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Smart grid power quality problems

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Abstract

The availability of energy in uninterrupted, ideal-friendly conditions is a critical issue with multi-layered dimensions, such as financial, industrial and security for both consumers and manufacturers. This can also depend on the power quality. With the increased renewable energy sources in modern power networks, the bidirectional energy flow, increased nonlinear loads, and power quality problems increased. Power quality problems affect a very large frame that also encompasses everyday life, and is also a complex topic that requires special terminology to accurately identify situations and problems. However, when the correct information is provided, the right solutions can be produced. Therefore, the detection and monitoring of power quality problems is critical for the future development of both today and the power grid.
This article discusses power quality problems in smart grids.

Introduction

Strong power quality in electrical networks; it is necessary to minimize the risks caused by deviations from nominal conditions, as well as affecting the efficiency of industrial activities, the performance of electrical equipment. The development of new technologies is important for energy providers as poor power quality has high financial implications. Since it is not possible to maintain the ideal sinusoidal current and voltage at all nodes of the networks, it is aimed to keep them within the limits set by the standards already established. This article reviews the role of power quality impacts on smart grids.

Reactive power flow and loads and harmonics caused by high power switching circuits causes voltage instability, interference, and wave distortion [1]. Power quality is the ability to provide a continuous and stable power flow with a noiseless sinusoidal waveform, within the voltage and frequency tolerances specified in the standards for electrical networks. Power quality aspects are shown in Figure 1. The evolution of grids into smart grids, with the increase in power electronics interfaces such as renewable energy sources, smart metering technologies, electric vehicles, demand side management, photovoltaic panels, batteries or direct current loads in power systems and this has made networks complex and vulnerable in terms of power quality [2].

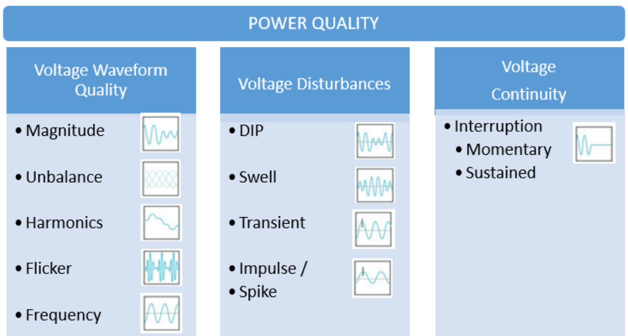

Figure 1. Power quality aspects

Power Quality Disturbances

Power quality problems can cause serious problems in banking, process control, security and monitoring systems, health network, hospitals, public safety, critical industrial processes and basic public services.

Adequate power quality ensures that all equipment connected to the grid network works in harmony. There can be two groups of deterioration in power quality; variations and events. Slow voltage changes, harmonics, vibrations and imbalances according to EN 50160 standard; continuous measurable and assessable changes are defined as variation. Unpredictable situations such as rapid voltage changes, dips, swells and interruptions are considered events. Actual power quality, ie distortion levels, is caused by the interaction between the grid and grid-connected equipment, as shown in Figure 2 [3].

Generating equipment : Although the microgeneration effect is expected to increase continuously in low voltage networks, the emission of low level harmonics can be neglected unless it shifts to the frequency range between 2 – 9 kHz. Also single-phase connection of microgeneration components can increase negative and zero-sequence voltage in low voltage network. This can cause limits on weak distribution networks to be exceeded quickly [3].

Consumer equipment : New and more technology in consumer equipment causes harmonic currents to increase while reducing the fundamental current in the network. It is undesirable for low-order harmonics, especially the fifth harmonic voltage, to rise above their compliance level. Discussions continue in IEC working groups regarding new emissions requirements for new technologies such as new low-voltage lighting technologies, energy-efficient drives, photovoltaics, battery chargers for electric and hybrid cars. However the negative differences caused by new technologies on power quality should not result in unnecessary obstacles, and efforts to increase compatibility levels should be increased [3].

Distribution network : In future grids, it will be possible to self-balance despite its high generation; however, this may cause more variation in short-circuit power compared to today's networks. In this case the approach based on fixed reference impedances will be insufficient. In addition the use of high emission loads may be acceptable in conjunction with certain grid operation or power quality regulators only. Damping stability problems with continuous decrease in resistive loads in low voltage networks, decrease in resonance frequencies due to increase in capacitive loads and EMC filters and appearance of resonance points with lower damping; will appear as problems [3].

Power Quality Components

Deviations from sinusoidal waveforms in current and voltage feeding distribution systems can harm users and cause overall performance degradation of distribution operators. Indicators of poor power quality shown below [4] and in Figure 2.

- Voltage magnitude variations (e.g., short-term spikes or dips, longer term surges,or sags)
- Frequency variations
- Low power factor
- Harmonics
- Interruptions in service.

