

# Competitiveness of companies in the design, engineering and construction of nuclear power plants

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ORIGINAL ARTICLE

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**Abstract.** Increasing electricity consumption in the modern world makes the unique nuclear power market. It provides growing secured demand, specific external development factors. However, only four companies involved in the design, engineering, and construction of nuclear power plants (NPPs). The competitiveness of those companies included into M. Porter's theory framework, but has its own characteristics. The purpose of the study is to determine the specifics of companies competitiveness engaged in the design, engineering, and construction of nuclear power plants, and assess the factors and prospects for their development. Besides, we define the theoretical base of international competitiveness with regard to the specific features of this economic sector, characterise the companies operating on the market, and build a model of the competitiveness formation of four representatives under the domestic factors of development. In conclusion, we will present the prospects for ROSATOM development in an internationally competitive environment. The models of competitiveness formation show the positive impact of investments in human capital, ESG agenda implementation, and long-term prospects of R&D projects. The research provides information for developing the theory of competitiveness and improving the company's activities in this economic sector.

**Keywords:** company competitiveness, international competitiveness of the company, companies in design, engineering and construction of nuclear power plants, nuclear energy, ROSATOM

**JEL codes:** D47, F63, L25

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## Introduction

Globalisation provides increasing of interaction and interdependence between countries. It refers to companies involved in the design, engineering, and construction of NPPs. Moreover, requirements for safety are becoming stricter every year. New production technologies are emerging. Therefore, companies are searching for new international partners to expand their operations. There is a constant increase in electricity consumption. As a result, maintaining market share and international competitiveness is becoming an important companies priority.

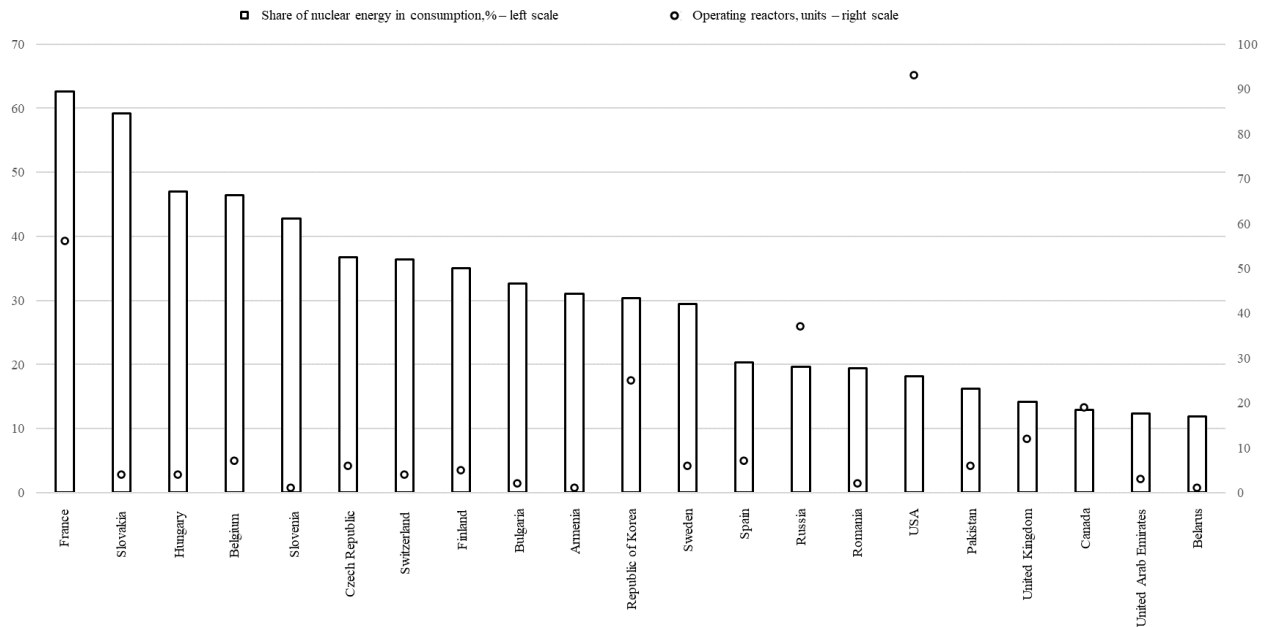
Increasing global electricity consumption causes companies to increase power generation and capacity<sup>1</sup>. The IAEA forecasts an increase in energy consumption (electricity is fifth of it) up to 15% in 2021-2030, and 30% in 2021-2050<sup>2</sup>. Nuclear energy accounts for about 10% of the global energy balance.

