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# Risk Analysis and Innovative Product Management in Rosatom State Corporation: A Case Study of a Green Project Floating Nuclear Thermal Power Plant “Akademik Lomonosov”

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**ABSTRACT**

Risk management plays a crucial role in ensuring the dynamic development and energy security of the national economy in the nuclear sector. This study **focuses** on the application of the smart card method for evaluating risks in the energy sector, using the example of a carbon-free energy technology development project at Rosatom State Corporation. The **subject** of the research is the Floating nuclear thermal power plant “Akademik Lomonosov”, which is designed to provide reliable electricity and heat supply to consumers in the Far North and Far East regions. This project is one of the key directions for developing the new business block in the State Corporation Rosatom. The **aim** of this study is to evaluate the risk management of innovative projects in the green nuclear sector, with a focus on the Floating nuclear thermal power plant “Akademik Lomonosov”. The authors used the **methods** of comparative analysis, system analysis, the analysis of statistical data, financial reports, and official documents. The **results** show that risk management is crucial for ensuring the dynamic innovative development of nuclear energy in the near-, medium- and long-term, and the smart card can be a beneficial tool in this regard. The **key conclusion** of the study is that the green project Floating nuclear thermal power plant “Akademik Lomonosov” has been successfully prepared for operation, considering most of the key risks. The risk evaluation conducted using the smart card method has demonstrated its effectiveness in identifying and managing risks associated with the project. The authors emphasize the importance of integrating smart cards into risk assessment practices in the nuclear industry and highlight their potential for use in future projects.

***Keywords:*** risk analysis; management of innovative products; energy sector; smart cards; Rosatom State Corporation; Floating nuclear thermal power plant Akademik Lomonosov; green project

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ОРИГИНАЛЬНАЯ СТАТЬЯ

# Анализ рисков и управление инновационными продуктами Госкорпорации «Росатом» на примере «зеленого» проекта «Плавучая атомная тепловая электростанция «Академик Ломоносов»

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**АННОТАЦИЯ**

Управление рисками играет решающую роль в обеспечении динамичного развития и энергетической безопасности национальной экономики в ядерном секторе. Данное исследование посвящено применению метода смарт-карт для оценки рисков в энергетическом секторе на примере проекта по разработке «безуглеродных» энергетических технологий в Госкорпорации «Росатом». **Предметом** исследования является плавучая атомная тепловая электростанция «Академик Ломоносов», которая предназначена для обеспечения надежного электро- и теплоснабжения потребителей в регионах Крайнего Севера и Дальнего Востока. Данный проект является одним из ключевых направлений развития блока «Новые бизнесы» в Госкорпорации «Росатом». **Целью** данного исследования является оценка управления рисками инновационных проектов в атомной отрасли на примере плавучей атомной тепловой электростанции «Академик Ломоносов». Авторы использовали **методы** сравнительного анализа, системного анализа, анализа статистических данных, финансовых отчетов и официальных документов. Результаты показывают, что управление рисками имеет решающее значение для обеспечения динамичного инновационного развития атомной энергетики в ближайшей, средне- и долгосрочной перспективе, и смарт-карта может стать полезным инструментом в этом отношении. **Ключевой вывод** заключается в том, что «зеленый» проект «Плавучая атомная тепловая электростанция «Академик Ломоносов» был успешно подготовлен к эксплуатации с учетом большинства ключевых рисков. Оценка рисков, проведенная с использованием метода смарт-карт, продемонстрировала свою эффективность в выявлении рисков, связанных с проектом, и управлении ими. Авторы подчеркивают важность интеграции смарт-карт в практику оценки рисков в атомной отрасли и подчеркивают их потенциал для использования в будущих проектах.

***Ключевые слова:*** анализ рисков; управление инновационными продуктами; энергетический сектор; смарт-карты; Государственная корпорация по атомной энергии «Росатом»; «Плавучая атомная тепловая электростанция «Академик Ломоносов»; зеленый проект

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## Introduction

In the context of the current geopolitical situation, the emerging trends of reducing nuclear programs in several countries, and the world community's growing interest in alternative energy, the innovative component plays a very important role for the Russian nuclear industry. Alternative energy is a key concept of green development, as it is aimed at sustainable and environmentally friendly energy production. This concept proposes reducing dependence on fossil fuels, such as oil, coal and gas, and switch to the use of renewable energy sources. It is backed up by a collective international commitment to keep global warming below 2 °C in accordance with the Paris Agreement and nationally determined contributions. Therefore, when doing the strategic planning of innovative activities for nuclear industry enterprises, it is advisable to consider the features of forming an innovative potential, considering green technologies.

