

Project Risk Management of Electric Power Supply of Remote Consumers

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Abstract— The study presented in this paper analyzes the theoretical base for project risk management of electric power supply of remote consumers characterized by specifics of innovative projects. The essence and stages of risk management of the innovation projects are considered deeply. The main risks of this type of projects are considered by studying the example of the project of creation of an autonomous power complex for remote consumers. Risks are ranged on the basis of probability and the level of impact on project deliverables. Specific project risks on electric power supply of remote consumers are described, the recommendations about use of methods of quantitative risks assessment and implementation of anti-risk actions for increase in effective management of projects of this type are made.

Keywords: *remote consumers, autonomous energy complex, risk, project risk management, risk management, energy supply projects, risk assessment*

I. INTRODUCTION

Power supply of remote consumers is one of priority problems of strategic development of sparsely populated and remote territories for complex development of economic space of the Russian Federation.

Modern technologies based on application of renewable energy resources within autonomous power complexes are used in terms of the solution of this problem.

Today projects on creation of the isolated power supply systems in the remote areas where carrying out electrical networks is inexpedient already exist.

At the enterprises providing power supply of remote consumers methods of project management are implemented actively, instruments of scheduling and network, organizational, financial planning are used as well as mechanisms of project control and monitoring.

At the same time, energy supply projects for remote consumers are characterized by a high degree of uncertainty and complexity, involving many specialists, third-party contractors and companies, which increases the likelihood of risks of such projects.

At the same time, the innovativeness of such projects, the lack of practical experience, actualizes the risk management problem for projects of this type, since the methodological foundations of risk management for energy supply projects for remote consumers are only just beginning to take shape.

II. LITERATURE REVIEW

The carried-out analysis of references and researches of the Russian and foreign authors on a problem of risk management of projects of power supply of remote consumers showed that researches of the corresponding subject actually are absent that updates a subject of this article.

According to the author, because projects on power supply of remote consumers are innovative, they can use approaches which are offered by researchers for risk management of the innovation projects.

In a general, the risk of the innovation projects can be defined as the probability of the losses arising at the moment of investment of the organization's capital in production of new goods and services, in development of the new equipment and technologies which, perhaps, will not find the expected demand in the market and also at capital investment in development of managerial innovations which will not bring about the expected effect [5].

Decrease in probability of losses during implementation of the innovation projects is one of the most important functional tasks of the project manager as some risks can have catastrophic character and result in impossibility of obtaining the planned result. Therefore during planning and project implementation efforts on risk management are necessary.

In turn, risk management of the innovation project represents set of the practical measures that allow to reduce uncertainty of results of an innovation, to increase usefulness of realization of an innovation, to reduce costs for achievement of the innovation purpose [5].

The following features of risk management of innovative projects are highlighted by other researchers, which are also typical of energy supply projects for remote consumers:

- risk management of an innovation project depends on the scope of innovation and should take into account industry affiliation;

- a set of risks of the innovation project differs depending on project implementation phase;
- risks of the innovation projects possess the dynamic nature, the lack of repeatability and uniformity therefore they difficult give in to identification and forecasting [4] is characteristic of them.

In general, risk management process of the innovation project represents the sequence of the following managerial actions:

- detection and identification of project risks;
- qualitative and quantitative risks' assessment, ranging depending on influence on a resulting effect of the project;
- development of measures of counteraction to risks of the innovation project;
- optimization of risk management system of the project with taking into account costs for holding anti-risk actions;
- realization of the developed actions for elimination and minimization of risks of the innovation project, monitoring and risk control [3].

At the same time, most authors [2] emphasize that innovation projects are characterized by a significantly higher level of uncertainty in the phases of initiation and planning than projects without an innovative component. Consequently, risk management in the initial stage of innovative projects should be given special attention.

Monitoring and risk control of innovative projects must be carried out not only within the framework of separate phases and stages, but also because a high level of uncertainty due to the uniqueness of innovative projects requires the timely detection of threats and deviations in order to make management decisions to minimize them [8].

To create an effective risk management system for innovative projects, individual authors ([6], [7]) also recommend the creation of an informational base that stores information about risks identified at the planning stage of the project and their real occurrence, about measures taken to reduce and eliminate risks and their effectiveness, the costs incurred for anti-risk activities, and the losses averted. Despite the fact that the dynamic nature of the risks of the innovation project was pointed out, such a base can become one of the most important tools for making decisions in the field of risk management for enterprises implementing innovative projects, including ones in the field of energy supply to remote consumers.

