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A REVIEW ON PROBLEMS AND SOLUTIONS IN POWER QUALITY

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Abstract— Now-a-days the demand has increased for supply of electrical power. The importance of producing the quality of power has gained the interest in various power utility devices. The power quality survey is the first, and perhaps most important, step in identifying and solving power problems. In other words it is thus designed to locate, identify and eliminate the electrical disturbances which disrupt data collection networks, PLCs, variable speed motor drives; thyristor controlled heating elements and other sensitive electronic equipment. Power quality is the combination of voltage quality and current quality. Voltage quality is concerned with deviations of the actual voltage from the ideal voltage, while current quality is concerned with deviations of the actual current from the ideal current. The main concern of consumers for the usage of electricity is reliability of supply. All electrical power utility devices requires clean and uninterrupted power such as traffic control, processing plants, hospitals (life support, operation theatre, patient database system) and bank security etc. The problems in power quality like voltage sag, swell, flicker, harmonics voltage distortion, etc. In this paper various power quality problems and its solutions are discussed.

Keywords — Power quality, problems, corrective methods.

I. Introduction

Over the decade the importance of power quality has been increased attention all over the world. The problem in power quality gained importance since the late 1980s. The interest in power quality concerned with the utility companies, equipment manufactures and electric power consumers. The main concern of consumers of electricity is reliability of supply i.e. continuity of electric supply. All Electrical power utility devices requires clean and uninterrupted power such as traffic control, processing plants, hospitals (life support, operation theatre , patient database system) and bank security etc. The increase in concern about the quality of electric power is the continuous increase in productivity for all utility manufacturers wants faster, more productive and more efficient machinery. Throughout the world, many governments have revised their laws for regulating electric utilities with the intent of achieving more cost competitive sources of electric energy [9].

Power quality problems such as voltage sag, swell, and flicker and harmonics voltage distortion results in poor power quality that cannot be completely eliminated [6]. The power quality survey is the first, and perhaps most important, step in identifying and solving power problems. In other words it is thus designed to locate, identify and eliminate the electrical disturbances which disrupt data collection networks, PLCs; variable speed motor drives thyristor controlled heating elements and other sensitive electronic equipment [8].

There are two types of power quality surveys: The first type is a preventative survey, uses a number of tests and inspections to locate potential problems before they cause a production outage. The second type is, a troubleshooting survey, it is used to locate and eliminate problems as quickly as possible after a production outage [2].

Power quality is the combination of voltage quality and current quality. Voltage quality is concerned with deviations of the actual voltage from the ideal voltage. The ideal voltage is single frequency sine wave of constant frequency and constant amplitude. Current quality is concerned with deviations of the actual current from the ideal current. The ideal current is also of constant amplitude and frequency, but additionally the current frequency and phase are the same as the frequency and phase of the voltage. Any deviation of voltage and current from the ideal waveform/value is a power quality disturbance. A disturbance can be a voltage disturbance or a current disturbance. Voltage disturbances originate in the power system network and potentially affect the customers, whereas current disturbances originate with a customer and potentially affect the network [5].

II. Types Of Power Quality Issues

A. Voltage Sag

Voltage sag is defined as a decrease in voltage magnitude below 90% of nominal, but not a complete interruption. The typical duration is from 3- 10 cycles, 50 to 167 milliseconds. Devices mostly affected are: Computers, programmable logic controllers, controller power supplies and motor starter contractor etc [7].

B. Voltage Swells

A swell is a short duration increase in rms line voltage valid of 110 to 180 percent of the nominal line voltage for duration of 0.5 cycles to 1 minute. Voltage swells lasting longer than two minutes are classified as over voltages.

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Voltage swells and over voltages are commonly caused by large load changes and power line switching.

C. Interruption

Interruption occurs when voltage levels drop to zero. Interruptions are classified as momentary, temporary or long-term. Momentary interruptions occur when service is interrupted, but is automatically restored in less than two seconds. Temporary interruptions occur when service is interrupted for more than two seconds, but is automatically restored in less than 2 minutes. Long-term interruptions last longer than two minutes and many require field work to restore service [11].

D. Distortions

Distortions occurs when harmonic frequencies are added to the 60 hertz voltage or current wave form, making the usually smooth wave appear jagged or distorted distortion can be caused by solid state devices such as rectifiers, adjustable speed controls, fluorescent lights and even computers[17].

E. Transients

Transients are sudden but significant deviations from normal voltage or current levels. Transients typically last from 200 million that of a second to half a second. Transients are typically caused by lighting, electro static discharges and load switching [3].

F. Oscillatory And Impulsive Transient

Oscillatory transients are sudden, non-power frequency change in the steady state condition of voltage, current or both, that includes both positive and negative polarity values [10].

G. Flicker

Flicker can be defined as small amplitude changes in voltage levels occurring at frequencies less than 25 Hertz (25Hz) flicker is caused by large rapidly fluctuating loads such as arc furnaces and electric welders [12].

H. Noise

Electrical noise is a rapid succession of transients tracking up and down along the voltage wave form. The magnitude of these rapid transients is usually much less than that of an isolated transient.