In the dynamic market environment, the potential for innovation is fostered by diverse resources that are strategically employed to achieve a competitive edge for businesses through the generation and implementation of green innovative ideas, products, or processes. This potential plays a pivotal role in driving the economic growth of enterprises.

The key characteristic of the innovative potential within an energy organization is that all its components operate synergistically as a cohesive system with the aim of decreasing carbon dioxide emissions into the atmosphere. The concept of innovation potential coordinates and harmonizes individual elements, directly influencing their characteristics and operational logic. This coordination enables transformation of capabilities into a higher-quality state, aligning with the latest advancements in the field. One of the main innovative products in the nuclear industry that can be considered in the context of green development, is the development and distribution of new types of reactors with improved characteristics.

## Literature review

The development and implementation of innovative products in the energy sector require careful consideration of potential risks and effective risk management strategies. In the energy sector, there are numerous risks associated with innovation and the dynamic structure of the industry, and there is interest in researching risk management in this area since the synergy of new tools and technologies in this industry has not been studied before.

However, the results of the existing research related to the management of innovative products and risks are not consistent, mainly due to a lack of expert opinion on the key features of a developed risk management system of innovative products and the way they are implemented in organizations in the green energy industry [1, 2].

However, as the authors of the study emphasize [3], the long-term development of the innovative sector of the green economy in Russia is the optimal solution that contributes to the technological progress of industry and the reduction of the hydrocarbon footprint. The interest of both the state and the private sector in the development of the green economy should lead to an improvement in the state of the energy sector, ensuring energy security and reducing the technological and innovation gap between Russia and the world leaders in green energy.

Innovative products in the energy sector as a whole pose significant risks, and effective risk analysis and management strategies are important for the successful development and implementation of such products [4]. According to the authors, risk analysis methods include scenario analysis, historical data analysis, expert opinion, comprehensive analysis, and the analytic hierarchy process [5]. They argue that these tools can help identify and mitigate potential risks associated with energy projects and technologies.

Another important theme is the use of risk management tools and techniques to address identified risks. In their article "Risk management in product development: risk identification, assessment, and mitigation — a literature review", the authors provide an overview of various risk management tools, including fault tree analysis, failure mode and effects analysis and event tree analysis [6]. The authors identify these methods as effective for risk assessment.

In addition to comprehensive risk assessments and risk management tools, effective risk management in the energy sector also requires collaboration and communication among stakeholders. In their article "Study of innovative technologies in the energy industry: Nontraditional and renewable energy sources", the authors argue that effective risk management requires collaboration between stakeholders, including project developers, regulators, and local communities [7]. They emphasize the importance of open communication and stakeholder engagement in identifying and mitigating potential risks associated with renewable energy projects.

Overall, the literature highlights the importance of comprehensive risk assessments, the use of risk management tools and techniques, and effective collaboration and communication among stakeholders. By addressing potential risks early in the innovation process and implementing effective risk management strategies, energy companies can increase the likelihood of successful innovation and sustainable growth in the industry.

At the same time, no previous studies have been conducted regarding the risk assessment of innovative products using the smart card tool, which, according to the authors of this article, is effective and can be applied in dynamic sectors that are associated with a high level of risk.

## Materials and methods

The methodology of risk analysis and management of innovative products in the green nuclear power industry is a system of principles and approaches to management, economic and engineering activities based on reference and verified system solutions that allows for the realization of the innovative potential of energy facilities reliably and safely [8].

The high degree of diversification of the activities of Rosatom State Corporation and the complexity of the relationships determine the need to assess the risks of innovative products in the development and launch of the energy market.

The results of the study were obtained using the basic provisions of system analysis, predictive qualitative and quantitative methods, smart cards, and petal diagrams.

## Results and discussion

To develop its innovative potential, Rosatom adopts the Program for Innovative Development and Technological Modernization until 2030[1]:

[1] Passport of the program of innovative development and technological modernization of Rosatom for the period up to 2030 in the civil part (p. 14). URL: https://rosatom.ru/upload/iblock/705/7057d872e3bcc6bd5ddcc636f32220c0.pdf (accessed on 13.04.2023).

