NUCET NUCLEAR ENERGY AND TECHNOLOGY

Nuclear Energy and Technology 7(4): 327–332
DOI 10.3897/nucet.7.78500

Research Article

Dynamic statistical assessment of the competitiveness of an energy generating company (as exemplified by Rosenergoatom Concern JSC)*

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Academic editor: Yury Korovin ♦ **Received** 19 June 2021 ♦ **Accepted** 4 September 2021 ♦ **Published** 17 December 2021

Citation: Burtseva TA, Khvorostyannikov SS, Kuznetsova AA (2021) Dynamic statistical assessment of the competitiveness of an energy generating company (as exemplified by Rosenergoatom Concern JSC). Nuclear Energy and Technology 7(4): 327–332. https://doi.org/10.3897/nucet.7.78500

Abstract

The depletion of traditional organic energy sources and aggravated environmental problems are the reasons why the level of energy efficiency is an important factor in the competitiveness of the national economy. Russia ranks third in the world in terms of total energy consumption and its economy is distinguished by a high level of energy intensity (amount of energy per unit of GDP). In 2019, this figure was 9.62 tons of oil equivalent (toe) per 1 million rubles, which is 40% higher than the world average.

The low energy efficiency of the Russian economy is a widely recognized problem. A special decree of the Government of Russia in 2018 sets the task of increasing the level of energy efficiency of the Russian economy by 23% by 2030. One of the ways to solve this problem is the development of nuclear energy, and increasing the competitiveness of nuclear energy is one of the key issues for the national economy. In this connection, solving the problem of assessing the competitiveness of the nuclear industry and its leading companies occupies a key place among the practical scientific problems, the solution of which is facilitated by the results presented by the authors in this article.

Rosenergoatom Concern JSC is the leading energy generating company in the Russian nuclear industry. The results of the study of the competitiveness of Rosenergoatom Concern JSC were obtained on the basis of the authors' methodology for assessing the competitiveness of an energy generating company. The novelty of the presented methodology lies in the developed normative and evaluative model and the coefficients of competitiveness of an energy generating company.

The advantages of the authors' model are that it allows (1) obtaining integral assessments of the competitiveness of a power generating company at short time intervals for a large number of indicators and (2) quantitatively measuring the effects of different factors on the competitiveness of a power generating company, provided that the grouping of indicators of competitiveness of a power generating company is justified by influencing factors. The two factors considered by the authors were: the general market factor and the industry factor.

According to the results of the study, it was found that Rosenergoatom Concern JSC demonstrates positive increase of the competitiveness indicator mainly due to the industry factor. With this regard, it was concluded that, within the framework of state policy, it is advisable to strengthen support for the Russian nuclear industry by creating additional conditions and opportunities for its energy generating companies on the domestic energy market.

* Russian text published: Izvestiya vuzov. Yadernaya Energetika (ISSN 0204-3327), 2021, n. 3, pp. 121–133.

Keywords

Competitiveness, energy generating company, normative and evaluative model

Introduction

Russia is one of the leaders on the world energy market utilizing different forms of energy generation. One of the main forms is nuclear power generation producing about 20% of electric power in the general energy balance of the country. At present in Russia 38 nuclear power units are in operation in Russia on 11 NPPs. Contribution of nuclear power generation is important in the European part of Russia and, especially, in the north-west where power generation by NPPs reaches 42% (Khvorostyannikov 2019). Changes of technological practices in the fuel production, consumption and reprocessing influenced to a significant extent the Russian power generating industry, the structure of the energy market and its indicators. This process affects as well the competitiveness of Russian energy generating companies.

The objective of the present study is to perform dynamic assessment of competitiveness of Rosenergoatom Concern JSC on the domestic market. This objective is achieved using statistical factor methods, dynamics analysis, dynamic normal, which allowed applying both conventional and newly introduced indicators of competitiveness of a business entity reflecting industry specifics of Rosenergoatom Concern JSC.

Factors of competitiveness of an energy generating company and their measurement indicators

Competitiveness of an energy generating company is the ability of the company to use both its own and natural resources with higher efficiency ensuring more beneficial competitive positions.

Normative and evaluative model of competitiveness of energy generating company was developed of the basis of the concept of the system of balanced indicators and the dynamic normal method for conducting diagnostics of competitiveness of Rosenergoatom Concern JSC.