The largest production of nuclear energy are in the United States (772.22 bn kilowatt-hours, 2022),

<sup>1</sup> *Energy Production and Consumption. Our World in Data. Available at: <https://ourworldindata.org/energy-production-consumption> (Accessed 15.11.2022)*

<sup>2</sup> *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050. International Atomic Energy Agency. Vienna: IAEA in Austria, 2021*

China (395.35), France (282.09), Russia (209.52), Republic of Korea (167.51), Canada (81.72), Spain (56.15), Japan (51.91). Belarus ranks world 29th in terms of nuclear production – 4.41 bn kilowatt-hours<sup>3</sup>. Meanwhile, the leading countries ranking in terms of the nuclear energy share in the total volume is different (Fig. 1).



**Figure 1.** Share of nuclear energy in consumption (%) and number of operating reactors (units) for some world countries, 2022

Source: *Nuclear Share of Electricity Generation, 2022*

Nuclear power plants (NPPs) are complex technical structures requiring significant financial and human resources for their design, construction, and operation. Geographically, they are located worldwide. Nowadays, there are 192 nuclear power plants with 442 power units in the world<sup>4</sup>.

The nuclear power generation market is highly competitive and has its own characteristics. Indeed, NPP design, engineering, and construction companies are actively expanding to new countries and regions, forging the partnerships, etc. To maintain competitiveness, companies are required to possess unique knowledge and technologies, attract high qualified specialists, and follow modern environmental and corporate liability trends.

ROSATOM, Russia is a key player in the Russian nuclear power industry. It incorporates 362 enterprises located in various regions. Moreover, the company has a lot of orders for the construction of nuclear power plants abroad (35 units in 12 countries). Revenue from ROSATOM foreign operations in 2021 was almost \$ 9 bn USD; and the volume of foreign orders exceeded \$ 140 bn USD<sup>5</sup>.

According to the definition of Atomenergomash, nuclear power is a branch of the energy industry engaged in the production of electrical and thermal energy through the use of chain reactions of fission of uranium-235 or plutonium nuclei. Today, nuclear power provides about 15-20% of the global electricity production<sup>6</sup>.

However, the main issue is people distrust and apprehension towards this type of energy. It complicates the construction of new NPPs and the development of effective interaction between the nuclear industry and society. Challenges are result of people memory about the consequences of known nuclear power plant

<sup>3</sup> *Nuclear Share of Electricity Generation in 2022*. Available at: <https://pris.iaea.org/pris/worldstatistics/nuclearshareofelectricitygeneration.aspx> (Accessed 23.12.2023)

<sup>4</sup> *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050*. International Atomic Energy Agency. Vienna: IAEA in Austria, 2021

<sup>5</sup> *State Atomic Energy Corporation Rosatom (ROSATOM). Annual reports, 2009-2021*. Available at: <https://www.report.rosatom.ru/53> (Accessed 24.11.2022)

<sup>6</sup> *Nuclear power engineering*. Available at: <https://aem-group.ru/mediacenter/informatory/atom.html> (Accessed 16.11.2022)

accidents. People are afraid of possible accidents and contamination with radioactive waste, which can negatively affect their health, safety, etc. One of the largest disasters of this kind was at the Chernobyl nuclear power plant accident in 1986; its consequences were experienced worldwide. The number of people injured in this disaster is estimated to be around 4,000<sup>7</sup>. The Chernobyl accident was the only one in which there were human deaths from radiation<sup>8</sup>. When discussing safety at nuclear power plants, it is important to note the lowest percentage of fatal accidents recorded at them<sup>9</sup>.

For instance, as a result of natural disasters, diesel generators at the Japanese nuclear power plant Fukushima-1 in 2011 were damaged. It causes the shutdown of the cooling system and release of radiation<sup>10</sup>, radioactive pollution of the surrounding areas, food, water, and air<sup>11</sup>. Both disasters had a negative impact on people's health. Nowadays, there is a poor public understanding of the safety measures taken at NPPs and the specifics of their operation. It forms a negative attitude towards the construction of new power units.

The second issue is the high cost of electricity generation at nuclear power plants. It is determined by several factors: high safety requirements, location, the cost of construction and subsequent operation of nuclear power plants [12]. According to the OECD, the cost of daily operation of nuclear power plants increased from \$ 1.900 to 3.850 USD per kWh between the late 1990s and 2009. In 2020, in various countries these costs ranged from \$2.157 to \$6.920 USD per kWh. For example, in China it was \$2.500 USD per kWh<sup>12</sup>.

