ENHANCING POWER QUALITY FOR A RELIABLE GRID

With the growth of semiconductor-based technology and an ever-growing number of sensitive consumer electronics being connected to the network, poor power quality has become more visible, says Mauro Damonte, Hub Business Unit Manager, Middle East and Africa for High Voltage Products, ABB.

Most of us have experienced a washing machine or dishwasher malfunction, or flicker on your computer screen in the office, or equipment breakdown at an industrial plant. Power interruptions are often considered as consequences of random events in the network or inherent faults in the equipment, but they may actually be a result of poor power quality.

World over billions of dollars are lost annually in revenue because of poor power quality. Hours of downtime and voltage disturbances lead to productivity loss, equipment malfunction, recurrent repairs and even premature replacement of critical and expensive machines. Power quality issues can lead to higher energy bills, and most utilities also impose penalties for non-compliance to grid regulations. For the environment, this can mean higher carbon emissions and energy inefficiency.

But this is not a new problem. Momentary outages have occurred for years. They were not so easily perceived, since electrical equipment—usually based on electro-mechanical technology—are less sensitive to disturbances in the power system. However, with the growth of semiconductor-based technology and an ever-growing number of sensitive consumer electronics being connected to the network, poor power quality has become more visible. In addition, the increased integration of renewables into the grid poses new challenges in voltage stability.

Today with utilities and industries demanding greater energy efficiency, reduced operating costs and higher productivity, reliable power supply has become a must for all.

To understand power quality, causes of disturbance in its supply and possible solutions, we spoke to Mauro Damonte, Hub Business Line Manager, Middle East Africa for High Voltage Products at ABB.

HOW IS POWER QUALITY DEFINED?

Power quality is the ability of the electrical grid to supply clean and stable power.

The utilities need to provide to consumers a waveform which is perfectly sinusoidal with an established rated value (Voltage), frequency of exactly 50 or 60 Hz (depending on the country) and with an availability close to 100%, without drops, sag, variation for even very short time (few ms). Good power quality means a steady supply of voltage that stays within the prescribed range. In other words, power quality is the electrical grid’s ability to supply clean and stable power.

WHAT ARE THE COMMON MYTHS

RELATED TO POWER QUALITY?

There are several misconceptions about poor power quality. The biggest one being that poor power quality cannot be mitigated. But it is equally true that many customers do not recognize events as a consequence of poor power quality. They are not aware that a power quality problem exists. Some of the other statements that I have heard from customers are:

• Power quality is something I have no control over (I take what the facility/utility gives me, and I have to tolerate it). It’s out of my control!
• I don’t have the time, money or resources to worry about power quality.
• Power quality doesn’t matter; anyhow there

are no regulations around this.

- Power quality cannot be controlled and corrected.

**WHAT ARE THE CUSTOMER NEEDS WHEN IT COMES TO POWER QUALITY?**

Customer needs are diverse. They depend on the industry, application, as well as the location of the application on the grid. An emerging trend which also defines the customer’s needs is their relationship with the utility - is the customer only a consumer or also a producer of electricity (prosumer)? The primary need of the customer is to reduce direct and indirect costs by improving power quality and energy efficiency and avoiding penalties for non-compliance to grid codes. Increased legislation and sanctions are likely to continue and drive an ongoing need for products and solutions that address poor power quality and energy inefficiency.

**WHAT ARE THE MAIN CAUSES OF POOR POWER QUALITY AND WHAT KIND OF SOLUTIONS ARE AVAILABLE TO ADDRESS THESE PROBLEMS?**

Some important causes of poor power quality are non-linear loads, intermittent generation, power electronics devices.

Main “symptoms” of poor power quality are low power factor, harmonics, and load or voltage imbalance. Let’s analyse each of them and arrive at some solutions:

**REACTIVE POWER**

Reactive power, measured in “kVAR”, is the vectorial difference between the total power consumed (apparent power measured in “kVA”) and the working power (active power measured in “kW”). Some electrical equipment used in industrial and commercial buildings require an amount of reactive power in addition to active power to work effectively. For example, the reactive power is responsible of the generation of the magnetic fields that are essential for inductive electrical equipment to operate, such as transformers, electric motors, electric generators.

