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DEVELOPMENT OF A COMBINED APPROACH TO FORECASTING PARAMETERS OF ELECTRIC CONSUMPTION OF THE OPERATING ENERGY SYSTEM OF THE KEMEROVO REGION - KUZBASS

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Introduction

The main consumers of electricity in the power system of the Kemerovo region - Kuzbass are industrial facilities - mining (35.1%), transport (22.4%) and manufacturing industry (45.93%) [1]. It is worth noting that all three leading sectors of the economy are connected into a single technological process. Also important is the fact that all electricity consumers in the region under study are characterized by different trends in the volumes of consumed electrical energy.

Properly predicted and calculated loads lead not only to efficient consumption of energy resources, but also make it possible to extend the life of expensive and technically complex equipment by an order of magnitude. In addition, being at a standard load level, electrical equipment is less likely to require unscheduled repairs, adjustments or replacement.

To meet the criteria defined in the study, it is necessary to implement a combined approach to forecasting power consumption parameters in the mining and transport industries of the region, based on a combination (set) of several forecasting methods that take into account the influence of associated factors, since the target parameter under study does not obey the law of normal distribution (chaotic) and depends on several related parameters.

Implementation of a combined approach to forecasting

The initial data for performing calculations are data on the level of coal production in the territory of the subject of the Russian Federation under study and the level of transport of coal raw materials in millions of tons. Also, as initial data, the electricity costs in millions of kW·h of the studied economic sectors and sectors of the fuel and energy complex were determined [2].

To carry out the procedure for forecasting the expected volumes of coal production and transport in the region, you should use the exponential smoothing formula, which in its classical form is written as follows:

$$d_{(j+1)} = \alpha \cdot d_j + (1-\alpha) \cdot d_j^{p.esa}; \quad (1)$$

where d_j - is the value of coal production for a certain year in million tons, t_j - is the value of coal transport for a certain year in million tons, $d_j^{p.esa}$ - is the base fore-

cast value of coal production for the previous study period in million tons, $t_j^{p.esa}$ - is the base value of coal transport for the previous study period in million tons, α - is the coefficient selected for forecasting.

To implement a combined approach to forecasting electricity consumption, the basis is the method of regression analysis with three conditions embedded in it:

- the regression equation must be compiled on the basis of initial information about the parameter under study for the previous 10 years;
- predicted parameters should depend on the predicted values of coal production in the territory of the region under study;
- predicted parameters should depend on the predicted values of coal transport in the territory of the region under study.

You can visually assess the development trend of the values obtained during forecasting using the exponential smoothing method on the graph (Figure 1).

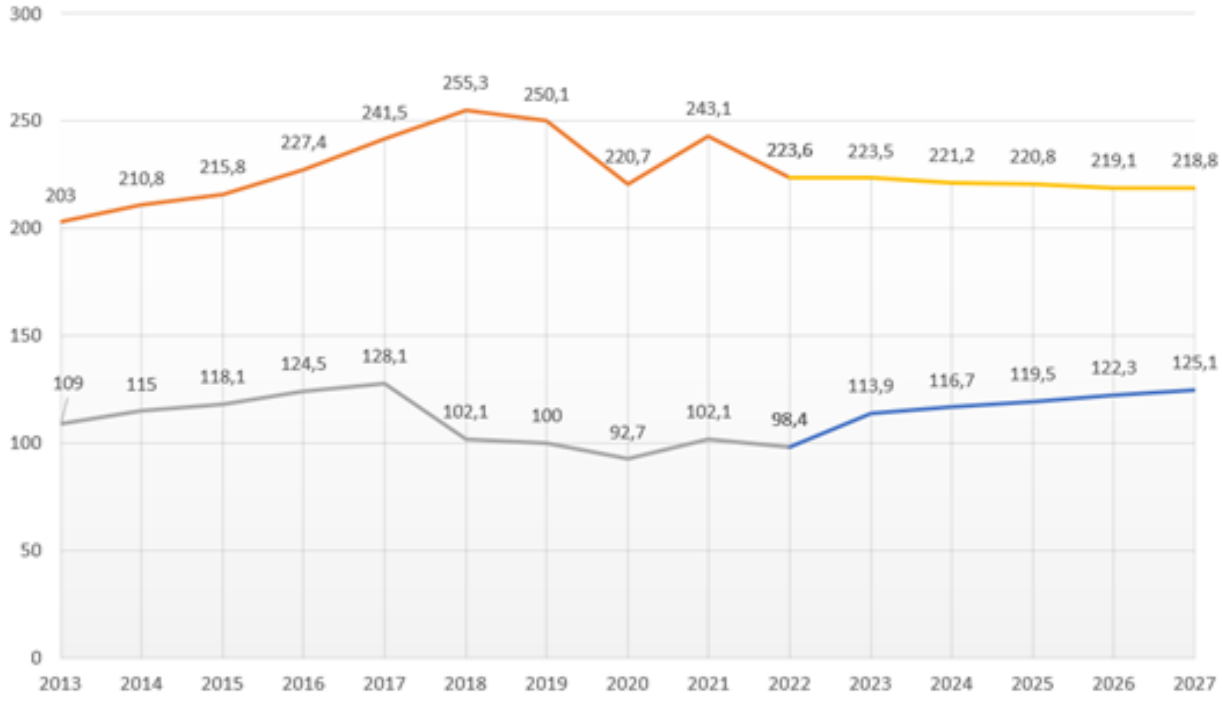

Fig. 1 Graph with actual data on the level of production and transport in the territory of Kuzbass in the period 2013-2022 and predictable for the period 2023-2027

As a working hypothesis, we will accept that the predicted value of electrical energy in each coming year depends on the actual consumption of electricity by the studied sectors of the economy in the region, on the increase or decrease in the level of production and transportation of coal raw materials.

