International Journal of Engineering

Journal Homepage: www.ije.ir

System of Comprehensive Assessment of Project Risks in Energy Industry

G. A. Stroykov[a], N. V. Babyr*[b], I. V. Ilin[c], R. S. Marchenko[c]

[a] *Organization and Management Department, Saint-Petersburg Mining University, Russian Federation*
[b] *Saint-Petersburg Mining University, St. Petersburg, Russian Federation*
[c] *Higher school of Business and Management, Peter the Great St. Petersburg Polytechnic, University Federal State Autonomous Educational, St. Petersburg, Russian Federation*

PAPER INFO

Paper history:
Received 19 April 2021
Received in revised form 08 May 2021
Accepted 06 June 2021

Keywords:
Project Risks
Energy Industry
Risk Assessment
Simulation Modeling
Monte Carlo Method
Investment Projects

ABSTRACT

The article proposes to consider the problem of comprehensive assessment of project risks as applied to the energy industry. The authors of the research focused on the description of the applied solution. A real investment project on replacement of a bark boiler at Mondi Syktyvkar enterprise was chosen as an object for testing the results. We proposed to divide the risks accompanying the project into 2 categories: risks for which there is necessary and statistical information for their quantitative assessment and risks for which this information is absent. As a technique of a quantitative assessment of risks from the first category it is expedient to apply a method of Simulation modeling of Monte Carlo. In this case, the authors of the article conducted a significant analysis of existing methods for assessing project risks and the choice of the Monte Carlo methodology is due to the practical orientation of the study. In practice, the real enterprise is quite problematic to use more complex methods of assessment, such as methods of Real Options or methods of fuzzy logic, neural networks, etc. As a method of qualitative risk assessment (from the second category) the method of expert evaluation with subsequent calculation of risk premium in the discount rate was chosen. This method is common in practice and easy enough to implement. According to the results of the analysis (statistical and expert) the most dangerous risks of energy projects were identified: Production and technological risks (the risk of choosing the wrong technological scheme, the risk of reducing the quality of internal controls, the risk of incorrect calculation of the design capacity of energy production, the risk of industrial safety), security risks (the risk of hacking attacks on information systems of energy enterprises), as well as country risks. Among the most influential risks (based on the analysis of their impact on the main technical and economic indicators of the project) are: the risk of rising prices for purchased gas (fuel), the risk of high volatility of the dollar exchange rate. The results of the study were used in a real project and the risk assessment methodology was implemented in the project activities of Mondi Syktyvkar enterprise.

***doi**: 10.5829/ije.2021.34.07a.22*

1. INTRODUCTION

Major investments in energy projects are fraught with a large number of risks that are both common to all investment projects and specific to energy industry. Lack of a comprehensive risk assessment methodology can result in negative consequences for the company.

As energy generating equipment that is operated by electricity providers (power grids, substations, and process control systems) and most manufacturing companies is always subject to wear, it becomes necessary to invest a large amount of money in equipment upgrades and projects connected with equipment upgrades in the energy industry. There are a lot of risks associated with such investments, including those specific to industry, that need to be correctly assessed at the stage of conducting a feasibility study for each investment project in energy sector. Companies usually do not use complex risk assessment methods; as a result, the quality of risk management deteriorates and they cannot reach the same quality level as some competitors boast. In fact, manufacturing companies

*Corresponding Author Institutional Email: babyr_nv@pers.spmi.ru (N. V. Babyr)

Please cite this article as: G. A. Stroykov, N. V. Babyr, I. V. Ilin, R. S. Marchenko, System of Comprehensive Assessment of Project Risks in Energy Industry, International Journal of Engineering, Transactions A: Basics Vol. 34, No. 7, (2021) 1778-1784

either do not assess risks at all or do it in a very formal way that does not take into account the specific features of the energy industry.