The company's main challenges in NPP design, engineering, and construction include a number of partner countries, risk management, prevention of emergencies, regular monitoring, and fair assessment of the market competitive position. ROSATOM has only three competitors, they are: Engie, Electricite de France, and Orano (France).

The concept of competitiveness is widely applied in various fields, including economics, marketing, business, international relations, politics, and education. It can capture a development level of a company and identify its advantages and disadvantages.

Competition can be defined as "the economic process of interaction and struggle between firms operating in a market in order to provide the best opportunities to distribute their products to meet different customer needs and maximise profits" [6]. The analysis of many approaches to the definition of competition allows us to identify some common features. Thus, competition is formed at the country level (macro level) [16], industry and regions levels (meso-) [15], enterprises level (micro-) [14], world regions as a group of countries [8], strategic groups [10], and products. All participants activities in a market environment characterized by economic interaction, interconnections, and rivalry between business entities. Competition is a driving force for economic growth, as it encourages enterprises to implement innovative strategies [9]. This process involves compliance with legal norms. Competition occurs between companies producing similar or complementary goods and services. It ensures the competing firms have mutual exposure. In general, competition motivates manufacturers to use and improve their competitive advantages [6].

A competitive advantage is "a set enterprise capabilities ensuring the customers needs have to be satisfied at the highest level compared to the previously existing one" [11].

M. Porter's "Diamond Model" approach determines 4 main factors and 2 additional ones of the international competitiveness.

The first key factor is the strategy of companies, their structure, and competition. A country where

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<sup>7</sup> *The largest accidents in the history of nuclear energy.* Available at: <https://www.rbc.ru/photoreport/09/02/2017/589c6fda9a79471b b97c44fa> (Accessed 20.11.2022).

<sup>8</sup> *Chernobyl Accident and Its Consequences.* Available at: <https://www.nei.org/resources/fact-sheets/chernobyl-accident-and-its-consequences> (Accessed 20.11.2022)

<sup>9</sup> *Advantages of nuclear energy.* Available at: <https://www.rosatom.ru/about-nuclear-industry/preimushchestva-atomnoy-energetiki/> (Accessed 22.11.2022)

<sup>10</sup> *The largest accidents in the history of nuclear energy.* Available at: <https://www.rbc.ru/photoreport/09/02/2017/589c6fda9a79471b b97c44fa> (Accessed 20.11.2022)

<sup>11</sup> *Environmental impact of the Fukushima accident: Radiological situation in Japan.* Available at: <https://www.bfs.de/EN/topics/ion/accident-management/emergency/fukushima/environmental-consequences.html> (Accessed 22.11.2022)

<sup>12</sup> *Economics of Nuclear Power // world-nuclear.org* URL: <https://world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power.aspx> (Accessed 25.11.2022)

a company is based and the region in which it operates largely determines its development strategies and competitive relationships. Internal competition between companies in the market stimulates their development and increases efficiency. In the nuclear power sector country affiliation is not particularly important, as there are a limited number of companies operating, most of them based in France. In Russia the entire industry is controlled by ROSATOM.

The second group of factors is the conditions themselves, both initial and artificial ones. M. Porter notes their great importance and the role of government in the process. Companies involved in the engineering, design, and construction of nuclear power plants benefit from favourable conditions and government support. It forms prerequisites for a higher level of competitiveness. Such assistance may include the creation of financial mechanisms for investing in large projects, the provision of subsidies and benefits, the governmental orders, accelerated consideration of the licensing process, obtaining permits, etc. This can also include the establishing of a technological and innovative environment for the development of companies, a training system, and guarantees of general security.

The third group of factors includes demand parameters. Demand generates the orders for the provision of services for companies engaged in engineering, design, and construction of nuclear power plants. However, the combined internal and external demand can stimulate companies to innovate and develop new technologies in nuclear energy. Increasing demand strengthens the competitive position of companies, establish additional prospects: they can plan their activities on a long-term basis and invest in the development of new projects. A decrease in demand, on the contrary, provides certain threats to the company competitiveness.

The fourth key factor of competitiveness involves interconnected and supportive industries. Company co-operation can proceed in materials production, technological development, innovation, etc. Interactions between participants in related industries stimulate the exchange of knowledge and experience. It contributes to improving the quality and efficiency of products and services, market expansion, etc. Company co-operation can proceed in materials production, technological development, and innovation. Moreover, the companies involved in the engineering, design, and construction of nuclear power plants in various collaborations allows them to optimize their production processes.

One of the additional factors in the competitiveness formation is the emergence of "unmanageable opportunities" or chances of changing the external environment. For companies in nuclear energy, these may be political, demographic, environmental, legal factors, etc. Certainly, positive changes should be used to increase competitiveness. However, such situations are temporary and provide only visible competitive advantages.

