PROBLEMS OF ENSURING ELECTRICITY QUALITY IN RURAL ELECTRIC NETWORKS

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Abstract: *Creating conditions for stabilizing electricity tariffs in rural power networks, improving the energy efficiency of grid enterprises, and ensuring the reliability of power supply are among the most important tasks today. This article analyzes the current state of rural electric networks and proposes ways to address these challenges.*

Keywords*: rural electric networks; reliability; energy losses; power quality indicators.*

Аннотация: *Создание условий для стабилизации тарифов в сельских электросетях, повышение энергоэффективности сетевых предприятий и обеспечение надежности электроснабжения являются основными задачами сегодняшнего дня. В этой статье перечислены способы решения перечисленных выше задач путем анализа текущего состояния сельских электросетей.*

Ключевые слова: *сельские электрические сети; надежность; энергетические потери; показатели качества электроэнергии.*

It is impossible to increase the industrial potential of economic sectors and regions, stimulate entrepreneurship, improve public welfare, and enhance quality of life without ensuring reliable and high-quality operation of electric power networks.

The urgency of improving the efficiency of power supply systems for rural consumers has increased due to the following factors:

-the technical condition of rural electric networks is unsatisfactory. About 40–90% of аварийных outages in 0.4 kV and 10 kV networks occur in rural areas, leading to unreliable power supply and significant raw material losses in rural production enterprises;

-more than 35% of rural electricity consumers are supplied with electricity that does not meet standards in terms of symmetry, sinusoidality, and voltage deviation. Poor electricity quality reduces electromagnetic compatibility between the power system and consumers, worsens the operation of electrical equipment, disrupts technological processes, and causes serious damage to agricultural enterprises.

In addition, the main problems of rural electric network systems include:

-difficult financial conditions, resulting in insufficient procurement of modern high-quality (and expensive) equipment and limited use of efficient technologies;

-high levels of actual (technical and commercial) energy losses;

-increasing electricity demand leading to insufficient capacity of existing networks and transformers;

-low levels of automation and digitalization in power facilities, negatively affecting the prevention and rapid elimination of technological failures;

-poor maintenance services due to insufficient provision of machinery, equipment, and highly qualified personnel;

-lack of investment aimed at developing rural distribution electric networks;

-high degree of wear and aging of network configurations, reducing reliability. A significant portion of installed equipment is physically and morally outdated, with many substation devices corresponding to technologies used in developed countries 25–30 years ago.

One of the main electricity consumers in rural networks is asynchronous motors. A characteristic feature of such consumers is their impact on the quality of electricity in the supplying network. In turn, the proper functioning of all electrical equipment depends on the quality of electricity.

Any deviation in quality indicators leads to inefficient energy use, improper operation of electrical devices, reduced production output, and disruption of various processes.

Solving power quality issues in rural networks requires addressing economic, mathematical, and technical tasks. The economic aspect involves developing methods to calculate losses caused by poor-quality electricity. The mathematical aspect includes calculating quality indicators using various methods. The technical aspect involves developing technical tools and measures to improve quality, as well as methods for monitoring and controlling quality indicators.

In general, “electricity quality” refers to the compliance of the main parameters of the power system with established standards during the generation, transmission, and distribution of electricity.

Many efforts are being made in our country to address problems related to electricity quality. Accelerating these efforts will ensure high-quality electricity supply to industrial enterprises, social infrastructure facilities, residential areas, and other consumers, especially in rural regions.

According to the Resolution No. PQ-2692 of the President of the Republic of Uzbekistan dated December 22, 2016, aimed at accelerating the renewal of obsolete equipment and reducing production costs, 34.5% of worn-out and outdated equipment was replaced in the first half of 2019.

As a result of replacing outdated equipment and implementing energy-saving measures, production costs were reduced by an average of 0.6%, and electricity consumption per unit of output decreased by an average of 5.3% compared to the previous year.

Based on our research, the following priority tasks have been identified to improve electricity supply for rural consumers:

1. Assessment of the current state of electricity supply in rural networks;

2. Application of existing methods for improving electricity quality indicators;

3. Improvement of methods for reducing reactive power consumption in rural networks;

4. Increasing energy efficiency in electricity generation, transmission, and distribution due to growing demand, along with gradual modernization of equipment;

5. Development and expansion of renewable energy sources and their integration into the unified power system;

6. Development and implementation of automated systems for reactive power compensation in rural enterprises.

In conclusion, to meet the demand for high-quality electricity in rural areas, it is necessary to widely implement modern automated devices incorporating the latest achievements of science and technology. Analysis shows that consumers mainly use capacitor banks as reactive power compensation devices. It has been noted that automating reactive power compensation can significantly improve energy efficiency.

To solve this problem, it is advisable to use voltage-controlled adjustable reactive power sources.

The use of such systems helps reduce voltage asymmetry without requiring additional installation space, as these devices are compact in size.

Moreover, due to their operation at low voltage levels, their installation is cost-effective, making them accessible for widespread use among consumers.

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