1. Main goals and objectives of innovation development.

2. Key performance indicators and their indicative values until 2030.

3. Priority directions for innovative development for energy and non-energy markets.

4. Features of the innovation management system, the innovation structure of the State Corporation, as well as the organization of interaction with third-party organizations.

In the strategic planning of innovation activities, Rosatom considers the specific features of the current situation in the world market and geopolitical tensions, existing economic and political uncertainties that lead to the closure or restrictions of work in certain foreign markets (for example, the markets of Ukraine and Georgia). The difficulties associated with restrictions on attracting modern technologies from abroad are being overcome by pursuing the import substitution policy since 2014, which included activation of scientific research within the State Corporation itself and involvement of third-party domestic organizations.

The current economic situation implies the use of new key indicators, one of which is the effectiveness of Rosatom's innovation activities, as the previously used indicator of the percentage of the established unconditional funding of R&D to the State Corporation's revenue is ineffective, since it does not reflect sufficient volume of innovation. In addition, the efficiency and commercial attractiveness of the results of innovative developments are actively promoted. At the end of 2020, new key indicators were implemented, such as the growth rate of labor productivity in the organizations of the nuclear power industry to the level of 2020, the level of research and development costs to the volume of output of innovative products and services, and the reduction in the consumption of energy resources in the nuclear industry. The main purpose of including these indicators is to conduct a relative analysis to assess the implementation of the innovation development program in the state corporation (in comparable conditions). An annual decrease or increase in indicators is expected due to an increase in the output of innovative products.

Key performance indicators of Rosatom's innovation activities, established by the Innovative Development and Technological Modernization Program for 2021, were fully achieved and exceeded (*Table 1*).

The innovation component is one of the main components of the national scientific potential and a source of competitive advantages. The key factor of development for industries and individual enterprises is the activity aimed at using and commercializing the results of research and development to release new competitive goods and services to the market. For the Russian nuclear power industry, the task of innovation activity is to develop existing technologies as well as develop and implement new nuclear technologies that will become the basis for the company's successful operations in the future. A promising direction is to create a new generation of nuclear energy technologies based on fast neutron reactors with a closed nuclear fuel cycle for nuclear power plants that meet the country's energy needs and increase the efficiency of using natural uranium and spent nuclear fuel.

Thus, to realize the innovative opportunities of the economy and increase the share in international markets, it is necessary to create new products for the Russian and international markets, reduce the cost of production and the timing of processes in the nuclear energy industry.

Nowadays, along with traditional businesses, Rosatom is actively developing new innovative business lines and entering new markets. The development of the "new businesses" core, which is primarily focused on non-industrial markets, will solve problems such as capacity utilization, employment of highly qualified specialists and will contribute to increasing labour productivity and improving the return on assets, which will, in turn, increase the company's attractiveness and, as a result, strengthen Russia's leadership in the world in the field of innovation and the nuclear industry.

Three approaches are defined for new businesses within Rosatom: bringing an existing product to new markets (for example, a nuclear power plant service); creating a new product with subsequent access to the company's markets or to markets with alternative energy (for example, creating a new product called "wind farm" and entering the understandable Russian market with it); and offering a new product with forming a market for it.

Table 1
*The planned and actual key indicators of innovation performance of the State Corporation Rosatom (based on the results of 2021)*

| Indicator | Plan | Fact | Results for year |
|---|---|---|---|
| A share of innovative products and services in total sales of products and services in the industry, % | 21.0 | 25.7 | Excessby 22.38% |
| The number of the results of the intellectual activity (patents, etc.), cumulative total, units. | 2520 | 2906 | Overperformance by 15.32% |
| A portfolio of foreign orders for 10 years, USD billion | 136.2 | 139.9 | Excess by 2.72% |
| A portfolio of orders for 10 years outside the contour, RUB billion | 1604.96 | 1974.1 | Excess by 23.00% |
| The growth rate of labor productivity in the organizations of the nuclear power industry to the level of 2020, % | 101.6 | 135.0 | Excess by 32.3% |
| The level of research and development costs to the volume of the output of innovative products and services (not higher), % | 14.6 | 13.68 | Overperformance by 6.30% |
| Reduction in the consumption of energy resources in the nuclear industry (in comparable conditions) relative to the base five-year period (2020), % | 0.5 | 0.99 | Excess by 1.98% |
| The number of deviations in the operation of nuclear power facilities at a level higher than 2 on the international scale of nuclear events INES (annually), units. | 0 | 0 | Realized |

*Source:* Compiled by the authors.*

* Results of activities of the State Atomic Energy Corporation Rosatom for 2021. Public annual report. URL: https://report.rosatom.ru/go/rosatom/go_rosatom_2021/rosatom_2021_ru.pdf (accessed on 13.04.2023).