Researchers study such aspects as risk-return analysis in application to investments in renewable energy sources [1], the importance of project finance in low-risk projects [2], the advantages of the Monte Carlo modeling method in evaluating public-private partnership projects [3], and conducting feasibility studies based on the Monte Carlo method using multi-energy balance financial equations that take into account the uncertainties and risks associated with different variables in the design and construction of solar thermal power stations [4].

Recently, the issue of risk assessment has been raised by many researchers around the world, in particular such issue of project risk assessment applied to public-private partnership projects using the example of waste incineration in energy industry [5]. Assessement of the effect of external risks on the success of oil and gas construction projects [6], study and classify structures, methods, and models of in-project quantitative risk analysis [7], discuss the issue of risk perception in the integrated design and construction project delivery [8], and analyze performance risks [9].

For many researchers, the most pressing issue remains the problem the issues of integrating risk management systems in project decision making and those of improving project effectiveness by assessing project risks [10-12]. Some researchers discussed the problem of involving experts in project risk analysis [13]. A number of researchers analyze project risks based on the characteristics of a project [14], and some researchers have set themselves the task of developing models and methods for managing supply chain risks and delays in construction projects [15].

Russian researchers discussed investment risk management in the mining industry, the use of a risk-based approach to safety issues at coal deposits [16-18]. The strategic risk analysis have implemented investment projects [19-21], economic assessment of heat and electricity generation [22-24], anthropogenic hazard assessment [25], organizational and economic mechanisms for implementing strategic innovation projects [26-29], and the development of a stationary intelligent system for assessing and monitoring power quality indicators [30].

The main purpose of this study is to develop a system for a comprehensive assessment of risks associated with energy investment projects based on a combination of simulation modeling methods and discount rate calculation. The results of the study were tested on the example of the company Mondi Syktyvkar. One of the company's activities is the generation of electricity as a result of burning wood waste from the main production and natural gas in measles boilers. The company uses the received electricity for its production needs, and also sells it to third-party consumers.

2. THEORY AND EXPERIMENTAL

The reliability and validity of the statements, conclusions, and recommendations presented in the article stem from the fact that a significant body of theory on the topic was studied and numerous documents and statistical data on various manufacturing and energy companies were analyzed, including methodological recommendations for assessing project cost effectiveness and reports produced by rating and consulting agencies. To achieve the aim of the study, probability and statistical analysis, expert evaluation, and simulation methods were used. The methodological foundation of the study consists of works by leading Russian and foreign researchers in such fields as project risk assessment, project risk management, and simulation modeling, data provided by consulting and analytical agencies, and publicly available business reports [31].

The algorithm for conducting a qualitative risk analysis using the questionnaire method is shown in Figure 1:

Based on the results of the expert opinion survey and the statistical analysis, we identified critical risks (risk level> 31), dangerous risks (risk level from 21 to 30), moderate risks (risk level from 11 to 20), and also low risks (from 0 to 10).

Based on the results of the qualitative analysis (the choice between quantitative and qualitative analysis was made based on the availability of sufficient statistical data for each of the parameters), it can be concluded that the most critical risks in developing a standard energy project are the risk of underestimating capital costs for equipment, the risk of cyber attacks, and the risk of mistakes in electricity price planning. The greatest emphasis in project development should therefore be placed on organizational, marketing, and security risks.

Application of the simulation modeling method (Monte

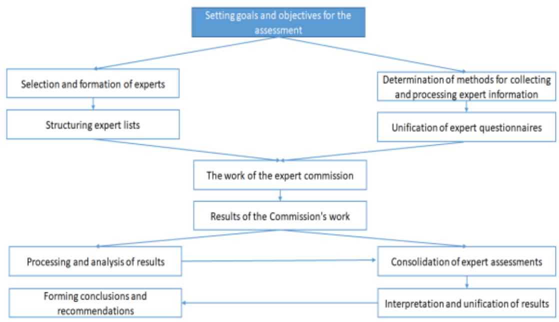

Figure 1. Algorithm of questionnaire method application for expert assessment of project risks

Carlo method) in combination with other statistical methods of qualitative and quantitative risk assessment provides the most realistic picture of the probability distribution of various risks in the aggregate affecting the investment project (provided that a qualitative assessment has been made, the risks have been identified, the probabilities and the degree of impact of risks have been determined) [32].

