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Statistical analysis of power waste in 6-10 kV tension overhead electrical transmission lines

Tovboev Akram Nurmonovich, Nodirov G'ulom Yusupovich, Togaev Islom Bekpolat ogli

Candidate of Technical Sciences Navoiy State of Mining and Technologies University. Uzbekistan.
Teacher of the Department of "Natural Sciences" of the Samarkand State Institute of Architecture and Construction. Uzbekistan.
Assistant of «Electrical power engineering» Department. Navoiy State of Mining and Technologies University. Uzbekistan.

ABSTRACT. A statistical analysis of the power and energy losses in overhead power lines with a voltage of 6-10 kV was carried out. In this process, direct wastages were identified and measures were developed to reduce wastages. Statistical analysis was mainly carried out using mathematical modeling, statistical analysis, theory of extremals, and forecasting methods. As a result of these studies, measures and recommendations were given to reduce power and electricity wastage and economic savings. A number of methods were used to calculate power and electricity waste. The compositional structure of wastages was studied and they were normalized.

KEY WORDS: Aerial power line, power wastage, commercial waste, loading waste, active power, reactive power, climatic waste.

I. INTRODUCTION

It is known that the process of transferring electrical energy is carried out due to the electromagnetic field of the wires, and this process has a wave-like nature, in which power dissipation occurs, that is, it causes overheating when the current flows through the wires and transformers. This dissipation is said to be load current because it is associated with load currents. On average, the waste makes up 10% of the transmitted power and turns into a loss of hundreds of millions of so per year for the economy. In addition to this wasteful cost over the course of the year, such systems require concurrent additional outlays for additional equipment, reactive power compensation equipment, additional personnel, fuel, etc., to cover the waste. It is one of the most important economic indicators of power grid enterprises. [1,2].Their value reflects the technical condition and level of operation of all transmission devices, the state of billing systems and metrological support of measuring devices, the efficiency of energy sales activities. In international practice, relative total losses during transmission and distribution of electricity are considered satisfactory if they do not exceed 4-5%. Power losses at the level of 10% are considered to be the maximum allowed in terms of the level of transmission through networks.

II. ESSENTIALS OF PERFORMANCE

A representation of the wastage associated with different stress ratings and cross-sectional areas. In such cases, use special tables for the convenience of calculations. Below is an example of such a table showing voltage losses in a three-phase overhead line with 0.4 kV aluminum wires. A design scheme for the distribution network with a voltage of 0.4 kV supplying the technological lines of enterprises and other electrical receivers is drawn up and the voltage loss is calculated in separate sections. [2,3]

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Table 1. Relative voltage losses, 1 kW * km, through the reactive power factor.

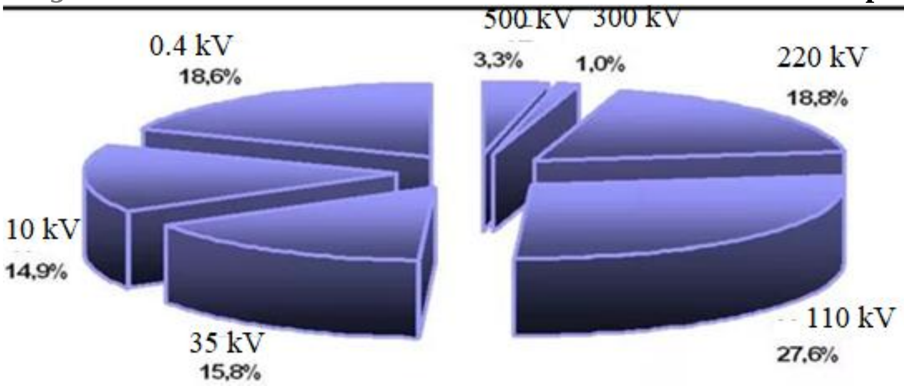
Nominal Cross sectional area mm^2	Relative voltage losses, 1 kW * km, through the reactive power factor.								
	1.02	0.88	0.75	0.62	0.53	0.48	0.36	0.28	0.90
16	1.52	1.58	1.55	1.52	1.50	1.49	1.46	1.44	1.37
25	1.13	1.10	1.07	1.03	1.02	1.00	0.97	0.96	0.89
35	0.87	0.84	0.81	0.78	0.76	0.75	0.72	0.70	0.64

Three-phase three-wire lines with a voltage of 6-10 kV operate with a uniform load, that is, each of the phases of such a line is equally loaded. In low-voltage networks, due to the light load, it is difficult to achieve an even distribution between the phases, so the 4-wire system of 380/220 V three-phase current is most often used there.

III. DIAGRAMMATIC REPRESENTATION .

Thus, since power is energy per unit of time, the power dissipation in a network can be determined by multiplying the power dissipation by the time the network operates at a given load. One of the main indicators of the functional efficiency and economy of electrical networks is the loss of electrical energy in the technical structure and use of electrical equipment and devices. Failure to continuously supply active electrical energy to operational processes and power grids results in excess electrical energy losses. This depends on the current load of network elements. Such losses are mainly active power loss, reactive power loss, and energy loss. Reactive power dissipation, active power dissipation and energy dissipation have a sufficiently negative and significant effect on line parameters. [3]

Diagram 1. **Efforts in different sectors. Distribution of waste in percentages.**



When supplying electricity to consumers, it is necessary to ensure uninterrupted, reliable and high-quality electricity. But later this process is not enough. Currently, measures are being developed to facilitate the solution of this issue as much as possible.If power losses in transformers have been sustained for 3 years, this means a decrease in the reactive power of the power transformer, as the number of connected consumers varies within the limits of negligible active power. At the same time there is an in crease in jet energy transmitted over the network. Therefore, the interconnection between the passage and charge of reactive energy the disparity between the constituent is the cause of this disparity.