An additional factor in increasing the company competitiveness is the governmental support. Indeed, as in the previous case, this advantage is not permanent one. Moreover, in creating a more favourable environment for the company's activities through protecting them against foreign competition, the government decreases the competitiveness. Companies unable to improve their efficiency, innovate, and survive in the market will lose their market positions. Practically, it often occurs in various industries, including engineering, design, and construction of nuclear power plants.

Consequently, the country global competitiveness as a significant impact on the competitiveness of an individual company, since a company can develop certain competitive advantages affecting its development.

International competitiveness is a phenomenon concerning to several levels of the global market [5]. However, in terms of the market strategy its ultimate goal [3] is achieving of excellent performance by international companies [7] and their subsidiaries [4]. International competitiveness of an enterprise is "a complex organisation's characteristic determined by the level and degree of its competitive advantages use, and have the ability to adapt to the constantly changing conditions of the external and internal environment, while maintaining profitability" [17]. Therefore, factors and conditions of competitiveness development are very interesting ones. There is an issue of organisations international competitiveness in terms of their structural characteristics, strategic elements, tactical implementation, opportunistic behaviour, or a combination of other potential components [2].

According to M. Porter, the importance of each of the competitive forces evolves over time and

represents unique aspects for each industry. These aspects are determined by the specific technical and economic characteristics of each sphere [14]. For example, in the nuclear energy industry entering the market is associated with a number of difficulties. They are: need for significant investments in research, construction, and design of nuclear power plants, negotiations with governments, obtaining appropriate construction permits, etc. Struggling against competitors with years of experience in this field is a major challenge. It is practically impossible to compete with large corporations in tenders for NPP construction. This process requires significant time and financial costs.

The purpose of the study is to determine the specifics of companies competitiveness engaged in the design, engineering, and construction of nuclear power plants, and assess the factors and prospects for their development. Besides, we define the theoretical base of international competitiveness with regard to the specific features of this economic sector, characterise the companies operating on the market, and build a model of the competitiveness formation of four representatives under the domestic factors of development. In conclusion, we will present the prospects for ROSATOM development in an internationally competitive environment.

### Methods

Currently, in addition to ROSATOM, three French companies specializing in the design, engineering and construction of nuclear power plants operate on the global nuclear energy market: Électricité de France (EDF), Orano and Engie. They are global ones in nature. Some sources, including ROSATOM annual reports, mention the American company Westinghouse, formerly owned by Toshiba, Japan. Westinghouse has been successfully operating in the global nuclear energy market for a long time, but in 2017 it declared bankruptcy due to problems during the construction of new nuclear power plants in South Carolina and Georgia, USA. The problems were critical delays and construction budget exceeding [1]. After bankruptcy, Westinghouse was acquired by Brookfield Business Partners, Canada<sup>13</sup>. Westinghouse currently provides nuclear power plant maintenance services worldwide and is in the process of being acquired by Cameco and Brookfield Renewables. However, public reporting on its activities and market share is not publicly available, therefore we do not analyse its activity.

Consider each of the companies mentioned:

1. EDF (Électricité de France) is a French company. It was established in 1955. Its headquarter is in Paris. In 2021, EDF's revenue amounted to \$ 78.7 bn USD; the number of employees was 171 thousand people. According to Forbes (The Global 2000), EDF is one of the world largest public companies, ranking 210th at the end of 2021<sup>14</sup>.

2. Orano is a French company. It is a key participant in the nuclear energy sector and operates worldwide. The company was established in 1971 under the name "Areva", but in 2018 it was renamed to "Orano". Its headquarter is in Paris. Orano's revenue in 2021 amounted to 4.7 bn EUR; the number of employees is about 19 thousand people<sup>15</sup>.

3. Engie is French company. It was established in 2008 as "GDF SUEZ"; renamed to "Engie" in 2015. The headquarters is in Paris<sup>16</sup>. Engie's revenue in 2021 amounted to 57.9 bn EUR; the number of its employees is about 171 thousand people<sup>17</sup>. According to Forbes (The Global 2000), Engie is one the world largest public companies, ranking 171st in 2022<sup>18</sup>.