The Monte Carlo method used in mathematical modeling is applicable to managing uncertainty in some technical and economic parameters of the projecta. The resulting variables of the equation describing the project model and including these parameters are NPV, ID, and IRR, i.e. the main indicators of project performance, based on which strategic decisions concerning the project will be made. The Monte Carlo method makes it possible to take into account the uncertainty of the variables in the equation which is connected with a probability distribution.

In addition, the method does not take into account the presence of correlations or other relationships between the parameters of the model; as a result, a large number of invalid scenarios are simulated. It follows from the above that the approach under consideration needs to be refined in order to improve the reliability of simulation results.

Taking into account correlations between input parameters is a very important task in making the model being used as objective as possible but it cannot be solved using the existing tools. It is advisable to use the following algorithm for taking into account correlations between parameters (Figure 2).

3. RESULTS AND DISCUSSION

The study is based on a model that was developed by the authors using the feasibility study for the project aimed at installing a new energy generating device (a bark boiler) at Mondi Syktyvkar. The result of developing an economic and mathematical model is project performance indicators that are used by investors and company directors to decide whether the project is feasible or compare it with other projects.

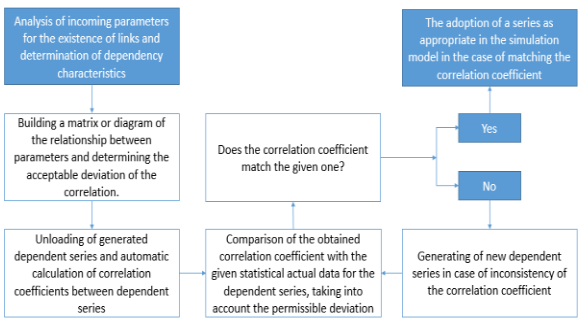

Figure 2. Flowchart of accounting for correlation between technical and economic parameters of the project model in Monte Carlo simulation. Source: developed by the authors

3. 1. Country Risk Premium Calculation The country risk premium was calculated based on data provided by Expert RA, a rating agency. It deals with analytics (mainly regarding the credit and insurance industry); since 1996, it has been compiling annual rankings of Russian regions by their attractiveness for investors. The methodology of country (and regional) risk rating is presented in researches.

Based on the scale presented, the country risk premium for the project aimed at installing a new bark boiler at a facility located in Syktyvkar (Komi Republic) is 3%.

3. 2. Risk Premiums for Other Types of Risks The discount rate, as mentioned earlier, takes into account all other important risks except for those that are covered in simulation modeling. According to the methodology, the least dangerous risks are not taken into account (natural hazards, environmental risks, and risks connected with infrastructure and logistics). The country risk premium in the project under consideration is 3%.

To find final risk values, the sum of the products of risk occurrence probabilities and numerical values of damage is calculated (in shares; the scale of damage corresponds to the scale in the questionnaire). The possible damage caused by the production risks is 26.8%, and that caused by the safety risks is 18.9%. To find risk premiums for these risks, it is necessary to add them up and analyze the sensitivity of the project's net present value (NPV) to changes in the discount rate (relative to net cash flows). The sum of the possible damage caused by the two types of risks being considered is 45%, so it is necessary to find the value of the discount rate at which the NPV deviates from the sum of cash flows by 45%. The results of the sensitivity analysis are shown in Table 1.

Based on the sensitivity analysis, the risk premium will be 4.37%. The value of the discount rate for the project aimed at installing a new bark boiler at Mondi Syktyvkar is taken to be 4.37% + 1.88% + 3% = 9.25%.

