite the fact that EPC contracts are usually signed for turn-key construction projects where licensed proven technologies are used, technology developers are still actively involved in those projects to take into account the specific conditions of the project. The advantages of EPC contracts include the reconciliation of a fixed cost, which protects both the investor and the customer from many investment and construction risks [9]. Currently, the major international contractors are companies from industrialized countries, although in the past 20 years companies from developing countries, primarily China, have become increasingly involved (see table 3).



**Figure 1.** Scheme of the EPC contract [7].

**Table 3.** Countries with the most developed contract markets [10-12].

	Country	Cumulative turnover of the companies, billion US dollars	Number of companies
1	China	124.050	62
2	Spain	78.896	13
3	USA	71.069	32
4	France	50.744	5
5	Germany	46.547	5
6	South Korea	42.422	13
7	Brazil	41.877	4
8	Italy	28.899	16
9	Japan	22.246	14
10	Turkey	20.409	42

The main areas of EPC contract cooperation in the world include the construction of buildings (25 – 26.5%), transport infrastructure (26–28%), and oil and gas complex (18 – 23%). Energy and mining facilities account for less than 7% [10]. The structure of EPC projects in the fuel and energy sector is presented in table 4.

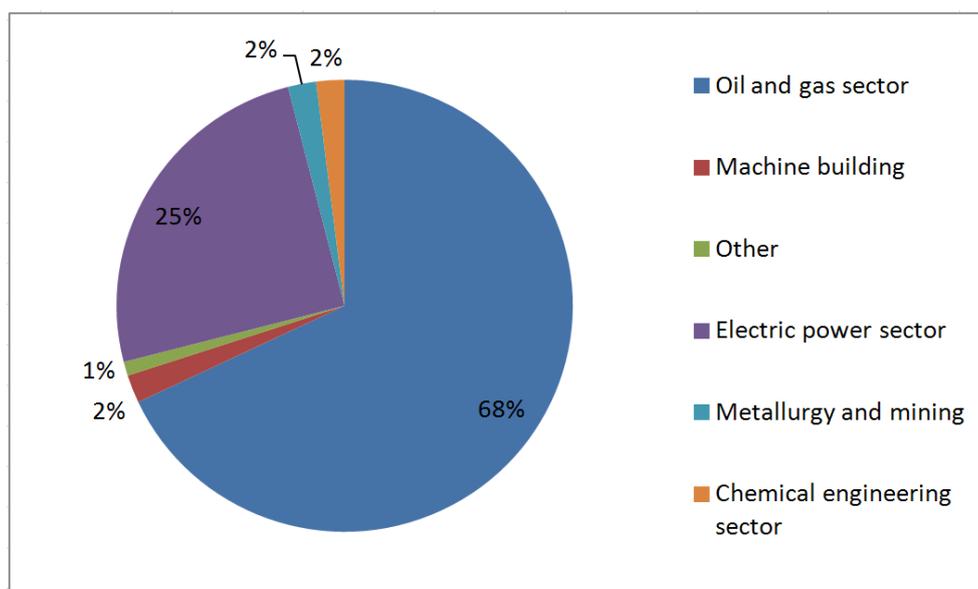
**Table 4.** Countries with the most developed contract markets [10-12].

	Sphere of activity	Number of projects
1	Oil and gas sector	1 135
2	Extraction of mineral resources	627
3	Electric power industry	561
4	Construction and infrastructure	78

Engineering contracts in the coal industry are widely used in the following activities: 1) exploration and development of deposits; 2) the construction and maintenance of facilities for production, processing, transportation and storage of coal; 3) the construction and maintenance of processing facilities [13].

### 3.3. Experience of cooperation between science, government and business in Russia with the participation of engineering companies

In Russia, EPC contracts are still rarely used, and engineering is understood in a very narrow sense as equipment installation and commissioning, which does not correspond to the modern world trends, the engineering services market is concentrated in the oil and gas sector, which accounts for more than 70% of the revenue of engineering services (figure 2). A small number of EPC contracts have been signed in the energy sector, the first contracts appeared in the sphere of coal mine construction. The demand for the services of engineering companies in Russia is formed mainly due to government orders and public corporations, which helps to attract the world's largest providers of EPC services to the Russian market. At the same time, one of the main drawbacks of attracting foreign companies is the high price for the services provided under the contract. This, in turn, gave impetus to the emergence and development of domestic engineering companies in Russia, which were formed basing on the pre-existing structures. However, in most cases, foreign engineering firms with licenses for modern technologies act as primary EPC contractors in the fuel and energy sector in Russia. Domestic companies mainly act as intermediary agencies. The share of large completed projects is still very small. All this leads to the conclusion that in Russia the EPC contracts market is at the stage of formation.

**Figure 2.** Structure of the Russian engineering services market [15].

To understand the key success factors of project implementation, especially in the coal industry, it is important to analyze all of the project forms of cooperation of government, business and science, and the projects involving engineering firms deserve particular interest.

In 2014, the engineering company “InTechPromEngineering” was established in Kemerovo region for preparing and implementing the major regional projects in the mining sector. The founders of the company were the Institute of Coal of the Siberian Branch of the Russian Academy of Sciences, Kuzbass Center of Welding and Control (the industrial partner of joint projects) and the non-profit organization (public professional association) “Association of machine builders of Kuzbass”. This created the conditions for long-term cooperation of government, business and science representatives in the coal mining region [16]. OOO “InTechPromEngineering”, basing on the results of the intellectual activity of the FRC CCC SB RAS, is involved in the implementation of several innovative projects for the benefit of the coal industry: the first stage of the regional project “Creation of new types of tools based on superhard composite materials for the effective destruction of rocks” has been implemented in the framework of the Federal target program; currently, several projects focusing on efficient and safe extraction of coal from thick steep and shallow seams using the elements of robotization in the main technological operations are being implemented [17]. Specialists from India, Georgia, and Vietnam have shown interest in the first results of the projects, which confirms their innovative character and allows developing the export component. In order to stabilize the implementation of these and future projects, the regional association of employers “Kuzbass Union of Employers” has signed the three-way Agreement with the Autonomous non-commercial organization “National Center for Development of Public-Private Partnership” (Moscow) and the Board of Administration of Kemerovo region addressing the development of PPP projects in the region [18]. In order to create a methodological base and monitor the implementation of PPP projects in the coal industry and related industries, in 2018, a specialized project office was created on the basis of the Laboratory for monitoring and forecasting of PPP projects in the field of integrated subsoil development of the FRC CCC SB RAS; the Office involved the specialists from Kemerovo region and neighboring regions.

This experience is interesting it shows a practical example of uniting and formalizing the interests of the authorities, business structures, and scientific organizations in the development of the leading industries (mining and engineering) in a certain region.

#### **4. Conclusion**

The analysis showed that Russia has created sufficient organizational and legal conditions for fruitful project cooperation between government, business and science in the coal industry in the field of innovation. However, despite the fact that there is a significant demand for such projects, modern forms of interaction are being implemented very slowly. This is especially noticeable on the example of the projects involving engineering firms as the main operator. In these circumstances, the experience of particular small regional engineering companies is extremely important, as in the long term they can become the ‘seedlings’ for the formation of new effective forms of cooperation in this field.

#### **Acknowledgements**

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