

# Human-related drivers of energy-sector companies efficiency

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**Abstract.** Today, the Russian energy complex faces several important challenges: finding a balance between the reliability and efficiency of using existing energy equipment, and implementing a digital energy project. In the context of solving these problems, in turn, issues of corporate efficiency are considered both in the global and domestic markets. The topic of interaction between humans and artificial intelligence, personnel policy in the field of human capital management, as an asset of a new quality in the context of the digital economy, is becoming relevant. The purpose of the article is to analyze the influence human capital development on the efficiency of Russian electric power industry. The study found that the efficiency of companies is affected by such factors as the share of managers in the personnel structure, the share of employees with higher education, the average salary level and the share of employees under 35 (young professionals).

## 1 Introduction

The role of the energy complex is difficult to overestimate, since it is directly related to the development of scientific and technological progress in the country, the quality of life of the population, the national economy as a whole, the emergence of new digital industries and, as a result, products, etc., since the electric power industry systematically covers each economic sector, providing it with the necessary level of energy resources [1]. This is reflected in the energy strategy of Russia up to 2035, within the framework of which it is planned to increase the efficiency, reliability, availability and quality of satisfaction in the domestic market of services of energy complex companies, develop fuel and energy infrastructure, increase the innovative activity of corporations (within the framework of the creation of scientific and technical clusters), introduce digital technologies in the sphere of public administration, widely introduce artificial intelligence systems, implement the National Technological Initiative [2-3].

Today, the Russian electric power industry faces both issues of implementing digital programs within the framework of the balance between reliability and efficient use of energy equipment, and issues related to the topic of increasing the efficiency of Russian corporations in the energy sector in the current geopolitical situation caused by sanctions pressure, increased competition in global markets and rising energy costs [4-8].

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Considering the aspect of increasing the efficiency of corporations in the electric power industry, one of the key areas in this context is the company's HR policy, which touches on the topic of both synergy between an employee and artificial intelligence, which provides a qualitatively new way of implementing professional competencies, and the management of human capital as an asset of the corporation, as a whole [9-14]. That is why an attempt to study whether the factors characterizing human capital affect the efficiency of corporations in the electric power industry seems relevant.

## 2 Methodology and Data

The sample of the current study was collected based on data from the RAEX rating agency (RAEX-600) and the RBC 500 analytical review of the RBC daily business newspaper. At the first stage, the studied companies in the electric power industry were sorted according to the revenue received for 2021 and 2022, respectively. At the second stage, the selected companies were sorted in the following order: open data (annual reports, financial reports, sustainability reports, recruiting agency websites according to the average salary level) published on the Internet were analyzed according to the following indicators, which became explanatory variables: number of personnel, injury rate, average salary in the company, share of managers from the total number of company employees, share of employees with higher education/academic degree (if any), share of young specialists. As part of the sorting process, seven companies in the electric power industry were selected that met the above criteria: PJSC Rosseti, PJSC Mosenergo, PJSC Territorial Generating Company No. 2, PJSC RusHydro, JSC Quadra, PJSC EL5-Energo, PJSC Yakutskenergo. The following hypotheses were put forward within the framework of the conducted research:

1. The efficiency of Russian corporations in the electric power industry is affected by the injury rate
2. The efficiency of Russian corporations in the electric power industry is affected by the average salary level
3. The efficiency of Russian corporations in the electric power industry is affected by the share of managers from the total number of employees
4. The efficiency of Russian corporations in the electric power industry is affected by the share of employees with higher education
5. The efficiency of Russian corporations in the electric power industry is affected by the share of young specialists

The efficiency is assessed by the return on sales (ROS) and labor productivity (Labor productivity), while the degree of influence is assessed by the linear correlation coefficient.

## 3 Results

As part of the study, the authors obtained the following results (table 1-3).

**Table 1.** Source financial and HR data of Russian power generating corporations

Power generating corporations	Sales revenue. billion rubles					Net profit. billion rubles					Number of employees. thousand people				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
PJSC "Rosseti"	1022.0	1030.0	1002.0	1182.0	1300.0	121.1	105.3	61.2	27.7	54.2	22.1	22.0	21.7	21.5	21.5
PJSC "Mosenergo"	198.9	189.8	180.9	224.8	227.0	21.4	16.5	14.3	17.7	20.7	7.9	8.0	8.2	7.9	8.1

PJSC "TGK-2"	36.4	37.6	44.1	47.0	47.4	3.0	2.1	-0.1	-0.9	1.5	4.9	4.9	5.0	4.8	4.6
PJSC "RusGidro"	358.8	366.6	382.8	406.0	418.6	70.8	51.5	67.0	78.4	44.7	69.7	69.5	66.0	65.8	67.6
JSC "Quadra"	53.4	55.6	56.6	62.3	62.6	1.0	1.9	2.0	3.0	-5.1	10.8	11.7	11.9	11.6	11.9
PJSC "EL5-Energo"	73.5	73.9	57.0	46.7	48.1	5.1	-12.1	3.5	2.6	-7.2	2.5	2.4	1.4	1.4	1.5
PJSC "Yakutskenergo"	34.6	36.0	34.7	32.6	29.8	2.3	-3.1	-3.4	-3.0	-1.1	5.3	5.3	5.3	4.4	4.4

The data presented in tables 2 and 3 are calculated and obtained on the basis of commonly used formulas. These data will be used to test the formulated hypotheses as explanatory variables.