Since the circulation of the reactive power in the network is increasing the network losses, we need to generate the needed of reactive power as close as possible to the device that absorbs it, in order to reduce the network losses.

In conventional power factor correction equipment, control is provided by the power factor (PF) controller that monitors the actual power factor and orders the connection and disconnection of capacitors to maintain a targeted PF.

However, today’s operators are experiencing sudden and drastic changes of PF in their networks. As a result, they integrate the latest solutions such as ABB’s modular reactive power compensators PQflexC and PQdyncE into their panels.

These solutions can react to the changing PF, providing stepless and variable reactive power compensation. Solutions like PQflexC can also be installed alongside or in combination with conventional fixed or switched capacitor banks for stepless reactive power compensation on a large scale. For a switched capacitor bank, PQflexC can play the role of controller for optimum system performance.

**HARMONICS**

Harmonic distortion is a form of network pollution. It can cause problems if the total content of harmonic currents and/or voltages increase above a certain limit. Such harmonic currents and voltages are usually generated by specific types of non-linear loads, such as variable speed drives, LED lighting, computers and uninterrupted power supply equipment.

Power quality equipments, like ABB’s active filter PQflex or the latest modular harmonics filtering solution PQactIF, are installed in parallel to such loads that pollute the network with harmonics. The active filter monitors line currents and generates a compensation current in perfect phase opposition for each harmonic frequency, creating a clean network. PQactIF can filter out up to 25 harmonics simultaneously.

**UNBALANCED LOADS**

ABB’s PQactIF, as an example, can balance three-phase load currents and eliminate the negative impact of voltage imbalance. This improves voltage stability on the phases, thereby improving the safety of the installation and the operation of sensitive loads.

**THE GROWING ROLE OF BATTERY ENERGY STORAGE IN POWER QUALITY**

Many grid operators and commercial customers are adopting battery energy storage to integrate renewable energy to provide peak shaving services, backup power, load levelling or frequency response or both.

But ABB’s battery energy storage solutions can do much more. The compact energy storage inverter PQstore can also help operators overcome power factor issues, filter out harmful harmonics and correct load imbalances. The key to achieving this is to adopt a battery energy storage inverter that has in-built control, monitoring and response capabilities to address power quality issues.

**CAN YOU SHARE AN EXAMPLE OF A POWER QUALITY ISSUE RESOLVED SUCCESSFULLY?**

Many customers who faced productivity issues and high operating costs due to power quality issues are now able to enjoy the benefits of good power quality because of right analysis and solutions.

A case in point is Oman’s Sohar Aluminium company. They are one of the world’s largest aluminium smelter facilities and produce more than 360,000 tons of the commodity annually. They are also one of the biggest power consumers in Oman.

The smelting process at the facility was creating high levels of harmonics and it was imperative to keep them under control to adhere to the grid codes and be connected to the Oman power grid without any compliance issues. ABB delivered a turnkey solution, including a study of the harmonics in the plant as well as the design, supply, installation, testing and commissioning of a harmonic filter system. The power quality solution comprised of four harmonic filter banks, rated 55 MVAR (Mega volt ampere reactive), and high-voltage switchgear.

The filter system minimizes harmonics and reactive power allowing Sohar Aluminium to connect to the Oman grid without any compliance issues. The system also improves power quality in the smelter facility and reduces electrical losses.

Power quality is key to improving grid availability and reliability. It enables the optimization of operating costs and secures grid code compliance. It also supports the integration of renewables into the grid and enhances energy efficiency.

ABB is a technology leader with a wide range of products and services that improve power quality, including capacitors and filters, power electronics-based compensators and software solutions across the power value chain in low, medium and high-voltage applications, helping shape a stronger, smarter and greener grid.