3. 3. Installing a New Bark Boiler at Mondi Syktyvkar: Simulation Modeling Simulation modeling was carried out using @RISK software and MS Excel[2]. The number of iterations was 5,000, and Latin hypercube sampling was the statistical method used. The main simulation modeling parameters are shown in Table 2.

[2] http://www.palisade.com/risk/ru/

TABLE 1. Analysis of NPV sensitivity to changes in the discount rate

Increase in the discount rate	NPV, mln RUB	Change in NPV, mln RUB
+4.37%	3931	-45%
+3.5%	4613	-20%

3. 4. Model Structure For the project under consideration, an economic model was developed using data provided by the company. According to this data, the estimated NPV is 692 million rubles, PI is 2.5, IRR is 28%, the payback period is 8.02 years, and the discounted payback period is 13.59 years.

3. 5. Choosing Distributions for the Input Parameters of the Model The type of probability distribution of a random value (as a characteristic of the input parameter of a simulation model) is determined by analyzing the distribution of a random value using special software (statistical analysis function @RISK). For this purpose, it is necessary to have a sufficient statistical base on the input parameter series. If such a database was available (e.g., by the values of actual and planned Capital costs of energy projects), the probability distribution of this value was analyzed. For Capital costs, the analysis showed the Exponential Distribution. In case there is no sufficient basis for the analysis, the normal distribution is accepted.

3.6 Input And Output Parameters Of The Model
Input model parameters selection is determined in each new project separately. Several technical and economic parameters used as input parameters have been selected in this study. The main principle of input parameters selection is influence of the revealed risks on the corresponding project model parameters. The following is a description of the input parameters of the energy project model, for which there was a sufficient basis for determining their probabilistic and statistical characteristics. For the other input parameters, the law of normal distribution of a random variable and a deviation from the mathematical expectation of about 10% of the studied parameter of the deterministic model were applied. The values of NPV, PI, and IRR are the output parameters of the simulation model.

TABLE 2. Simulation modeling parameters for installing a new bark boiler at Monti Syktyvkar

Number of simulations	1
Number of iterations	5,000
Number of inputs	56
Number of outputs	3
Random number generator	Mersenne Twister
RNG seed	1776983321

3. 6. 1. Price for Gas In the project under study, the main cost advantage of installing new energy-producing equipment was gained due to savings on fuel (gas). An analysis of the daily prices for gas over a 10-year period showed a triangular distribution of gas prices. The average value for this parameter was 3.9 rubles/m^3.

3. 6. 2. USD Exchange Rate It is proved that the hypothesis that the USD exchange rate is normally distributed. Based on this, normal distribution was adopted for the random variable of the USD/RUB exchange, and the main distribution characteristics (the mean value and the standard deviation) were taken based on an analysis of a sample of daily exchange rates for the last four years.

3. 7. Simulation Results

3. 7. 1. Net Present Value The main input parameter in the financial model of the investment project under consideration is the NPV. The simulation results are shown in Figure 4.

Simulation modeling was carried out using @RISK and MS Excel. As the simulation results showed, the most expected NPV value adjusted for risks is 587.65 million rubles, which is 15% less than that value that was calculated using the deterministic model (692 million rubles). The probability of having a non-negative NPV is 80%, which is a quite good result. Also, the probability of having a minimum NPV of -2,124.01 million rubles does not exceed 5%, with the same probability for having a maximum NPV of 6,945.67 million rubles.

At a confidence interval of 95% under the optimistic scenario, the NPV is 1,469 million rubles. The pessimistic scenario at a confidence interval of 5% reflects a negative NPV with a loss of 645 million rubles. The expected risk-adjusted PI is 1.9 (Figure 5).
The expected risk-adjusted IRR is 23%. In addition, a statistical analysis of the distribution of the risk-adjusted IRR was carried out.

Table 3 compares the two options for calculating the performance indicators of the project for installing new energy generating equipment (a bark boiler) at Mondi Syktyvkar, i.e. using a deterministic model and using Monte Carlo simulation modeling.

