Complex contracts in industrial construction –instrument for sustainable territorial development

Vitaly Shcherbakov and *Sergei* Beliakov[1]

Moscow State University of Civil Engineering, Moscow, Russian Federation

Abstract. The main volume of generation in the Russian electric power industry is provided by thermal power plants, causing the most extensive damage to the environment. The growing problems in ensuring environmental safety and the urgent need to reduce the harm to nature and public health must be addressed within the framework of the construction of new and reconstruction of existing facilities in the implementation of state programs to ensure sustainable development of territories. Organizational and managerial aspects of the application and improvement of mechanisms for the implementation of eco-innovations in the framework of industrial construction should be considered in the context of organizational and contractual modeling of the interaction of milestones of participants in investment and construction activities. The use of costly evaluation methods to confirm the results of the development and implementation of eco-innovations is a promising direction in using of complex contracts and their evaluation in the industrial construction of electric power facilities, taking into account their innovative nature.

Keywords: complex construction contracts, ecology, eco-innovations, cyclical economy, economics, industrial construction, electric power, thermal power.

1 Introduction

Today, industrial construction is subject to increased requirements to ensure environmental safety at all stages of the life cycle (LC) of a construction object, starting from the pre-investment stage (strategic [1] and territorial planning [2]), the pre-project stage (engineering surveys and environmental impact assessment [3]), at the stages of design, construction and ending with operation and disposal, technical and environmental solutions for which should be incorporated in the design [4-6]. Due to the scale of the facilities being built and reconstructed, industrial construction is one of the most significant factors of the future environmental situation in Russia and in the world.

[1] Corresponding author: serj-bel@yandex.ru

Electric power construction, as a key factor in the development of the real sector of the economy and the electric power industry as a whole, as the most energy–intensive sector of the Russian economy (27.4%) [7], depend on current trends, consisting in a simultaneous increase in energy consumption and at the same time increasing energy efficiency, the dynamics of these indicators directly affects the environmental situation - energy consumption over energy efficiency worsens the environmental situation. The increasing global energy consumption and energy efficiency are associated with the growth of scientific and technological progress and the transition to a possibly new technological and world economic structure (digitalization, robotization, nanotechnology, etc.) [8]. Also, energy efficiency is dictated by the need to reduce costs and environmental burden, which is enshrined in Russian and international legislation. In Russia the growth of production (with the exception of 2020 and 2022) and the critical environmental situation in large cities [9] and in mining sites [10, 11] are added to these factors, respectively. These trends should be taken into account when designing industrial construction facilities within the framework of the implementation of complex construction contracts, including engineering surveys, design and construction. In addition, the direct process of construction of complex and large-scale industrial facilities, including electric power, requires the development and implementation of organizational and technological solutions that take into account the environmental load during the work [12]. Therefore, one of the features of integrated industrial construction in general and electric power construction in particular is the environmental aspect.

Despite the growth of renewable energy generation in Russia by 62% in 2021 compared to 2020, the share in the total generation volume is only 0.5%. The main volume of generation is accounted for by thermal power plants (TPP) (61.6%), and the share of thermal power plants in the increase in generation in 2021 compared to 2021 was a record 84.8% [13]. For the coming decades, there is no alternative to replacing thermal power plants with renewable energy if there are sufficient energy resources (gas, oil and coal) in the bowels of the country, ensuring both long-term generation growth and economic independence in the conditions of sanctions policy. In addition, the basic option of commissioning new capacities in the amount of 100 GW by 2035 provides for 70% of them for the construction and modernization (reconstruction) of thermal power plants [14].

The conversion of thermal energy into electrical energy at thermal power plants is carried out by burning gas, coal, heating oil, oil shale and peat, in exceptional cases diesel fuel, and the subsequent conversion of water into steam, which creates by many indicators the largest man-made environmental burden of all sectors of the national economy of our country.

