CASE STUDY

Supraharmonic Measurements in Distributed Energy Resources

Power Quality Observations in a Microgrid

Problem:
A regional power utility in North America needed clear visibility of how a DER impacts voltage and frequency stability in a medium voltage microgrid.

Solution:
The utility used Powerside's PQube® 3 power quality analyzer and G&W Accusense® capacitive voltage divider (CVD) sensors to monitor and measure supraharmonics coming from renewable energy sources.

Results:
The measurements confirm that DERs do have an impact on grid power quality — generating supraharmonic frequencies beyond what traditional technologies can measure at the medium voltage level.

Power utilities now have a way to **see and measure quality issues on medium voltage lines** that were undetectable with previous monitoring methods.

Real-world microgrid simulation

Background:
Renewable energy initiatives are gaining traction to produce more efficient, environmentally sustainable energy. It's the right thing to do — but the new technologies being implemented create some challenges for power utilities.

For context, distributed energy resource (DER)-based microgrids contribute to renewable power generation. DERs may include a mix of solar panels, wind turbines, and battery storage.

Problem:
This diverse infrastructure creates conditions that can impact power quality and the grid. For example:

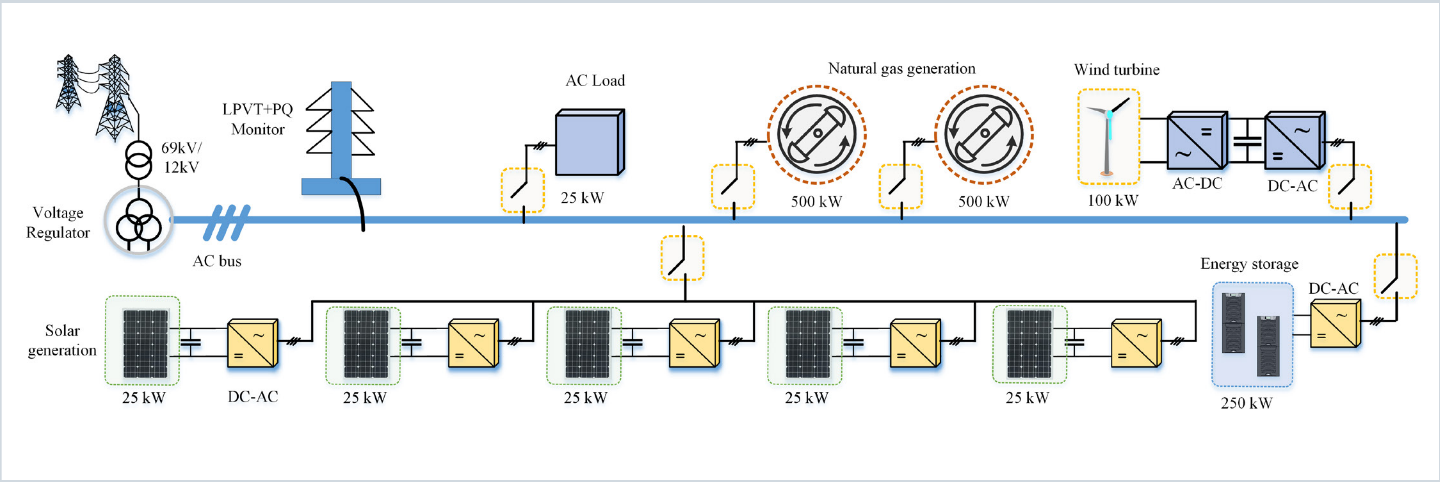
- Accelerate degradation and failure of underground cables/terminations
- Overheating and failure of potential transformers and motors
- Mis-operation of protection relays and meters
- Nuisance issues: light flicker, GFCIs tripping, malfunctioning home appliances

To help a utility better understand the susceptibility of power quality issues in a microgrid, a series of seven tests were performed to intentionally introduce disturbances and measure the resulting impact.

Solutions used

The ability to optimize energy efficiency and resiliency requires the use of high-precision sensing technologies such as instrument transformers that enable applications for metering, protection and control of modern power grids. However, traditional instrument transformer technologies typically have frequency cut-off measurement limitations (at 3 kHz) that inhibit their ability to measure supraharmonics.

Our testing process relied on a set of G&W Accusense® capacitive voltage divider sensors and a **Powerside PQube® 3 power quality analyzer.** The PQube® 3 offers the rare ability to continuously measure and record all conducted emissions across the 2 kHz-150 kHz supraharmonic range on medium voltage lines.

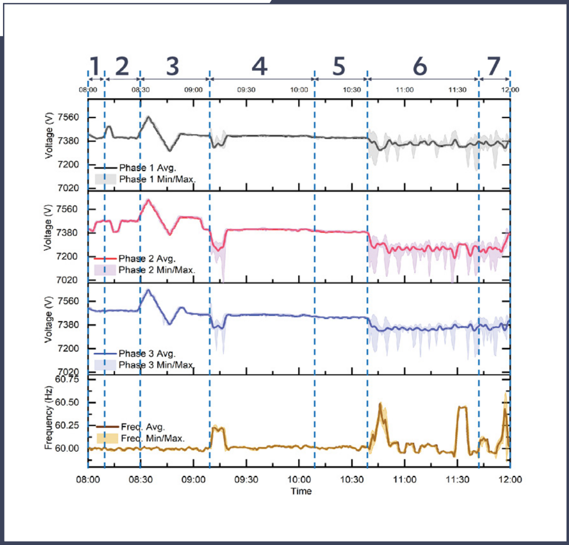


Simplified scheme of the microgrid test bed network and location of measuring devices

In this study, we measured conducted emissions in 2 kHz segments with minimum, average and maximum magnitudes of the rms voltage in each segment.