It should be noted that Rosatom has been operating in non-traditional and new markets for decades. However, the decision to transform "other products", which were not previously included in the priority direction of development of the State Corporation, into the innovative core "new businesses", has been made relatively recently. Therefore, the development of new segments of the nuclear industry market, coupled with increasing influence in those where it is already represented, should create a basic basis for forming a competitive advantage (*Table 2*).

When implementing new businesses, the competitive advantages will include the price factor, which provides for a flexible system of discounts developed by Rosatom. In addition, when ordering complex infrastructure projects or other works that determine a large transaction, the price may be reduced, but at the same time, as with standard volumes, the cost of each stage of production and price will be monitored.

For the export of new businesses, an important competitive advantage will be the ability to use various project financing tools, from the possibility of assistance in providing interstate credit for constructing nuclear power plants to investment participation in the authorized capital of companies responsible for the construction and future operation of nuclear power plants, in which it is mandatory to conclude an intergovernmental agreement with the borrower's state guarantee.

New businesses will have a high level of competitiveness in both the Russian and global markets. However, several measures that will help strengthen competitiveness should be considered. Main measures include the assessment and elimination of emerging risks at all stages, as

Table 2
*Competitive advantages of Rosatom`s new businesses*

| Factor | Characteristic |
|---|---|
| Price | A flexible system of discounts, the possibility of reducing the price due to the scale of the transaction |
| Financing condition | The possibility of crediting and other forms of financial support for projects |
| The disposal of spent nuclear fuel | Rosatom has technologies for reprocessing spent nuclear fuel |
| Staffing | Highly qualified personnel. Training in specialized programs, including advanced training. |
| International experience | The long-term history of effective and profitable economic relations. |
| Strategic partnership between states with a focus on nuclear power products | The potential inclusion of a nuclear power product transaction in an interstate partnership program and within the broader framework of interstate relations. |
| The capacity for localizing | The suggestion to establish significant volumes of industrial production in the partner country, with the aim of promoting economic and infrastructural development. |

*Source:* Compiled by the authors based on [9].

increasing the production of innovative products will increase the number and significance of risks. Rosatom utilizes a process-based management model, where each process has its own passport that includes a section dedicated to risks. Risk management is overseen by the process owners, while a dedicated department is responsible for monitoring risks and providing methodological and methodical support, as well as collecting relevant data.

Risk analysis is the study of information about the risk, which provides input data for making decisions about the need to develop an appropriate methodology, as well as for choosing the most appropriate measures to apply. The risk should be analyzed considering the combination of the consequences of the risk's impact and the probability of its implementation, as well as from the point of its multiple consequences and impact. There are two main methods of risk analysis: qualitative and quantitative.

The combination of these methods of risk assessment for managerial decision-making is used in preparing a smart card for evaluating innovative projects. A smart card is a tool for visualizing and assessing risks using numerical values or percentages. It helps organizations and project teams identify and classify various risks. This card provides information about the current level of achievement of the project goals and, at the same time, highlights possible risks that may affect the further implementation of the project. By analyzing the smart card, managers can determine which aspects of the project are performed below the set values, and the associated risks. This helps to focus efforts on the most critical areas of the project, where it is necessary to take measures to achieve the required percentage of completion and minimize risks.

A smart card is a valuable tool for decision-making and project management because it provides an overview of the current state of the project, helps quickly respond to risks and problems, as well as plan measures to manage them.

The method of calculating a smart card includes several stages:

1. Risk identification: identification of a list of potential risks that may affect the project.
2. Selection of indicators characterizing risks: identification of indicators characterizing the project according to the list of potential risks.
3. Classification of risks: division of indicators into categories depending on their nature, for example, technical, financial, operational, etc.
4. Collecting data on indicators: obtaining targeted quantitative and qualitative data on selected indicators from the project regulatory documents.