As a result of the study, the main project performance indicators that were adjusted for general risks, industry-specific risks, and correlations between input parameters turned out to be approximately 15% lower than the project values that were not adjusted for risks by simulation modeling.

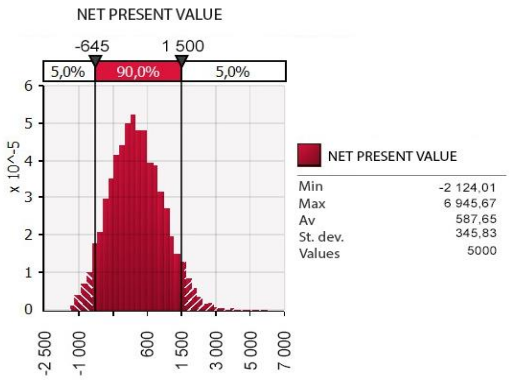

Figure 4. NPV distribution obtained by simulation modeling. Source: developed by the authors

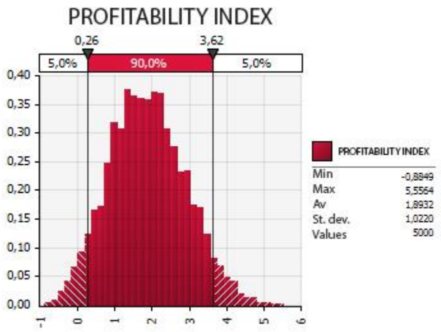

Figure 5. PI distribution. Source: developed by the authors

TABLE 3. Model output parameters of the project for installing a new bark boiler at Mondi Syktyvkar

	Deterministic model	Monte Carlo simulation modeling
NPV (expected), mln RUB	692	587
PI (expected)	2.5	1.9
IRR (expected)	28%	23%

4. CONCLUSIONS

The findings of the study resulted in the following conclusions:

1. In order to apply a complex and comprehensive approach to investment project evaluation, a methodology was developed for assessing risks and risk types that companies face when implementing investment projects connected with energy producing equipment.When the methodology was tested on the project for installing a new bark boiler at Mondi Syktyvkar, the project performance indicators fell by almost 15%. This suggests that if risks are not properly assessed, project performance indicators may be exaggerated, which can lead to negative economic consequences for the company if a decision is made to invest in the project.

2. The authors proposed a methodology for calculating risk premiums which should be taken into account when calculating the discount rate for the project. As it is necessary to factor in important risks that cannot be covered by simulation modeling due to the fact that there are no input parameters in the model structure that can be directly affected by these risks, the risk premium should be calculated based on an analysis of the project's NPV sensitivity to changes in the discount rate, which is found by analyzing possible damage from the occurrence of these risks. Based on the results of the qualitative analysis, it was concluded that the most critical risks in developing a standard energy project are the risk of underestimating capital costs for equipment, the risk of cyber-attacks, and the risk of mistakes in electricity price planning.

3. To improve simulation modeling results, it is advisable to use a modification of the Monte Carlo simulation method that takes into account correlations between risks. If possible, correlations are not factored in the simulation results can become distorted. The modification of the simulation method has the form of an addition to the simulation algorithm (step 4) that includes six steps:

1. Analyzing the NPV calculation model and finding input and output parameters
2. Identifying and analyzing possible risks
3. Finding the type of probability distribution and the statistical characteristics
4. Finding correlations between model parameters
5. Carrying out NPV simulation modeling, generating scenarios that take into account the correlations, and checking scenarios for compliance with a given correlation coefficient
6. A statistical analysis of the resulting values

The methodology was tested using as a case study the project for installing a new bark boiler at Mondi Syktyvkar.

Besides, the expert methods applied for qualitative estimation of design risks can be not absolutely reliable. To level out this possibility, it is necessary to choose the right experts in accordance with their competence. Or a possible solution may be to apply certain weighting coefficients for evaluation of each expert. However, this methodology requires additional description and justification, which should be developed as a continuation in future studies of authors.

