ANALYSIS OF THE QUALITY OF PRODUCED ELECTRIC POWER

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Abstract. *Analysis of the quality of generated electricity is an important process that allows us to determine the compliance of electricity parameters with requirements and standards.*

To analyze the quality of generated electricity, specialized instruments and systems are used, such as electrical parameter analyzers. The results of the analysis help to identify problematic issues in the power supply system and take measures to eliminate or minimize them. The article discusses the main parameters that you should pay attention to when analyzing the quality of electricity.

Keywords: *electricity, standard, quality indicators, electronic devices, automation.*

Introduction. Relations in the field of supply and consumption of electrical energy in the Republic of Uzbekistan are regulated by the laws of the Republic of Uzbekistan "On Electric Power Industry", "On the Rational Use of Energy", "On the Legal Framework for the Activities of Business Entities", "On Natural Monopolies", "On the Protection of Consumer Rights" » and other regulatory legal acts.

The Resolution of the Cabinet of Ministers of the Republic of Uzbekistan "On additional measures to improve the procedure for using electrical energy and natural gas" dated January 12, 2018 No. 22 states that the quality of electrical energy is the compliance of electrical energy parameters with the requirements established by state standards.

An analysis of the quality of electricity produced in Uzbekistan can be made by comparing the requirements for electricity, which are specified in national and international standards. This analysis can be useful in identifying areas for improvement and developing strategies to ensure stable and quality electricity in the country.

Standards for electrical energy quality indicators define regulatory requirements for electrical energy parameters that must be met to ensure reliable and high-quality operation of electrical power systems. These standards are developed by national and international organizations, as well as regulatory authorities. Below are some of the most well-known electrical energy quality standards:

1. IEC 61000 (Standard series IEC 61000):

• A family of International Electrotechnical Commission (IEC) standards that address electromagnetic compatibility and electrical power quality characteristics, including harmonics, surges, surges, electromagnetic interference, and others.

2. IEEE 519 (IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems):

• A standard developed by the Institute of Electrical and Electronics Engineers (IEEE) for managing harmonics in electrical power systems.

EN 50160 (Voltage Characteristics of Electricity Supplied by Public Distribution Systems):

• European standard defining voltage quality parameters in electrical power systems, such as voltage levels, overvoltage's, sub voltages and phase angles.

These standards define various parameters of electrical energy quality, such as voltage levels, frequency, harmonics, overvoltage's, duration of power interruptions and others, and also establish acceptable limits and requirements for them. Continuous compliance with these standards is important to ensure the stable operation of electrical equipment and the reliability of electrical power systems.

The use of high-quality electricity is of great relevance for several reasons:

1. Ensuring system reliability and safety: High-quality electricity not only maintains the normal functioning of electrical equipment, but also helps prevent failures and accidents, which is essential for the safety and reliability of electrical power systems.

2. Saving resources: High quality power helps reduce energy losses, increases the efficiency and service life of electrical equipment, which helps save energy resources and reduce maintenance costs.

3. Maintaining production efficiency: In manufacturing plants and industrial facilities, electricity plays an important role. Quality power not only reduces the risk of equipment damage, but also ensures stable production and maintains product quality.

4. Compliance with regulations and standards: Many countries have regulations and standards that the supplied electricity must comply with. Violation of these regulations may result in fines and penalties.

5. Grid Resilience to Renewable Energy Sources: When renewable energy sources such as solar panels and wind turbines are integrated into grids, stable and high-quality power supply becomes especially important to maintain the balance and reliability of electrical systems.

6. Modern technologies: Modern technologies and smart control systems require high quality power to operate properly, and they are playing an increasingly important role in modern societies.

7. Electric vehicles and charging stations: The development of electric vehicles and the proliferation of charging stations requires reliable and high-quality electricity to charge vehicles.

With the increase in electronic devices, automation and electrification in various walks of life, power quality is becoming a more important factor in ensuring the safety, sustainability and efficiency of society and the economy.

Analysis of the quality of electricity produced in Uzbekistan may include an assessment of various parameters and aspects of electricity in the country. Here are a few key factors that may be important to such an analysis:

1. Network voltage and frequency: Assessment of voltage and frequency levels of the electricity network in Uzbekistan and their compliance with standards. This is an important indicator of power quality, since deviations from the norm can cause problems in the operation of electrical equipment.

2. Harmonics and Distortion: Analyze the level of harmonics and distortion of voltage and current waveforms. Harmonics can be created by non-linear loads and their presence can affect the operation of sensitive devices and equipment.

3. Power factor: Estimation of power factor and its compliance with standards. Low power factor can affect transmission efficiency and power consumption.

4. Duration of power interruptions and failures: Estimate the duration and frequency of power interruptions. This is important for assessing the reliability of the electrical power system.

5. Transmission Efficiency and Energy Loss: Analyze the transmission efficiency of electricity in a network and identify factors that may cause energy loss.

6. Development of renewable energy sources: Assessment of the integration and development of renewable energy sources in the energy system of Uzbekistan and their impact on the quality of electricity.

7. Network structure and infrastructure: Analysis of the state of the network infrastructure and its readiness for increased energy consumption and the introduction of new technologies.

8. Management and monitoring system effectiveness: Assess the effectiveness of the network monitoring and management system to ensure stability and quality of electricity.

The list of electrical energy quality indicators used in payments for electrical energy is established in the electricity supply contract based on state standards.

Analysis of methods for determining electrical energy quality indicators includes the assessment and measurement of various electrical energy parameters that are important for ensuring reliable and efficient operation of electrical power systems. Below are the main methods and parameters used to determine the quality of electrical energy:

• Voltage: Measuring the voltage level allows you to evaluate the stability and quality of the supplied electricity. Voltmeters are used for this.