5. Risk probability assessment: analysis of the implementation of the indicator set by the corporation for each parameter for the project from 100% with the assignment of categories (A: 0–33.2%, B: 33.3–66.6%, C: 66.7–74.9%, D: 75–100%). The assessment is carried out based on the qualitative and quantitative characteristics of the project, established in the plan, considering its goals and objectives. This may be also a subjective assessment based on experience and expert opinion, or the use of statistical data, if available.

6. Graphical representation of the evaluation results: visual interpretation of the results obtained, where various methods can be used from the construction of a two-dimensional matrix to various kinds of diagrams.

7. Risk analysis and management: development of risk management strategies for indicators where categories A and B are assigned.

Currently, plastic cards equipped with microprocessors and memory can be used to build digital smart cards to minimize errors in corporations. They are used for storing, processing, and transmitting information, as well as performing various authorization and authentication functions. By using special software applications and algorithms, digital smart cards can analyze and assess risks based on the data provided to them. They allow for complex calculations, modeling, and simulation, which help to predict and assess the likelihood of certain risks and their potential consequences.

Rosatom employs a risk management system that encompasses unified methodological guidelines for effective risk mitigation. The system utilizes a scoring expert system, enabling a systematic evaluation of risks. In essence, the process involves assessing the likelihood of risk occurrence, expressed as the fractional values determined by expert judgment. This assessment is followed by completing a table, incorporating ranges and corresponding scores, to quantify the risk probability. Likewise, the consequences of realized risks are evaluated based on expert assessment, considering the monetary impact in terms of millions of rubles. A similar table is filled out, associating ranges with scores to determine the risk consequences.

To establish the risk criticality, the scores from the probability table and the consequences table are multiplied, resulting in a comprehensive risk score. The risk matrix is then divided into different zones, such as green, yellow, red, and the control boundary. Depending on the assigned score, corresponding risk management strategies are adopted.

According to the authors, the smart card tool can be successfully applied in practice in a state corporation because it allows evaluating projects using a point-based expert system, considering both qualitative and quantitative indicators and their distribution, which corresponds to the Rosatom management system. Moreover, the utilization of smart cards can address several limitations observed in the scoring process. For instance, traditional scoring relies on expert opinions, leading to subjective and ambiguous outcomes. In contrast, smart cards assess projects based on predefined indicators, goals, objectives, and key performance indicators, thereby reducing the risks associated with subjective judgment.

In this article, application of the smart card tool was illustrated by a case study of the green project Floating nuclear thermal power plant (FNTPP) Akademik Lomonosov in Pevek, Chukotka Autonomous Okrug. This project provides a unique new-generation energy source based on Russian technologies of civil and military shipbuilding and nuclear power engineering, designed to provide reliable electricity and heat supply to consumers in the Far North and Far East [10]. In the context of carbon regulation introduced at the initiative of the EU, the FNTPP project can serve as an example of the introduction of "green" technologies in the energy sector. The results of the research conducted during the first public ecological expedition to the floating nuclear thermal power plant in Pevek City confirmed its safety for the environment.

It is assumed that there is a step of 25 or 33.3% between the stages of completion, depending on the completeness of the indicator analysis. The final goal has been set, and in accordance with the achieved result, the percentage of completion for each parameter will be estimated. For risk analysis, seven groups of parameters are considered: price characteristics, market-product, technical, macro and infrastructure indicators, profitability parameters and indicators for safety assessment. These parameters were chosen because the risk assessment is carried out by the innovation project for making management decisions.

The first indicator is price analysis. The goal is that the costs of the declared goods, works, services correspond to the industry average of similar data. Currently, the price corresponds to the industry average for similar works and the amount of investment in the project is 10,460 mln RUB, which corresponds to 66.7% of the final goal completion.

The second group of indicators are market and product parameters. The first analyzed risk in this group is the product/result image. The image of the product/result must be formed, details and specific measured values must be described, and a specific value for the consumer must be justified. The plant is designed with a large margin of safety to counter external threats. The station is equipped with two KLT-40S icebreaker-type reactor units, which can generate up to 70 MW of electricity and 50 Gcal/h of thermal energy, which is enough to ensure the energy consumption of a city with a population of about 100 thousand people [6]. The life cycle of this power plant is designed for 40 years to fill not only the current electricity deficit, but also to meet the growing needs of residents in the settlements of the Chukotka Autonomous Okrug in the future. Thus, the completion with ultimate goal is 100%. The same situation is with the consumer/customer indicator. Specific consumers/customers of the product are proposed, it is justified by the type of need the product implements, this need is evaluated, and there is a documentary proof of interest. This can be substantiated by the fact that the construction of the station was undertaken as part of the state program "Development of the Nuclear Power Industry Complex" in Russia. One of the most notable characteristics of the floating nuclear thermal power plant is its capacity to supply power to industrial facilities and populations in areas that lack access to centralized power supply but hold considerable untapped economic potential.