Summing up all of the above, it is necessary to emphasize once again that risk management is an important and effective means of reducing the negative consequences of possible errors in the decision-making process and is aimed at removing possible uncertainties in the activities of enterprises [5].

III. RESEARCH METHODOLOGY

To study the risk management problem of energy supply projects for remote consumers due to the lack of a developed knowledge base and theoretical research on the topic, the author used a retrospective analysis of the implementation of this type of project using the example of the project "Development of a prototype and testing of an intelligent control system for an autonomous energy complex (AEC) with subsequent installation on the territory of the Radovo-Pokrovskaya monastic community in the Arkhangelsk region, and setting up trial operation for reserving of existing power consumers."

The project was implemented by Avangard OJSC, one of the largest enterprises in the RF electronics industry, with the involvement of other enterprises under external cooperation agreements (PSM LTD and RosModul LTD).

The project was implemented from January 16, 2017 to August 18, 2017.

Within the framework of the project, an autonomous energy complex was created, the main elements of which were a wind and solar generation system, a diesel generator set, an electric energy storage system, an energy conversion system and a source control system.

Based on the study of project documentation for the analyzed project, as well as reporting on the results of the project, the main problems, risks and threats that the project team encountered during its implementation were identified.

The international standard PMBoK [1], which provides comprehensive methodological techniques and tools for managing project risks regardless of their specifics, was also the methodological basis for the study of risk management of energy supply projects for remote consumers..

IV. RESEARCH RESULT

During the implementation of the project "Development of a prototype and testing of the intelligent control system for an autonomous energy complex (AEC), followed by installation on the territory of the Radovo-Pokrovskaya monastic community in the Arkhangelsk region, and setting up trial operation to reserve existing electrical receivers", no targeted risk management was carried out by the project team. However, according to the results of the implementation, the need for the formation of tools for identifying, assessing and managing risks in order to achieve more accurate results of projects of this type became apparent.

Based on a retrospective analysis of the project, it was revealed that when implementing energy supply projects for remote consumers, the project team may encounter risks that are typical for projects of any type (non-specific) in general, and specific risks that can arise only in projects of this type.

Based on the analysis of risks and threats faced by the team of the project in question. the author of the article compiled a register of risks of the project for energy supply to remote consumers (see Table 1), in which the risks are classified as non-specific and specific, and are also distributed by phase of the project.

TABLE I. RISK REGISTER OF ENERGY SUPPLY PROJECTS FOR REMOTE CONSUMERS

Risk	Probability of occurrence	Level of exposure	Risk rating
<i>1. Non-specific risks</i>			
1.1. Initiation risks			
1.1.1. Marketing (related to incorrect positioning, incorrect determination of the needs of target consumer groups)	0,1	0,8	0,08
1.2. Planning Risks			
1.2.1. The risk of errors in the calendar-network and organizational planning	0,3	0,3	0,09
1.2.2. Risks of incorrect project estimates	0,7	0,4	0,28
1.3. Implementation risks			
1.3.1. Technical risks (occurrence of breakdowns, malfunctions during the construction and installation of equipment)	0,5	0,6	0,30
1.3.2. Personnel risks (related to the lack of qualified personnel)	0,2	0,7	0,14
1.3.3. Contingency Risks	0,9	0,6	0,54
1.3.4. Risks of unsatisfactory quality of work	0,4	0,5	0,20
1.3.5. Risks of disruption to outsourced work	0,6	0,6	0,36
1.4. Completion risks			
1.4.1. Technical risks (problems in the implementation of commissioning, commissioning)	0,7	0,3	0,21
1.5. Exploitation risks			
1.5.1. Failure to achieve economic performance indicators	0,7	0,5	0,35
2. Specific risks			
2.1. Initiation risks			
2.1.1. Technological risks (risks associated with the wrong choice of energy supply technology, equipment configuration for a specific territory and category of consumers)	0,6	0,8	0,48
2.2. Planning Risks			
2.2.1. Design risks (deviation from predetermined technical characteristics, errors in the design documentation, unplanned increase in the volume of design work, additional tests)	0,7	0,7	0,49
2.3. Implementation risks			
2.3.1. Disciplinary risks (associated with the fact that workers carry out installation of equipment in remote areas with limited control capabilities)	0,3	0,2	0,06