The seven test scenarios examined a variety of DER sources:

1. Grid tied generator
2. Grid tied battery
3. Voltage regulator
4. Islanding all DERs
5. Solar inverters: grid-tied & isolated
6. Solar inverters: islanded & isolated
7. Wind turbine: islanded & isolated



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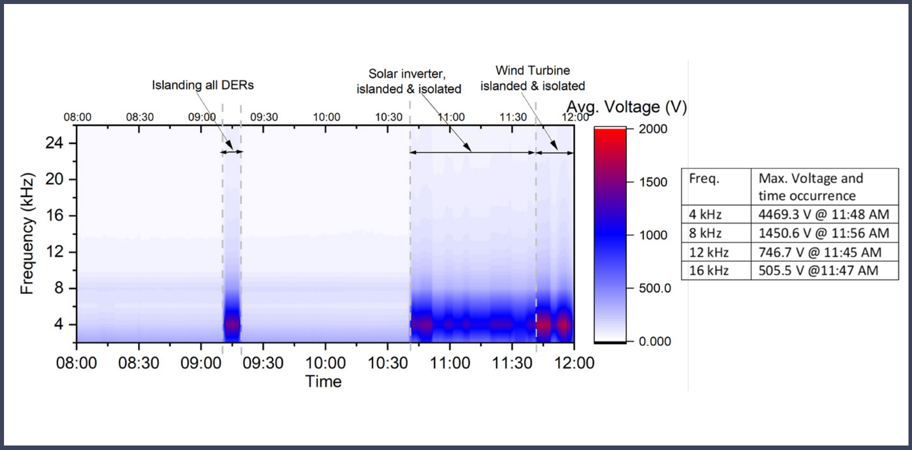
Results

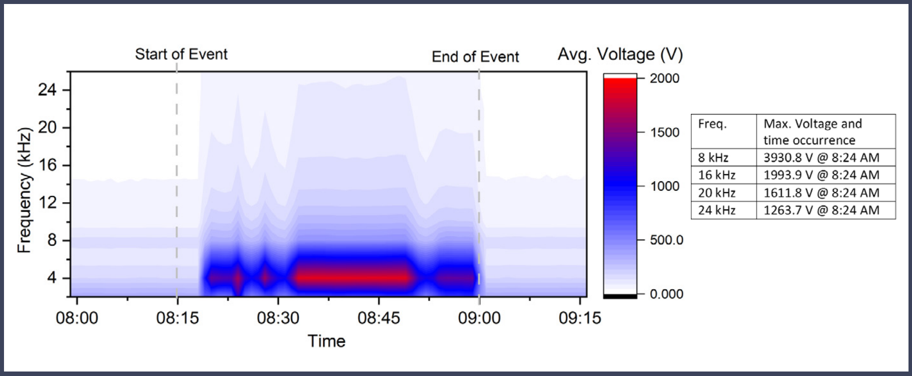
The measurement observations demonstrate that DERs do have an impact on grid power quality. The PQube® 3 power quality analyzer paired with Accusense CVD sensors proved that DERs are susceptible to generating power quality phenomena such as supraharmonics, voltage instability, total harmonic distortion and flicker.

Key highlights:



Supraharmonics observed during the testing scenarios

Supraharmonic measurements were **observed throughout the islanding transition and islanded/isolated solar and wind experiments.** The maximum values were observed when the **solar inverters and wind turbines were islanded,** suggesting they are the **main sources of medium voltage supraharmonic distortion.** In addition to results from these planned operational experiments, the **graph below goes on to evidence supraharmonics** produced by events ocurring during the test period.



Supraharmonics observed during island event

The graph on the left represents the **average conducted emissions voltage measurements observed** and **the table represents the maximum voltages observed at four frequencies in the supraharmonic range**, from 8kHz to 24kHz. These observations show that **the emission behavior during the event reached maximum values that are approximately 3 to 4 times higher** than what was observed in the test scenarios during islanding.

Note: **Download our white paper for a full report of the seven tests conducted, with results.**

The Powerside PQube® 3 power quality analyzer and G&W Accusense CVD system used in this microgrid test bed demonstrated supraharmonic frequency measurements of 4 kHz-24 kHz that otherwise **may be limited or undetectable with traditional measurement systems.**

This unprecedented visibility enables power utilities to precisely identify the root cause(s) of quality issues and effectively rectify them.

Benefits of the PQube® 3 power quality analyzer

- Continuously measures and records all conducted emissions **across the 2 kHz–150 kHz range on medium voltage lines**
- Enables **multiload analysis** including AC and DC
- Offers **outstanding secure direct communications** via SCADA or Powerside's free QubeScan cloud platform
- Automatically **emails data and graphs directly to your inbox** without the need for special software
- **Fully Class A compliant** with the new **Edition 3 of IEC 61000-4-30** (Power Quality Measurement Methods)

Stay ahead of emerging technologies. Ensure power reliability. Proactively address issues.

Bring grid monitoring and quality analysis to a higher level — literally — with our PQube® 3. Learn more:

Supraharmonics Page

Download the Supraharmonics eBook

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