III. Solutions to PQ Problems

The mitigation of PQ problems may take place at different levels: transmission, distribution and the end-use equipment. As seen in Fig. 1, several measures can be taken at each different level [1].

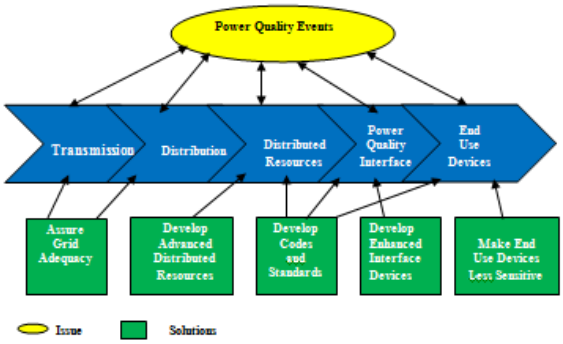

Fig 1. Power quality problems measure

A. Grid Adequacy

Many PQ problems have origin in the transmission or distribution grid. Hence, a proper transmission and distribution grid with adequate planning and maintenance is essential to minimize the occurrence of PQ problems [14].

B. Distributed Resources Energy Storage Systems

Interest in the use of distributed energy resources (DER) has increased substantially over the last few years because of their potential to provide increased reliability. These resources include distributed generation and energy storage systems [18]. Energy storage systems, also known as restoring technologies are used to provide the electric loads with ride through capability in poor PQ environment. Recent technological advances in power electronics and storage technologies are turning the restoring technologies one of the premium solutions to mitigate PQ problems [12].

The first energy storage technology used in the field of PQ yet the most used today is electrochemical battery. Although new technologies, such as flywheels, super-capacitors and superconducting Magnetic Energy Storage (SMES) present many advantages, electrochemical batteries still rule due to their low price and mature technology [13]. Fig. 2 explains the restoring technology principle.

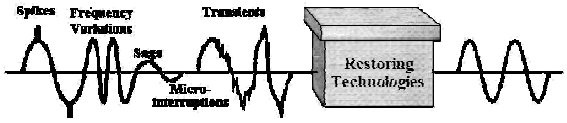

Fig 2. Restoring technology principle

C. Flywheels

A flywheel is an electromechanical device that couples a rotating electric machine (motor/generator) with a rotating mass to store energy for short durations. The motor/generator draws power provided by the grid to keep the rotor of the flywheel spinning. During a power disturbance, the kinetic energy stored in the rotor is

transformed to DC electric energy by the generator, and the energy is delivered at a constant frequency and voltage through an inverter and a control system [20]. Traditional flywheel rotors are usually constructed of steel and are limited to a spin rate of a few thousand revolutions per minute. Advanced flywheels constructed from carbon fibre materials and magnetic bearings can spin in vacuum at speeds up to 40,000 to 60,000 RPM. The stored energy is proportional to the moment of inertia and to the square of the rotational speed. High speed flywheels can store much more energy than the conventional flywheels. The flywheel provides power during a period between the loss of utility supplied power and either the return of utility power or the start of a back-up power system (i.e., diesel generator). Flywheels typically provide 1100 seconds of ride-through time, and back-up generators are able to get online within 5 to 20 seconds [4].

D. Super-capacitors

Super-capacitors (also known as ultra-capacitors) are dc energy sources and must be interfaced to the electric grid with a static power conditioner, providing energy output at the grid frequency. A super-capacitor provides power during short duration interruptions or voltage sags. Medium size super-capacitors are commercially available to implement ride through capability in small electronic equipment, but large super-capacitors are still in development, but may soon become a viable component of the energy storage field. Capacitance is very large because the distance between the plates is very small (several angstroms), and because the area of conductor surface (for instance of the activated carbon) reaches 1500- 2000 m^2/g (16000 21500 ft^2/g). Thus, the energy stored by such capacitors may reach 50-60 J/g [16].

E. Superconducting Magnetic Energy Storage (SMES)

A magnetic field is created by circulating a DC current in a closed coil of superconducting wire. The path of the coil circulating current can be opened with a solid-state switch, which is modulated on and off [19]. Due to the high inductance of the coil, when the switch is off (open), the magnetic coil behaves as a current source and will force current into the power converter which will charge to some voltage level. Proper modulation of the solid-state switch can hold the voltage within the proper operating range of the inverter, which converts the DC voltage into AC power. Low temperature SMES cooled by liquid helium is commercially available. High temperature SMES cooled by liquid nitrogen is still in the development stage and may become a viable commercial energy storage source in the future due to its potentially lower costs. SMES systems are large and generally used for short durations [15].

IV. Conclusion

This paper presents a review on power quality terms, problems and their corrective methods. Poor power quality can create many serious effects on power system like overheating in system equipment, over loading, harmonics generations and waveform distortion etc. which can be mitigated through various techniques through filters FACTS devices and power factor correction circuits etc. This paper will be helpful for researchers, users and suppliers of electrical power to get a guideline about the power quality. Many power quality problems are easily identified once, a good description of the problems is obtained. Unfortunately, the tension caused by power problems often result in vague or overly descriptions of the problem.

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