Мамарасулова Таджинисо Сагатовна
доцент, ТГТУ, Ташкент
Mamarasulova Tadjiniso Sagatovna, TSTU

СТРАТЕГИЧЕСКИЕ ПОДХОДЫ К СНИЖЕНИЮ ЭНЕРГОПОТРЕБЛЕНИЯ С СОХРАНЕНИЕМ ПРОИЗВОДИТЕЛЬНОСТИ
STRATEGIC APPROACHES TO MINIMIZE ENERGY CONSUMPTION WHILE MAINTAINING PRODUCTIVITY

Аннотация: В статье рассматриваются вопросы основные мероприятий по снижению потребляемой энергии без снижения производительности. Предлагается разделить мероприятий по экономии электроэнергии на промышленных предприятиях на пять основных групп. Расчетная величина экономии электроэнергии (общезаводская), которую следует учитывать при расчетах себестоимости заводской продукции, должна включать снижение потерь электрической энергии в трансформаторах, преобразователях, в цеховых и заводских сетях до точки раздела сетей с энергосистемой. Так как затраты на электроэнергию, топливо, сырье включаются в калькуляцию по ценам, по которым они отпускаются предприятию, естественно, что эффект от внедрения мероприятий, который отражается на себестоимости продукции, иначе, чем по тарифу, оцениваться не может.

Abstract: This article addresses the main initiatives for reducing energy consumption without compromising productivity. It suggests dividing energy-saving measures at industrial enterprises into five principal groups. The calculated magnitude of electricity savings (plant-wide) that should be considered in the cost calculations of factory production should include reductions in electrical energy losses in transformers, converters, and within shop and factory networks up to the point of division with the power system networks. Since the costs of electricity, fuel, and raw materials are included in the costing at the prices at which they are released to the enterprise, it is natural that the effect of implementing measures, which reflects on the cost of production, can only be assessed based on tariffs.

Ключевые слова: производительность, экономия электроэнергии, энергоэффективность, коэффициент мощности, потерь энергии, удельный расход энергии, себестоимость продукции.

Keywords: productivity, electricity savings, energy efficiency, power factor, energy loss, specific energy consumption, cost of production.

Most measures to save electricity are inherently linked to the rationalization of existing technology and the introduction of new technologies, improving the organization of production, increasing the volume of products manufactured, and enhancing the quality indicators of their production. Clearly, in developing and implementing each measure for electricity conservation, the assessment and justification of their economic feasibility and efficiency should be performed only in conjunction with the entire complex of technological, energy, and organizational-technical factors. An incorrect assessment of the reduction in electrical energy costs as a result of implementing any given measure can lead to a distortion of the total cost magnitude and, consequently, to erroneous results [1].

For determining the feasibility of electricity saving measures, increasing the power utilization factor, and reducing electricity losses, outdated methods are often used. It is apparent that an assessment of measures based solely on the amount of electricity saved, without considering important factors such as changes in operating conditions and the capital expenses associated with the implementation of the measure, is flawed. Moreover, the absolute value of electricity savings cannot be a complete indicator of the effectiveness of the measure if it is considered in isolation from the operating mode of the equipment on which the measure is implemented, whether it is at maximum load or forced reduction due to restrictions from the power supply organization.

All electricity saving measures at industrial enterprises can be divided into the following groups [2, 3, 4]:

1. Measures to reduce consumed power.
2. Measures to reduce consumed energy without reducing productivity.
3. Measures to increase electricity (power) consumption and productivity.
4. Measures to increase productivity and consumed energy.
5. Measures to identify productivity without changing consumed power and energy.

These measures can be divided into two groups:

a) measures not related to the volume of products manufactured;

b) measures related to the volume of products manufactured.

In calculations related to increasing the power factor and reducing active losses in electrical machines and devices, the goal is to achieve a minimum of referred losses, i.e., a minimum of total active power losses in the electrical installations themselves and losses of active power in the power system networks caused by the reactive load of these machines and devices [5].

Referred losses cannot serve as a basis for assessing measures in conditions of a self-accounting enterprise, since it is known that only the energy directly consumed in the enterprise's energy management can be reflected in the technical-economic indicators of the enterprise.

