IRSTI 44.01.75 https://doi.org/10.32523/2789-4320-2025-1-25-51
Article type: research article

Assessing public administration practices in Kazakhstan's electric power industry: an econometric approach

A. Nurgaliuly*[1], S. Smagulova[2], K.N. Beketova[1]

[1]*Korkyt Ata Kyzylorda University, Kyzylorda, Kazakhstan*
[2]*University of International Business named after Kenzhegali Sagadiev, Almaty, Kazakhstan*

*(E-mail: [1]*arys1097messi@gmail.com, [2]shsmagulova@mail.com, [3]kamar82@mail.ru)*

Abstract. Issues of improving public administration in the electric power industry are more relevant than ever in the current conditions of the global economic crisis. The Republic of Kazakhstan occupies an important position in Central Asia's energy sector. The electric power industry is one of the leading links within Kazakhstan's socio-economic system. However, the country faces a chronic problem of electricity shortages, which is detrimental to the national energy system and other sectors of the economy. The purpose of this study is to analyze the state and assess the factors that most strongly affect electricity generation from 2011 to 2023 and offer recommendations for improving government regulation of the development of the electricity market in Kazakhstan. This study is based on the methods of logic, statistics, and econometric modeling. The results of the study indicated that the growth of electricity production is positively influenced by attracting investments in the electric power industry, prices of manufacturing enterprises for electricity sold on the domestic market, as well as the size of the urban population at the end of the year. According to the forecasts for 2024-2030, subject to rising electricity prices, urban population, and investments, the volume of electricity production will increase.

Key words: electric power industry, electricity generation, public administration, investments in the electric power industry, electricity prices, urban population.

Received 20.02.2025. Revised 12.02.2025. Accepted 14.03.2025. Available online 31.03.2025

[1]***the corresponding author**

Introduction

The electric power industry is a critically important component of the socio-economic system, which determines the viability of any country and the well-being of society. The functioning of a great number of production and consumer activities depends on energy. At the beginning of the 21st century, the lives of more than five hundred million people were paralyzed for several days because of the disaster that occurred in Canada and the USA. This event illustrates the exceptional importance of the electric power industry [1].

Major accidents, which took place in India in 2012, in Germany in November 2004, and in Brazil in February 2011, led to massive power outages and caused significant damage to the entire economy and social sphere of these countries. Recently, the probability of threats to the electric power industry has increased sharply as a result of such challenges as escalated geopolitical conflicts, instability of the financial system, and the largest energy crisis caused by the new energy transition in the last 50 years [2].

It should be noted that the issue of the effective management of the energy sector affected both developed markets and developing ones, in particular, countries exporting energy resources.

By 2023, the tension of the energy markets has been increased for these reasons: the global economic crisis, geopolitical turmoil in Eastern Europe and the Middle East, and problems with emissions of harmful substances into the atmosphere.

However, as it is indicated in the report of the World Energy Outlook 2023 from the International Energy Agency (IEA), positive trends in accessing electricity and clean cooking methods have been slowed in some countries. 2022 was a challenging year for the global energy market. Prices for the energy, particularly, for natural gas, have risen significantly in Europe and many other countries around the world. The effects of the price shock were mitigated by the government intervention. Global electricity requirement was increased by 1,3% [3].

However, despite geopolitical differences, volatile commodity prices, and uncertainty about consumption, global investment in clean energy has increased by 40% since 2020. As a result of the global energy crisis, global demand for conventional energy resources is expected to reach its peak by 2030, according to the Stated Policies Scenario. There are trends toward a reduction in the number of new natural gas and coal-fired power plants in comparison to the period before the COVID-19 pandemic, improvement prospects for the development of nuclear power, diversification, and innovation in the energy system [4].

Kazakhstan is a significant energy market for European and Asian regions. The energy sector of Kazakhstan is one of the most important industries, the basis for the functioning and development of the country's economy. The Republic has significant reserves of energy resources, such as oil, gas, uranium, coal, and hydro resources. This industry consists of two areas in Kazakhstan: thermal power and electric power, which, in turn, include the production, transaction, supply, and consumption of electrical and thermal energy.

The installed capacity of power plants in Kazakhstan amounted to 23,9 GW in 2022. Thermal power plants (TPP), most of which are coal and gas, produce 75-80% of the total electricity in the country, and hydroelectric power plants (HPP) produce about 8%, due to the climatic, geographical, and economic features of the country. It indicates a low level of diversification of electricity production. In 2022, the electricity generation of thermal power plants and hydroelectric power plants was lower compared to previous years. This observation indicates factors constraining the growth of electricity generation [5].

The main challenge for Kazakhstan's electric power industry is the electricity shortage, which reduces the sustainability of the energy sector and the national economy. It means that the volume of electricity generation is not enough to cover the population and economic entities' demands. The electricity generation represents the final result of the economic entities' activities in the industry, which does not depend only on the public and private economic agents' decisions, but also depends on the industry regulation as a whole. According to the IEA report, in 2022, a drop was recorded in the electricity production compared to 2021, despite the annual increase in the electricity demand in Kazakhstan [6]. The forecast for the electricity generation in 2023-2025 was lowered by the Ministry of Energy of the Republic of Kazakhstan [7].

The growth of Kazakhstan's national economy since the 2000s has transformed the country into an economy with an upper-middle-income status. In 2000, GDP growth of 14,5% was recorded due to the expansion of production capacity in the oil sector and rising world oil prices [8]. Increasing living standards and reducing poverty have led to an increase in the urban population and, hence, an increase in demand for electricity [9].

The relevance of this study lies in the key role of Kazakhstan's electric power industry in the development of not only the country's economy but also the entire Central Asian region. In recent years, the situation with the depreciation of fixed assets and the shortage of electricity has not improved qualitatively, and due to the obsolescence of energy equipment, it continues to worsen further. The purpose of this study is to analyze the state and assess the factors that most strongly affect electricity generation from 2011 to 2023 based on econometric modeling, and offer directions for improving government regulation of the development of the electricity market in Kazakhstan.

Problems of the energy sector in the Republic of Kazakhstan are not isolated, but they are systemic and remain relevant as an energy-exporting country. The government's further ignoring of old problems and a belated response to new ones can ultimately lead to a catastrophe on a regional and national scale and the collapse of the socio-economic system. Critically important industries, including those related to national security and citizens' well-being, depend on the stable operation of the electric power industry.

Literature Review

One of the most important components of the development in the electric power industry, like any other one, is attracting additional financial resources as an investment. The role of investment in clean energy for reducing the impact of climate change on risks in the energy sector is studied by Iyke's research [10].

The impact of investments in efficient and environmentally friendly technologies on reducing the energy intensity is noted by Rahman and other scientists' works [11]. The impact of the investment on energy, energy security in Chinese provinces was studied by Bamisile et al. [12]. Results showed that investments in the energy sector achieved the maximum positive effect on energy security during the timeline from 2010 to 2014. The reaction to changes in the energy capacity investment among 17 European countries was studied in the research article by Radulescu & Sulger. A negative interrelation was found between countries' investments in energy capacity [13]. The authors Yuegang et al. concluded that the investment in energy infrastructure plays a crucial role in increasing the electricity production from renewable energy sources (RES) [14].

Implemented investments contribute effectively to improving the energy infrastructure, which makes a positive impact on labor productivity. This statement is statistically and economically confirmed in Fedderke & Kayathe's study [15].

In the case of the Republic of Kazakhstan, the importance of increasing labor productivity of energy sector workers to reducing energy intensity is reflected in target indicators in the field of energy efficiency, as noted in the work of Soltangazinov et al. [16].

A great attention is paid to the problems of developing the renewable energy sector, the transition to «green» energy, and reducing emissions of carbon dioxide and other greenhouse gases. Thus, Shabir et al. in their study confirm the need to increase public budget expenditures on research and development works (R&D) and stimulate technological innovation in the energy sector for achieving environmental well-being [17].

The state policy of the former Soviet bloc countries in the field of renewable energy sources (Azerbaijan, Armenia, Georgia, Kazakhstan, Moldova, Poland, Russia, Ukraine) was discussed in the article by Karatayev et al. The need to improve national laws on projects in the field of renewable energy sources and review the models for calculating feed-in tariffs is emphasized [18].

A detailed overview of renewable energy-related tariff regulation policy and strategies, predominantly in developed and developing countries, is presented in the study by Supriyanto et al. The key section of the scientific work provides a comparative analysis of Indonesia and other countries' energy policies regarding renewable energy sources. The problems of the “green” transition from the point of view of economic efficiency and the importance of the tariff policy in stimulating the electricity industry are discussed [19].

An economic assessment development of the electric power industry was conducted by Kazakh scientists, and measures for the implementation of innovative projects in the field of digital energy were presented [20].

The growth of the urban population and rapid technological development have led to significant increases in electricity production and consumption, as stated in the study by Huang & Jin [21]. Evidence that the urban population influences the electricity production variability in China was provided in the research article by Michieka & Fletcher [22].

Publications of recent years have also been devoted to improving the method for assessing energy security and developing integral indicators that allow for assessing the efficiency of economic activities of energy sector entities. The main indicators of energy security include the volume of electricity production, the volume of attracted capital investments, etc.

The results of the study by Muço et al., using a vector autoregressive model, show that in European transition countries between 1990 and 2018, energy efficiency investments have a positive impact on economic competitiveness and the environment [23].

In the publication by Wang et al. using statistical models built for Chinese economy, such as ordinary least squares (OLS), confirmed the need for diversified state and regional energy policy that address structural changes in the production of the energy [24].

Batóg & Pluskota used statistical correlation coefficients, trend, and econometric models in their study. The received results confirmed the importance of financial instruments in transforming the energy sector, as well as the need for proper government regulation. The lack of correlation is noted between the economic development of the region and the level of funds allocated for energy efficiency and renewable energy sources (RES) [25].

