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ANALYSIS OF ELECTRICAL EFFICIENCY OF THE ENTERPRISE'S POWER SUPPLY SYSTEM

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ABSTRACT

Analyzing the electrical efficiency of an enterprise's power supply system involves evaluating how efficiently the system converts input electrical energy into useful output energy. By identifying and summarizing indicators such as the efficiency of the energy source, loses in the transmission of electricity, the impact of electricity production on the environment, the integration of renewable energy sources into the electricity grid, the coefficient of reliability of electricity supply and the share of electricity in the unit product volume provides an opportunity to evaluate. This analysis is crucial in determining the overall performance and economic efficiency of the power supply system.

Keywords: Power supply system, energy saving, energy management, loses in the transmission of electricity, the impact of electricity production on the environment, the integration of renewable energy sources into the electricity grid.

INTRODUCTION

Increasing energy efficiency in industry is crucial for reducing operational costs and promoting sustainability. This abstract provides recommendations for enterprises to implement strategies and measures to improve energy efficiency. These include conducting energy audits, implementing energy management systems, upgrading equipment and systems, optimizing processes, engaging employees through training and awareness programs, participating in demand response programs, integrating renewable energy sources, entering into energy performance contracts, implementing continuous monitoring and maintenance, and benchmarking and sharing best practices.

MATERIAL AND METHODS

By following these recommendations, enterprises can enhance their energy efficiency, reduce costs, and contribute to a more sustainable future.

To conduct this analysis, several key factors need to be considered:

1. Power generation efficiency: This refers to the efficiency of converting fuel or other energy sources into electrical energy. It is important to assess the efficiency of the power generation process, such as thermal power plants, renewable energy sources, or any other methods used by the enterprise.

2. Transmission and distribution losses: During the transmission and distribution of electricity, losses occur due to resistance in power lines and transformers. These losses can significantly impact the overall efficiency of the power supply system. Evaluating the transmission and

distribution losses helps identify areas where improvements can be made to minimize energy wastage.

3. Power factor: Power factor is a measure of how effectively electrical power is being used in a system. Low power factor can result in increased energy consumption and reduced efficiency. Analyzing the power factor of the enterprise's power supply system can help identify opportunities for power factor correction and improve overall efficiency.

4. Load management: Efficient load management plays a crucial role in optimizing energy consumption. By analyzing the load profile of the enterprise, it is possible to identify peak demand periods and implement strategies to reduce energy consumption during these times. Load management techniques such as load shedding or demand response programs can improve overall efficiency.

5. Energy storage systems: Implementing energy storage systems, such as batteries or pumped hydro storage, can help optimize energy usage and improve overall efficiency. Analyzing the efficiency of these storage systems is essential to assess their impact on the enterprise's power supply system.

6. Monitoring and control systems: Implementing advanced monitoring and control systems can provide real-time data on energy consumption, allowing for better optimization and management of the power supply system. Analyzing the effectiveness of these systems can help identify areas for improvement and increase overall efficiency.

By analyzing these factors, the enterprise can gain insights into the electrical efficiency of its power supply system. This analysis can help identify areas for improvement, implement energy-saving measures, and ultimately reduce energy costs while minimizing environmental impact.

It does not work without the power part of the power supply system, it is not efficient, but it can work without secondary electronic devices. For example, there is no automation, no backup or no accounting system. Therefore, the order of rating is determined by the level of importance of indicators for operating conditions. Priority coefficients (with high weight coefficients) are coefficients that describe the power part of the power supply system.

RESULTS AND DISCUSSION

The generalized indicator of the efficiency of the power supply system of the enterprise is determined by the summation of three generalized indicators: the efficiency coefficient of the power unit of the power supply system and the efficiency coefficient of the secondary circuits of the power supply system of the enterprise (automation, protection, measurement and metering, etc.), as well as the coefficient of economic efficiency of the enterprise's electricity supply. For convenience, all indicators are calculated in relative units.