Electricity savings in an industrial enterprise are achieved by reducing electricity losses in networks, devices, machines, and also by reducing the specific energy consumption per unit of product.

The annual electricity savings for a given technological unit, process, device, etc., can be determined from the expression:

$$W_{es} = \left(P_a - P_c\right) \cdot \tau = \Delta P_{es} \cdot \tau \text{, kWh/year} \quad \textbf{(1.1)}$$

or

$$W_{эк} = \left(d_b - d_a\right) \cdot П \text{, kWh/year} \quad \textbf{(1.2)}$$

where, P_a, P_c – the average and consumed power, respectively, before and after the implementation of the measure;

d_b, d_a – specific electricity consumption per unit of product, respectively, before and after the implementation of the measure;

$П$ – productivity of units, machines, processes, etc., one year after the implementation of the measure;

τ – the number of operating hours per year.

The calculated amount of electricity savings (plant-wide) that should be considered in the cost calculations of factory production should include the reduction of electrical energy losses in transformers, converters, in shop and factory networks up to the point of division with the power system networks. The magnitude of this savings is:

$$W_{з.эк} = W_{эк} \frac{1}{\eta_з}, \Delta P_{з.эк} = \Delta P_{эк} \frac{1}{\eta_з}, \quad \textbf{(1.3)}$$

where, $\eta_з$ – the resulting efficiency of electricity transmission and conversion in the factory network from the point of energy reception to the point of division of the factory network with the power system network. Since the costs of electricity, fuel, and raw materials are included in the costing at the prices at which they are released to the enterprise, naturally, the effect of implementing measures, which reflects on the cost of production, cannot be assessed otherwise than by tariff.

The organization of energy conservation and enhancement of energy efficiency in industry is not only a relevant but also an extremely complex task. This complexity is due to the great diversity of enterprises in terms of both the nomenclature and volumes of products produced, as well as the specifics of each technological unit and process [7]. To this, one must also add the differences in the operating regime of each enterprise – around-the-clock continuous operation, operation with technological breaks, single-shift, and two-shift work modes. This explains the necessity to solve a number of tasks aimed at reducing energy consumption, which include a large complex of measures taking into account the characteristics of each electricity-consuming entity.

References:

1. Jalo, N., Johansson, I., Kanchiralla, F. M., & Thollander, P. (2021). Do energy efficiency networks help reduce barriers to energy efficiency? -A case study of a regional Swedish policy program for industrial SMEs. Renewable & Sustainable Energy Reviews, 151, 111579. https://doi.org/10.1016/j.rser.2021.111579

2. Su, H., Huang, Q., & Wang, Z. (2021). An Energy Efficiency Index Formation and Analysis of Integrated Energy System Based on Exergy Efficiency. Frontiers in Energy Research, 9. https://doi.org/10.3389/fenrg.2021.723647

3. Wang, X., & Zhou, D. (2023). The underlying drivers of energy efficiency: a spatial econometric analysis. Environmental Science and Pollution Research, 30 (5), 13012-13022. https://doi.org/10.1007/s11356-022-23037-1

4. de Souza, D. F., da Guarda, E. L. A., Sauer, I. L., & Tatizawa, H. (2021). Energy Efficiency Indicators for Water Pumping Systems in Multifamily Buildings. Energies, 14 (21), 7152. https://doi.org/10.3390/en14217152

5. Luo, Q., Li, D., Yu, J., Shen, X., & Bai, K. (2021). Testing Method and Experimental Research on Energy Efficiency of Aerostatic Restrictor. In Proceedings of 2021 7th International Conference on Condition Monitoring of Machinery in Non-Stationary Operations (CMMNO) (pp. 135-140). IEEE. https://doi.org/10.1109/CMMNO53328.2021.9467612

6. Liddle, B., & Sadorsky, P. (2021). Energy efficiency in OECD and non-OECD countries: estimates and convergence. Energy Efficiency, 14 (7), 72. https://doi.org/10.1007/s12053-021-09992-7

7. Tanaka, K., & Managi, S. (2021). Industrial agglomeration effect for energy efficiency in Japanese production plants. Energy Policy, 156, 112442. https://doi.org/10.1016/j.enpol.2021.112442