• Frequency: Line frequency (usually 50 or 60 Hz) is also an important power quality parameter. It is measured using frequency meters.

• Harmonics: Harmonics are the higher harmonic components of a sinusoidal voltage or current. Harmonic measurements are carried out using specialized harmonic analyzers.

• Phase Angle: The phase angle between voltage and current can indicate the presence of reactive power. It is measured using phase meters.

• Duration of outages: Measuring the duration of outages and power failures allows you to assess the reliability of the power supply.

• Power factor: This parameter characterizes the ratio of active power to apparent power in the system. Power factor is measured using power meters.

• Measuring overvoltages and subvoltages: Overvoltages and subvoltages can affect the operation of equipment. Their measurement is carried out using voltmeters and recorders.

• Waveform Quality: This parameter determines the degree of distortion of a sinusoidal voltage or current waveform. Assessing the quality of the waveform may require the use of oscilloscopes.

• Duration and frequency of power outages: These parameters assess the degree of instability in the power supply and are measured using event recorders.

• Event monitoring and data recording: Modern monitoring and data recording systems allow continuous monitoring and analysis of electrical power quality parameters.

Power quality analytics helps utilities, consumers, and regulators monitor the performance of electric power systems, identify problems, and improve power quality.

Measurements of power quality indicators are carried out by an accredited testing laboratory together with the territorial power grid enterprise and the consumer. In cases where low-quality electrical energy is identified, regulations provide for discounts (surcharges) to the tariff for electrical energy.

Electrical energy certification is a procedure for assessing and confirming the compliance of electrical energy with certain standards and regulations. This process may include the following aspects:

1. Quality Standards Certification: Power companies can certify their electrical power to established power quality standards, such as EN 50160 in Europe or IEEE 519 in the United States. This ensures that the energy supplied meets voltage, frequency, harmonics and other requirements.

2. Green Certification: If a company uses renewable energy, it can certify its electricity to environmental sustainability standards, such as certificates of origin (RECs) or guarantees of origin (GOs). These certifications confirm that the energy is produced from clean sources, such as wind or solar power.

3. Certification to Safety Standards: Depending on local legal requirements, electric utilities may be required to certify their systems and processes to safety standards to ensure the protection of workers and the public.

4. Certification by efficiency standards: Certification may also include an assessment of the efficiency of electricity generation and transmission. Companies can seek certification to standards that validate their efforts to reduce waste and improve efficiency.

Electrical energy certification can be important for companies providing energy to consumers or in markets with transparency and high standards. This helps build confidence among consumers, investors and regulators that the energy supplied meets high standards of quality, safety and sustainability.

Producing quality electricity is a complex process that may face various problems and challenges.

Overcoming these challenges and ensuring high power quality requires ongoing monitoring, infrastructure upgrades, development of standards and regulations, and investment in clean and efficient power generation and distribution technologies.

Producing quality electricity may face various challenges, but there are ways and means to overcome them. Here are some of the most common problems and how to solve them:

1. Unsustainable energy sources:

Problem: Wind and solar energy are dependent on weather conditions, which can cause instability in the supply of electricity.

Solution: The use of energy storage systems such as batteries helps smooth out fluctuations in energy production. Diversification of energy sources, including geothermal and hydropower, also reduces dependence on a single source.

2. Harmonics and Waveform Distortion:

Problem: AC loads can create harmonics and distort voltage and current waveforms.

Solution: Installing harmonic filters and regulators, and following standards such as IEEE 519, help manage harmonics and improve power quality.

3. Overvoltage and undervoltage:

Problem: Temporary voltage changes can damage equipment and cause malfunctions.

• Solution: The use of voltage regulation (AVR) systems, voltage regulators and circuit breakers helps control voltage and prevent surges and surges.

4. Distributed Manufacturing:

Problem: The implementation of distributed energy sources can create difficulties in managing energy on the grid.

Solution: Improved network management systems, including digital technologies and smart management systems, help integrate and effectively manage distributed sources.

5. Aging and wear of equipment:

• Problem: Aging and wear and tear of equipment can reduce system performance and reliability.

• Solution: Regular maintenance, upgrades and replacement of obsolete equipment help improve reliability and performance.

6. Lack of infrastructure and investment:

• Problem: Lack of investment in grid infrastructure can impact power reliability and quality.

• Solution: Increased investment in infrastructure and grid upgrades can improve power quality and ensure stability.

7. Effective management and monitoring: The development of power grid monitoring and control systems, including the use of Internet of Things (IoT) technologies and data analytics, allows grid operators to more quickly detect and resolve power quality problems.

Solving power quality problems requires a collaborative effort from utilities, government agencies, engineers, and other stakeholders. It also deals with innovation in technology and infrastructure to improve power generation and distribution.

The leadership of the Republic of Uzbekistan is reviewing its standards in the field of electricity. The standards in force in the country will be gradually revised to harmonize with international standards.

In order to speed up this process, the French company Assystem Engineering and Operation Services SAS was involved in the analysis of the standards. This work is being carried out as part of the implementation of the decree of the President of the country “On the strategy for further development and reform of the electric power industry of the Republic of Uzbekistan.”

To this end, more than 700 standards in the field of high-voltage power lines, substations, relay protection, and electromagnetic compatibility will be considered. Of the total number, 536 standards were recognized as not meeting modern requirements. Currently, the process of replacing them with international standards is underway, carried out by the Uzbek Agency for Technical Regulation. Standards for low-voltage electrical networks, solar and wind power plants will be reviewed and adapted to modern requirements.

Conclusion.

The adoption of these standards will optimize the costs of technical management of the design, construction and operation of energy facilities and will increase the reliability of electrical networks. Therefore, analysis of the quality of the generated power is necessary to ensure the reliability of the electrical system and prevent possible problems associated with poor power quality.

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