The systems and models of indicators as the instruments for assessment of competitiveness and results of operations of business entities are in application already for almost 100 years. One of the first attempts was the Dupont model (1920), which found widespread application by large corporations. *Tableau de bord* model is applied in French-speaking countries in the analysis of company management since 1932. Prominent scientists R. Kaplan and D. Norton (Kaplan and Norton 1996, 1997) and their followers (Martinsons et al. 1999, Norrekli 2003, Paladino 2007, Schonberger 2008) successfully dealt with the problem of development of the system of company specific indicators. R. Kaplan and D. Norton (1996) created the system of indicators "Balanced Scorecard" application of which allows solving such management problems as the disbalance between the strategic and the tactical company management levels, accounting for the effects of intangible assets on the results of company operations, and control over the implementation of strategic goals of the company (including enhancement of its competitiveness).

Dynamic normal method became the new approach to the assessment of enterprise management in a state-planned economy. The method for the first time treated the enterprise as the economic system including not only material and technical assets, but the management system as well. The basis of the dynamic normal method is the procedure of selection of economic indicators and their systematization. The idea of systematization of dynamic indicators for economic systems belongs to I.M. Syroezhkin (Syroezhin 1980); subsequently it was further developed by his followers (Stojanovich Dragica 1986, Saarepera 1987, Eissner 1988). Examples of examination of normative (optimal) ratios of indicator evolution measures can also be found in the present-day studies and references (Zakharchenko 1993, Pogostinsky 1999, Zavgorodnyaya 1999, Zhambekova 2000, Ivleva 2008, Burtseva 2009, 2010, 2012, Svetunkov et al. 2012, Burtseva and Chausov 2016). This approach was applied by the authors of the present study for assessment of competitiveness of an enterprise.

The list of indicators (dynamic normal) structured according to the growth rates (indices) was defined for constructing the model. Correlations between basic indicators (structuring principles) are shaped on the basis of coefficients characterizing competitiveness of an energy generating company suggested by the authors. The assessment demonstrating the fraction of realized correlations between the rates (indices) of growth of factual values of dynamic normal indicators in the normative and evaluative model of competitiveness of the energy generating company is the integral indicator of competitiveness 22]. The obtained value of the integral characteristic is found within the interval [0, 1]. The closer is the value of the integral estimation to unity the higher is the level of competitiveness of the energy generating company.

The following indicators are included in the dynamic normal.

1. Fixed assets according to their depreciated value include the assets involved in the economic operations of the company and operated during more than one

year taking into account their depreciation. These assets generate revenues for the company because the value of such assets is transferred on the ready products portionwise. Assessment of value of fixed assets takes into account their wear, i.e., duration of their operation, which is extremely important for the comparative assessment of competitiveness of energy generating companies utilizing different energy sources.

2. Current assets: the assets involved in the economic operations of the company consumed during one year.
3. Revenues: the aggregate earnings from the company's economic operations.
4. Profit: the difference between the aggregate earnings and expenditures resulting from company's operations.
5. Installed capacity: the aggregate rated electric power of electrical machines of the same type.
6. Total generated energy: the total quantity of electric energy generated during one year (Khvorostyannikov 2020).
7. Yearly annual number of employees: the number of people employed by the enterprise during one year.
8. Cost of electricity generation: the indicator characterizing operation of the energy generating company which is the aggregate of all costs in the process of generation, transfer and distribution of electricity in electric grids expressed in monetary terms (RUR/kW×hour).

The above dynamic normal indicators are divided into two groups as follows: universal indicators (applicable in the analysis of competitiveness of any company) and unique indicators (can be applied only in the examination of competitiveness of energy generating companies), which allows quantitative measurement of the effects of the conventional (general market) factor and the industry factor taken separately on the competitiveness of the energy generating company (Fig. 1).

Normative and evaluative model of competitiveness of the energy generating company

Paired comparison method and competitiveness coefficients suggested by the authors, as well as preset targeted limits for their variation (Columns 1 and 2 in Table 1) were used for constructing the normative and evaluative model. Normative and evaluative model represents a matrix, each row and each column of which correspond to the dynamic normal indicator (Column 2 in Table 2). The values of ratios of the dynamic normal indicators are entered in the cells of the matrix if these values are determined on the basis of derived indicators, i.e., the economic competitiveness coefficients (Column 1 in Table 1). The coefficients per se must be meaningful economically with respect to the object of the assessment (See Column 3 in Table 1). If the indicator in a row must be growing faster than the indicator in the column in order to satisfy the preset target values, then the value equal to 1 is entered in the cell and the value equal to -1 is entered in the symmetrical place. In the opposite case the values equal to -1 and 1, respectively, are entered. The value equal to 0 is entered in the absence of correlation.