However, considering such an indicator as external/foreign markets, only 66.7% is completed, as there is a market for the product, but the product allows the organization to reach a new level. Currently, and at the initial stage of design and development, China has shown the greatest interest in the FNTPP. Foreign companies from Southeast Asia, the Republic of Cape Verde, Indonesia, and others are also showing interest in FNTPP with its desalination equipment. In the case of successful operation of the FNTPP, it can be expected that countries that do not need large amounts of electricity and do not have the opportunity to operate large-capacity reactor installations will want to implement the project. Such countries now dominate the market, so the appearance of a small-capacity FNTPP will allow many countries to use nuclear energy. At the same time, the project provides a unique new-generation energy source based on Russian technologies of civil and military shipbuilding and nuclear power engineering, which means that the product surpasses all known analogues in Russia and abroad in terms of the main claimed technical and economic characteristics and is competitive in the Russian and global markets.

The third group of analyzed parameters can be called technical support indicators. The most important characteristic in this group is the novelty of the solution. The ultimate goal is to discover a fundamentally new solution or phenomenon. However, only 50 percent of this parameter was successfully completed. In the case of FNTPP, a well-known principle that has not been used before to solve similar problem was used. In foreign countries, the most commonly used are floating power plants based on renewable energy sources that contribute to the displacement of carbon, which affects the climate and people's livelihoods. Considering the specificity of domestic maritime borders, Rosenergoatom has developed a variant of the FNTPP — an innovative type of power plant located in the water areas or in the water spaces of mainland territories to increase the scale of economic development of relatively confined spaces, continents, and their coastal territories for energy supply to the population and enterprises.

The fourth group is macro parameters. Considering the compliance with the Rosatom strategy and the business strategies of the divisions, the project is directly aimed at achieving the goals and fulfilling the tasks of the Innovative Development Program of Rosatom. Also, the FNTPP project has a significant impact on developing science and technology on the scale of a separate industry, which means that the indicator significance for further technological development is