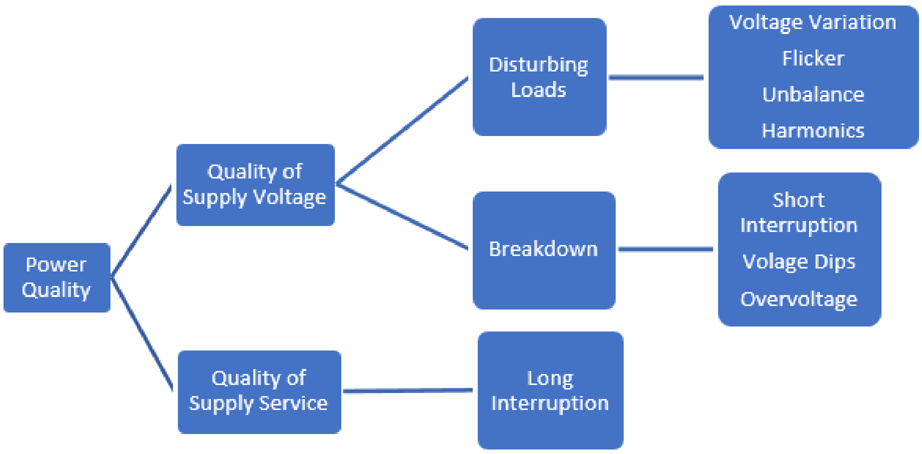

Figure 2. Power quality components

Power Quality Monitoring

Monitoring is necessary to analyze the power quality. There is simple classification approach:

- *Local monitoring* is on a single customer.
- *System monitoring* can determine general behavior and power quality status of wide grid system.

The objectives of the PQ monitoring system are to follow for measures to be taken to ensure network degradation, continuous evaluation of power quality changes, performance of power conditioning equipment, monitoring harmonic interactions between networked devices, and taking precautions for sudden changes.

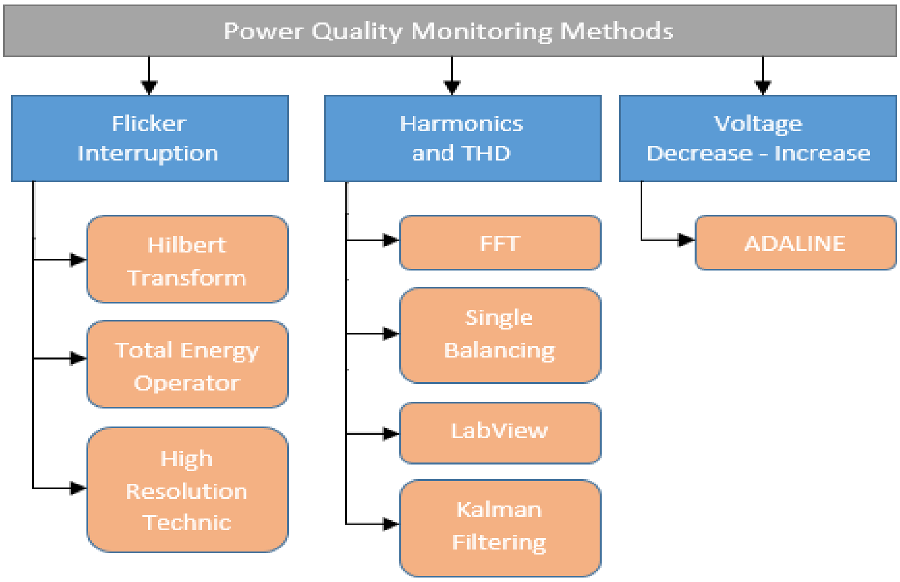

Figure 3. Power quality monitoring technics [5]

Power Quality Measurement

Measurement could be requirement of contractual conditions, corrective maintenances, electrical installations operations optimization, advanced monitoring systems.

- ***Contractual conditions:***

Contract relations can be between electrical transmission, distribution and end user. For each party involved in the contract, the parameters relating to power quality must be clearly set. It should be considered whether these parameters are provided.

- ***Corrective maintenances:***

The deterioration may not be considered or correctly estimated. Installation may have been modified due to new loads or modifications. Actions to get results as soon as possible can cause errors.

- ***Optimization of operations:***

Energy management is required and depends on power quality to increase productivity gains by reducing operating costs.

- ***Monitoring systems:***

Power quality monitoring systems are captured by a significant amount of data, power quality monitoring systems to determine the performance of the Power System and the condition of the equipment. With technology advancements, this data is made available in real time.

Conclusion

It is important to have high power in power systems in developed and developing countries. High power quality will prevent losses from consumers, manufacturers and suppliers, and will provide economic and performance-satisfactory results for all parties involved. It is therefore very important to accurately monitor, measure and analyze power quality. This paper provides a brief assessment of power quality defects, issues and the impact it has on network efficiency and reliability. Power quality compensators based on power electronics converters, emission levels caused by interaction between the mains and the mains, interactions of renewable energy sources with the mains, power quality monitoring and control methods at large distributed power plants, broadband semiconductors, or multi-level modular technology, Active power quality controllers such as solid-state circuit breakers and transformers, MMC-HVDC are priority issues for power quality research on smart networks.

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