Then you can write a fairly simple regression equation to find the predicted value of electrical energy:

$$E_{(j+1)}^{p.r} = \alpha_{1j} \cdot E_j + \alpha_{2j}(\Delta d_{(j+1)} + \Delta t_{(j+1)}), \qquad (2)$$

where $\Delta d_{(j+1)}$ and $\Delta t_{(j+1)}$ - is the values of the increase in the level of coal production and transportation in million tons relative to the previous year, E_j - is the value of electricity consumption of the previous year in millions of kW·h, α_{1j}, α_{2j} - is the coefficients selected for forecasting.

Table 1

Results of the forecast of electricity consumption values in the transport and mining sectors of the economy in the period from 2023 to 2027

Year	Forecast of electricity consumption, million kW·h	Coefficient value α_{1j}	Coefficient value α_{2j}	Relative forecast error, %
2023	12343,3	1,03867	1,0196718	-4,0
2024	12797,3	1,03673	1,2106423	-3,7
2025	13595,0	1,06214	1,0392980	-6,2
2026	12597,4	0,92655	0,9118040	7,3
2027	11607,2	0,92125	1,2096120	7,9

The results of the values obtained during the study are shown in the figure. 2.

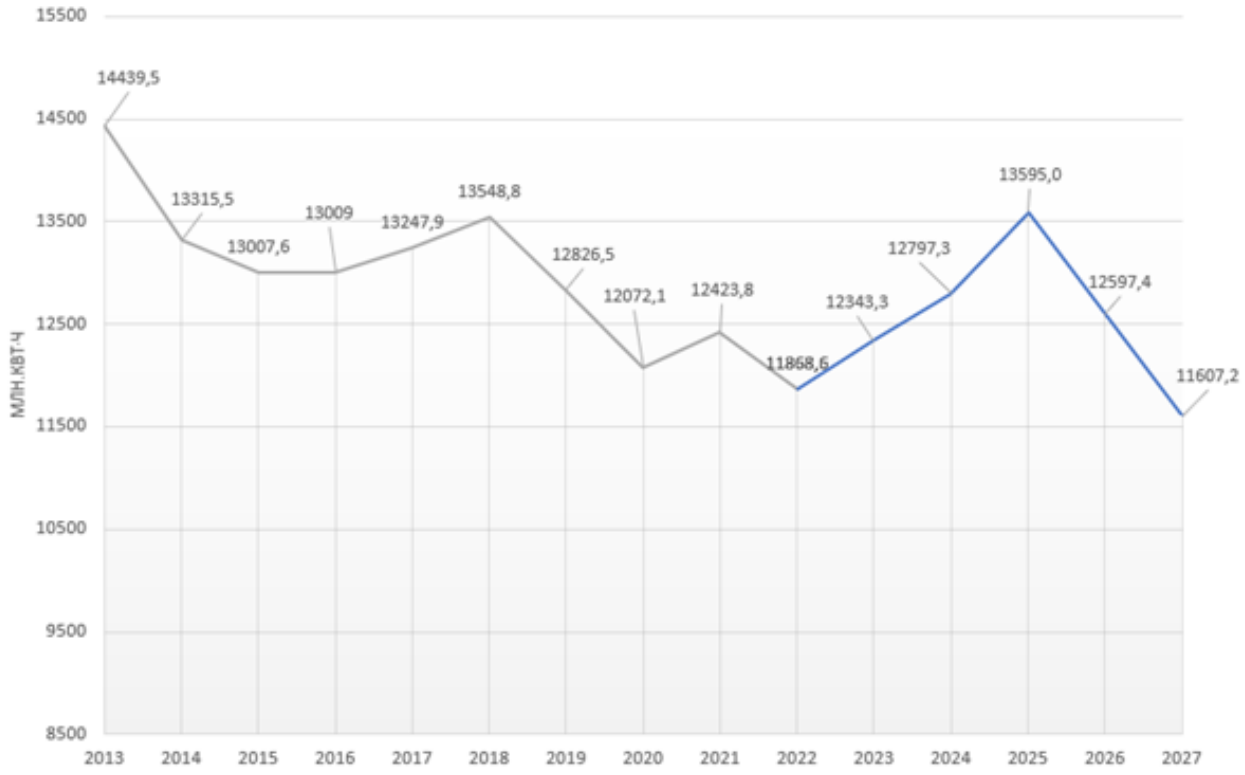

Fig. 2 Graph with actual data on the level of electricity consumption by the transport and mining sectors of the economy in territory of the region in the period from 2023 to 2027

Conclusions from the study

A combined approach to forecasting using regression equations and taking into account the functional relationship between electricity consumption and the process of coal mining and transportation allows us to ultimately obtain a forecast with an error of less than 1%.

Based on the data obtained during the implementation of the chapter, one can judge the growing share of electricity consumption in the near future by the fundamental sectors of the region's economy - mining and transport. The figures obtained during forecasting can be used to carry out the expert assessment procedure and adjust previously planned optimization measures in the field of energy in the region.

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