By combining qualitative methods of risk assessment and modern quantitative ones, it is possible to achieve really excellent results. In addition, it is necessary to consider the implementation of the developed risk assessment system in the business processes of the company, as well as to offer an application toolkit in the form of an information system.

These are the questions that lie in the plane of our research, which we are going to continue within the framework of this topic.

5. REFERENCES

1. Krömer, S., Gatzert, N. "Renewable energy investments with storage: a risk-return analysis", ***International Journal of Energy Sector Management***, Vol. 12, No. 4, (2018), 714-736. DOI: 10.1108/IJESM-02-2018-0009
2. Steffen, B. "The importance of project finance for renewable energy projects", ***Energy Economics***, Vol. 69, (2018), 280-294. DOI: 10.1016/j.eneco.2017.11.006
3. Berk, A.S., Podhraski, D. "Superiority of Monte Carlo simulation in valuing real options within public-private partnerships" ***Risk Management***, Vol. 20, No. 1, (2018), 1-28. DOI: 10.1057/s41283-017-0025-9
4. Gu, Y., Zhang, X., Are Myhren, J., Han, M., Chen, X., Yuan, Y. "Techno-economic analysis of a solar photovoltaic/thermal (PV/T) concentrator for building application in Sweden using Monte Carlo method", ***Energy Conversion and Management***, Vol. 165, (2018), 8-24. DOI: 10.1016/j.enconman.2018.03.043
5. Wu, Y., Xu, C., Li, L., Wang, Y., Chen, K., Xu, R. "A risk assessment framework of PPP waste-to-energy incineration projects in China under 2-dimension linguistic environment", ***Journal of Cleaner Production***, Vol. 183, (2018), 602-617. DOI: 10.1016/j.jclepro.2018.02.077
6. A Kassem, M., Khoiry, M.A., Hamzah, N. "Assessment of the effect of external risk factors on the success of an oil and gas construction project", ***Engineering, Construction and Architectural Management***, (2020). DOI: 10.1108/ECAM-10-2019-0573
7. Hartono, B. "From project risk to complexity analysis: a systematic classification", ***International Journal of Managing Projects in Business***, Vol. 11, No. 3, (2018), 734-760. DOI: 10.1108/IJMPB-09-2017-0108
8. Wu, P., Xu, Y., Jin, R., Lu, Q., Madgwick, D., Hancock, C.M. "Perceptions towards risks involved in off-site construction in the integrated design & construction project delivery", ***Journal of Cleaner Production***, Vol. 213, (2019), 899-914. DOI: 10.1016/j.jclepro.2018.12.226
9. Lee, P., Lam, P.T.I., Lee, W.L. Performance risks of lighting retrofit in Energy Performance Contracting projects. ***Energy for Sustainable Development***, Vol. 45, (2018), 219-229. DOI: 10.1016/j.esd.2018.07.004
10. Enshassi, M.S.A., Walbridge, S., West, J.S., Haas, C.T. Integrated Risk Management Framework for Tolerance-Based Mitigation Strategy Decision Support in Modular Construction Projects. ***Journal of Management in Engineering***, Vol. 35, No. 4. (2019), DOI: 10.1061/(ASCE)ME.1943-5479.0000698
11. Chen, C.C., Nakayama, M., Shou, Y., Charoen, D. (2018), Increasing project success in China from the perspectives of project risk, methodology, tool use, and organizational support. ***International Journal of Information Technology Project Management***, Vol. 9, No. 1, 40-58. DOI: 10.4018/IJITPM.2018010103
12. da Rocha, J.E.N., Pacheco, M.A.C. "Energy efficiency risk analysis and policy in Brazil", ***Energy Efficiency***, Vol. 12, No. 8, (2019), 2227-2239. DOI: 10.1007/s12053-019-09815-w
13. Baptistucci, C.B., Pech, G., Carvalho, M.M. "Experts' engagement in risk analysis: A model merging analytic hierarchy", ***Journal of Modern Project Management***, Vol. 6, No. 1, (2018), 6-17. DOI: 10.19255/JMPM01601