Paying attention to the geographical location of the four companies' activities in design, engineering, and construction of NPPs, all companies operate on the African continent. Indeed, ROSATOM and EDF are the most active in co-operation with African countries. Orano has the least number of partners in African

<sup>13</sup> The American Westinghouse will be bought for 7.88 billion dollars. Available at: <https://strana-rosatom.ru/2022/10/15/amerikanskuju-westinghouse-kupyat-za-788-mlrd-dolla/> (Accessed 28.03.2023)

<sup>14</sup> Électricité de France (EDF). Available at: <https://www.forbes.com/companies/edf/?sh=3020b65a653c> (Accessed 02.04.2023)

<sup>15</sup> ORANO, 2012-2021. Annual results. Available at: [https://cdn.orano.group/orano/docs/default-source/orano-doc/actualites-groupe/2021/cp-finance-21/orano\\_2020\\_annual-result\\_presentation\\_vdef.pdf?sfvrsn=57e8d5c8\\_4](https://cdn.orano.group/orano/docs/default-source/orano-doc/actualites-groupe/2021/cp-finance-21/orano_2020_annual-result_presentation_vdef.pdf?sfvrsn=57e8d5c8_4) (Accessed 26.12.2022)

<sup>16</sup> The History of the ENGIE Group. Available at: <https://www.engie.com/en/group/history-engie-group> (Accessed 07.04.2023)

<sup>17</sup> Financial results. Available at: <https://www.engie.com/en/financial-results> (Accessed 26.12.2022)

<sup>18</sup> ENGIE. Available at: <https://www.forbes.com/companies/engie/?sh=ee1b79428f2b> (Accessed 07.04.2023)

countries. Only three of four companies are active in Australia; ROSATOM is the exception. ROSATOM was active in Australia but after the sanctions imposed against Russia in 2014 this particular activity failed. Currently, Australia is most actively cooperating with Orano, France. EDF, France and Engie, France also operate here [13]. In Europe and Asia the activity of companies is maximum one. All companies operate in this region. ROSATOM is more East-oriented than the other three companies. The Corporation actively cooperates with Asian countries and builds several nuclear power plants in Asia. It indicates its great interest in this region. For example, in China ROSATOM builds two nuclear power plants<sup>19</sup>. French companies are highly active in Europe. They operate in many European countries.

Some European countries have abandoned or are in the process of abandoning nuclear energy. However, ROSATOM continues to successfully cooperate with those are mutually beneficial. For example, "a joint project was launched to research the long-term storage and processing of highly active radioactive waste" together with Germany<sup>20</sup>.

Engie, EDF and Orano cooperate with the USA and Canada in North America. ROSATOM, operates in Mexico. The cooperation in South America is very different. Orano is less active, while other companies are active ones. In Cuba and the Dominican Republic, ROSATOM is the only operator. EDF and Engie have an equal number of partner countries in South America. However, companies on this continent is relatively evenly distributed.

Each of the companies has a significant number of partner countries for cooperation. Only a few countries are present in the list of four companies. Basically, they cooperate with different countries and strive to find new markets. ROSATOM has the highest number of partner countries (about 70); EDF and Engie have 50 foreign partners each; Orano has the lowest (23) one.

## Results

The success of companies in this economy segment depends on many factors, including internal ones. To conduct an economic analysis of their impact on the company competitiveness, we build an econometric model. Revenue indicator is the criterion of competitiveness; it is a dependent variable. Consider these indicators in Table 1.

**Table 1** – Characteristics of econometric analysis indicators for the companies' competitiveness formation

Variable	Designation	Explanation	Role in models
Company revenue	Revenue	Companies revenue, 2012-2021	Dependent
Company costs on personnel	Personnel	Company costs on personnel, 2012-2021.	Independent
Company costs on environmental protection	Env_costs	Company costs on environmental protection, 2012-2021	Independent
Company costs on R&D	RD_costs	Company costs on R&D, 2012-2021	Independent
Company costs on taxes	Taxes	Company costs on taxes, 2012-2021	Independent
Company cash flow	Cash_flow	Company cash flow, 2012-2021	Independent

Source: composed by the authors

<sup>19</sup> State Atomic Energy Corporation Rosatom (ROSATOM). Annual reports, 2009-2021. Available at: <https://www.report.rosatom.ru/53> (Accessed 24.11.2022)

<sup>20</sup> State Atomic Energy Corporation Rosatom (ROSATOM). Annual reports, 2009-2021. Available at: <https://www.report.rosatom.ru/53> (Accessed 24.11.2022)

The function of company income dependence on the selected indicators is as follows:

$$\text{Revenue} = F(\text{Pers\_costs}, \text{Env\_costs}, \text{RD\_costs}, \text{Taxes}, \text{Cash\_flow}).$$

Descriptive statistics of the given variables are shown in Table 2.

