Power Quality and Microgrids

Mitigating Utility Supply Issues with On-Site Generation

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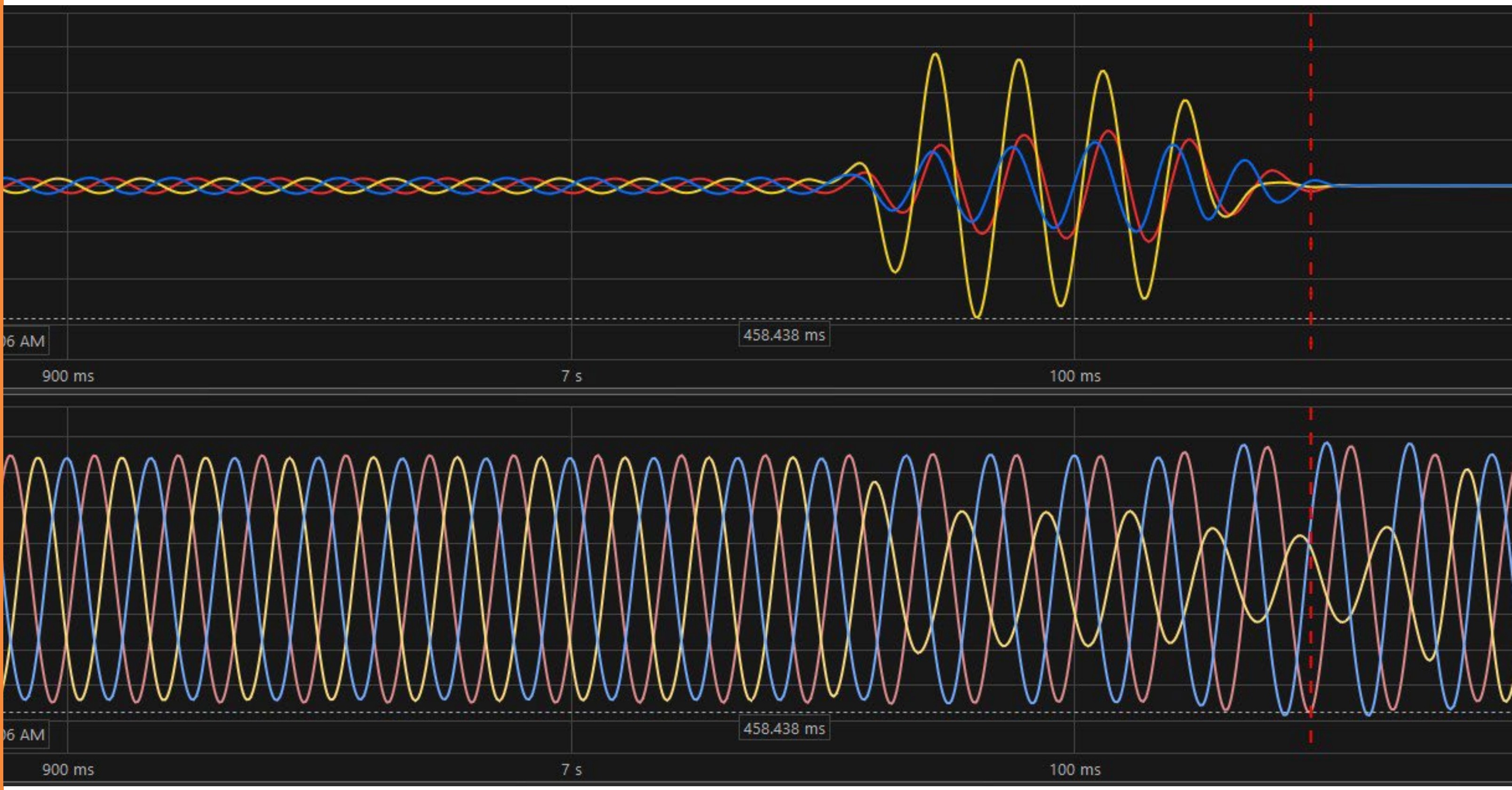


Facilities experiencing power quality issues from the utility grid can often improve voltage regulation, grid stiffness, and harmonics by deploying microgrids that include synchronous generation using reciprocating engines or gas turbines.

It is not uncommon for facilities to experience power quality issues that cause nuisance downtime, financial impacts, and even equipment failures. The right microgrid can offer facilities a more reliable power supply to mitigate these types of disruptions.