The main negative impact from the operation of thermal power plants is due to:

- emissions of polluting agents into the atmosphere in the form of dust, sulfur oxides, nitrogen and carbon;
- emissions into the atmosphere, followed by gravitational deposition, of ash particles with a high content of uranium-238, radium-226, polonium-210, lead-210, 212 and 214, thorium-232, potassium-40, etc., which are then washed into the soil (for coal-fired thermal power plants);
- emissions of steam from cooling towers into the atmosphere (10% of heat generated by thermal power plants);
- discharge of heated cooling system waters into surface waters (50% of heat generated by thermal power plants);
- discharge of chemically contaminated wastewater into surface waters;

- acoustic pollution (noise);
- electromagnetic fields.

During the construction of thermal power plants due to:

- alienation of land;
- deforestation;
- exhaust gases;
- dust from loose building materials (sand, cements, loose mixtures);
- storage of construction and household waste, followed by leaching of harmful substances into the soil;
- leakage of petroleum products into the soil from the equipment used in construction.

According to some data, thermal power engineering makes the greatest contribution to environmental pollution on the scale of Russia [15].

Thus, when implementing and evaluating the effectiveness of complex construction contracts in the electric power industry, it is necessary to take into account the environmental component, which is an urgent and promising task.

2 Methods

Organizational and managerial aspects of the application and improvement of mechanisms for the introduction of eco-innovations in the framework of industrial construction should be considered in the context of organizational and contractual modeling of the interaction of milestones of participants in investment and construction activities. Taking into account the long-term nature of the processes of implementing eco-innovations and achieving its results, the instrument of organizational, managerial and economic modeling in this case should be complex contracts covering a significant part of the total life cycle of the industrial construction objects being created.

Since complex construction contracts in industry are engineering and inherently innovative contracts, the environmental component of the implementation of such contracts should correspond not only to the current level of scientific and technological progress, but also take into account promising areas of further development, including the development of consumers of products and other entities (the state and society).

The life of the TPP is on average 30-50 years, the construction period is 2-5 years, therefore, the cumulative period of the TPP housing and communal services is a factor in planning and implementing technical and environmental components for this period, taking into account subsequent modernization, expansion and liquidation. Engineers, economists, lawyers and scientists in the field of environmental innovations (eco-innovations) are engaged in solving the problems of promising technological areas of environmental safety. Despite the wide variety of definitions, the essence of eco-innovations is reduced to the development and implementation of proven technologies that can ensure the development of any branch of the national economy by reducing the negative impact on the environment [16-20]. Such an effect can be achieved both directly – through energy efficiency and reducing emissions of polluting substances and greenhouse gases, replacing raw materials with more efficient and energy-saving ones, recycling waste, and indirectly through state incentives for the introduction of eco-innovations in the economic activities of enterprises.

Alenkova I.V., in her work on the assessment of ecological and innovative activity of industrial enterprises [21], highlights among others effective and costly eco-innovations. By

effective, the author understands such eco–innovations that, when implemented, give a positive economic effect, and costly - "investments in which exceed the economic effect of their implementation." This approach reflects the real situation when eco-innovations can reduce the income of the enterprise that implements them. Such a situation can develop either with errors in economic planning and implementation, or in the case of state coercion, or when an enterprise tries to increase its capitalization by improving its image. Also, the introduction of eco-innovations may cost more than the economic effect, for example, in the case of state programs for environmental improvement and co-financing, when the loss of the enterprise is assumed by the state.

But the examples listed above are rather special cases and do not reflect the general pattern, which consists in the direct dependence of the dynamics of the development and implementation of eco-innovations on their economic efficiency, along with other barriers: technical and technological, legal, political and organizational constraints, infrastructure constraints. But the leading factor is the economic feasibility and security of the state, which is confirmed by statistical and other studies [22, 23].

This implies the main directions of solving this problem:

1. Finding a balance between the costs of innovation by enterprises, long-term sustainable development of territories and the profit of participants in investment and construction activities.
2. The implementation of the legislative and regulatory framework in the field of ecology in accordance with the realities and opportunities of business, the requests of society.
3. Development of scientific and engineering potential of the national economy.
4. Development of mechanisms for the formation and implementation of public initiatives.