**Table 2** – Descriptive statistics of the given variables

	Average	Median	Minimum	Maximum	Standard deviation	Variation
Revenue	39.525	3.6210	3.623	87.117	30.995	0.7842
Costs on personnel	7.120	6296.2	500	14.494	4824.7	0.67763
Costs on environmental protection	685.17	462.5	54.93	5.872	932.01	1.3603
Costs on R&D	346.52	363.07	87	661.51	193.66	0.55887
Costs on taxes	1251.7	952.5	3	3.023	939.51	0.75058
Cash flow	26681.4	2429.5	209	7.262	1851.2	0.69038

	Asymmetry	Excess	5% percentile	95% percentile	The inter-quarter scope	Missed observations
Revenue	0.072656	-1.8094	3689.2	81.861	59.868	0
Costs on personnel	0.058492	-1.6024	1.100	13.949	9858.8	0
Costs on environmental protection	4.4554	22.315	57.172	1569.2	636.42	0
Costs on R&D	-0.0089369	-1.6768	90.35	604.76	376.11	0
Costs on taxes	0.33403	-1.2496	30.3	2862.8	1708	0
Cash flow	0.37251	-0.84456	337.3	5.702	3278.2	0

Source: received by the authors in the gretl programme

The analysis shows that the average income is 39,525. Over the last ten years, ROSATOM, and Orano have never been above average indicators, while Engie and EDF (France) have always remained above average ones. Regarding the independent variables related to investment in R&D, personnel development and environmental protection, the highest average investment is in personnel, i.e. financial investment in employee remuneration. The standard deviation for the variable "personnel costs" is also the highest. It highlights the wide variation in the values of the indicator between companies.

Construct a linear and two logarithmic models (Table 3).

**Table 3** – Modelling of company performance indicators

Indicator	Model 1	Indicator	Model 2	Model 3
Dependent variable	Revenue	Dependent variable	l_Revenue	l_Revenue
const	-793.346 (3178.26)	const	1.22776* (0.681021)	0,872228* (0,495173)
Personnel	6.28451*** (0.36049)	l_Personnel	0.910339*** (0.100313)	0.922989*** (0.105584)
Env_costs	0.0225801 (1.75935)	l_Env_costs	0.334588*** (0.101172)	0.224418** (0.0961240)
RD_costs	-18.6893* (10.1287)	l_RD_costs	-0.151848 (0.104117)	–

Indicator	Model 1	Indicator	Model 2	Model 3
Taxes	-1.72111 (2.38026)	l_Taxes	-0.0699566 (0.0558977)	-
Cash_flow	1.56154 (0.936054)	l_Cash_flow	0.0537965 (0.0655249)	-
R <sup>2</sup>	0.939954	R <sup>2</sup>	0.939981	0.926713
Constant error	8134.43	Constant error	0.299891	0.317665
Number of observations	40	Number of observations	40	40

\*\*\* – the level of significance 1%; \*\* – 5%; \* – 0%. The constant error is indicated in parentheses.

Source: obtained by the authors using the gretl programme

By comparing the three models, we can identify the factors affecting the income of ROSATOM (Russia), EDF, Engie, and Orano (France) companies.

The first model is linear and reflects a linear relation. The second and third models are based on logarithms. The analysis shows the greatest impact of personnel costs on companies revenue. This factor is significant at 1% level for all three models. According to the second and third models, an increase in personnel costs by 1% will increase company revenue by 0.91-0.92%. This is because of the employees potential is the company key indicator. Therefore, companies make efforts to attract qualified specialists and motivate their employees through salary increases, bonuses, and pension payments. For instance, ROSATOM wages are indexed annually to the inflation rate. Therefore, employees do not decrease their living standards. In addition, all analyzed companies provide pension payments to retired employees and bonuses for their employees<sup>21</sup>.

Moreover, some factors have a negative impact on revenue, for example, R&D cost. R&D investments do not always ensure profits immediately, but they are necessary to provide the long-term competitiveness of companies. ROSATOM actively invests in R&D and cooperates with leading universities. This regarded in the innovative development program until 2030 and partnerships with technical universities. ROSATOM partner universities are as follows: National Research Nuclear University MEPhI, Moscow, Russia; Moscow Institute of Physics and Technology (National Research University), Moscow, Russia; Bauman Moscow State Technical University, Moscow, Russia; Lobachevsky University, Nizhny Novgorod, Russia.

Hence, a comparative analysis of the models allows us to identify the key factors forming the companies revenue. This also serves to better understanding the strategies are used to manage the profits and investments<sup>22</sup>.

Since the coefficient of determination R<sup>2</sup> is almost the same in all three models and close to 0.93, the selected factors explain the change in the dependent variable quite accurately. Thus, all three models are relevant ones. Meanwhile, the constant error is lower in the logarithmic models. It is indicating more accurate results of models 2 and 3.