Tariffs and prices are very important ones in the development of the electric power industry. Schöniger & Morawetz's studies are devoted to the analysis of the correlation between the share of renewable energy sources in the electricity production and electricity price deviations [26]. The importance of ensuring favorable tariffs and energy prices for consumers and companies, environmental responsibility, and technological modernization of energy enterprises was confirmed with the regression analysis method used in the research article by Gitelman et al. [27].

Thus, the topic of the research, analysis, and assessment problems associated with renewable energy sources prevails significantly, since they are relevant and significant not only for developed countries in Europe and North America, but they are also relevant for developing countries in modern foreign scientific literature. Much attention is paid to the investment and tariff policy in the selected publications, emphasizing their importance in the economic stimulation of the energy sector. The problems of achieving energy efficiency, choosing optimal strategies for the energy industry development, and developing new econometric models for a more accurate assessment state of the industry are touched upon.

During the extended meeting of the Government of the Republic of Kazakhstan on February 7, 2024, the President noted that the worsening deficit in the fuel and energy market was caused by the excessive price regulation. The need for accelerated modernization of the energy sector was also noted to ensure the stability of the most important systems that support the functioning of populated areas. In general, the country experiences a shortage of the capacity for the production, distribution, and transmission of heat, electricity, and water. It is a direct consequence of systemic errors and omissions on the part of management bodies. Errors of this kind include non-compliance with the principle of transparency in the functioning of natural monopoly entities, postponements of renovation and reconstruction of Ekibastuz State District Power Plant-1 and State District Power Plant-2, unfinished construction of the Balkhash Thermal Power Plant, and artificial containment of tariffs [28].

Research methods

To achieve the goal of the study, econometric regression methods are used to predict and analyze the interrelation of the objects in this scientific work. The Ordinary Least Squares (OLS) method is applied in regression analysis, which is one of the most commonly used tools in research practice. This method allows for the identification and evaluation of the interrelation between several independent variables and one dependent variable. Owing to the regression analysis, it is possible to identify a significant connection between indicators, assess the relative strength of the influence of various independent variables on the dependent one, and make predictions based on the obtained data [29].

There are linear, multiple linear, and non-linear regression analyses, but a simple linear analysis is the most common one. At the same time, according to Taylor's opinion, nonlinear regression analysis is used for complex data sets where there is a nonlinear interrelation between the dependent and independent variables [30].

The following formula is used to calculate the variation coefficient:

$$C_v = \frac{\sigma}{\mu} \tag{1}$$

Where, C_v is the variation coefficient, σ is the standard deviation, and μ is the average deviation.

Checking the statistical significance of the determination coefficient, one should use Fisher's *F* test values, which can be determined by the formula:

$$F = \frac{R^2}{1-R^2} * \frac{n-m-1}{m} \tag{2}$$

Where *R^2* is the determination coefficient, *n* is the number of observations, and *m* is the number of parameters.

The multiple linear regression models are expressed as follows:

$$Y = \int(X_1) + \int(X_2) + \int(X_n) + \varepsilon \tag{3}$$

Where *Y* is the dependent variable, X_n is the independent variable, *n* is the number of factors, and ε is a random error.

There are correlation coefficients (R), which indicate the interrelation degree of the resulting characteristic with the 10 variables below. The value of R varies from -1 to 1. The closer the coefficient value is to 0, the weaker the correlation between indicators. A positive correlation (R>0) means that one variable is directly related to another variable. According to econometric science, when making decisions about the level of a strong significance indicator, if R is above 0,5, then it is accepted. When there is a negative correlation (R<0), an increase in one variable leads to a decrease in another. The results of the analysis are presented in the correlation matrix.

Statistical data was collected and analyzed to carry out multiple regression analysis. The timeline was chosen from 2011 to 2023. Data were taken from various official sources, such as: statistical yearbooks, publications of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, Kazakhstan Electric Power Association's reports (KEPA), press releases and documents of the Ministry of Energy of the Republic of Kazakhstan, analytical reviews provided by JSC "Samruk-Energo", information on the electric power industry of the Republic of Kazakhstan from Kazakhstan Electric Network Management Company "KEGMC", republican budgets from 2011 to 2023.

The main calculations were carried out by the "Gretl", an application software package designed for econometric modelling.

The following are econometric modeling hypotheses for this research:

Hypothesis 1 – The volume of electricity production is positively affected by attracting investment in the electricity sector.

Hypothesis 2 – The growth of electricity production is positively influenced by the size of the urban population.

Hypothesis 3 – The growth of the electricity production volume is positively influenced by the price of manufacturing enterprises for sold electricity on the domestic market.

Results and Discussion

Before conducting the author's quantitative assessment of the electric power industry (E/E) state on the national scale, a set of indicators was compiled that met the following criteria: public availability of statistical data for the selected timeline; direct dependence between indicators and the industry development and related sectors; indicators should reflect the main results of the industry entities' activities; indicators should reflect socially-significant and environmental aspects of the industry activity; absolute and relative values should be used for more complete information in calculations.

Thus, based on the above criteria, indicators that characterize the position of the electric power industry in Kazakhstan for 2011-2023 were selected by us. They are designed to build a multiple linear regression model. The volume of the electricity production was chosen as the resulting indicator. Fluctuations of this indicator directly affect the satisfaction of the electricity consumers' demand in other sectors of the national economy. Therefore, it is important to identify exactly which factors have the greatest impact on the volume of electricity production, for which multivariate regression analysis was carried out. Factors include indicators that determine the state of the country's energy industry and the national economy as a whole (Table 1).

Table 1. Main indicators for building the model

Year	Electricity production volume, million kWh (Y)	Number of people employed in E/E, thousand people (X_1)	Attracting investments in E/E, million tenge (X_2)	Level of the depreciation of fixed assets in E/E, % (X_3)	Interest rate of the National Bank at the end of the year, % (X_4)	Urban population at the end of the year, thousand people. (X_5)	State financing of E/E, million tenge (X_6)	GDP per capita, USD (X_7)	Electricity losses, million kWh (X_8)	Price of manufacturing enterprises for electricity sold on the domestic market, tenge/MWh (X_9)	Index of physical volume of electricity production, as a percentage of the previous year (X_{10})
2011	86586	146,7	349759	34,3	7,5	9127,1	107185	11634,5	6367,4	6352	106,5
2012	90614	158,5	416356	34,2	5,5	9277,7	111734	12387,4	7141,9	6808	104,7

2013	92615,7	161,7	441512	37,5	5,5	9433,5	102806	13890,8	11173,5	7220	101,5
2014	94643,2	173,4	570185	30,6	12	9868,7	94809	12806,7	7063,8	7532	101,9
2015	91645,1	165,1	545064	31,2	16	10035,6	79855	10509,9	5149,6	8127	98,4
2016	94642,4	161,2	490871	30,1	12	10331,5	62772	7714,8	5308,8	8281	100,8
2017	103128	151,0	570794	32,3	10,25	10509,8	89066	9247,6	6380,9	8480	106,5
2018	107268,8	150,6	543644	35,5	9,25	10698,2	78225	9812,5	6543,2	8930	101,1
2019	106483,2	150,2	915455	75,4	9,25	10938,7	84891	9812,5	9688,9	8294	104,5
2020	108628,4	149	749645	73,1	9	11151,4	79547	9121,7	6720,1	9292	98,8
2021	115079,2	150,1	766854	71,8	9,75	11353,9	99649	10370,8	9444,8	11144	106,5
2022	113552,1	148,1	828749	72,3	16,75	12209,9	153275	11476,6	12440,5	12377	101,3
2023	113585,5	148,9	1265074	70,5	15,75	12451,2	189028	13193,7	14986,6	15878	105,6

Note: Authors' compilation based on [31, 32, 33].

The resulting indicator in the model under consideration is the volume of the electricity production in the republic (Y), which showed an increase by 31,1% over the specified timeline. The number of people employed in the electricity industry (X_1) increased only by 1,5%, indicating a shortage of qualified workers.

Attracting investment to the electric power industry (X_2) is the driving mechanism for the high-quality development of the industry, as both the timely modernization of the equipment and hiring specialists depend on it. The volume of attracted investment funds during the period from 2020 to 2022 was less than the value achieved in 2019. This situation is associated with an outflow of investment in Kazakhstan due to the pandemic and the onset of the global economic crisis.

One of the current problems of the energy industry in Kazakhstan is the unacceptable level of the depreciation of fixed assets (X_3), which is confirmed by large-scale accidents in Ekibastuz and Ridder in the winter of 2022-2023.

An increase in the urban population is visible (X_5) by 36,4%. At the same time, the rural population increased only by 0,4% during this period.

The level of the depreciation of fixed assets is also associated with the indicator of electricity losses (X_8), which almost doubled during the observation period.

The price of manufacturing enterprises for sold electricity on the domestic market (X_9) is the price of 1 megawatt per hour of the electricity at the time of its release, excluding excise taxes, value added tax (VAT), sales and trade margins, and costs of electricity delivering from the manufacturer to consumers.

It was decided to identify a linear dependence between the volume of electricity production and 10 independent variables using the correlation analysis. The correlation matrix was built based on the data from Table 1, using the application program «Gretl». Owing to the correlation analysis, it is possible to define whether there is any dependence between the indicators and how strong it is at the moment.

Next, using the correlation coefficient, a selection of factors was chosen that makes the greatest impact on the dependent variable Y. R_{yx2} is 0,7995. According to the data from the correlation matrix, the relationship between the resulting indicator and attracting investment in the electricity industry is very close and positive. R_{yx5} is 0,9311. There is a very high and positive relationship between the volume of electricity production and the number of the urban population. R_{yx9} is 0,8059. There is a strong and positive correlation between the dependent variable Y and the prices of manufacturing enterprises for sold electricity on the domestic market.