Different generation types will affect power quality in their own ways, but microgrids that include synchronous generation driven by reciprocating engines or gas turbines offer inertia due to spinning mass, which means they are able to offer more power quality support and robustness than renewable-only microgrids that rely on inverter-based generation alone. Although renewable technologies have their place and their own unique benefits, including synchronous generation in the form of a cogeneration system adds important resiliency to any microgrid and improves its ability to operate independent of the grid.

Common Utility Power Quality Issues

Utility power quality issues may be limited to flickering lights or unnoticeable changes in voltage and current waveforms. However, they can also lead to nuisance trips of equipment, increased susceptibility to grid disturbances, and even the premature failure of electrical equipment such as

motors and compressors. Given the importance of the equipment in your facility, it is clear that power quality cannot be taken for granted.

Unlike occasional grid disturbances that can be linked to a storm or traffic accidents, more frequent grid-related power quality issues are caused by utility equipment like tap changers, capacitor banks, dirty upstream loads, and the distance to the closest utility substation. For example, a longer distance means higher impedance in the utility's distribution feeder, which may cause a site at the end of the line to experience a wider range of power quality issues.

Whether grid-connected or in island mode, the right microgrid design can help a facility address the following components of power quality:

Voltage regulation: Voltage regulation means a system can provide near-constant voltage regardless of load conditions, which is important for supporting a facility's energy needs. Regulating voltage is the responsibility of the utility grid when available but is difficult across an entire distribution circuit. Conversely, voltage regulation in island mode can be a harder task without the support of the utility grid and its electrical inertia via thousands of amps of capacity. Including synchronous generation as on-site microgrid generation can support voltage and improve regulation.

Harmonics: Harmonic frequencies are a type of waveform distortion caused by non-linear loads. They degrade power quality, potentially leading to equipment failures. Harmonics issues need to be understood when designing a microgrid, but can usually be accommodated. Inverters (which produce power using high-speed IGBT-based switching components) introduce harmonics by nature and can compound other harmonics caused by motors and variable frequency drives, so care must be taken in the design to handle these non-fundamental currents. If necessary, harmonic filters can be added to a design.

Grid stiffness: A stiff grid is one where the voltage at the facility connection is not particularly affected by load transients. Transients caused by changes in facility load, changes in intermittent generation, and even changes in unknown upstream loads may affect the voltage. Even moderate "end-of-line" conditions will reduce power quality and cause the site to see more transients. Power quality problems will often be lurking in the background until a disturbance or transient occurs. When considering a microgrid, the overall performance of the system will be improved by the addition of synchronous generation that offers an on-site boost to grid stiffness. This benefit will be evident when grid-connected, when isolated, and especially during the transition into microgrid mode when success is most vital.

Inverter-based generation

- Solar or battery storage
- DC power converted to AC power
- Low inertia due to lack of moving parts
- Low surge capacity
- Produce harmonics
- Low fault current

Synchronous generation

- Gas turbines or reciprocating engines
- A type of rotating/anchor generation that produces AC power
- Inertia offered by moving parts; inertia offers higher surge capacity
- Offers greater fault current

Inverter-Based Generation vs. Synchronous Generation

A microgrid can help solve utility power problems — but not all microgrids are created equal. Microgids are more robust when they include what is known as synchronous generation. While a robust microgrid can include inverter-based generation, that should not be the sole form of generation if the facility has experienced power quality problems. Only synchronous generation offers sufficient electrical inertia, surge capacity, and fault current to support voltage regulation, grid stiffness, and mitigate harmonics.