The analysis of models 2 and 3 shows positive effects of companies' environmental protection costs on their revenue. However, the nuclear power is considered as one of the most environmentally friendly ways to generate electricity. Therefore, companies actively concern with reducing emissions and protecting the environment. Environmental costs significantly affect the revenue of companies involved in the design, engineering, and construction of nuclear power plants. These plants are often located in places remote from cities. It provides favorable environmental conditions necessary for efficient operation. For example, it is necessary to prevent the negative impact of extreme natural and weather conditions, i.e., forest fires or severe frosts. This can damage the companies operation. Environmental pollution will cause and develop such conditions, and therefore companies are actively investing in environmental projects.

#### *ROSATOM development prospects in an internationally competitive environment*

<sup>21</sup> State Atomic Energy Corporation Rosatom (ROSATOM). Annual reports, 2009-2021. Available at: <https://www.report.rosatom.ru/53> (Accessed 24.11.2022)

<sup>22</sup> State Atomic Energy Corporation Rosatom (ROSATOM). Annual reports, 2009-2021. Available at: <https://www.report.rosatom.ru/53> (Accessed 24.11.2022)



In a competitive market for the design, engineering and construction of nuclear power plants, ROSATOM should take a complex of actions to maintain and strengthen its market position. These actions are being taken by ROSATOM to increase competitiveness. Therefore, the company can use a variety of strategies aimed at various aspects of its activities.

To determine the sources of an enterprise's competitiveness, one should refer to the Michael Porter model. According to his opinion, these are strategic positioning and operational efficiency [14]. To assess ROSATOM operational efficiency, the following indicators are considered: the asset turnover ratio, labour productivity, income, the quality of products and services provided, customers feedback, business expansion, etc.

Hence, some ROSATOM indicators are the highest ones among competitors: the turnover ratio of assets, intangible assets; others are at a lower level: the labor productivity coefficient. This allows us to identify areas have to be improved by the corporation.

The following indicators to be used to evaluate the corporation efficiency: return on sales by net profit (ROS), return on assets by net profit (ROA), and return on equity by net profit (ROE). They are shown in Table 4.

**Table 4** – The coefficients of return on sales by net profit (ROS), return on assets by net profit (ROA), return on equity by net profit (ROE), ROSATOM, 2012-2021

Index, ROSATOM	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
ROS, %	6.7	6.6	4.75	17.16	8.53	10.81	20.05	11.55	13.00	13.39
ROA, %	1.4	1.3	1.11	4.46	2.24	3.04	5.46	3.10	3.32	3.71
ROE, %	2.1	1.8	1.71	6.94	3.49	4.59	8.35	5.10	5.58	6.34

Source: annual reports of ROSATOM State Corporation, 2012-2021

Over the past 10 years, each of these indicators has stable growth. Although there have been some fluctuations, the overall growth trend over this ten-year period is clearly noticeable. For example, there was an increase in the ROS indicator by almost half; the ROA and ROE indicators increased by 2.65 and 3 times, respectively. This indicates the company high efficiency of in providing services in the market and using its capital to generate profits.

ROSATOM has its activities in many countries. For instance, the construction of 12 nuclear power plants, and the successful receipt of tenders for the construction of new power units are clear show the high degree of customer satisfaction to the Corporation. ROSATOM cooperates with those partner countries where no NPPs are being built. Indeed, the company cooperates with them in supplying nuclear fuel, uranium products, developing joint ventures, peaceful use of nuclear energy, etc.

The business expansion is confirmed by the world's largest portfolio of foreign orders for NPP construction, exceeding those of major competitors. In 2021, this portfolio amounted to \$139.9 bn USD, compared with \$66.5 bn USD in 2012.

ROSATOM is the only company in Russia operating in the field of nuclear energy. The level of support for nuclear energy in the Russian Federation increased from 66% in 2012 to 77.4% in 2021. This shows large public support. All above indicates an increase in approval and confidence in the success of ROSATOM operation<sup>23</sup>.

Regarding strategic positioning, Michael Porter defines it as "performing activities that differ from competitors or are provided in a different way" [14]. In nuclear energy, it is quite difficult for companies to act completely differently from competitors. There are common safety and operation standards for the construction and design of nuclear power plants, as well as various requirements for their further maintenance. Failure to meet these standards may have catastrophic consequences.

However, ROSATOM has an undeniable competitive advantage. It is the only company providing a full cycle of its projects for the design, engineering, and construction of nuclear power plants from development

<sup>23</sup> State Atomic Energy Corporation Rosatom (ROSATOM). Annual reports, 2009-2021. Available at: <https://www.report.rosatom.ru/53> (Accessed: 24.11.2022)

to subsequent maintenance at all operation stages. Some of the services provided by ROSATOM are unique ones.