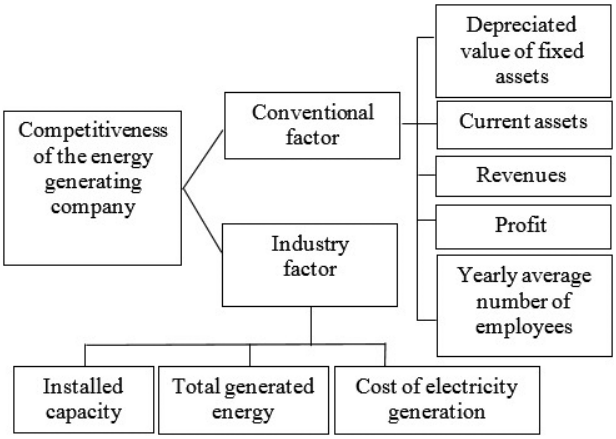

Figure 1. Factors and indicators of competitiveness of an energy generating company.

The normative and evaluative model is formalized as the $\mathbf{E} = \{e_{ij}\}_{n\times n}$, where n is the number of indicators in the dynamic normal; in our case this number is equal to eight (See Column 2 in Table 2):

$$e_{ij} = \begin{cases} 1, \text{ if } \mathrm{Tp}(\Pi_i) > \mathrm{Tp}(\Pi_j) \\ -1, \text{ if } \mathrm{Tp}(\Pi_i) < \mathrm{Tp}(\Pi_j) \\ 0, \text{ if there is no correlation between the indicators} \end{cases}, \quad (1)$$

where i, j are the numbers of indicators in the dynamic normal; Π_i, Π_j are the indicators with i-th and j-th numbers in the dynamic normal, respectively; $Tp(\Pi_i) > Tp(\Pi_j)$ и $Tp(\Pi_i) < Tp(\Pi_j)$ are the standard correlations between the rates of growth of the indicators of the dynamic normal.

The matrix **E** after the exposure of additional correlations on the basis of the transitivity principle becomes the normative and evaluative model (Table 2).

The formula for calculating the quantitative level of the integral estimation Y has the following form:

$$Y = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n} |e_{ij}|}, \quad (2)$$

where

$$e_{ij} = \begin{cases} 1, \text{ if } \left(e_{ij} = 1 \text{ and } f_{ij} \geq 0\right) \\ AND\left(e_{ij} = -1 \text{ and } f_{ij} \leq 0\right). \\ 0, \text{ in other cases} \end{cases} \quad (3)$$

In the above expressions b_{ij} is the element of the matrix of coincidences of the factual and the standard growth rates $\mathbf{B} = \{b_{ij}\}_{n\times n}$; e_{ij} is the element of the matrix of the normative and evaluating model (1); f_{ij} is the element of the matrix of factual correlations $\mathbf{F} = \{f_{ij}\}_{n\times n}$:

Table 1. Coefficients of competitiveness of the energy generating company (developed by the authors)

Coefficient	Targeted objective	Economic meaning
1	2	3
Return on FA	Growth	Increased volume of profit due to the annual average balance of the company
Return on CA	Growth	Increased volume of profit due to the increase of the CA volume
Return on sales	Growth	Financial efficiency of sales of EG on the market
Return on IC	Growth	Large number of IC generates larger profit
Return on DC	Growth	The more efficiently is the use of fixed assets the higher is the profit
Capital to labor ratio	Growth	Efficiency of use of fixed assets
CA turnover	Growth	With increasing intensity of CA use their turnover increases
Efficiency of labor	Growth	Increased efficiency of labor reduces operating costs and increases profit
Return on labor	Growth	Operating costs must not exceed the profit
CEG per 1 kWhr	Reduction	DC 1 kWh reduces with increasing VEG
Correlation of EG volume with FA	Growth	Increase of FA results in the increase of VEG
Correlation of CEG with FA	Reduction	CEG decreases with reduction of DC of the FA
Correlation of VEG with FA	Growth	Increasing FA results in the increase of VEG
Correlation of CEG with CA	Reduction	Cost of electricity generation reduces with decreasing CA
Correlation of revenues with IC	Growth	Efficiency of use of the IC
Correlation of revenues with VEG	Growth	Revenues increase with growing VEG
Correlation of revenues with yearly average NE	Growth	Revenues increase with growing NE
Correlation of CEG with revenues	Reduction	CES decreases with growing revenues
VEG profitability	Growth	Higher VEG generates larger profit
Return on CEG	Growth	Reduction of CEG generates higher profit
Correlation of VEG with IC	Growth	Increasing IC increases the VEG
Correlation of VEG with NE	Growth	Increased NE increases the VEG
Correlation of CEG with IC	Reduction	Cost of generation reduces with increasing IC
Correlation of CEG with NE	Reduction	CEG reduces with reduction of NE