14. Shishodia, A., Dixit, V., Verma, P. "Project risk analysis based on project characteristics", ***Benchmarking***, Vol. 25, No. 3, (2018), 893-918. DOI: 10.1108/BIJ-06-2017-0151
15. Panova, Y., Hilletofth, P. "Managing supply chain risks and delays in construction project", ***Industrial Management and Data Systems***, Vol. 118, No. 7, (2018), 1413-1431. DOI: 10.1108/IMDS-09-2017-0422
16. Frolova, V., Dolina, O., Shpilkina, T. "Investment risk management at mining enterprises", ***E3S Web of Conferences***, Vol. 105, (2019), DOI: 10.1051/e3sconf/201910501054
17. Korshunov, G.I., Rudakov, M.L., Kabanov, E.I. "The use of a risk-based approach in safety issues of coal mines", ***Journal of Environmental Management and Tourism***, Vol. 9, No. 1, (2018), 181-186. DOI: 10.14505/jemt.v9.1(25).23
18. Semykina, I.Y., Skrebneva, E.V. "Problems and solutions of reliability issues for external power supply in the coal mines", ***Journal of Mining Institute***, Vol. 226, (2017), 452-455. DOI: 10.25515/pmi.2017.4.452
19. Gasparian, M.S., Kiseleva, I.A., Korneev, D.G., Lebedev, S.A., Lebedev, V.A. "Strategic analysis of risks when implementing investment projects", ***Espacios***, Vol. 39, No. 27, (2018).
20. Dmitrieva, D., Ilinova, A. "Application of strategic analysis methods and tools in Russian mining and chemical complex", ***International Journal of Applied Engineering Research***, Vol. 11, No. 8, (2016), 5567-5572.
21. Nedosekin, A.O., Rejshahrit, E.I., Kozlovskiy, A.N. "Strategic approach to assessing economic sustainability objects of mineral resources sector of Russia", ***Journal of Mining Institute***, Vol. 237, (2019), 354-360. DOI: 10.31897/PMI.2019.3.354
22. Tcvetkov Pavel, Cherepovitsyn, A.E., Makhovikov Aleksei. "Economic assessment of heat and power generation from small-scale liquefied natural gas in Russia", ***Energy Reports***, Vol. 6, (2020), 391-402. DOI: 10.1016/j.egyr.2019.11.093.
23. Ptashkina-Girina, O.S., Nizamytdinova, N.S., Guseva, O.A. "Technical-Economic Assessment of Small Hydro-Power Units" Proceedings - 2018 International Ural Conference on Green Energy, UralCon, article number 8544277, (2018), 101-106. DOI: 10.1109/URALCON.2018.8544277
24. Bozhkov, M.I., Kostin, V.N. "Technocenological approach to managing power supplying substation loads", ***International Journal of Applied Engineering Research***, Vol. 11, No. 9, (2016), 6736-6739
25. Carranza, J.R.Z., Kovshov, S., Lyubin, E. "Assessment of anthropogenic factor of accident risk on the main oil pipeline pascuales-cuenca in Ecuador", ***Journal of Applied Engineering Science***, Vol. 16, No. 3, (2018), 307-312. DOI: 10.5937/jaes16-17019
26. Nikulina, A.Y., Kruk, M.N. "Organizational and economic mechanism of oil and gas projects in the Russian arctic shelf", ***Journal of Internet Banking and Commerce***, Vol. 21 (Special Issue 6), (2016).
27. Ponomarenko, T.V., Cherepovitsyn, A.E., Fedoseev, S.V., Sidorov, D.E. "Organizational-economic mechanism of financing strategic investment projects at the regional level in regions with poor infrastructure", ***International Journal of Applied Engineering Research***, Vol. 11, No. 16, (2016), 9007-9013.
28. Kremcheeva, D., Kremcheev, E. "Use of a quality management system at the iron and steel enterprise", ***Journal of Mechanical Engineering Research and Developments***, Vol. 41, No. 1, (2018), 151-155. DOI: 10.7508/jmerd.2018.01.018
29. Cherepovitsyn, A.E., Ilinova, A.A. "Methods and tools of scenario planning in areas of natural resources management", ***European Research Studies Journal***, Vol. 21, No. 1, (2018), 434-446.