The models proposed by Savitskaya G.V. [24], Bazhenov O.V. [25], Maltseva O.P. [26], Murzina A.D. and Murzina S.M. [27], Balandina O.V. [28], Damineva R.M. [29], Ratner S.V. and Iosifova V.V. [30] et al. can serve as examples of mathematical methods for calculating the balance between the costs of implementing eco-innovations by an enterprise, its long-term sustainable development and the profit of enterprises. In particular, to solve financial planning tasks, it is recommended to use the existing software packages Maple, Mathematica, Matlab and Statistica [31], taking into account the environmental component, individually in each case, choosing the appropriate program in which the task is solved easier.

3 Results

In the most comprehensive form, the studied problems can be formulated as the need to develop economic and mathematical methods and organizational and managerial tools based on them, ensuring the choice of effective eco-innovations in the field of industrial construction and the effectiveness of their implementation, taking into account the balance of interests of subjects of investment and construction activities, the state and society as a whole.

The prospect of improving models for assessing the economic efficiency of the development and implementation of eco-innovations, taking into account their level of environmental effect, is to form a generalizing system of indicators reflecting the targets at all hierarchical levels of project implementation:

1. At the level of an investment and construction project:

- assessment and selection of eco-innovations and investment projects according to their economic and environmental feasibility, taking into account the prospects of modernization and liquidation;
- ensuring an acceptable level of efficiency (profitability) for all participants in investment and construction activities, taking into account the time factor in medium- and long-term planning.

2. At the regional and state level:
   - ensuring environmental and socio-economic efficiency within the framework of sustainable development of territories;
   - assessment of expediency and adoption of decisions on state co-financing or provision of other preferences that would compensate for possible economic losses of a particular economic entity from the introduction of eco-innovations.

Legislative initiatives today, as many researchers note, are not sufficiently developed for the effective implementation of eco-innovations by enterprises, including in the electric power complex, in which the influence of the state is most pronounced (more than 80% of electric power enterprises belong to the state).

But, in our opinion, entrepreneurs and investors need a simple and understandable model for making managerial decisions in the field of development and implementation of eco-innovations. Such a model should include:

- motivational part in the form of a high fee for the negative impact on the environment;
- system of preferences from the state for the introduction of proven eco-innovations, depending on the level of environmental efficiency;
- system for assessing the environmental and economic effect approved by the state to confirm the receipt of preferences from it.

Schematically, this approach is shown in Figure 1.

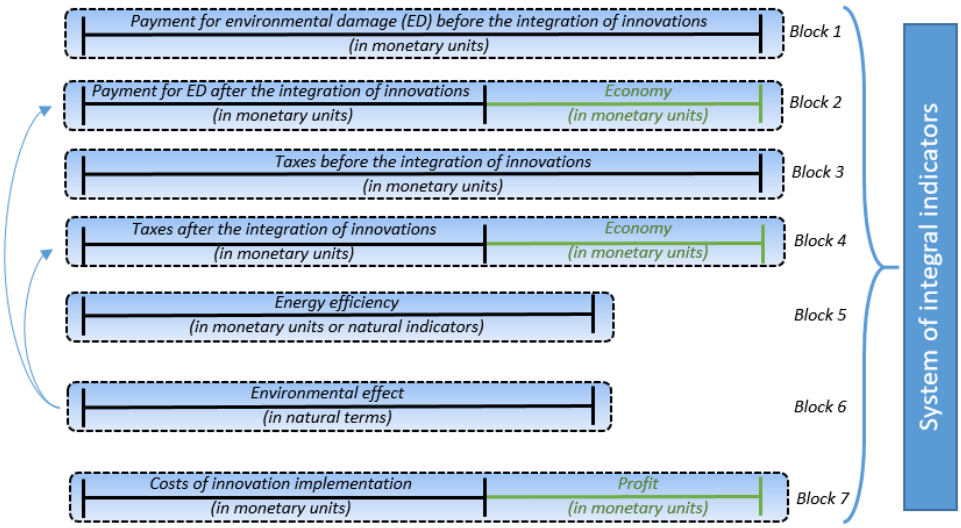

Fig. 1. Schematic diagram of the mechanism for assessing eco-innovations when receiving preferences from the state.