Thus, it was revealed that factors X_2, X_5, and X_9 have a close relationship with the dependent variable Y. Factor X_1 shows an insignificant influence at the same time.

Next, a multivariate regression analysis of the data was carried out using the software program «Gretl» to find out which variables satisfy the requirements of t-ratio and p-values, that is, whether they are statistically significant. The least squares method (OLS) was used for this purpose. A selection of significant factors was carried out based on the above values of the correlation coefficient. It is clear that out of 10 R coefficients, factors X_2, X_5, and X_9 have a close and reliable connection with the resulting attribute from the correlation matrix. The rest are either examples of weak relationships or spurious correlations. There are results of the linear regression analysis to build the model $Y(X_2)$ below (Table 2).

Table 2. Model 1: OLS, using observations 2011-2023 (T = 13). Dependent variable: Y

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	80678,7	5010,28	16,10	<0,0001	***
X2	0,0318962	0,00722566	4,414	0,0010	***
Mean dependent var		101420,9	S.D. dependent var		9992,606
Sum squared resid		4,32e+08	S.E. of regression		6269,301
R-squared		0,639179	Adjusted R-squared		0,606377
F(2, 9)		19,48601	P-value(F)		0,001038
Log-likelihood		−131,0248	Akaike criterion		266,0496
Schwarz criterion		267,1795	Hannan-Quinn		265,8174
rho		0,304934	Durbin-Watson		1,276410

Note – compiled by the authors based on econometric modeling using the Gretl program.

The coefficient of determination (R^2) is 0,63. It demonstrates the proportion of variation in the resulting indicator based on the research of the presented factors. There is no multicollinearity between Y and factor X_2, thanks to which it is possible to build a regression model $Y(X_2)$, which demonstrates the relationship of variable X affecting the value of the dependent variable Y. The regression model looks like:

$$Y = 80678{,}7 + 0{,}0318962 * X_2 \tag{4}$$

This model can be interpreted as follows: a positive impact on the growth of electricity production is exerted by an increase in attracted investment funds (X_2). The regression model demonstrates that with an increase in factor X_2 by 1 c.u. (conventional unit), then the indicator of the volume of electricity production will increase by 0,0318962.

The next stage of the study was testing the model for autocorrelation and normal distribution of residuals to objectively assess the coefficients of the regression model. To obtain information about the adequacy of the constructed linear regression model, analysis of regression residuals is used. One of the methods of preliminary research for heteroskedasticity of the model is visual analysis of the residual plot. The purpose of this analysis is to detect factors influencing the change in variance, measurement number, or value of one of the characteristics. According to the results of the Breusch-Godfrey test, the p-value exceeds 0,05, which is typical in the absence of autocorrelation of the residuals of random deviations.

Let's summarize the test results:

White's test for heteroskedasticity – Null hypothesis: heteroskedasticity not present. Test statistic: LM = 1.49345, with p-value = P (Chi-square (2) > 1.49345) = 0.473915.

Test for normality of residual – Null hypothesis: error is normally distributed. Test statistic: Chi-square (2) = 3.67291, with p-value = 0.159381.

LM test for autocorrelation up to order 1 – Null hypothesis: no autocorrelation. Test statistic: LMF = 1.85878, with p-value = P (F(1, 10) > 1.85878) = 0.20267.

Next, we should build forecasts based on the regression model. First of all, it is necessary to conduct a retro forecast (Table 3).

Table 3. Retro forecast results for 95% confidence intervals, t(11, 0.025) = 2.201

Obs	Y	prediction	std. error	95% interval
2011	86586.0	91834.6	6858.83	(76738.4, 106931.)
2012	90614.0	93958.8	6721.99	(79163.8, 108754.)
2013	92615.7	94761.2	6678.59	(80061.7, 109461.)
2014	94643.2	98865.4	6531.67	(84489.3, 113241.)
2015	91645.1	98064.1	6550.25	(83647.1, 112481.)
2016	94642.4	96335.6	6607.17	(81793.3, 110878.)
2017	103128.	98884.8	6531.28	(84509.6, 113260.)
2018	107269.	98018.8	6551.45	(83599.2, 112438.)
2019	106483.	109878.	6782.19	(94950.7, 124806.)
2020	108628.	104589.	6545.44	(90183.1, 118996.)
2021	115079.	105138.	6560.24	(90699.4, 119577.)
2022	113552.	107113.	6632.50	(92514.6, 121711.)
2023	113586.	121030.	7877.81	(103691., 138369.)

Note – compiled by the authors based on econometric modeling using the Gretl program.

Based on the data obtained, a graph with a forecast for years 2024-2030 was constructed (Figure 1):

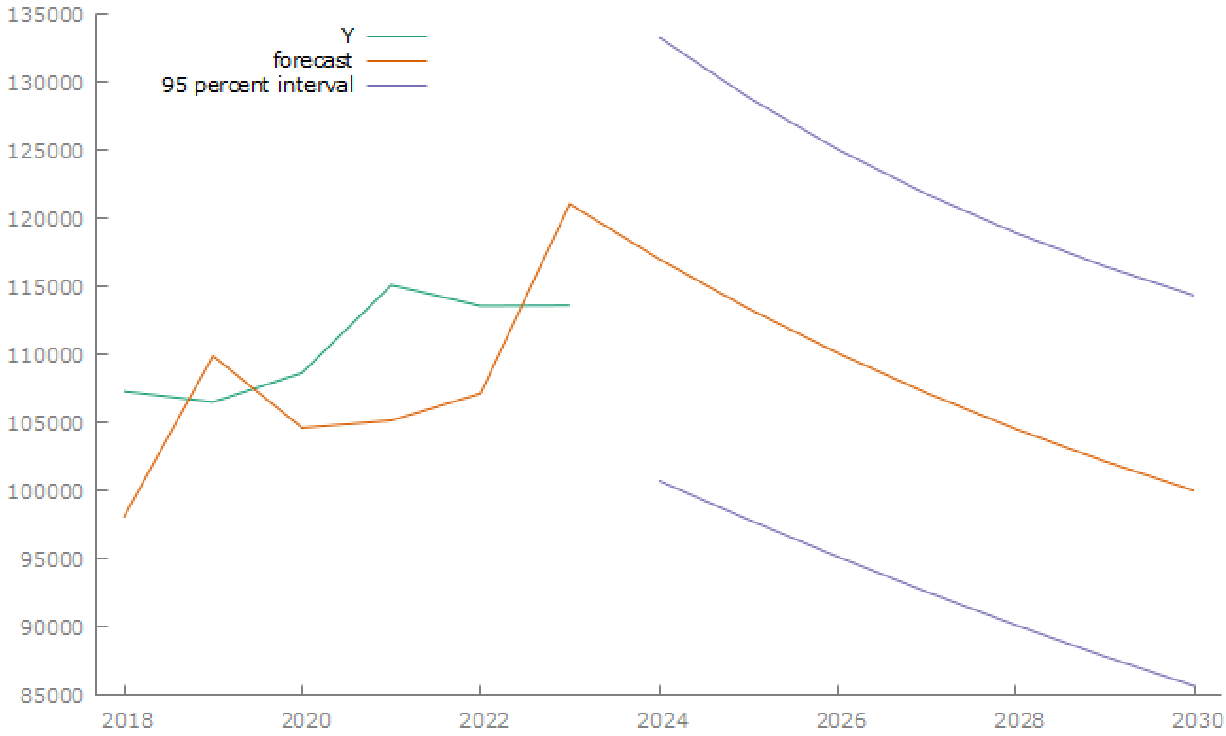

Figure 1 – 2024-2030 forecast graph

Note – compiled by the authors based on econometric modeling using the Gretl program.

Next, it was decided to predict the values of the dependent variable Y for 2024-2030 (Table 4). Let's assume that factor X_2 decreased by 10% annually during the forecast period.

Table 4. Confidence analysis of the forecast, 2024-2030, for 95% confidence intervals, t(11, 0.025) = 2.201

Obs	Y	prediction	std. error	95% interval
2024	undefined	116995.	7400.97	(100705., 133284.)
2025	undefined	113363.	7046.01	(97854.8, 128871.)
2026	undefined	110095.	6796.20	(95136.2, 125053.)
2027	undefined	107153.	6634.28	(92551.0, 121755.)
2028	undefined	104506.	6543.38	(90103.6, 118907.)
2029	undefined	102123.	6507.90	(87799.0, 116447.)
2030	undefined	99978.4	6514.16	(85640.9, 114316.)

Note – compiled by the authors based on econometric modeling using the Gretl program.

By the above forecast from Table 4 and graph (Figure 2), during 2024-2030, there will be a decrease in the volume of electricity production to 99978,4 million kWh.

Next, the following model $Y(X_5)$ was built (Table 5).

Table 5. Model 2: OLS, using observations 2011-2023 (T = 13). Dependent variable: Y

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7722.63	11119.8	0.6945	0.5018	
X5	8.86602	1.04743	8.465	<0.0001	***
Mean dependent var		101420.9	S.D. dependent var		9992.606
Sum squared resid		1.59e+08	S.E. of regression		3807.605
R-squared		0.866906	Adjusted R-squared		0.854807
F(1, 10)		71.64850	P-value(F)		3.80e-06
Log-likelihood		−124.5422	Akaike criterion		253.0843
Schwarz criterion		254.2142	Hannan-Quinn		252.8521
rho		0.329034	Durbin-Watson		1.271391

Note – compiled by the authors based on econometric modeling using the Gretl program.

The coefficient of determination R^2 is 0.86. This model shows the influence of variable X_5 on the value of the dependent variable Y. The regression model is presented below:

$$Y = 7722{,}63 + 8{,}86602 * X_5 \tag{5}$$

From this model, it is clear that the resulting indicator will increase by 8,86602 with an increase in the urban population (X_5).