**Table 2.** Characteristics of HRM in Russian power generating corporations

Power generating corporations	Injury rate, units (X1)					Salary, thousand rubles (X2)					Share of managers, % (X3)				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
PJSC "Rosseti"	0.14	0.09	0.05	0.42	0.19	79.6	83.4	84.0	88.0	98.2	13.7	13.8	13.2	13.3	13.0
PJSC "Mosenergo"	0.13	0.07	0.14	0.14	0.16	85.4	88.4	91.0	92.8	99.3	35.1	34.9	35.0	22.0	22.0
PJSC "TGK-2"	0.17	0.09	0.18	0.20	0.23	56.8	57.3	58.8	62.1	68.7	16.2	16.4	16.4	16.8	17.7
PJSC "RusGidro"	0.24	0.24	0.25	0.33	0.22	72.4	78.6	82.7	89.5	102.8	14.9	15.0	15.1	15.1	14.9
JSC "Quadra"	0.14	0.15	0.13	0.12	0.12	39.8	41.0	42.1	44.0	45.6	17.4	16.1	16.3	15.8	15.6
PJSC "EL5-Energo"	0.15	0.56	0.23	0.16	0.00	115.4	117.3	117.7	118.9	121.7	18.0	18.3	20.1	20.2	22.0
PJSC "Yakutskenergo"	0.01	0.01	0.02	0.01	0.09	78.1	82.1	82.2	90.4	107.1	15.0	15.0	15.0	16.5	16.3

**Table 3.** Characteristics of HRM in Russian power generating corporations

Power generating corporations	Share of employees with higher education, % (X4)					Share of young specialists, % (X5)				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
PJSC "Rosseti"	63.3	64.0	64.3	64.8	65.4	31.4	28.7	26.9	24.6	23.0
PJSC "Mosenergo"	53.0	53.0	53.0	54.0	53.0	31.0	28.0	26.0	25.8	25.5
PJSC "TGK-2"	43.8	44.3	45.1	45.8	47.2	14.2	13.9	13.2	12.1	11.0
PJSC "RusGidro"	55.0	55.0	57.1	57.4	57.6	24.1	23.5	23.4	23.2	22.1
JSC "Quadra"	43.7	41.8	42.4	43.6	44.3	23.7	20.7	19.7	19.4	19.0
PJSC "EL5-Energo"	65.6	65.6	78.1	78.4	79.0	8.0	8.0	6.0	6.0	7.0
PJSC "Yakutskenergo"	43.1	43.9	44.7	43.7	44.1	20.0	19.0	18.0	17.0	16.0

The data obtained as a result of the study allow us to draw a conclusion about the

diversity of the final sample: for example, in terms of revenue, the studied corporations in the electric power industry vary from RUB 29.8 billion to RUB 1,300 billion, on average across the industry demonstrating growth of this indicator by 1.82% over the study period. It is noteworthy that in 2022, which became a painful year for many companies due to the geopolitical situation, the companies managed to maintain revenue growth, albeit insignificant (on average across the industry 1.44%); in terms of net profit, the sample ranged from RUB -7.2 billion to RUB 54.2 billion, on average across the industry demonstrating a decrease in the indicator over the study period by 25.88%, while only a number of companies managed to maintain positive growth rates of the indicator in the painful 2022: PJSC Rosseti - 95.81% and PJSC Mosenergo - 16.86%. This is also largely due to the growing role of the implementation of investment programs that have become fundamental in achieving state sovereignty. In the same way, companies vary in size in terms of the number of employees: from 1,461 people in 2022 to companies with 65,792 people. There is also heterogeneity in the HR policies implemented in the companies studied. On average, the injury rate in the companies studied is identical, in the industry it is 0.16 units: this is explained primarily by the fact that the companies are strictly committed to the "Goal - Zero" technology, the essence of which is to reduce the number of accidents that occur at work. It is noteworthy that only one company - PJSC "EL5-Energo" managed to achieve significant results in terms of reducing industrial injuries: having a coefficient value of 0.56 units in 2019, the company managed to reduce the number of accidents to zero in 2022. The share of managers in the total number of employees of the enterprise also decreased on average across the industry by 0.51% during the period under study. However, there is no uniformity in the companies in the context of distributing one manager per n-th number of employees: the highest percentage of managers is recorded in companies with a small number of employees (PJSC Mosenergo and PJSC EL5-Energo), while the smallest shares of 13 and 14.9% are recorded in large companies (PJSC Rosseti and PJSC RusHydro). The dynamics of the share of employees with higher education shows a good result: over the study period, the value of this indicator increased in almost all companies, which primarily allows us to conclude that, although having different HR policies within their system, companies somehow pay attention to the development of their main asset - human capital, participating in the process of improving its quality. The dynamics of the share of young employees in companies in the electric power industry is negative: over the entire study period from 2018 to 2022, the share of employees under 35 years of age decreased. This is largely due to reforms in the HR policies of companies (the structure was optimized personnel), and the specifics of the industry, within which more "senior specialists" have the necessary skills and competencies formed during the adaptation period in the company and passing the stages of training in it. Values of the efficiency indicators were determined: sales profitability and labor productivity (see table 4).