The evaluation system should be two-stage. At the first stage, a model is used to select an eco-innovation based on an integrated indicator consisting of:

- energy efficiency from the integration of eco-innovations;
- provable environmental effect according to the required environmental indicator or indicators;
- indicator of the dependence of state preferences on the environmental effect;
- economic efficiency of eco-innovations in terms of profit, taking into account discounting and cash flow, as well as preferences from the state for the environmental effect.

The target function system can take the form:

$$\{E_{int} = \sum_{i=1}^{t} \Delta C_r * k_i - C_0 \rightarrow max\, R_{eco} \rightarrow min\, R_{tech} \rightarrow min\, E_{inv} \rightarrow max \quad (1)$$

where E_{int} - integral effect of the implementation of eco-innovations;

ΔC_r - saving resources as a result of the implementation of eco-innovation;

k_i - value of the weighting factor, taking into account the importance of certain aspects of eco-innovation;

C_0 - costs of innovation;

R_{eco} - environmental risks;

R_{tech} - technical and technological risks;

E_{inv} - investment efficiency for project participants.

At the second stage, the actual effect is calculated according to the same indicators at various stages of the object's housing and communal services.

Based on the evaluation results, indicators should be developed that determine the contractual mechanism for the implementation of an investment and construction project.

4 Discussion

In our study, attention is focused on "lost" energy, the reduction of which leads to energy saving and, accordingly, gives a multiplicative effect on saving the energy carriers used, starting from their extraction to involvement in the workflow aimed at both labor and consumer goods. The formation of a reasonable level of quality of the living environment in various locations in urbanized territories will serve as an incentive to their effective development.

$$EF_e = EF_0 - EF_{inn} \quad (2)$$

where, EF_e efficiency savings from innovation;

EF_0 - efficiency before innovation;

EF_{inn} - efficiency after the implementation of innovations.

At the same time, any amount of energy and of any kind can be expressed in man-hours of simple labor. And man-hours, in turn, can be translated into monetary terms. This approach makes it possible to measure the characteristics of any equipment, including energy, and compare them with each other.

In this regard, the transition to the assessment of scientific and technological progress by the criterion of labor saving can also be used to calculate the effect of energy saving. The greater the labor savings of innovative technology in its consumption and the reduction of losses of non-involved energy carrier energy, the greater the energy saving effect, respectively, and hence the environmental effect.

5 Conclusions

The use of costly evaluation methods to confirm the results of the development and implementation of eco-innovations, in our opinion, is a promising direction in the implementation of complex contracts and their evaluation in the industrial construction of electric power facilities, taking into account their innovative nature. This problem is connected with the need to implement programs aimed at building a closed-cycle economy (circular economy or cyclical economy), which is especially relevant in today's conditions of sanctions policy, the need for industrialization and ensuring Russia's energy security. In this regard, the experience of state planning of the PRC [32] and state regulation of Japan, Belgium, UAE, Canada, Germany [33] and other countries that are leaders in building a cyclical economy today can also be useful.

The boundaries of the introduction of eco-innovations are reduced to the development and implementation of proven technologies to reduce the negative impact on the environment, as a rule, provided that the development of sectors of the national economy and employment of the population is ensured, which is a pattern in the form of dependence of eco-innovations on the economy. In this regard, there is a need for state planning and regulation to stimulate investment in eco-innovations on the one hand, as well as the development of mechanisms for the implementation and evaluation of complex contracts in the implementation of ICPs in terms of the introduction of eco-innovations.