The model was checked for normal distribution of residuals, autocorrelation. Analysis for heteroscedasticity was carried out. Let's present the results of the tests performed:

White's test for heteroskedasticity – Null hypothesis: heteroskedasticity not present. Test statistic: LM = 2.60133, with p-value = P(Chi-square(2) > 2.60133) = 0.27235.

Test for normality of residual – Null hypothesis: error is normally distributed. Test statistic: Chi-square(2) = 0.0884745, with p-value = 0.956727.

LM test for autocorrelation up to order 1 – Null hypothesis: no autocorrelation. Test statistic: LMF = 1.19599, with p-value = P(F(1, 10) > 1.19599) = 0.299767.

It is necessary to construct a retro forecast and identify confidence intervals (Table 6).

Table 6. Retro forecast results for 95% confidence intervals, t(11, 0.025) = 2.201

Obs	Y	prediction	std. error	95% interval
2011	86586.0	88643.7	4229.85	(79333.8, 97953.5)

2012	90614.0	89978.9	4176.16	(80787.2, 99170.6)
2013	92615.7	91360.2	4126.23	(82278.4, 100442.)
2014	94643.2	95218.7	4018.70	(86373.6, 104064.)
2015	91645.1	96698.4	3990.53	(87915.3, 105482.)
2016	94642.4	99321.9	3959.11	(90607.9, 108036.)
2017	103128.	100903.	3951.81	(92204.8, 109601.)
2018	107269.	102573.	3953.68	(93871.1, 111275.)
2019	106483.	104705.	3970.35	(95966.7, 113444.)
2020	108628.	106591.	3998.27	(97791.0, 115391.)
2021	115079.	108387.	4036.12	(99503.1, 117270.)
2022	113552.	115976.	4309.27	(106491., 125460.)
2023	113586.	118115.	4416.21	(108395., 127835.)

Note – compiled by the authors based on econometric modeling using the Gretl program.

Based on the data obtained, a graph with a forecast for the years 2024-2030 was constructed (Figure 2):

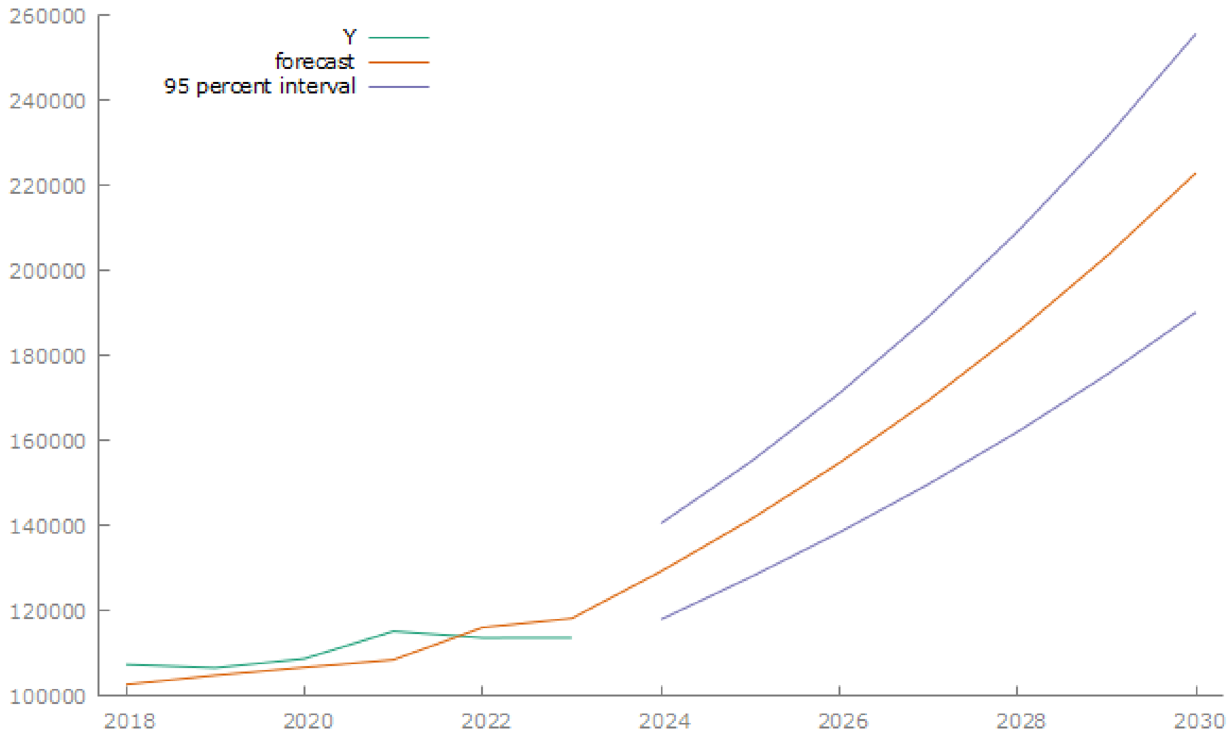

Figure 2 – 2024-2030 forecast graph

Note – compiled by the authors based on econometric modeling using the Gretl program.

Next, it was decided to predict the values of the dependent variable Y for 2024-2030 (Table 7). Let's assume that the independent factor X_5 increases by 10% every year.

Table 7. Confidence analysis of the forecast, 2024-2030, for 95% confidence intervals, t(11, 0.025) = 2.201

Obs	Y	prediction	std. error	95% interval
2024	undefined	129154.	5133.03	(117857., 140452.)
2025	undefined	141297.	6148.69	(127764., 154830.)
2026	undefined	154655.	7427.31	(138307., 171002.)
2027	undefined	169348.	8944.94	(149660., 189036.)
2028	undefined	185511.	10691.4	(161979., 209042.)
2029	undefined	203290.	12666.9	(175410., 231170.)
2030	undefined	222847.	14879.5	(190097., 255596.)

Note – compiled by the authors based on econometric modeling using the Gretl program.

In accordance with the above forecast from Table 7 and Figure 2, during 2024-2030, there will be an increase in electricity production to 222847 million kWh.

Next, the third model $Y(X_9)$ was built (Table 8).

Table 8. Model 2: OLS, using observations 2011-2023 (T = 13). Dependent variable: Y

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	73351.5	6450.28	11.37	<0.0001	***
X9	3.07377	0.680952	4.514	0.0009	***
Mean dependent var	101420.9	S.D. dependent var	9992.606		
Sum squared resid	4.20e+08	S.E. of regression	6179.793		
R-squared	0.649408	Adjusted R-squared	0.617536		
F(1, 10)	20.37552	P-value(F)	0.000881		
Log-likelihood	−130.8379	Akaike criterion	265.6757		
Schwarz criterion	266.8056	Hannan-Quinn	265.4435		
rho	0.682503	Durbin-Watson	0.604645		

Note – compiled by the authors based on econometric modeling using the Gretl program.

The coefficient of determination R2 is 0,64. This model shows the influence of variable X9 on the value of the dependent variable Y. The regression model is presented below:

$$Y = 73351{,}5 + 3{,}07377 * X_5 \quad (6)$$

From this model, it is clear that the resulting indicator will increase by 3,07377 with an increase in the urban population (X_9).

The model was checked for normal distribution of residuals, autocorrelation. Analysis for heteroscedasticity was carried out. Let's present the results of the tests performed:

White's test for heteroskedasticity – Null hypothesis: heteroskedasticity not present. Test statistic: LM = 2.99913, with p-value = P(Chi-square(2) > 2.99913) = 0.223228.

Test for normality of residual – Null hypothesis: error is normally distributed. Test statistic: Chi-square(2) = 3.28234, with p-value = 0.193753.

LM test for autocorrelation up to order 1 – Null hypothesis: no autocorrelation. Test statistic: LMF = 10.9037, with p-value = P(F(1, 10) > 10.9037) = 0.00798554.

It is necessary to construct a retro forecast and identify confidence intervals (Table 9).

Table 9. Retro forecast results for 95% confidence intervals, t(11, 0.025) = 2.201

Obs	Y	prediction	std. error	95% interval
2011	86586.0	92876.1	6686.62	(78158.9, 107593.)
2012	90614.0	94277.7	6605.43	(79739.2, 108816.)
2013	92615.7	95544.1	6543.89	(81141.1, 109947.)
2014	94643.2	96503.1	6504.96	(82185.8, 110820.)
2015	91645.1	98332.0	6449.48	(84136.8, 112527.)
2016	94642.4	98805.4	6439.20	(84632.8, 112978.)
2017	103128.	99417.0	6428.42	(85268.2, 113566.)
2018	107269.	100800.	6414.55	(86681.9, 114919.)
2019	106483.	98845.3	6438.41	(84674.5, 113016.)
2020	108628.	101913.	6414.00	(87795.8, 116030.)
2021	115079.	107606.	6557.80	(93171.9, 122039.)
2022	113552.	111395.	6783.10	(96466.0, 126325.)
2023	113586.	122157.	7888.61	(104794., 139519.)

Note – compiled by the authors based on econometric modeling using the Gretl program.