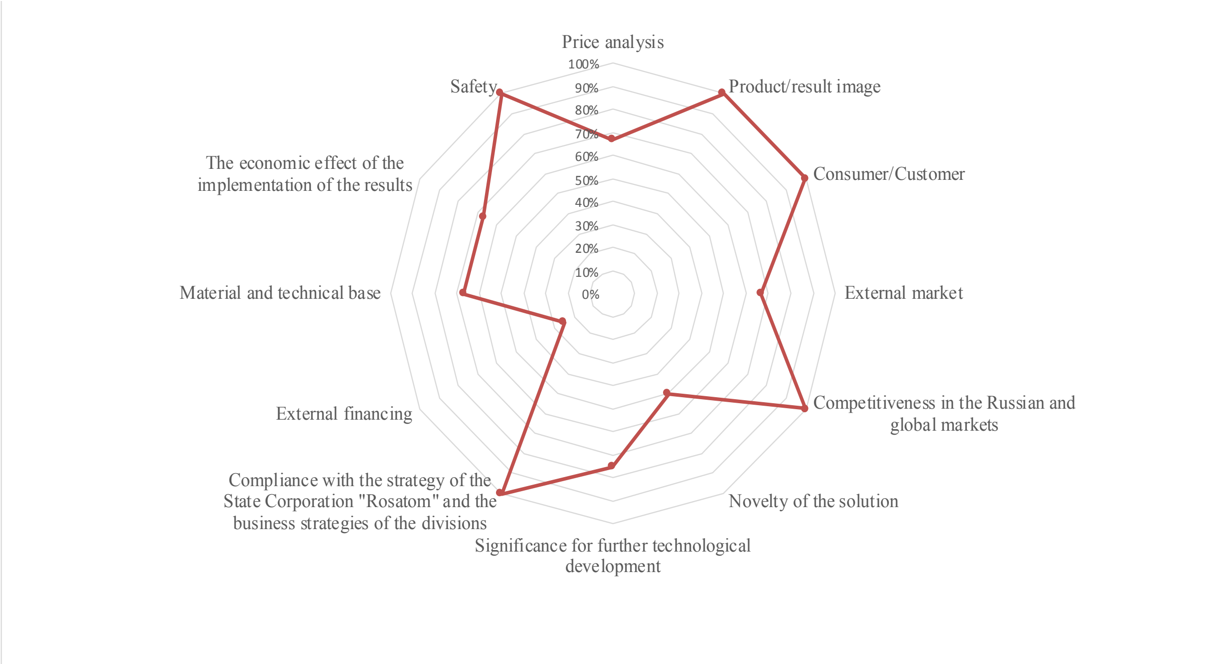


*Fig.* **A petal diagram of risks within the FNTPP project**

*Source:* Developed by the authors.

completed by 75% as it has not had a cardinal influence yet. The riskiest in this section are the opportunities to attract external financing, as the work is carried out with the involvement of external financing, but external financing accounts for less than 50% of the project cost. The investment Committee of the Russian Federation Budget (17%) and Rosenergoatom Concern JSC (83%) participate in the project implementation [10].

The fifth group of parameters to consider is infrastructure, where the most important indicator is material and technical base. The ultimate goal is that the material and technical base must be sufficient for the successful implementation of the declared works within the framework of one organization. However, to implement the Akademik Lomonosov project, it was necessary to involve co-executors who have the necessary equipment or software. There was all the necessary material and technical base for the FTNPP, which means only 66.7% of it is complete and falls into the risk group for further analysis.

Under profitability parameters, it is necessary to analyze the economic effect of implementing the results. The economic effect must be two or more times higher than the costs. Considering a Floating thermal nuclear power plant, the economic effect exceeds the costs. In a moderately optimistic scenario, the NPV of FTNPP is 8,359 mln RUB and the IRR = 8%, while in a conservative scenario, the NPV = 5,819 mln RUB and the IRR = 7% [11].

The safety of a project is one of the most important parameters to recognize in order to eliminate risk in the future. In the case of FTNPP, all the measures necessary to confirm the reliability and safety of the FTNPP operation were carried out in accordance with the schedule. Firstly, the reserve of time before the start of the reactor core's melting is sufficient for the operator to carry out corrective actions. Secondly, the water supply to the reactor at various stages of the accident does not lead to an increase in the yield of hydrogen and prevents the complete destruction of the core. Thirdly, during the operation of the reactor shaft bay system, the retention of the core melt in the housing is reliably ensured.

From the compiled smart card for the project of a Floating nuclear power plant, we can draw conclusions about the usefulness and complexity of the project. Most of the risks are minimized, which shows high quality and planning at the preparation stage. However, for a more visual representation of the risks, the authors have chosen to present the smart card as a petal diagram (see *Figure*). It consists of several petals radiating from a central point, with each petal representing a specific category. The length of each petal is proportional to the value or magnitude associated with that category, allowing for easy comparison and analysis.

## Conclusions

The petal diagram clearly shows that the greatest risk for the project is one of the macro parameters, the possibility of attracting external financing, which occurred due to the small funding from the Federal Budget. However, according to other analyzed indicators, such as NPV and IRR, in optimistic and pessimistic scenarios, the financial risks are minimized, and the payback of the project is high. At the same time, there are no safety, compliance with the strategy, competitiveness, product/result image and consumer/customer risks, which indicate the high quality and great prospects of the project. In addition, the process of making managerial decisions on this project could be simplified since the necessary risks are analyzed using the smart card, which describes each parameter, shows the achieved result and the one that could potentially be achieved, and a petal diagram that clearly reflects all the risks and based on which the project manager can quickly accept, reject, or adjust the project.

Risk management of innovative projects in the nuclear sector is the most important tool for ensuring the dynamic development of nuclear energy in the near-, medium- and long-term, ensuring the energy security of the national economy of Russia. Based on the conducted risk evaluation using the smart card applied to the case of the Floating nuclear thermal power plant "Akademik Lomonosov", it can be concluded that this green project was successfully prepared for operation, considering most of the key risks. Thus, the smart card is a simulator for evaluating innovative projects and can be used in the nuclear field. The example of the FNTPP illustrates the effectiveness and visibility of this tool to reflect the risks in the nuclear industry for further management decision-making, as this station is currently being effectively operated, and in December 2019, the FNTPP issued the first electricity to the isolated network of the Chaun-Bilibinsky node of the Chukotka Autonomous Okrug.

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