Comments: BA – fixed assets; EG – electricity generation; CA – capital assets; VEG – EG volume; DC – depreciated cost; CEG – cost of electricity generation; IC – installed capacity; NE – number of employees

Table 2. Normative and evaluative model of competitiveness of an energy generating company (developed by the authors)

Index i in Π_{ij}	Indicator of the dynamic normal Π_{ij}	Index j in Π_{ij}							
		1	2	3	4	5	6	7	8
1	Depreciated value of fixed assets	0	0	–1	–1	0	–1	1	1
2	Capital assets	0	0	–1	–1	0	–1	0	1
3	Revenues	1	1	0	–1	1	1	1	1
4	Profit	1	1	1	0	1	1	1	1
5	Installed capacity	0	0	–1	–1	0	–1	1	1
6	Volume of energy generation	1	1	–1	–1	1	0	1	1
7	Yearly average number of employees	–1	0	–1	–1	–1	–1	0	1
8	Cost of electricity generation	–1	–1	–1	–1	–1	–1	–1	0

$$f_{ij} = \begin{cases} 1, & \text{if } \mathrm{Tp}(\Pi_i) > \mathrm{Tp}(\Pi_j) \\ -1, & \text{if } \mathrm{Tp}(\Pi_i) < \mathrm{Tp}(\Pi_j), \\ 0, & \text{if } \mathrm{Tp}(\Pi_i) = \mathrm{Tp}(\Pi_j) \end{cases} \quad (4)$$

where $Tp(\Pi_i)$, $Tp(\Pi_j)$ are the factual growth rates for the i-th and j-th indicators of the dynamic normal, respectively.

Effects from each of the indicators on the growth of the estimation is determined according to the following formula:

$$\Delta Y(\Pi_i) = \frac{\sum_{j=1}^{n} b_{ij}^{o} - \sum_{j=1}^{n} b_{ij}^{o}}{\sum_{i=1}^{n}\sum_{j=1}^{n} |e_{ij}|}, \quad (5)$$

where $\Delta Y(\Pi_i)$ is the increment of growth of the integral estimation caused by the dynamics of correlations of growth rates between the i-th indicator and the remaining indicators; b^{o}_{ij}, b^{6}_{ij} are the elements of the matrix of coincidences of the factual and the standard correlations between the growth rates of indicators for the reporting and the base periods, respectively. Application of the suggested methodology is discussed in more details in (Norrekli 2003).

Results of the study

Calculated indices of growth of indicator values for Rosenergoatom Concern JSC for years 2018 and 2019 (Table 3) were used in the assessment (Annual Financial Statements for 2018, 2019). The indices are the growth rates expressed not in percent but as factors, – for the purpose of analysis it does not matter in which units the dynamics indicators are compared between each other.

The obtained matrices of factual coincidences for years 2018 and 2019 for Rosenergoatom Concern JSC are presented in Tables 4 and 5, and the matrices of coincidences – in Tables 6 and 7.

The integral estimations of competitiveness obtained, as the result, using formula (2) for Rosenergoatom Concern JSC for 2018 and 2019 are following:

$$Y_{2018} = 0.541667;$$
$$Y_{2019} = 0.91667.$$

Based on the obtained results the statement can be made that competitiveness of Rosenergoatom Concern JSC for 2019 increased by $\Delta Y = 0.91667 - 0.541667 = 0.375$ or by 69%.

Table 3. Indices of growth of indicators for Rosenergoatom Concern JSC for years 2018 and 2019 (developed by the authors)

Indicators in the dynamic normal	2018	2019
1. Discounted value of fixed assets	1.04	1.02
2. Capital assets	1.20	1.41
3. Revenues	1.08	1.17
4. Profit	0.86	2.55
5. Installed capacity	1.08	1
6. Volume of electricity generation	1.01	1.02
7. Yearly average number of employees	0.95	0.96
8. Cost of electricity generation	0.94	0.82

Table 4. Matrix of factual correlations between the indicators of competitiveness in the dynamic normal for Rosenergoatom Concern JSC for 2018 (developed by the authors)

Index i in Π_{ij}	Indicator in the dynamic normal Π_{ij}	Index j in Π_{ij}							
		1	2	3	4	5	6	7	8
1	Discounted value of fixed assets	0	–1	–1	1	–1	1	1	1
2	Capital assets	1	0	1	1	1	1	1	1
3	Revenues	1	–1	0	1	0	1	1	1
4	Profit	–1	–1	–1	0	–1	–1	–1	–1
5	Installed capacity	1	–1	0	1	0	1	1	1
6	Volume of electricity generation	–1	–1	–1	1	–1	0	1	1
7	Yearly average number of employees	–1	–1	–1	1	–1	–1	0	1
8	Cost of electricity generation	–1	–1	–1	1	–1	–1	–1	0