Based on the data obtained, a graph with a forecast for the years 2024-2030 was constructed (Figure 3):

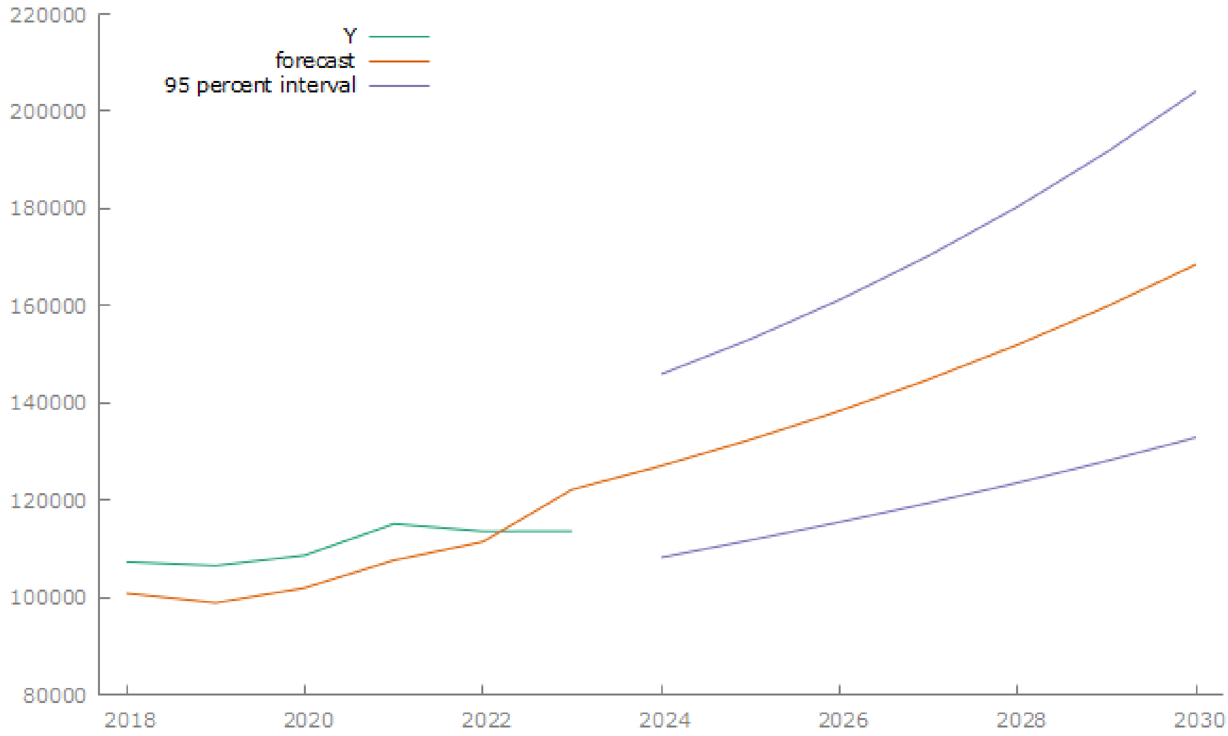

Figure 3 – 2024-2030 forecast graph

Note – compiled by the authors based on econometric modeling using the Gretl program.

Next, it was decided to predict the values of the dependent variable Y for 2024-2030 (Table 10). Let's assume that the independent factor X_9 increases by 10% annually.

Table 10. Confidence analysis of the forecast, 2024-2030, for 95% confidence intervals, t(11, 0.025) = 2.201

Obs	Y	prediction	std. error	95% interval
2024	undefined	127037.	8563.46	(108189., 145885.)
2025	undefined	132406.	9393.95	(111730., 153082.)
2026	undefined	138311.	10388.4	(115447., 161176.)
2027	undefined	144807.	11554.7	(119375., 170239.)
2028	undefined	151953.	12901.5	(123557., 180349.)
2029	undefined	159813.	14438.4	(128034., 191592.)
2030	undefined	168459.	16176.9	(132854., 204065.)

Note – compiled by the authors based on econometric modeling using the Gretl program.

In accordance with the above forecast from Table 10 and Figure 3, during 2024-2030, there will be an increase in electricity production to 168459 million kWh.

So, the following conclusions can be drawn based on the obtained results of the model. Indeed, the growth of the indicator of attracted investments in the electricity sector (X2) strongly influences the increase in electricity production in Kazakhstan. In other words, the more the volume of attracted investments increases, the greater the volume of electricity production. Hence, hypothesis 1 is confirmed.

According to statistical data, the urban population indicator (X5) increased by 12,3% at the end of the research period. There is a positive relationship with the Y indicator. It means that the growth in electricity production is directly related to the increase in this indicator. It means that the second hypothesis of the model is confirmed.

Taking into account the initial modeling data, the price of manufacturing enterprises for electricity sold on the domestic market (X9) increased by more than 1,5 times during the observation period. There is a positive relationship with the resulting indicator. It means that the third hypothesis of the model is confirmed.

The authors of the study identified the following problems in the electric power industry of Kazakhstan that impede the satisfaction of the demand for electricity and the growth of electricity production. Firstly, the volume of attracted investments plays an important role. When assessing the impact of investment funds on the electric power industry, it is necessary to take into account such a phenomenon as an investment lag, which denotes the timeline between the implementation of investments and the construction of energy facilities, as well as the achievement of the designed capacity of the commissioned facilities.

Thus, the effectiveness of raised funds should be assessed after a certain period equal to the payback period, and the amount of the investment should continuously grow over several years to make a qualitative, positive impact on the development of the sector. The insufficient volume of the investment indicates the unattractiveness of the researched industry, foreign companies' low interest, problems arising in the adoption and implementation of large projects of the regional and national scales that require the investment of large financial resources, and a general stagnation in the industry.

Secondly, an increase in the urban population is directly related to the increase in demand for electricity and its production, since citizens living in rural areas consume much less electricity than urban residents.

Thirdly, the deficit is accompanied by low prices for the electricity from manufacturing enterprises, which negatively affect energy companies’ income. Consequently, the lack of funds prevents a full-fledged, large-scale renewal of fixed assets without involving the state budget. Despite the smaller-scale modernization carried out by industry enterprises, the efficiency of power plants does not allow them to generate such a volume of electricity that would satisfy the growing demand.

The limitations of this study are the final set of indicators, characterizing the electricity sector and the economy of the Republic of Kazakhstan, selected for constructing regression models. In addition, limitations are imposed by the subject of the study is the analysis of factors affecting the state of the electricity production in the Republic of Kazakhstan, and the object of the study is the electric power industry of the Republic of Kazakhstan. When carrying out econometric calculations, the timeline was strictly taken into account from 2011 to 2023.

Privatization of private energy enterprises, specifically thermal power plants, hydroelectric power plants, and other energy facilities into state-owned ones was decided by the government, since own investments of private companies are not enough for the widespread renewal of fixed assets and the introduction of new technological solutions.

It is planned to introduce a digital energy platform to monitor the technical condition of power plants and implement timely risk management. The control over the implementation of investment programs and high-quality repair companies will be carried out with the assistance of the increased role of the Nuclear and Energy Supervision Committee [34]. Three new thermal power plants are planned to be built with the assistance of JSC "Samruk-Energo" and Russian investors represented by "INTER RAO Export", which is also aimed at eliminating the deficit in three cities of Kazakhstan – Ust-Kamenogorsk, Semey, and Kokshetau [35]. The volume growth of the electricity production is also due to the growth of the urban population. It not only leads to the increased demand for electricity, but it also leads to greater air pollution in large cities such as Karaganda, Ekibastuz, and Pavlodar [36].

As a proposal for improving public administration of the electric power sector in Kazakhstan, one can note the implementation of smart grids – improved versions of power grids that use the achievements of digitalization, such as computers, sensors, Internet technologies, etc. to improve the safety and efficiency of energy systems, as well as for more flexible control over electricity consumption. Smart grids, unlike traditional ones, imply many small electricity producers, a decentralized market, and active consumer involvement. However, it is worth noting that the smart grid system requires uninterrupted access to the Internet.

Digital technologies are also needed for tariff regulation. In particular, smart meters are used for dynamic electricity pricing. A similar practice is used in Germany, however, there is a shortage of smart meters for electricity consumers. The implementation of dynamic tariffs depending on the network load is impossible without the joint use of smart grids and a developed renewable energy sector. Thanks to more flexible tariff regulation, it is possible to reduce electricity costs.

For the development of renewable energy sources in Kazakhstan, joint participation of the government and the private sector (public-private partnership, PPP) is necessary. This will increase the efficiency of investments. Private companies provide investments and technologies, at the same time government provides benefits, subsidies, and guarantees of return on investment. The government can also reduce investment risks through long-term energy purchase contracts. PPP also helps to optimize tariff regulation by reducing the burden on end consumers.

Improving the security and availability of electricity can also be achieved through green bonds, which are securities designed to raise funds for financing environmentally friendly and sustainable projects. They are issued by public or private organizations, and the funds raised are directed exclusively to projects that help reduce carbon emissions or adapt to climate change, including the development of RES.

In Kazakhstan, green bonds can become a key tool for implementing programs to decarbonize the economy, especially within the framework of the strategy to achieve carbon neutrality by 2060. In 2020, the country launched a green bond market on the KASE stock exchange, which creates a basis for financing renewable energy projects.

Conclusion

Thus, thanks to the econometric modeling, it was discovered by the authors that the volume of the electricity production is positively influenced by investments attracted to the electricity sector, the size of the urban population at the end of the year, as well as the prices of manufacturing enterprises for sold electricity on the domestic market. The listed factors make the greatest positive impact on one of the key parameters of the electric power industry in Kazakhstan.

In our opinion, the crucial role in solving the above-mentioned problems and preventing risks should be decided by the state apparatus. Due to the features of the industry and the significant presence of the state capital, it is not possible to uncover the enormous potential of the electricity industry in Kazakhstan without the government's active intervention, an authorized body, and other organizations. In January 2024, a plan was developed by the Ministry of Energy of the Republic of Kazakhstan for the development of the electricity industry on commissioning additional capacities to cover the deficit due to the expansion and repair of the operating power plants, which provide 5,6 GW. It is planned to build gas stations that will provide an additional 2,4 GW in some cities of Western and Southern Kazakhstan (Aktau, Atyrau, Aktobe, Kyzylorda, Taraz, Shymkent). Investing in renewable energy sources continues, which, in total with the above-mentioned measures, aims to level out the deficit in the energy system by 2029 and reduce the volume of pollutant emissions into the atmosphere per capita.

