Ensuring Utility Power Quality

The importance of power quality to utilities cannot be overstated. Hawaiian Electric asserts, “Power Quality is a set of metrics used to benchmark the quality of the electric service provided to customers. The American National Standards Institute (ANSI) and the Electric Power Research Institute (EPRI) have developed power quality metrics that most electric utilities in the United States use to measure the quality of electricity being delivered.”[i] EPRI published an update recently on their Power Quality research program. In the program description they state, “Power Quality has evolved to become a critical enabler of operation and economic excellence for modern electric utilities. Electric utilities worldwide consistently report that power quality (PQ) is a fundamental component of three key utility business performance metrics: grid system performance, utility economic performance, and customer satisfaction. A resurgence of interest in electric power quality performance is being driven by the need to significantly improve the economic performance of existing infrastructure, reduce the cost of grid operations and repairs, manage and respond to increasing grid complexity...”[ii]

Ensuring the reliability of electrical power has always been a concern for utilities, but as mentioned in the EPRI article, both the necessity of remaining economically viable and responding to challenges arising from integration of renewable energy sources has raised the importance of reliable and high quality power. Consumers today rely on their utility to provide the energy they need to power their technology, both at home and at work. Even short periods of power outage have a more significant detrimental effect than they did twenty or more years ago. Modern manufacturing plants and data centers are specific industries that suffer greatly if power is interrupted.

Let’s look at the three utility performance metrics mentioned in the EPRI article, for which PQ is very important – grid system performance, utility economic performance, and customer satisfaction.[iii]

Grid System Performance

Grid system performance centers on the ability of the utility to provide reliable power consistently to their customers. Power reliability is centered on high power quality. When power quality is low, flickering lights, lower than needed voltage, and brownouts can be experienced by customers. Voltage variability can also cause voltage surges that can damage sensitive customer equipment. Maintaining high power quality is dependent on measuring PQ indices, such as power factor, harmonics, and voltage unbalance, and being able to respond to these PQ issues when they arise. Utilities rely on software and hardware to perform these tasks. We’ll talk more about that later.

Utility Economic Performance

Utility economic performance is dependent on utilities being able to make a profit. PQ affects not only grid performance, but it impacts utilities’ bottom lines. As mentioned in the EPRI article, improving power quality reduces a utility’s maintenance and equipment replacement costs. This is because recurrent power quality events can stress and even damage the utility’s equipment, necessitating expensive repairs or replacement. Power outages due to low power quality also reduce a utility’s revenue stream. And in areas where there is a choice of provider, poor power quality can lead to a loss of customers. Improving power quality will improve the utility’s economic performance.

Customer Satisfaction

Utility customers are satisfied when they experience reliable power at a fair rate. Frequent outages, brownouts, voltage and current surges and sags, all greatly reduce customer satisfaction. By improving PQ, utilities can gain customer support and goodwill. They can also retain customers that might be tempted away by alternative suppliers. And because of savings on maintenance and equipment, utilities are able to charge their customers a rate that both customer and utility owners can be happy with.

How to Ensure Utilities' High Power Quality

As mentioned earlier, utilities rely on hardware and software to improve and maintain high PQ. By using advanced meters to monitor key PQ indices, such as power factor, harmonics and interharmonics, transients, voltage stability, etc., utility operators can see real time grid conditions. By setting alarms on specific limits, e.g., voltage levels or harmonics, utility personnel can be notified as soon as there is a problem in the system. Phasor measurement units (PMUs) can monitor and report back on specific measurements, such as frequency and rate of change of frequency, to give utility operators wide area awareness of grid conditions. This is very important as many large utilities cover a large geographical area. For all these applications, a high accuracy power quality monitor that can also function as a PMU is needed.

The role that energy management software plays for the utility is to take the metering data and make it accessible to the utility operator. Software that provides real time dashboards of energy values and the ability to respond to changing grid conditions helps utilities respond to PQ problems before they escalate and affect the customer. SCADA systems and newer synchrophasor systems can be combined with control applications and equipment so that situational awareness is supported by remedial actions, to prevent PQ events from becoming critical and leading to power outages.

Additionally, as renewable energy sources, such as solar and wind, are being integrated into the grid, the specific PQ challenges they introduce must be addressed. Equipment such as line regulators, digital capacitor banks, and automated protection and control systems, in addition to standard PQ monitoring, can dynamically respond to voltage unbalance, power factor changes, and other issues, to maintain high PQ while addressing environmental concerns and legislation.

Conclusion

Hawaiian Electric concludes their statement on PQ with "Power quality means a voltage and frequency compatible with operation of our customers' end-use equipment. In many respects, power quality is as important as reliability."[iv] As we have seen, high power quality forms the basis for a utility's reliability, and is central to grid performance, economic viability, and customer satisfaction. By utilizing advanced PQ monitoring, energy management software systems, and modern control applications, utilities can be aware of PQ issues and respond in a timely manner to ensure the highest quality power for their customers.

NOTES

[i] "Power Quality," accessed from https://www.hawaiianelectric.com/electrical-services/power-quality#:~:text=Power%20Quality%20is%20a%20set,and%20costly%20repairs%20or%20replacement on 10/15/2024.
[ii] "Power Quality," accessed from https://www.epri.com/portfolio/programs/053119 on 10/7/2024.
[iii] *ibid.*
[iv] "Power Quality," accessed from https://www.hawaiianelectric.com/electrical-services/power-quality#:~:text=Power%20Quality%20is%20a%20set,and%20costly%20repairs%20or%20replacement on 10/15/2024.