Table 5. Matrix of factual correlations between the indicators of competitiveness in the dynamic normal for Rosenergoatom Concern JSC for 2019 (developed by the authors)

Index i in Π_{ij}	Indicator in the dynamic normal Π_{ij}	Index j in Π_{ij}							
		1	2	3	1	5	6	1	8
1	Discounted value of fixed assets	0	–1	–1	–1	1	0	1	1
2	Capital assets	1	0	1	–1	1	1	1	1
3	Revenues	1	–1	0	–1	1	1	1	1
4	Profit	1	1	1	0	1	1	1	1
5	Installed capacity	–1	–1	–1	–1	0	–1	1	1
6	Volume of electricity generation	0	–1	–1	–1	1	0	1	1
7	Yearly average number of employees	–1	–1	–1	–1	–1	–1	0	1
8	Cost of electricity generation	–1	–1	–1	–1	–1	–1	–1	0

Factorization of the increments of the assessed competitiveness of Rosenergoatom Concern JSC (See (5)) on the basis of which the effects of the conventional and the industry factors were investigated, is presented in Table 8.

The conclusion can be drawn according to the data in Table 8 that for Rosenergoatom Concern JSC the main increment of the quantitative level of assessment of competitiveness is formed by the variation of the "Profit" and the "Volume of electricity generation" indicators.

As it has been mentioned above, the conventional factor of competitiveness is characterized by the following five indicators:

- Discounted value of fixed assets;
- Capital assets;
- Revenues;

Table 6. Matrix of coincidences for 2018 (developed by the authors)

Index i in Π_{ij}	Indicator in the dynamic normal Π_{ij}	Index j in Π_{ij}							
		1	2	3	1	5	6	1	8
1	Discounted value of fixed assets	0	0	1	0	0	0	1	1
2	Capital assets	0	0	0	0	0	0	0	1
3	Revenues	1	0	0	0	1	1	1	1
4	Profit	0	0	0	0	0	0	0	0
5	Installed capacity	0	0	1	0	0	0	1	1
6	Volume of electricity generation	0	0	1	0	0	0	1	1
7	Yearly average number of employees	1	0	1	0	1	1	0	1
8	Cost of electricity generation	1	1	1	0	1	1	1	0

Table 7. Matrix of coincidences for 2019 (developed by the authors)

Index i in Π_{ij}	Indicator in the dynamic normal Π_{ij}	Index j in Π_{ij}							
		1	2	3	1	5	6	1	8
1	Discounted value of fixed assets	0	0	1	1	0	1	1	1
2	Capital assets	0	0	0	1	0	0	0	1
3	Revenues	1	0	0	1	1	1	1	1
4	Profit	1	1	1	0	1	1	1	1
5	Installed capacity	0	0	1	1	0	1	1	1
6	Volume of electricity generation	1	0	1	1	1	0	1	1
7	Yearly average number of employees	1	0	1	1	1	1	0	1
8	Cost of electricity generation	1	1	1	1	1	1	1	0

Table 8. Factorization of the increment of the assessment by indicators in the dynamic normal for Rosenergoatom Concern JSC (developed by the authors)

Indicator in the dynamic normal	$\Delta Y(\Pi_i)$
1. Discounted value of fixed assets	0.041667
2. Capital assets	0.020833
3. Revenues	0.020833
4. Profit	0.145833
5. Installed capacity	0.041667
6. Volume of electricity generation	0.062500
7. Yearly average number of employees	0.020833
8. Cost of electricity generation	0.020833

- Profit;
- Yearly average number of employees.

The industry factor is characterized by the following three indicators:

- Installed capacity;
- Volume of electricity generation;
- Cost of electricity generation.

Effects of each indicator on the increment of assessed competitiveness of Rosenergoatom Concern JSC for 2018–2019 were estimated by summing up the increments for these indicators in Table 8. As the result the conclusion was made that positive effects are to a greater extent associated with the conventional factor of competitiveness of

an energy generating company. These results substantiate the conclusion that the growth of competitiveness of an energy generating company depends, first of all, on the performance of operations by the company itself. Significant growth of competitiveness of Rosenergoatom Concern JSC in 2019 is associated with revenues from the executed foreign orders of clients increased by 10.7%. The main competitive advantages of Rosenergoatom Concern JSC are the comprehensive offer for the duration of the whole NPP lifecycle allowing guaranteed competitive cost of electricity generation per kilowatt-hour (*LCOE*) and the maximum level of safety of the applied technologies.

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