According to the results of the econometric models constructed by the authors, the volume of electricity production, which is the main indicator in assessing electricity shortages, is positively affected by an increase in electricity prices from manufacturing enterprises. For instance, the “Tariff in exchange for the investment” program for 2009-2015 made it possible to update the equipment of power plants and carry out major repairs, thereby forming a safety margin, which was exhausted by the beginning of the 2020s. The results of the implementation of this program demonstrated the exceptional importance of reviewing tariff setting, increasing tariffs in combination with rational energy savings, and increasing annual investments. It also confirms the authors’ conclusions based on the correlation and regression analysis.

Accordingly, important aspects of the further development of the industry are improving the investment climate to attract large volumes of investment to cover the costs of modernizing fixed assets and introducing new technological solutions. The volume of electricity production is also positively affected by the price set by manufacturing enterprises for sold electricity on the domestic market, which is determined by the need to compensate costs which is determined by the need to compensate expenses. In turn, a high degree of depreciation of fixed assets leads to an increase in electricity losses, stagnation in the growth of electricity production, and the need for large amounts of government funding.

Based on the implemented research, the following recommendations are suggested by authors: implementing smart grids in electric power industry to improve the quality of control and monitoring, to obtain up-to-date, reliable data on the state of the industry; expanding the role of PPP and green bonds in the development of renewable energy sources; optimization of tariff regulation through the introduction of dynamic electricity pricing; strengthening the role of the government intervention at the level of budgetary financing of the electric power industry; modernizing fixed assets, primarily at large energy facilities of the national importance; and preventing accidents and malfunctions that occur at energy facilities; increasing the attractiveness of the industry from the point of investors and potential employees view due to the exploitation of new and updates of old energy capacities, digitalization, improving working conditions, development and distribution of alternative energy sources, technologies of the environmental monitoring. preventing accidents and malfunctions that occur at energy facilities; increasing the attractiveness of the industry from the point of investors and potential employees' views through the commissioning of new and the renewal of old energy capacities, digitalization, improving working conditions, developing and distributing alternative energy sources, and environmental monitoring technologies.

The worsening of the electricity shortage in the next ten years, certainly, will make a negative impact on vital links in the functioning of the socio-economic system, the defense industry, the state, and public institutions. Kazakhstan, having large reserves of energy resources and a favorable climate for the development of renewable energy sources, has a potential to become a leading energy player in the Central Asian region and the EAEU countries, which also make a beneficial effect on European countries, due to the growing energy crisis caused by recent geopolitical events. However, it requires the creation and constant support of an integrated system, including the state, households, private enterprises, and foreign agents. It is necessary to establish relationships between government bodies, authorized and competent organizations, citizens, and foreigners. Ultimately, meeting the population's needs for electricity and the continuous development of economic facilities in the industry are ones of the main conditions for energy and national security.

The contribution of the authors

Nurgaliuly Arys – justification of the research concept, formulation of hypotheses, research planning, collection of literature data, analysis and synthesis of literature data, writing the manuscript text, editing the manuscript text, manuscript design, and econometric data analysis.

Smagulova Sholpan Asylkhanovna – editing the manuscript text, collection of literature data, development of the research methodology, and research planning.

Beketova Kamar Nazarbekovna – data curation, data collection, and systematization.

Acknowledgments

The authors gratefully acknowledge the valuable comments and suggestions from anonymous reviewers and the editor. However, the usual disclaimers apply.

References

1. Andersson, G., Donalek, P., Farmer, R., Hatziargyriou, N., Kamwa, I., Kundur, P. Causes of the 2003 Major Grid Blackouts in North America and Europe, and Recommended Means to Improve System Dynamic Performance//IEEE Transactions on Power Systems- 2005.-№20(4) .-P. 1922- 1928, DOI: http://dx.doi.org/10.1109/TPWRS.2005.857942

2. Gitelman, L., Magaril, E., Kozhevnikov, M. Energy Security: New Threats and Solutions// Energies.-2023.-№16(6).-2869, DOI: https://doi.org/10.3390/en16062869

3. Pathways for the energy mix, 24.10.2023 – [Электрон. ресурс] - URL: https://www.iea.org/reports/world-energy-outlook-2023/pathways-for-the-energy-mix (дата обращения: 19.03.2024)

4. World Energy Outlook 2023, 24.10.2023 – [Электрон. ресурс] - URL: https://iea.blob.core.windows.net/assets/86ede39e-4436-42d7-ba2a-edf61467e070/WorldEnergyOutlook2023.pdf (дата обращения: 19.03.2024)

5. Аналитический обзор. АО «Самрук-Энерго», 11.2023 – [Электрон. ресурс] - URL: https://www.samruk-energy.kz/ru/press-center/analytical-review (дата обращения: 07.01.2024)

6. Electricity Market Report 2023, 08.02.2023 – [Электрон. ресурс] - URL: https://www.iea.org/reports/electricity-market-report-2023 (дата обращения: 23.03.2024)

7. Казахстан снижает прогнозы по выработке электроэнергии, 16.01.2023 – [Электрон. ресурс] - URL: https://kz.kursiv.media/2023-01-16/zhnb-electro1/ (дата обращения: 08.01.2024)

8. GDP per capita (current US$) – Kazakhstan, 21.05.2024 – [Электрон. ресурс] - URL: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=KZ (дата обращения: 21.05.2024)

9. Urban population (% of total population) – Kazakhstan, 21.05.2024 – [Электрон. ресурс] - URL: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=KZ (дата обращения: 21.05.2024)

10. Iyke, B. N. Climate change, energy security risk, and clean energy investment//Energy Economics. - 2024.-№129(C). -107-225, DOI: https://doi.org/10.1016/j.eneco.2023.107225

11. Rahman, M.M., Khan, Z., Khan, S., & Tariq, M. How is energy intensity affected by industrialisation, trade openness and financial development? A dynamic analysis for the panel of newly industrialized countries//Energy Strategy Reviews. -2023.-№49(8). -101182, DOI: https://doi.org/10.1016/j.esr.2023.101182

12. Bamisile, O., Ojo, O., Yimen, N., Adun, H., Li, J., Obiora, S., & Huang, Q. Comprehensive functional data analysis of China's dynamic energy security index//Energy Reports.-2021.-№7(46).-P. 6246–6259, DOI: https://doi.org/10.1016/j.egyr.2021.09.018

13. Radulescu, D., & Sulger, P. Interdependencies between countries in the provision of energy// Energy Economics. -2022.-№107(1). -105799, DOI: https://doi.org/10.1016/j.eneco.2021.105799

14. Yuegang, Song & Shahzad, Umer & Paramati, Sudharshan Reddy. Impact of energy infrastructure investments on renewable electricity generation in major Asian developing economies//Australian Economic Papers. -2022.-№62(1). -P. 1-23, DOI: https://doi.org/10.1111/1467-8454.12282

15. Fedderke, J. W., & Kaya, T. E. Productivity impact of infrastructure in Turkey, 1987-2006//Journal of Infrastructure Systems. -2014.-№20(3), DOI: https://doi.org/10.1061/(ASCE)IS.1943-555X.0000173

16. Soltangazinov, A., Smagulova, Z., Amirova, M., Kashuk, L., Karimbergenova, M., Kadyrova, A., & Zhaltyrova, O. Energy efficiency as a factor of sustainable development in Kazakhstan//International Journal of Energy Economics and Policy.-2020.-№10(1).-P. 325–330, DOI: https://doi.org/10.32479/ijeep.8618

17. Shabir, M., Pazienza, P., De Lucia, C. Energy innovation and ecological footprint: Evidence from OECD countries during 1990–2018//Technological Forecasting and Social Change.-2023.-№196(1).-122836, DOI: https://doi.org/10.1016/j.techfore.2023.122836

18. Karatayev, M., Lisiakiewicz, R., Gródek-Szostak, Z., Kotulewicz-Wisińska, K., & Nizamova, M. The promotion of renewable energy technologies in the former Soviet bloc: Why, how, and with what prospects? //Energy Reports. -2021.-№7.-P. 6983–6994, DOI: https://doi.org/10.1016/j.egyr.2021.10.068

19. Supriyanto E, Sentanuhady J, Hasan WH, Nugraha AD, Muflikhun MA. Policy and Strategies of Tariff Incentives Related to Renewable Energy: Comparison between Indonesia and Other Developing and Developed Countries//Sustainability. -2022.-№14(20).-P. 1-18, DOI: http://dx.doi.org/10.3390/su142013442

20. Smagulova, S., Yermukhanbetova, A., Akimbekova, G., Yessimzhanova, S., Razakova, D., Nurgabylov, M., Zhakupova, S. Prospects for Digitalization of Energy and Agro-Industrial Complex of Kazakhstan//International Journal of Energy Economics and Policy.-2022.-№12(2).-P. 198–209, DOI: https://doi.org/10.32479/ijeep.12859

21. Huang, Z., & Jin, G. Navigating urban day-ahead energy management considering climate change toward using IoT enabled machine learning technique: Toward future sustainable urban//Sustainable Cities and Society.-2024.-№101(1).-105162, DOI: https://doi.org/10.1016/j.scs.2023.105162

22. Michieka, N.M., & Fletcher, J.J. An investigation of the role of China's urban population on coal consumption//Energy Policy. -2012.-№48.-P. 668–676, DOI: https://doi.org/10.1016/j.enpol.2012.05.080

23. Muço, K., Valentini, E., & Lucarelli, S. The Relationships between GDP growth, Energy Consumption, Renewable Energy Production and CO2 Emissions in European Transition Economies//International Journal of Energy Economics and Policy.-2021.-№11(4).-P. 362–373, DOI: http://dx.doi.org/10.32479/ijeep.11275

