



ENERGY WASTE: CAUSES, CONSEQUENCES AND PREVENTIVE MEASURES

Tashkent State Transport University

Yakubov Mirjalil Sagatovich,

Ph.D., prof.

Bakhtiyorov Hasanboy Inomjonov

is a 2nd year student.

Urinboyev Farrukh Farhodov,

master's degree.

Annotation. The issue of electricity waste in electricity supply is widely covered, its causes, economic and environmental consequences, as well as ways to prevent waste through the introduction of energy-saving technologies are analyzed. The results of the study show the need for rational management of energy resources, improving the energy culture of the population, and applying the principles of sustainable development.

Keywords: energy waste, energy efficiency, energy saving, sustainable development, ecology, technological modernization.

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Energy waste is currently on the agenda as one of the global problems. Energy consumption is increasing due to population growth, expansion of production volumes, and the development of digital technologies.

The nature and types of energy waste

Energy waste is defined as the amount of energy consumed in production, transportation, housing, or domestic use that exceeds a technically or economically justifiable level.

The main types of waste are:

Technical waste is associated with the obsolescence of equipment, losses in pipelines and electrical networks, and the use of inefficient technologies. [1]

Organizational waste is the lack of mechanisms to control energy consumption in production processes.

Household waste - losses resulting from the unnecessary use of electricity, gas, and water by the population, failure to turn off electrical appliances at night, and excessive heating or cooling.

Ecological consequences

In the process of energy production, fuel products are often burned. As a result, harmful gases such as carbon dioxide and sulfur dioxide are released into the air. Energy waste means burning excess fuel and, as a result, increasing atmospheric pollution.

Effective ways to reduce energy waste

many cases, electrical loads consume reactive power in addition to active power. In addition to active power, reactive power can be obtained directly from reactive power sources near the

loads. Installing reactive power sources is called reactive power compensation, and the sources themselves are called compensation devices. Reactive Power compensation issues are covered in detail in specialized courses. [2]

The basic idea of reactive power compensation is as follows: A line with active resistance R connects a load with voltage U and power $P+jQ$.

If there is no load compensation device, the active power losses on the line $Q_{k=0}$ are expressed as a drain.

$$\Delta P = (P^2 + Q^2) R / U^2 \quad (1)$$

If a compensating device is connected to the loads $Q_k \neq 0$, these losses will be reduced.

$$\Delta P = (P^2 + (Q - Q_k)^2) R / U^2 \quad (2)$$

Thus, reactive power compensation allows to reduce the waste of active power in the power supply scheme and, as a result, improves the technical and economic indicators of the scheme. From expressions (1) and (2) it is clear that power waste depends on ΔP the active power and Q /or $(Q - Q_k)$ reactive power transmitted from the line to the two generating units. Taking into account that reactive power compensation only affects the second component of the losses, we will now consider only the losses resulting from the transmission of reactive power.

When designing power supply schemes, the cost of this scheme is minimized. Reducing power waste due to compensating devices makes the scheme cheaper, because each kW of wasted power must be used at power stations, which means that money is spent on this. But money is also spent on compensating devices. This relationship raises the problem of determining the optimal power of the compensating devices that minimizes the total cost. It is appropriate to solve such a problem using gradient methods.

of the compensating devices for power supply systems Q_k can be given by any technical conditions. In this case, Q_k an optimal distribution of reactive power within the system is required. This problem can be solved, for example, by the Lagrange method [5].

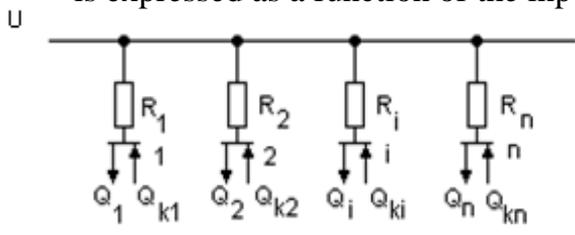
We consider such a problem for a radial power supply scheme. The source has a voltage U . This source Q_1, Q_2, \dots, Q_n supplies n consumers with reactive power. The source and consumers $R_1, R_2, R_3, \dots, R_n$ are connected by a line with active resistance

Each i consumer Q_{ki} can be equipped with a device with its own power. Q_k It is necessary to find the optimal distribution of compensating devices with a total power equal to 1, 2, ... n consumers. The optimality criterion is that the active power dissipation in the circuit is minimal.





The objective function is to minimize the active power dissipation in the circuit, which is expressed as a function of the input.



$$\Delta P = \sum_{i=1}^n (Q_i - Q_{ki})^2 \frac{R_i}{U^2} \rightarrow \min \quad (3)$$

The relative minimum of the objective function is found at the following bounds.

$$\sum_{i=1}^n Q_{ki} = Q_k \text{ or } \sum_{i=1}^n Q_{ki} - Q_k = 0 \quad (4)$$

1. Radial power supply diagram

We write the Lagrange function:

$$L = \sum_{i=1}^n (Q_i - Q_{ki})^2 \frac{R_i}{U^2} + \lambda \left(\sum_{i=1}^n (Q_{ki} - Q_k) \right) \rightarrow \min \quad (5)$$

To find the minimum value of the function L, we set its special derivatives equal to zero:

$$\left. \begin{aligned} \frac{\partial L}{\partial Q_{k1}} &= -2R_1(Q_1 - Q_{k1})U^2 + \lambda = 0 \\ \frac{\partial L}{\partial Q_{k2}} &= -2R_2(Q_2 - Q_{k2})U^2 + \lambda = 0 \\ \dots & \dots \\ \frac{\partial L}{\partial Q_{ki}} &= -2R_i(Q_i - Q_{ki})U^2 + \lambda = 0 \\ \dots & \dots \\ \frac{\partial L}{\partial Q_{kn}} &= -2R_n(Q_n - Q_{kn})/U^2 + \lambda = 0 \\ \frac{\partial L}{\partial \lambda} &= \sum_{i=1}^n Q_{ki} - Q_k = 0 \end{aligned} \right\} \quad (6)$$

The analysis of the system shows that Q_k the optimal distribution of the total set of compensating devices in a radial scheme should be based on the equation below.

$$R_1(Q_1 - Q_{k1}) = R_2(Q_2 - Q_{k2}) = \dots = R_i(Q_i - Q_{ki}) = \dots R_n(Q_n - Q_{kn}) \quad (7)$$

Conclusion

Energy waste is not only a technical problem, but also an economic, environmental, and social issue. Reducing waste contributes to the sustainable development of the country, economic growth, and environmental balance. [3]

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