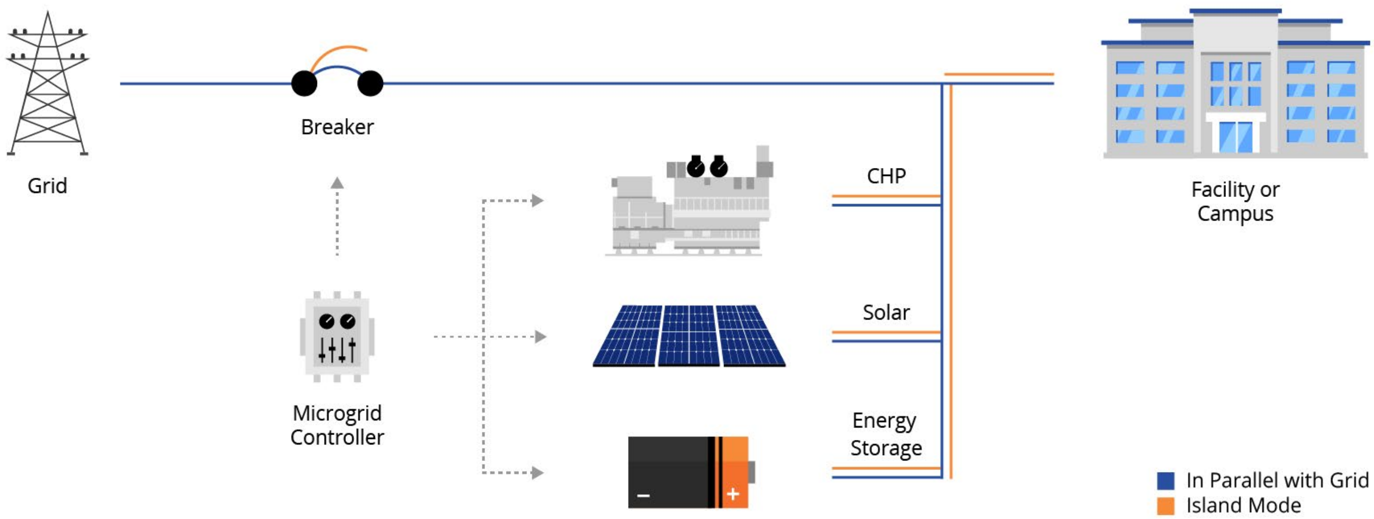
Inverter-based generation, typically in the form of photovoltaic (PV) generation or batteries, produces DC power that must be converted using an inverter to usable AC power. On their own, inverters do not typically offer inertia or surge capacity — lacking moving parts, they generate power with high-speed switching components that can only generate small amounts of surge power above their continuous rating. Inverters also tend to produce harmonics.

It's true that recent improvements in grid support by UL-1741SA have helped inverters ride through grid disturbances on their own. However, the sudden export of reactive power or a momentary cessation of the inverter doesn't improve power quality issues. An inverter-only microgrid would need to be sufficiently oversized for the application, which is rarely efficient.

In addition, inverters offer low fault current. This is typically not a concern until they are faced with a current spike in island mode, and the result is often an instantaneous trip without proper downstream breaker operation. Utilities consider it a problem when faults cannot be properly cleared or located and may not allow the facility to restart power in this case.

Synchronous generation, supplied by gas turbines or reciprocating engines, offers rotating or anchor generation. It is created by the spinning motion of heavy iron in magnetic fields to produce electrical AC current directly. Due to its rotating mass and kinetic energy, synchronous generation offers electrical inertia, and as a result has a higher surge capacity and can deliver several times its rated output for short periods when needed. Put simply, this stiff generation helps everything else: it will support voltage better per usable capacity and will provide the grid stiffness necessary to realize more robust operation in both grid-connected and island mode.

How Microgrids Provide High Quality, Low Carbon, Resilient Power



Compared with inverter-based generation, synchronous generation ensures more fault current, which means more reliable operation when in island mode. A robust system will have enough available fault current to clear a minor fault within the microgrid without tripping the generation offline. The inclusion of synchronous generation can be vital to avoiding this type of trip in the first place or at least enabling safe recovery or black start without delay from the utility.

Solving Utility Power Quality Problems with the Right Microgrid

A facility with poor power quality will see immediate benefits from the addition of a well-designed on-site generation system. Unison Energy designs, installs, owns, and operates microgrids centered around combined heat and power (CHP) systems and can incorporate renewables (like solar and storage) when beneficial for the facility. A properly sized CHP system offers the synchronous generation needed to mitigate pre-existing power quality issues and ensure a high level of performance. Additionally, a microgrid that combines synchronous generation with inverter-based renewable resources can address power quality issues while also achieving other sustainability and financial savings goals.

It is not uncommon to hear of customers who had frequent equipment failures prior to installing a Unison Energy cogeneration system, but experienced none afterwards. One grocery store client was experiencing brownouts and two or three compressor failures each year — but with a Unison Energy microgrid, the brownouts ended and the refrigeration equipment required less maintenance and to date, no equipment replacements. Another client, a Maryland hospital, was experiencing momentary voltage sags and flickering lights, with the emergency generators turning on for a few minutes (a nuisance to the client) — our microgrid solved this issue as well.

Beyond careful design and engineering, Unison Energy also provides expert supervision, with on-site technicians as well as 24/7 live monitoring through several hundred data acquisition parameters for each site. With real-time professional supervision of the power being delivered, Unison has achieved a high level of fleet performance metrics: an industry-leading level of uptime at 97+% for our customers. Our microgrids provide not just improved power quality, but also a high level of resiliency for customers who rely on our systems.

Learn more about how a Unison Energy microgrid can improve your power quality. Contact a representative at sales@unisonenergy.com or visit www.unisonenergy.com.