30. Zamyatin, E.O., Shklyarskiy, Y.E., Yakovleva, E.V. “Concept for electric power quality indicators evaluation and monitoring stationary intellectual system development”, ***International Journal of Applied Engineering Research***, Vol. 11, No. 6, (2016), 4270-4274.

31. Kryzia, D., Kopacz, M., & Kryzia, K. “The Valuation of the Operational Flexibility of the Energy Investment Project Based on a Gas-Fired Power Plant” ***Energies***, Vol. 13, No. 7, (2020), 1567.

32. Platon, Victor & Constantinescu, Andreea. “Monte Carlo Method in Risk Analysis for Investment Projects”, ***Procedia Economics and Finance***, Vol. 15, (2014), 393-400. 10.1016/S2212-5671(14)00463-8.

Persian Abstract

چکیده

در این مقاله پیشنهاد شده است که مسئله ارزیابی جامع ریسک های پروژه در صنعت انرژی مورد استفاده قرار گیرد. نویسندگان تحقیق بر توصیف راه حل کاربردی متمرکز شده اند. یک پروژه سرمایه گذاری واقعی برای جایگزینی دیگ بخار پوست در شرکت Mondi Syktyvkar به عنوان یک هدف برای آزمایش نتایج انتخاب شد. ما پیشنهاد کردیم ریسک های همراه پروژه را به ۲ دسته تقسیم کنیم: ریسک هایی که اطلاعات لازم و آماری برای ارزیابی کمی آنها وجود دارد و خطراتی که این اطلاعات برای آنها وجود ندارد. به عنوان یک روش ارزیابی کمی خطرات از گروه اول ، استفاده از روشی برای مدل سازی شبیه سازی مونت کارلو به مصلحت است. در این مورد ، نویسندگان مقاله تجزیه و تحلیل قابل توجهی از روش های موجود برای ارزیابی خطرات پروژه انجام داده اند و انتخاب روش مونت کارلو به دلیل جهت گیری عملی مطالعه است. در عمل ، شرکت واقعی برای استفاده از روش های پیچیده تر ارزیابی ، مانند روش های گزینه های واقعی یا روش های منطق فازی ، شبکه های عصبی و غیره ، کاملاً مشکل ساز است. به عنوان یک روش ارزیابی ریسک کیفی (از دسته دوم) ، روش ارزیابی کارشناس با محاسبه بعدی حق بیمه در نرخ تخفیف انتخاب شد. این روش در عمل معمول است و اجرای آن به اندازه کافی آسان است. با توجه به نتایج تجزیه و تحلیل (آماری) خطرناکترین خطرهای پروژه های انرژی مشخص شد: خطرات تولید و فن آوری (خطر انتخاب طرح اشتباه فن آوری ، خطر کاهش کیفیت کنترل های داخلی ، خطر نادرست محاسبه ظرفیت طراحی تولید انرژی ، خطر ایمنی صنعتی) ، خطرات امنیتی (خطر حملات هک به سیستم های اطلاعاتی شرکت های انرژی) و همچنین خطرات کشور. از جمله مهمترین خطرات (بر اساس تجزیه و تحلیل تأثیر آنها بر شاخص های اصلی فنی و اقتصادی پروژه) عبارتند از: خطر افزایش قیمت برای گاز خریداری شده (سوخت) ، خطر نوسان زیاد نرخ ارز دلار. نتایج این مطالعه در یک پروژه واقعی مورد استفاده قرار گرفت و روش ارزیابی ریسک در فعالیت های پروژه شرکت Mondi Syktyvkar اجرا شد.