**Table 4.** Return on sales and labor productivity of Russian power generating corporations

Power generating corporations	Return on sales, % (Y1)					Labor productivity, mil.RUR per person (Y2)				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
PJSC "Rosseti"	11.85	10.22	6.11	2.34	4.17	46.35	46.76	46.20	54.87	60.57
PJSC "Mosenergo"	10.77	8.67	7.90	7.89	9.13	25.03	23.60	22.19	28.30	28.09
PJSC "TGK-2"	8.29	5.47	-0.19	-1.98	3.08	7.43	7.66	8.85	9.73	10.27
PJSC "RusGidro"	19.73	14.05	17.50	19.31	10.68	5.15	5.27	5.80	6.17	6.19
JSC "Quadra"	1.82	3.48	3.51	4.83	-8.21	4.95	4.76	4.77	5.38	5.27

PJSC "EL5-Energo"	6.92	-	6.21	5.46	-	29.43	30.73	39.96	33.10	32.95
PJSC "Yakutskenergo"	6.53	-8.51	-9.65	-9.36	-3.59	6.50	6.84	6.54	7.37	6.80

To test the hypotheses set by the authors, linear correlation coefficients were calculated (table 5 and table 6). According to the calculations, at a 5% significance level, the hypotheses about the influence of the proportion of managers (X3), the proportion of employees with higher education (X4) and the proportion of young specialists (X5) on the efficiency of power generation corporations in the context of ROS are partially confirmed. The influence of such factors is negative.

**Table 5** Correlation of independent variables with Y1 (ROS)

	X1	X2	X3	X4	X5
2019	-0.756	0.142	-0.578	-0.501	-0.699
2020	0.255	0.416	-0.539	-0.676	0.766
2021	-0.213	0.061	0.172	0.200	-0.505
2022	0.214	0.594	-0.764	-0.519	-0.567

According to the calculations performed, at the 5% significance level, the hypotheses about the impact of wages (X2) and the share of employees with higher education (X4) on the efficiency of power generation corporations in the context of Labor productivity are partially confirmed. At the same time, the influence of the wage factor is of medium strength and is partially confirmed from 2018 to 2020, the influence of the factor of the share of employees with higher education is confirmed throughout the entire period and high (from 2018 to 2020) and medium strength of the connection.

**Table 6.** Correlation of independent variables with Y2 (Labor productivity)

	X1	X2	X3	X4	X5
2018	-0.019	0.575	0.140	0.811	0.273
2019	0.223	0.578	0.128	0.834	0.223
2020	-0.104	0.647	0.105	0.827	-0.041
2021	0.549	0.489	0.019	0.695	0.144
2022	-0.078	0.393	-0.021	0.664	0.178

## 4 Conclusion

The indicators characterizing human capital in Russian corporations of the electric power industry do not have a direct connection with each other, which determines the thesis that the enterprises of the industry do not have a unified HR policy in the context of their own systems and, most likely, the HR policy is a unique product of each individual enterprise. The hypotheses on the influence of the share of managers, the share of employees with higher education and the share of young specialists on ROS were partially proven. Thus, the lower the share of young specialists, the higher the ROS is determined by the specific nature of the industry that employees of a more mature age are the most productive within the framework of the tasks set. The relationship between the decrease in the share of managers and the decrease in the share of employees with higher education in the context

of increasing ROS is also explained by the fact that the more valuable and qualified the personnel, the more expensive it is to maintain them (and the higher, accordingly, the wage fund). The article partially proved that labor productivity is affected by such factors as wages and the proportion of employees with higher education, which is quite natural: wage growth accompanies employee motivation to increase labor productivity, as well as more qualified and competent employees will bring a larger amount of revenue per person to the enterprise. This task becomes especially relevant in the context of pushing back routinization processes, when artificial intelligence replaces routine processes, thus giving rise to qualitatively different professions. Based on the above, it can be said that the indicators characterizing human capital have a direct impact on the efficiency of corporations in the electric power industry, although they have heterogeneous personnel policies in their understanding, which is rather positive within the specifics of a single company. Nevertheless, for a more detailed analysis of the study, the authors believe, it is necessary to analyze both more companies and a larger number of time periods.

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