In addition, ROSATOM produces commodities unrelated to nuclear power. The revenue from its sale in 2021 amounted to 1.9774.1 bn RUB<sup>24</sup>. This is certainly a competitive advantage, as the Company's activities are diverse and not limited to only one field.

ROSATOM is improving labour productivity. This affected a reduction in the employee turnover rate from 14.2% in 2012 to 10% in 2021<sup>25</sup>. Indeed, the number of employees quitting ROSATOM, Russia for various reasons is being reduced.

Salaries at ROSATOM correspond to the best companies in Russia and depend on the employee's performance. In 2021, the average salary in ROSATOM was RUB 96.2 thousand per month. One of the ways to increase productivity is the availability of corporate social programmes, such as insurance, providing employees with vouchers to health resorts and sanatoriums, and improving housing conditions. For these purposes in 2021 were allocated 11.5 bn RUB<sup>26</sup>. ROSATOM also regularly trains its employees: in 2021, the average number of training hours per employee was 42 hours. The 56% employees have higher education<sup>27</sup>.

ROSATOM actively cooperates with universities and schools, organises career events for students, and allocates target places in various educational institutions. In 2021 was established a branch of Lomonosov Moscow State University, Sarov, Russia. It will enroll and train specialists in physics and mathematics for ROSATOM.

These measures contribute to the development of ROSATOM as a reliable employer and attract young specialists. The company has repeatedly been ranked as the Forbes "Best Employer". Moreover, the active development of ESG policy in the company contributes to its international competitiveness. ROSATOM aims to reduce emissions of harmful emissions and actively develop closed production cycle technologies. This is consistent with the environmental aspect. The social aspect includes concern for employees and consists of insurance, better working conditions, training, and improved living standards.

The management aspect is evident in the availability of reliable information about the company's activities, the control of corruption and the establishment of an general regulatory system. ROSATOM complies with all necessary requirements by publishing comprehensive annual reports on its website, including coverage of all important aspects of its activities, financial indicators and specific data like number of industrial accidents. Furthermore, the company conducts external audits to assess the quality of internal regulation.

ROSATOM devotes significant attention to the implementation of the ESG agenda. This allows it to be equal to its competitors. The analysis of the company's activities and modeling of competitiveness factors define personnel costs as a key factor. Measures aimed at increasing labour productivity, such as corporate social programmes, are also included in this category.

Environmental protection costs are an important factor. ROSATOM reduces harmful emissions and efficiently uses the resources. The company develops environmental protection strategies every three years. A significant part of environmental protection costs is aimed at ensuring radiation safety and wastewater treatment. ROSATOM actively invests in environmental protection activities of the Russian Federation. This is confirmed by the data on these investments share in the total investments volume.

## Conclusion

After considering the characteristics of companies engaged in the design, engineering, and construction of nuclear power plants, we have determined this business has relatively high demand and a relatively low number of competitors in the market. However, conditions for their successful activity are traditional ones.

<sup>24</sup> State Atomic Energy Corporation Rosatom (ROSATOM). Annual reports, 2009-2021. Available at: <https://www.report.rosatom.ru/53> (Accessed: 24.11.2022)

<sup>25</sup> State Atomic Energy Corporation Rosatom (ROSATOM). Annual reports, 2009-2021. Available at: <https://www.report.rosatom.ru/53> (Accessed: 24.11.2022)

<sup>26</sup> State Atomic Energy Corporation Rosatom (ROSATOM). Annual reports, 2009-2021. Available at: <https://www.report.rosatom.ru/53> (Accessed: 24.11.2022)

<sup>27</sup> State Atomic Energy Corporation Rosatom (ROSATOM). Annual reports, 2009-2021. Available at: <https://www.report.rosatom.ru/53> (Accessed: 24.11.2022)

Firstly, these are investments into labour resources. The implementation of the ESG agenda has a positive impact due to the high degree of dependence on the natural and climatic environment. Conducting R&D is very expensive, and investments do not return immediately and quickly. Taxes have a negative impact on a company's competitiveness. This provides the prerequisites for state support of this economic sector. The study of new trends in nuclear power company operation will allow one's to correct the assumptions of international competitiveness theory.

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#### CONFLICT OF INTEREST

The authors declare no conflict of interest.

#### AUTHORS' CONTRIBUTION

Svetlana N. Rastvortseva – conceptualization, project administration, writing – original draft.

Anna A. Tikhonova – data curation, investigation.

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