General and partial ratings of weight coefficients are made on the basis of a condition: the more important the coefficient, the greater the number of places occupied by the coefficient in the overall rating. In this case, the criterion is selected, which is sorted by the performance indicators of the power supply system. As such a criterion, the importance of the influence of power supply system efficiency indicators on energy losses in the power supply system, annual reduced costs, reliability of the power supply system, environmental pollution conditions, etc. can be taken.

As such criterion, we take the effect of the selected indicators on the change of losses in the supply of electricity and express it by the efficiency of the electricity supply system.

For example, let's analyze the daily schedule of EUROSNAR LLC, which was calculated during our energy audit.

As can be seen from Table 1 above three indicators change over time: energy factor, quality factor and regulation factor (automation factor).

We conduct a correlational analysis of the indicators and calculate the correlation coefficient to determine the degree of interdependence of the indicators with respect to the efficiency coefficient of the power supply system (Table 1).

Table 1. Daily consumption schedule of EVROSNAR company

Measurement time, hours	8	9	10	11	12	13	14	15	16	17	18
K_{EN} –	0.8	0.8	0.84	0.84	0.79	0.79	0.84	0.79	0.8	0.79	0.8
K_{EQ}	0.93	0.92	0.93	0.94	0.92	0.92	0.93	0.9	0.93	0.92	0.93
K_{reg} –	0.93	0.97	0.98	0.96	0.97	0.98	0.97	0.95	0.98	0.95	0.97
K_{η} –	0.96	0.96	0.97	0.97	0.95	0.95	0.96	0.95	0.96	0.95	0.96

We calculate the correlation coefficient for the compared pairs by:

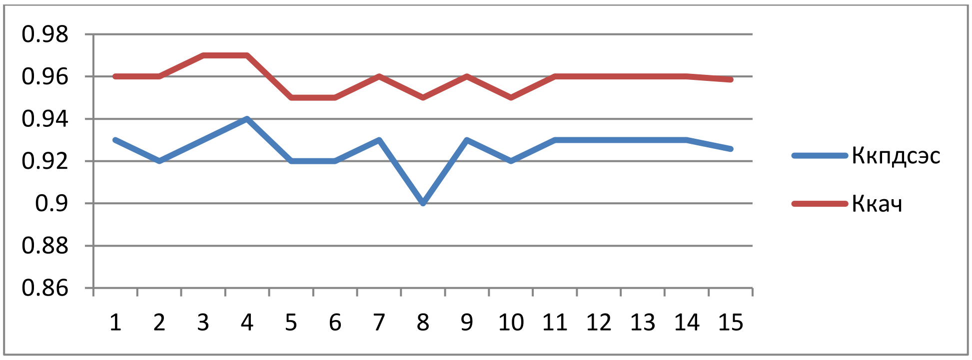
K_{EN} *–correlation coefficient - 0.89.*

K_{EQ} *–correlation coefficient - 0.76.*

K_{reg} *– the correlation coefficient is equal to 0.15*

As can be seen from the calculations and graphs, the related indicators are the energy factor and the efficiency of the power supply system, followed by the quality factor and the regulation factor.

Based on the analysis of the effect of these indicators on the loss of electricity, we get the following order of weighting coefficients. The first three generalized coefficients are: energy coefficient; quality factor; the redundancy ratio describes the power part of the power supply system. The following two generalized coefficients: the automation coefficient and the information security coefficient describe the secondary circuits of the power supply system.