24. Wang D, White B, Mugera A, Wang B. Energy Transition and Economic Development in China: A National and Sectoral Analysis from a New Structural Economics Perspectives//Sustainability. -2022.-№14(24).-16646, DOI: https://doi.org/10.3390/su142416646

25. Batóg, J., Pluskota, P. Renewable Energy and Energy Efficiency: European Regional Policy and the Role of Financial Instruments//Energies. -2023.-№16(24).-8029, DOI: https://doi.org/10.3390/en16248029

26. Schöniger, F., & Morawetz, U. B. What comes down must go up: Why fluctuating renewable energy does not necessarily increase electricity spot price variance in Europe//Energy Economics. -2022.-№111(3).-106069, DOI: https://doi.org/10.1016/j.eneco.2022.106069

27. Gitelman, L.D., Dobrodey, V.V., Kozhevnikov, M.V. Tools for sustainable development of regional energy systems//Economy of Regions. -2020.-№16(4).-P. 1208–1223, DOI: http://dx.doi.org/10.17059/ekon.reg.2020-4-14

28. Расширенное заседание правительства с участием Токаева, 07.02.2024 – [Электрон. ресурс]-URL: https://www.zakon.kz/sobytiia/6423491-rasshirennoe-zasedanie-pravitelstva-s-uchastiem-tokaeva--tekstovaya-translyatsiya.html (дата обращения: 27.03.2024)

29. Sarstedt, M. & Mooi, E. Regression Analysis. A Concise Guide to Market Research. – Springer Berlin, Heidelberg, 2014. – P. 193-233, DOI: http://dx.doi.org/10.1007/978-3-642-12541-6

30. Taylor, S. Regression Analysis. Corporate Finance Institute, 11.02.2020 – [Электрон. ресурс] - URL: https://corporatefinanceinstitute.com/resources/data-science/regression-analysis/ (дата обращения: 19.01.2024)

31. Статистический ежегодник Казахстана, 31.10.2024 – [Электрон. ресурс] - URL: https://stat.gov.kz/ru/publication/collections/?year=&name=17203&period=year (дата обращения: 07.01.2024)

32. Топливно-энергетический баланс Республики Казахстан (2021-2022 гг.), 01.08.2023 – [Электрон. ресурс] - URL: https://stat.gov.kz/ru/industries/business-statistics/stat-energy/spreadsheets/?year=&name=19275&period=year&type (дата обращения: 28.05.2024)

33. Топливно-энергетический баланс Республики Казахстан (2011-2020 гг.), 28.07.2021 – [Электрон. ресурс] - URL: https://stat.gov.kz/ru/industries/business-statistics/stat-energy/spreadsheets/?year=&name=28138&period=year&type (дата обращения: 28.05.2024)

34. Цифровую платформу энергетики создадут в РК, 17.01.2024 – [Электрон. ресурс] - URL: https://profit.kz/news/65297/Cifrovuu-platformu-energetiki-sozdadut-v-RK/ (дата обращения: 29.02.2024)

35. Три новые ТЭЦ построят в Казахстане: стала известна предварительная стоимость, 16.01.2024 – [Электрон. ресурс] - URL: https://tengrinews.kz/kazakhstan_news/novyie-tets-postroyat-kazahstane-stala-izvestna-523309/ (дата обращения: 29.02.2024)

36. Загрязнение воздуха в Казахстане: новое исследование считает виновной грязную промышленность, 22.09.2023 – [Электрон. ресурс] - URL: https://arnika.org/ru/novosti/zagryaznenie-vozdukha-v-kazakhstane-novoe-issledovanie-schitaet-vinovnoj-gryaznuyu-promyshlennost(дата обращения: 29.04.2024)

А. Нұрғалиұлы*[1], Ш.А. Смагулова[2], К.Н. Бекетова[1]

[1]Қорқыт Ата атындағы Қызылорда университеті, Қызылорда, Қазақстан

[2]Кенжеғали Сағадиев атындағы Халықаралық Бизнес Университеті, Алматы, Қазақстан

Қазақстанның электр энергетикасы саласындағы мемлекеттік басқару практикасын бағалау: эконометрикалық тәсіл

Аннотация. Электр энергетикасы саласында мемлекеттік басқаруды жетілдіру мәселелері әлемдік экономикалық дағдарыстың қазіргі жағдайында бұрынғыдан да өзекті болып отыр. Қазақстан Республикасы Орталық Азияның энергетикалық секторында маңызды орын алады. Электр энергетикасы Қазақстанның әлеуметтік-экономикалық жүйесінің жетекші буындарының бірі болып табылады. Алайда, елде электр энергиясының тапшылығының созылмалы проблемасы сақталуда, бұл ұлттық энергетикалық жүйеге және экономиканың басқа салаларына зиян келтіреді. Бұл зерттеудің мақсаты 2011-2023 жылдар кезеңінде электр энергиясын өндіруге неғұрлым қатты әсер ететін факторлардың жай-күйін талдау және бағалау және Қазақстанда электр энергиясы нарығын дамытуды мемлекеттік реттеуді жетілдіру бойынша ұсынымдар ұсыну болып табылады. Бұл зерттеу логика, статистика және эконометрикалық модельдеу әдістеріне негізделген. Зерттеу нәтижелері Электр энергетикасы өндірісінің өсуіне электр энергетикасына инвестицияларды тарту, өңдеу өнеркәсібі кәсіпорындарының ішкі нарықта өткізілетін электр энергиясына бағалары, сондай-ақ жыл соңындағы қала халқының саны оң әсер ететінін көрсетті. 2024-2030 жылдарға арналған болжамдар бойынша электр энергиясына бағаның өсуін, қала халқының саны мен инвестицияларды ескере отырып, электр энергиясын өндіру көлемі ұлғаятын болады.

Түйін сөздер: электр энергетикасы, электр энергиясын өндіру, мемлекеттік басқару, электр энергетикасына инвестициялар, электр энергиясының бағасы, қала халқы.

А. Нұрғалиұлы*[1], Ш.А. Смагулова[2], К.Н. Бекетова[1]
[1]Кызылординский университет имени Коркыт ата, Кызылорда, Казахстан
[2]Университет Международного Бизнеса имени Кенжегали Сагадиева, Алматы, Казахстан

Оценка практики государственного управления в электроэнергетической отрасли Казахстана: эконометрический подход

Аннотация. Вопросы совершенствования государственного управления в электроэнергетической отрасли как никогда актуальны в современных условиях мирового экономического кризиса. Республика Казахстан занимает важное место в энергетическом секторе Центральной Азии. Электроэнергетика является одним из ведущих звеньев социально-экономической системы Казахстана. Однако в стране сохраняется хроническая проблема дефицита электроэнергии, что наносит ущерб национальной энергосистеме и другим отраслям экономики. Целью данного исследования является анализ состояния и оценка факторов, наиболее сильно влияющих на выработку электроэнергии в период с 2011 по 2023 годы, и предложение рекомендаций по совершенствованию государственного регулирования развития рынка электроэнергии в Казахстане. Данное исследование основано на методах логики, статистики и эконометрического моделирования. Результаты исследования показали, что на рост производства электроэнергии положительное влияние оказывают привлечение инвестиций в электроэнергетику, цены предприятий обрабатывающей промышленности на электроэнергию, реализуемую на внутреннем рынке, а также численность городского населения на конец года. По прогнозам на 2024-2030 годы, с учётом роста цен на электроэнергию, численности городского населения и инвестиций, объёмы производства электроэнергии будут увеличиваться.

Ключевые слова: электроэнергетика, производство электроэнергии, государственное управление, инвестиции в электроэнергетику, цены на электроэнергию, городское население.

References

1. Andersson, G., Donalek, P., Farmer, R., Hatziargyriou, N., Kamwa, I., Kundur, P. Causes of the 2003 major grid blackouts in North America and Europe, and recommended means to improve system dynamic performance//IEEE Transactions on Power Systems, 20(4), 1922-1928 (2005), DOI: http://dx.doi.org/10.1109/TPWRS.2005.857942

2. Gitelman, L., Magaril, E., Kozhevnikov, M. Energy Security: New Threats and Solutions//Energies, 16(6), 2869 (2023), DOI: https://doi.org/10.3390/en16062869

3. Pathways for the energy mix. Available at: https://www.iea.org/reports/world-energy-outlook-2023/pathways-for-the-energy-mix (assessed 19.03.2024)

4. World Energy Outlook 2023. Available at: https://iea.blob.core.windows.net/assets/86ede39e-4436-42d7-ba2a-edf61467e070/WorldEnergyOutlook2023.pdf (assessed 19.03.2024)

5. Analiticheskij obzor. AO «Samruk-Jenergo», [Analytical overview. JSC «Samruk-Energo»]. Available at: https://www.samruk-energy.kz/ru/press-center/analytical-review (accessed 07.01.2024) [in Russian]

6. Electricity Market Report 2023. Available at: https://www.iea.org/reports/electricity-market-report-2023 (accessed 23.03.2024)

7. Kazahstan snizhaet prognozy po vyrabotke jelektrojenergii, [Kazakhstan lowers its electricity generation forecasts]. Available at: https://kz.kursiv.media/2023-01-16/zhnb-electro1/ (accessed 08.01.2024) [in Russian]

8. GDP per capita (current US$) – Kazakhstan. Available at: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=KZ (accessed 21.05.2024)

9. Urban population (% of total population) – Kazakhstan. Available at: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=KZ (accessed 21.05.2024)

10. Iyke, B. N. Climate change, energy security risk, and clean energy investment//Energy Economics, 129(C), 107225 (2024), DOI: https://doi.org/10.1016/j.eneco.2023.107225