Active power dissipation in the network: $\Delta P_l = \frac{P^2+Q^2}{U_{\text{H}}^2} \cdot R$ (1.1)

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Conductor type	U_L kV	L km	r om/km	R om	I A	T hour	W kw*hour	cosφ	ΔW *kw*hour*	% waste

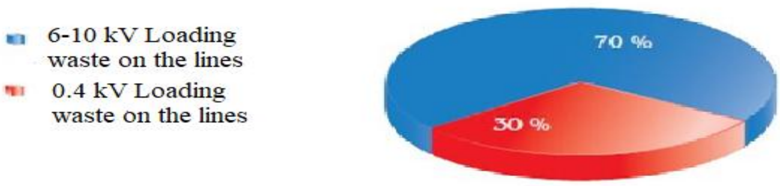
Reactive power dissipation in the network: $\Delta Q_l = \frac{P^2+Q^2}{U_H^2} \cdot X$ (1.2)

Energy consumption in the network: $\Delta A_l = \Delta P_l \cdot \tau$ (1.3)

Acquaintance with existing parameters of power (active and reactive) in overhead power transmission lines and mathematical justification; Development of a statistical method of structural analysis of power and energy waste; Reducing the impact on power transmission networks by considering the feasibility and implementation of measures aimed at reducing reactive power wastage. [4,5]

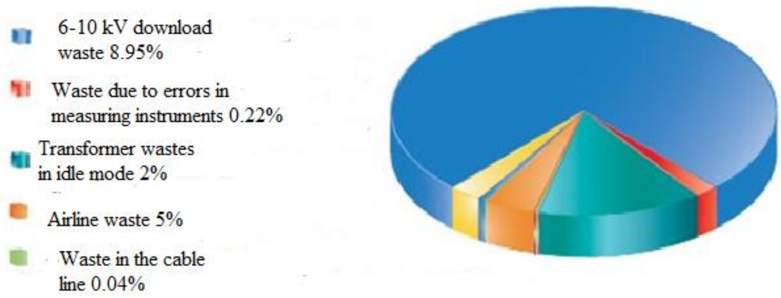
Overview of load losses in 6 (10) kV and 0.4 kV overhead power lines in city power networks (in %)

Diagram 2. Overview of waste in 6-10 kV power networks. It can be seen that there is a lot of waste in networks with relatively high voltage.



When calculating the economic efficiency, the costs of all the calculated and selected electrical devices, electrical networks and electrical equipment, the costs incurred for installation, that is, the total costs, are calculated. In order to determine the economic efficiency, the economic indicators of the system being designed and which can replace it are calculated, and the period of reimbursement of expenses is determined based on the determined results.

Diagram 3. The structure of technological losses of electric energy in urban electric networks, in the supply of electric networks (%)



Also, the use of one or another method depends on the characteristic of the calculated network. Thus, taking into account the simplicity of 0.4 - 6 - 10 kV network circuits, the large number of such lines and the low reliability of data on transformer loads, methods based on the representation of lines in the form of equivalent resistance are used to calculate losses in these networks. The use of such methods is appropriate in determining general wastage in all directions or in each one, as well as in identifying centers of wastage. [5]

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AS-95	6	3.6	0.341	1.224	12.68	2184	276384	0.96	1422.62	0.515
AS-95	35	1,1	0,34	0,374	12,98	8640	6516930	0,96	1868,797	0,029
AS-70	6	0,95	0,43	0,408	0,19	2184	4080	0,96	0,107	0,258
AS-70	6	0,96	0,43	0,412	1,85	2184	40200	0,96	10,541	0,026
AS-70	10	18	0,43	7,722	0,10	2184	3480	0,96	0,533	0,015
AS-70	10	18	0,43	70722	0,37	2184	13520	0,96	8,048	0,060
AS-70	10	15	0,43	6,435	0,27	2184	9920	0,96	3,611	0,036
AS-70	10	18	0,43	7,722	0,68	2184	24680	0,96	26,818	0,109
AS-70	10	18	0,43	7,722	1,08	2184	39040	0,96	67,104	0,172

Table 2. Electrical energy losses for power transmission lines of different voltages.

IV. RESULTS

This chapter deals with 6-10-35 kV power networksexamples are developed, and annual, daily electricity losses and power losses are shown using tables. It is presented in the form of charts and graphs. Taking into account significant differences in the structure of networks, their length, the standard of waste for each energy supply organization is an individual value determined based on the schemes and modes of operation of power networks and the characteristics of accounting for the reception and delivery of electricity. Effective ways to reduce electrical energy waste are as follows: Installation of static capacitors, in which the level of waste is reduced by 20-25 percent.*[5]*

V. CONCLUSION

In this way, the total wastage will grow insignificantly and the equipment will be used more rationally. Measures to reduce electricity waste in the electrical network can be divided into the following groups: 1.Relation to capital expenditures to increase the capacity of networks, taking into account the increase in loads with the expansion of electric networks. 2. Network health management, which may or may not involve capital expenditure. 3. Proper organization and management of the work mode of consumers. In such cases, the place of installation of capacitor batteries should be in the 0.4 kV part of the network. In this case, the cross-sectional area of the cables and the waste of electrical energy in the distribution network are reduced. The difference between high-voltage and low voltage capacitors is as follows: voltage 6-10 kV - up to 15%; voltage is 0.4 kV - 35 percent.

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