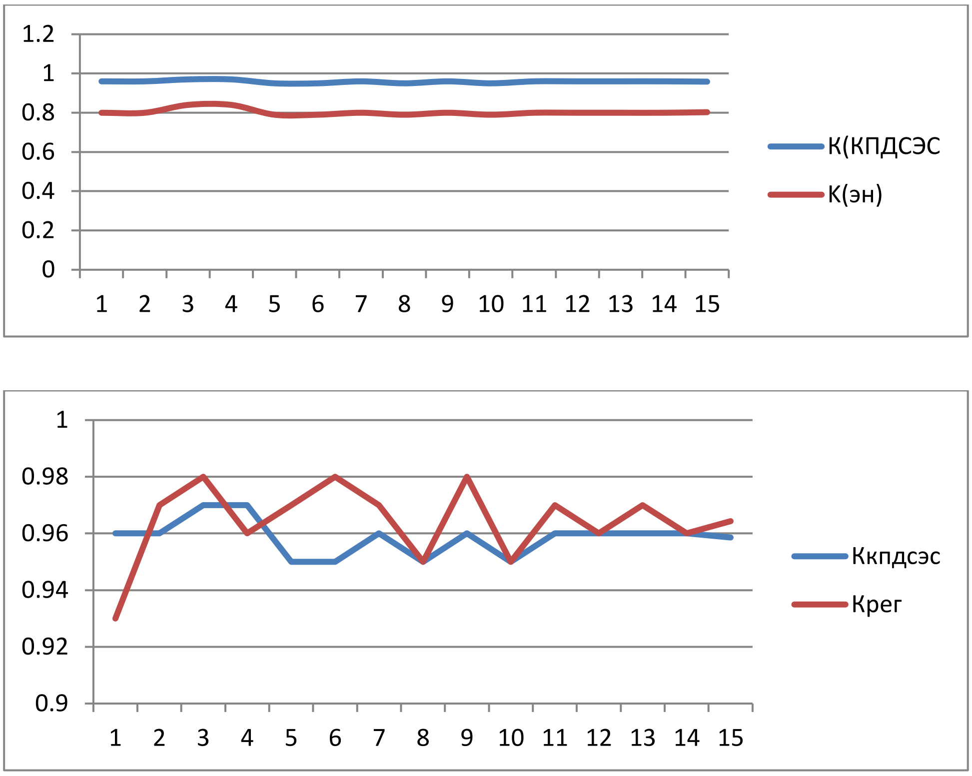


Fig.1. Correlation graph of studied pairs

If we take the criteria of minimum losses as the basis for evaluating the energy efficiency of the power supply system, the correlation analysis showed that energy and quality coefficients are highly related.

The energy coefficient is determined by multiplying the energy consumption indicators:

$$K_{EN} = K_{\eta}^{'} \cdot K_{\varphi}^{'},$$

Here: K_{η}' – the efficiency of the power supply system in the supply of electricity is determined by the following formula:

$$K_{\eta}^{'} = 1 - \frac{K_{\eta.n} - K_{\eta}}{K_{\eta,n}},$$

Here: $K_{\eta.n}$ –the standard efficiency of the power supply system of the enterprise, established by the energy inspection of the enterprise according to the recommended project of the power supply system of the enterprise, K_{η} – the current value of the efficiency of the electricity supply system, determined by the computer model of the enterprise's electricity supply system or analytical data on the meter readings of the electricity accounting systems.

The given coefficient of the power supply system of the enterprise is determined by the following formula:

$$K_{\varphi}^{'} = 1 - [\frac{\cos\varphi_n - \cos\varphi_d}{\cos\varphi_n}]$$

Here: $cos\varphi_n$ is the standard value of the energy consumption factor established by the state energy control authorities; $cos\varphi_d$ is the effective value of the energy consumption factor of the enterprise according to the commercial electricity meter.

The generalized quality indicator at the output of the power supply system is determined by the following formula:

$$K_{EQ} = \prod_{n=1}^{n} K_n = K_1 \cdot K_2 \cdots K_n = K_{\sin} \cdot K_{\Delta U} \cdot K_{Sim},$$

where: K_{sin} – the sinusoidal coefficient, $K_{\Delta U}$ – the voltage deviation coefficient, K_{sim} – the voltage symmetry coefficient, determined depending on the value of the current voltage on the busbars of the power supply system. If necessary, if the effect of the power supply system on this indicator is significant, other quality indicators are also taken into account.
We determine the energy efficiency of the power supply system using the following formula:

$$K_{ESS} = K_{EC} \cdot K_{EQ}$$

CONCLUSION

The following should be mentioned as a conclusion:
1. The method of comprehensive assessment of the energy efficiency of the industrial enterprise was developed. As a result, determination of the energy efficiency of the industrial enterprise is achieved on the basis of complex automated analysis.
2. By the method of relative normalization of activity indicators and their generalization into a single coefficient, a generalized indicator of technological electrical equipment of the enterprise was developed.

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