Risk	Probability of occurrence	Level of exposure	Risk rating
2.3.2. Logistic risks (associated with the delivery of equipment and people to the project site)	0,4	0,5	0,20
2.4. Completion risks			
2.4.1. Difficulties in teaching consumers the proper operation of the complex	0,4	0,1	0,04
2.5. Operational Risks			
2.5.1. Failure to achieve energy efficiency indicators	0,5	0,8	0,40
2.5.2. The risk of misuse of the energy complex by remote consumers	0,2	0,5	0,10

Source: compiled by the authors

The risk register also indicates the range of probability of occurrence of risks and their impact on project results, they are rated on a scale from 0.1 to 0.9, where 0.1 is the lowest level of probability or impact, and 0.9 is the highest level of probability and impact. The risk rating of the project for providing remote consumers was also found, which is calculated as the product of the probability values and the impact of the risk in question..

So, the most significant risks of energy supply projects for remote consumers can be considered the risks of unforeseen costs (rating 0.54), design risks (0.49), technological risks at the project initiation stage (0.48), the risk of failure to achieve energy efficiency indicators (0,40), the risks of disruption to outsourced work (0.36), etc.

Note that the estimates obtained are based on the experience of implementing the project under consideration to create an autonomous energy complex on the territory of the Radovo-Pokrovskaya monastic community. However, in the case of the implementation of other projects of this type, it is necessary to revise the values of probability and impact based on data on the specific characteristics of a particular project.

The specific risks of energy supply projects for remote consumers should also be described in more detail.

So, even in the project initiation phase, companies implementing energy supply projects for remote consumers may encounter the fact that the choice of a specific configuration of an autonomous energy complex will be made on the basis of standard solutions, without taking into account the specifics of energy needs and the geographical, climatic factors of a particular territory.

In the process of designing autonomous energy complexes, the project team may also be faced with the need for additional design work and testing, which should be carried out at the enterprise's production base, which may increase the project's implementation time and require additional funding.

Also, a specific risk of energy supply projects for remote consumers in the implementation phase is the logistical risk associated with the need to transport project participants, equipment and tools to the site of the facility. In this case, there

may be disciplinary risks, difficulties in monitoring the progress of the project due to the fact that the implementation takes place in remote regions without the presence of senior management.

Risks of this type of project may also arise at the final stage due to the need to train remote consumers in the operation of autonomous energy complexes. Despite the existence of an intelligent management system, users should have the knowledge and skills to properly handle the equipment of the complex to ensure its long-term uninterrupted operation.

One of the most important risks of the implementation of the project for energy supply to remote consumers when creating autonomous energy complexes is the failure to achieve established energy efficiency indicators. So, in the project under consideration, several technologies were used to generate electricity - wind and solar, a diesel generator set. Obviously, the necessary level of efficiency of its use is achieved in the case of the predominant use of renewable energy sources. However, such generation depends on the natural and climatic conditions of a particular locality, which are difficult to predict in advance without first studying them.

Thus, the practice of implementing energy supply projects for remote consumers confirms that the implementation of such projects can be complicated by the emergence of threats and risks of various kinds.

V. CONCLUSIONS

Based on the study, it can be concluded that energy supply projects for remote consumers are characterized by a high level of uncertainty and risk due to the fact that they are not only threatened by common risks characteristic of most projects, but also specific ones that negatively affect the terms, implementation cost and quality of the final product of the project.

The presence of a significant number of non-specific and specific risks of energy supply projects for remote consumers suggests that risk management processes should not be ignored by a team of projects of this type.

In this regard the author of article recommends to perform fully at project implementation of this type all functions of a risk management

So, an important step in the risk management of a project for energy supply to remote consumers should be a quantitative risk assessment using sensitivity analysis methods, scenario analysis, and decision tree methods.

The scope of sensitivity analysis in energy supply projects for remote consumers concerns the identification of the most significant economic factors that affect the financial results and financial and economic efficiency of the project. Thanks to this analysis, the project management will receive data on the problematic items of income and expenses of the project and will be able to propose methods for their correction in advance.

Scenario analysis in projects to provide remote consumers is necessary to assess the impact on the project results (both financial and technological) of changes in various parameters of the project in order to assess the likelihood of a successful completion of the project and the feasibility of its implementation in the given conditions.