References

1. M. Yu. Dyakov, E.G. Mikhailova, V.N. Sharakhmatova, Problems of territory development, 2(100) (2019)
2. I. V. Ivashkina, Ecological aspects of territorial planning of the city of Moscow, in Geography and Geoecology: problems of science, practice and education, Moscow State Regional University, Moscow (2016)
3. Environmental impact assessment – mandatory requirement provided for by Russian and foreign legislation (Federal Law No. 7–FZ dated 10.01.2002 (as amended on 14.07.2022) "On Environmental Protection", Directive 2014/52/EU of the European Parliament and of the Council of April 16, 2014, National Environmental Policy Act, NEPA, etc.) (2022)
4. Decree of the President of the Russian Federation No. 216 dated 13.05.2019 "On Approval of the Energy Security Doctrine of the Russian Federation". Paragraph 22, subparagraph M, paragraph 26, subparagraph B (2019)
5. Federal Law No. 7-FZ dated 10.01.2002 (as amended on 14.07.2022) "On Environmental Protection" (with amendments and additions). Article 2, Paragraph 7, Article (2022)
6. Federal Law No. 174-FZ dated 23.11.1995 (as amended on 14.07.2022) "On Environmental Expertise" (2022)

7. On the state of energy conservation and energy efficiency improvement in the Russian Federation in 2021, State report of Ministry of Economic Development of the Russian Federation (2022)
8. S. Yu. Glazyev, A leap into the future. Russia in the new technological and world economic structures (Book World, 2018)
9. On the state and environmental protection of the Russian Federation in 2021, State report of Ministry of Natural Resources of Russia (2022)
10. H. B. Badarchi, D. F. Dabiev, Economic Analysis: Theory and practice, 46(349) (2013)
11. The main indicators of environmental protection. Statistical Bulletin, Federal State Statistics Service (ROSSTAT) (2021)
12. A. A. Lapidus, R. L. Makedonska, Construction production, 3 (2019)
13. On the state of energy conservation and energy efficiency improvement in the Russian Federation in 2021, State Report of Ministry of Economic Development of the Russian Federation (2022)
14. F. Veselov, A. Solyanik, L. Urvantseva, Energy Policy, 11(165) (2021)
15. V. F. Protasov, Ecology, health and environmental protection in Russia (Finance and Statistics, 2000)
16. M. P. Imekova, Eco-innovation as a means of ensuring environmental safety, in Modern problems of ensuring environmental and food security, Volgograd Institute of Management – branch of the Russian Academy of National Economy and Public Administration, Volgograd (2019)
17. M. Brutyan, Self-government, 3 (2012)
18. I. V. Prikhodko, Mizhnarodny naukoviy journal of International Science, 2(42) (2018)
19. E. I. Pavlova, Creative economy, 2(86) (2014)
20. E. V. Lyadova, World experience in the application of eco-innovations, in Socio-economic prerequisites and results of the development of new technologies in the modern economy, Nizhny Novgorod (2022)
21. I. V. Alenkova, Assessment of ecological and innovative activity of industrial enterprises, Dissertation of Candidate of Economic Sciences, Nizhny Novgorod (2021)
22. K. Elsayed, D. Paton, Structural Change and Economic Dynamics, 3 (2005)
23. O. A. Borodina, Economic Sciences, 2-2 (2022)
24. G. V. Savitskaya, Economic analysis (INFRA-M, 2017)
25. O. V. Bazhenov, Discussion, 7 (2013)
26. O. P. Myltseva, Russian entrepreneurship, 9-10 (2008)
27. A. D. Murzina, S. M. Murzina, Mining information and analytical Bulletin, 1 (2017)
28. O. A. Balandina, Actual problems of economics and law, 4 (2014)
29. R. M. Damineva, Bashkir Chemical Journal, 13-8 (2006)
30. S. V. Ratner, V.V. Iosifov, Financial analytics: problems and solutions, 34 (2016)
31. S. N. Yashin, I. L. Tukkel, E. V. Koshelev, S. A. Makarov, Yu. S. Korobova, Evaluation of the effectiveness of innovation activity (Publishing House of Nizhny Novgorod State University, 2018)
32. G. A. Shmarlovskaya, Vesnik MDU, 1(59) (2022)
33. M. A. Guryeva, V. V. Butko, Economic relations, 9-4 (2019)