11. Rahman, M. M., Khan, Z., Khan, S., & Tariq, M. How is energy intensity affected by industrialisation, trade openness and financial development? A dynamic analysis for the panel of newly industrialized countries//Energy Strategy Reviews, 49(8), 101182 (2023), DOI: https://doi.org/10.1016/j.esr.2023.101182

12. Bamisile, O., Ojo, O., Yimen, N., Adun, H., Li, J., Obiora, S., & Huang, Q. Comprehensive functional data analysis of China's dynamic energy security index//Energy Reports, 7(46), 6246–6259 (2021), DOI: https://doi.org/10.1016/j.egyr.2021.09.018

13. Radulescu, D., & Sulger, P. Interdependencies between countries in the provision of energy//Energy Economics, 107(1), 105799 (2022), DOI: https://doi.org/10.1016/j.eneco.2021.105799

14. Yuegang, Song & Shahzad, Umer & Paramati, Sudharshan Reddy. Impact of energy infrastructure investments on renewable electricity generation in major Asian developing economies//Australian Economic Papers, 62(1), 1-23 (2022), DOI: https://doi.org/10.1111/1467-8454.12282

15. Fedderke, J. W., & Kaya, T. E. Productivity impact of infrastructure in Turkey, 1987-2006//Journal of Infrastructure Systems, 20(3) (2014), DOI: https://doi.org/10.1061/(ASCE)IS.1943-555X.0000173

16. Soltangazinov, A., Smagulova, Z., Amirova, M., Kashuk, L., Karimbergenova, M., Kadyrova, A., & Zhaltyrova, O. Energy efficiency as a factor of sustainable development in Kazakhstan//International Journal of Energy Economics and Policy, 10(1), 325–330 (2020), DOI: https://doi.org/10.32479/ijeep.8618

17. Shabir, M., Pazienza, P., De Lucia, C. Energy innovation and ecological footprint: Evidence from OECD countries during 1990–2018//Technological Forecasting and Social Change, 196(1), 122836 (2023), DOI: https://doi.org/10.1016/j.techfore.2023.122836

18. Karatayev, M., Lisiakiewicz, R., Gródek-Szostak, Z., Kotulewicz-Wisińska, K., & Nizamova, M. The promotion of renewable energy technologies in the former Soviet bloc: Why, how, and with what prospects?//Energy Reports, 7, 6983–6994 (2021), DOI: https://doi.org/10.1016/j.egyr.2021.10.068

19. Supriyanto E, Sentanuhady J, Hasan WH, Nugraha AD, Muflikhun MA. Policy and Strategies of Tariff Incentives Related to Renewable Energy: Comparison between Indonesia and Other Developing and Developed Countries//Sustainability, 14(20), 1-18 (2022), DOI: http://dx.doi.org/10.3390/su142013442

20. Smagulova, S., Yermukhanbetova, A., Akimbekova, G., Yessimzhanova, S., Razakova, D., Nurgabylov, M., Zhakupova, S. Prospects for Digitalization of Energy and Agro-Industrial Complex of Kazakhstan//International Journal of Energy Economics and Policy, 12(2), 198–209 (2022), DOI: https://doi.org/10.32479/ijeep.12859

21. Huang, Z., & Jin, G. Navigating urban day-ahead energy management considering climate change toward using IoT enabled machine learning technique: Toward future sustainable urban//Sustainable Cities and Society, 101(1), 105162 (2024), DOI: https://doi.org/10.1016/j.scs.2023.105162

22. Michieka, N. M., & Fletcher, J. J. An investigation of the role of China's urban population on coal consumption//Energy Policy, 48, 668–676 (2012), DOI: https://doi.org/10.1016/j.enpol.2012.05.080

23. Muço, K., Valentini, E., & Lucarelli, S. The Relationships between GDP growth, Energy Consumption, Renewable Energy Production and CO2 Emissions in European Transition Economies//International Journal of Energy Economics and Policy, 11(4), 362–373 (2021), DOI: http://dx.doi.org/10.32479/ijeep.11275

24. Wang D, White B, Mugera A, Wang B. Energy Transition and Economic Development in China: A National and Sectorial Analysis from a New Structural Economics Perspectives//Sustainability, 14(24), 16646 (2022), DOI: https://doi.org/10.3390/su142416646

25. Batóg, J., Pluskota, P. Renewable Energy and Energy Efficiency: European Regional Policy and the Role of Financial Instruments//Energies, 16(24), 8029 (2023), DOI: https://doi.org/10.3390/en16248029

26. Schöniger, F., & Morawetz, U. B. What comes down must go up: Why fluctuating renewable energy does not necessarily increase electricity spot price variance in Europe//Energy Economics, 111(3), 106069 (2022), DOI: https://doi.org/10.1016/j.eneco.2022.106069

27. Gitelman, L.D., Dobrodey, V.V., Kozhevnikov, M.V. Tools for sustainable development of regional energy systems//Economy of Regions, 16(4), 1208–1223 (2020), DOI: http://dx.doi.org/10.17059/ekon.reg.2020-4-14

28. Rasshirennoe zasedanie pravitel'stva s uchastiem Tokaeva – tekstovaja transljacija, [Extended government meeting with the participation of Tokayev - text broadcast]. Available at: https://www.zakon.kz/sobytiia/6423491-rasshirennoe-zasedanie-pravitelstva-s-uchastiem-tokaeva--tekstovaya-translyatsiya.html (accessed 27.03.2024) [in Russian]

29. Sarstedt, M. & Mooi, E. Regression Analysis. A Concise Guide to Market Research. (Springer Berlin, Heidelberg, 2014, p. 193-233), DOI: https://doi.org/10.1007/978-3-642-12541-6

30. Taylor, S. Regression Analysis. Corporate Finance Institute. Available at: https://corporate-financeinstitute.com/resources/data-science/regression-analysis/ (accessed 19.01.2024)

31. Statisticheskij ezhegodnik Kazahstana, [Statistical yearbook of Kazakhstan]. Available at: https://stat.gov.kz/ru/publication/collections/?year=&name=17203&period=year (accessed 07.01.2024) [in Russian]

32. Toplivno-jenergeticheskij balans Respubliki Kazahstan (2021-2022 gg.), [Fuel and energy balance of the Republic of Kazakhstan (2021-2022)]. Available at: https://stat.gov.kz/ru/industries/business-statistics/stat-energy/spreadsheets/?year=&name=19275&period=year&type (accessed 28.05.2024) [in Russian]

33. Toplivno-jenergeticheskij balans Respubliki Kazahstan (2011-2020 gg.), [Fuel and energy balance of the Republic of Kazakhstan (2011-2020)]. Available at: https://stat.gov.kz/ru/industries/business-statistics/stat-energy/spreadsheets/?year=&name=28138&period=year&type (accessed 28.05.2024) [in Russian]

34. Cifrovuju platformu jenergetiki sozdadut v RK, [A digital energy platform will be created in the Republic of Kazakhstan]. Available at: https://profit.kz/news/65297/Cifrovuu-platformu-energetiki-sozdadut-v-RK/ (accessed 29.02.2024) [in Russian]

35. Tri novye TJeC postrojat v Kazahstane: stala izvestna predvaritel'naja stoimost', [Three new thermal power plants will be built in Kazakhstan: the preliminary cost has become known]. Available at: https://tengrinews.kz/kazakhstan_news/novyie-tets-postroyat-kazahstane-stala-izvestna-523309/ (accessed 29.02.2024) [in Russian]

36. Zagrjaznenie vozduha v Kazahstane: novoe issledovanie schitaet vinovnoj grjaznuju promyshlennost', [Air pollution in Kazakhstan: New study finds dirty industry to blame]. Available at: https://arnika.org/ru/novosti/zagryaznenie-vozdukha-v-kazakhstane-novoe-issledovanie-schitaet-vinovnoj-gryaznuyu-promyshlennost (accessed 29.04.2024) [in Russian]

Information about authors:

Nurgaliuly A. **–** Corresponding author, Master of Economics, Doctoral student, Korkyt Ata Kyzylorda University, Aiteke bi st., 29A, Kyzylorda, Kazakhstan

Smagulova S.A. **–** Doctor of Economics, Professor, University of International Business named after Kenzhegali Sagadiev, Abay Ave., 8A, Almaty, Kazakhstan

Beketova K.N. **–** Candidate of Economics, Associate Professor, Korkyt Ata Kyzylorda University, Aiteke bi st., 29A, Kyzylorda, Kazakhstan

Нұрғалиұлы А. **–** автор для корреспонденции, магистр экономических наук, докторант, Кызылординский университет имени Коркыт ата, ул. Айтеке би, 29А, Кызылорда, Казахстан

Смагулова Ш.А. **–** доктор экономических наук, профессор, Университет Международного Бизнеса имени Кенжегали Сагадиева, пр. Абая, 8А, Алматы, Казахстан

Бекетова К.Н. **–** кандидат экономических наук, ассоциированный профессор, Кызылординский университет имени Коркыт ата, ул. Айтеке би, 29А, Кызылорда, Казахстан

Нұрғалиұлы А. – корреспонденция авторы, экономика ғылымдарының магистрі, докторант, Қорқыт Ата атындағы Қызылорда университеті, Әйтеке би көшесі, 29А, Қызылорда, Қазақстан

Смагулова Ш.А. **–** экономика ғылымдарының докторы, профессор, Кенжеғали Сағадиев атындағы Халықаралық Бизнес Университеті, Абай даңғылы, 8А, Алматы, Қазақстан

Бекетова К.Н. **–** экономика ғылымдарының кандидаты, қауымдастырылған профессор, Қорқыт Ата атындағы Қызылорда университеті, Әйтеке би көшесі, 29А, Қызылорда, Қазақстан