The decision tree method for project risk management can be used at the design and planning stage of the project to select the best technical solutions, decisions regarding the configuration of power equipment, decisions regarding the organization of the assembly and installation process, involvement of third-party organizations in the project implementation process, personnel and material support, etc. based on the assessment of the impact of various solutions on the final economic result by constructing a decision tree.

Also, for the most accurate calculation of the energy and economic efficiency of the project to create an autonomous energy complex with several types of generation, it is necessary to study the natural and climatic conditions of the area and conduct simulation of the parameters of the complex based on the observations.

A quantitative assessment of risks is necessary to understand the extent of economic losses that may arise as a result of their occurrence.

Focusing on the generated risk register, the results of a quantitative assessment of project management need to develop a set of measures to minimize and eliminate risks and threats with the highest rating. In Table 2, we present authors' recommendations to minimize non-specific and specific risks of energy supply projects for remote consumers. However, for each project they can be expanded and supplemented in accordance with the specifics of the particular project being implemented.

TABLE II. MEASURES TO MINIMIZE THE RISKS OF ENERGY SUPPLY PROJECTS OF REMOTE CONSUMERS

Title of risk	Recommendations
1.1.1. Marketing risks	The need for a thorough study of the needs of remote consumers, climatic and other features of the project
1.2.1. The risk of errors in the calendar-network and organizational planning	Application of specialized software for project planning, close monitoring
1.2.2. Risks of incorrect project estimates	Inclusion of cost reserves in the final project budget
1.3.1. Technical implementation risks	Careful monitoring of installation processes, ensuring the availability of additional parts, assemblies and tools for timely troubleshooting
1.3.2. HR risks	Ensuring a competitive salary, staff training
1.3.3. Contingency Risks	Using cost reserves, identifying opportunities to reduce costs for other project items
1.3.4. Risks of unsatisfactory quality of work	Application of quality control methods, stimulation (tangible and intangible) of project team members to improve the quality of project work
1.3.5. Risks of disruption to outsourced work	Careful selection of contractors, conclusion of contracts, which provide for sanctions in case of improper performance of work
1.4.1. Technical Risks of Completion	Reserving time for additional tests, attracting additional specialists

1.5.1. Failure to achieve economic performance indicators	Optimization of expenses and income during the implementation of the project
2.1.1. Technological risks	Testing equipment at the production base of the enterprise, studying the experience of already implemented projects
2.2.1. Design Risks	Quality control of project documentation, attracting highly qualified specialists
2.3.1. Disciplinary risks	Using remote control methods using information and communication technologies
2.3.2. Logistic Risks	Careful calculation of the most optimal schemes for the relocation of material and human resources to the project site
2.4.1. Difficulties in teaching consumers the proper operation of the complex	Create detailed instructions for consumers, as well as providing communication channels with specialists to quickly solve problems
2.5.1. Failure to achieve energy efficiency indicators	Consideration of the possibilities of modernization of the autonomous energy complex based on data on its actual operation
2.5.2. Risk of misuse of the energy complex	Service support for remote consumers

Source: compiled by the authors

The proposed activities give only a general idea of the direction of minimizing or eliminating certain risks. At the same time, when planning them, project management needs to remember that the cost of anti-risk measures should not exceed the amount of potential losses from their occurrence. Often, risks that have received a low rating are not at all in need of any managerial impact.

Thus, the risk management of energy supply projects for remote consumers should be systematic and reasonable.

VI. DISCUSSION

To date, the risk management system of energy projects for remote consumers is only just beginning to take shape. Integration of risk management into the general project management system of this type will allow:

- to implement projects just in time;
- to reduce financial losses at project implementation;
- to improve the quality of the final result;

- to increase the level of certainty of the project and the likelihood of achieving all planned goals.

With the formation of knowledge bases on risk management of this type of project, the accumulation of practical experience in risk management in this area, it will be possible to talk about improving methodological approaches to risk management of the projects under consideration. Today, even the compilation of a risk register of a project for energy supply to remote consumers, the development of general directions for minimizing risk, their monitoring and control during implementation can significantly improve the quality and effectiveness of projects of this type.

Further research in the field of risk management of energy supply projects for remote consumers, according to the author, should relate to issues of improving the quality of assessing the likelihood of project risks and their impact on project financial results. Also of interest is the formation of integrated risk management systems and the development of internal risk management standards at enterprises implementing projects of this type.

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