# Supraharmonics:
An emerging threat to grid resiliency

Local power distribution networks see an increase in conducted emissions that can compromise our power supply system. Bring visibility and control to the problem.

# Progressive thinking brought smarter energy. Intelligent monitoring keeps it going.

As the world continues to embrace energy efficiency and renewables, a dark side has emerged: These newer, greener technologies often produce a phenomena called supraharmonics. And it can wreak havoc on power quality.

**Supraharmonics** — current and voltage waveform distortions in the 2 kHz-150 kHz frequency range cause problems on two fronts. Not only do they heat up and damage circuits, burn capacitors, knock out communications and even foul up revenue meters — they're also **virtually invisible to grid operators without proactive monitoring in place.**

## Why is this an issue now?

Traditional fossil fuel-based power sources supply power at a constant stable frequency. They were also designed to filter out harmonics. Switching and power electronics had limited presence on the system.

But technology has advanced, and the grid is evolving to meet the demands of a new day.

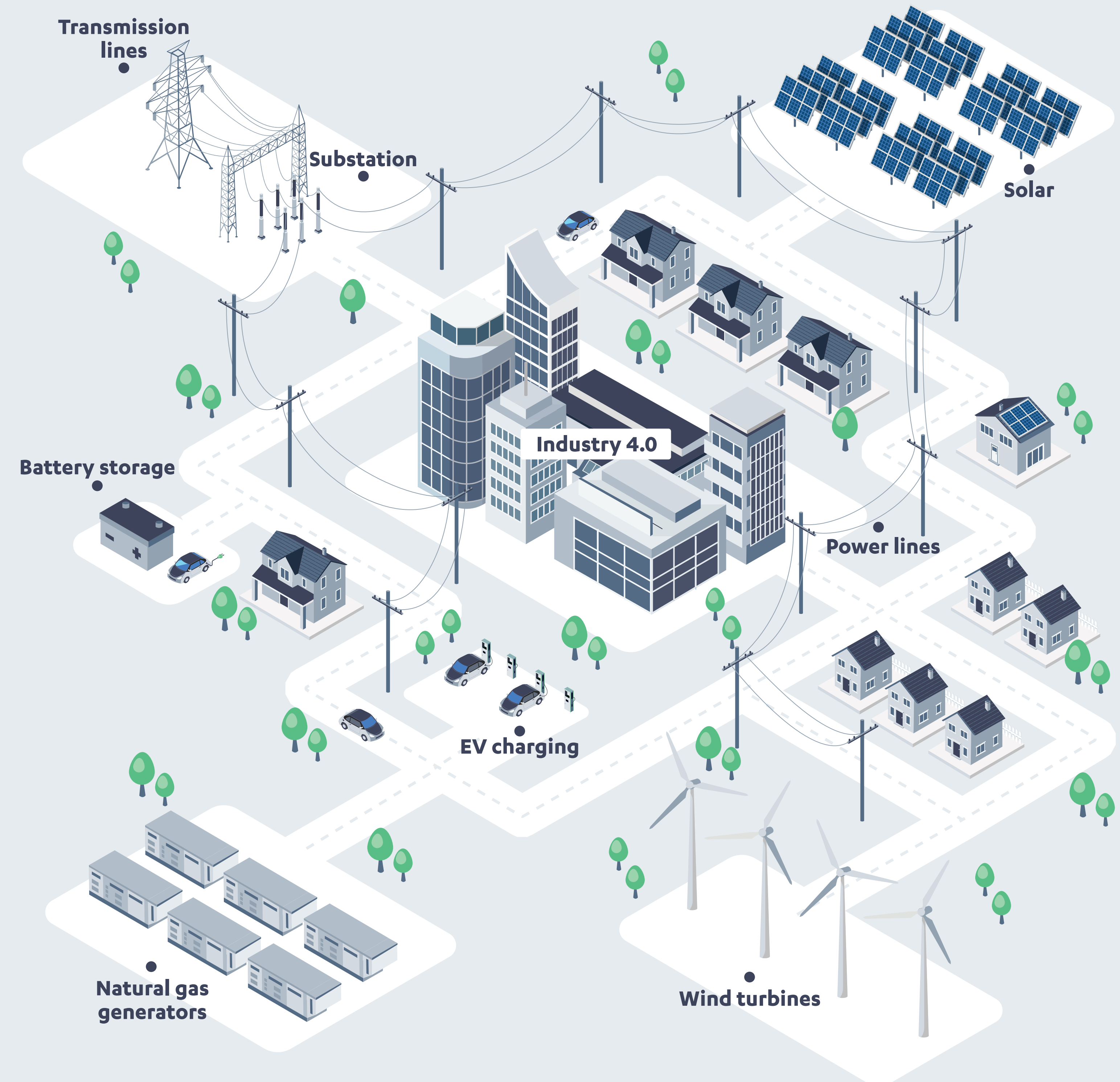
# New applications are built on technologies that create harmonic conditions.

Distributed energy resources (DERs) are a major backbone of modern energy efficient power generation. In fact, analysts project annual DER investments to **increase 75% globally by 2030[1].** These DER "microgrids" consist of multiple assets known contribute to supraharmonic emissions:

- solar panels
- wind turbines
- battery storage
- EV charging depots
- and more.

In addition, non-linear loads from variable speed drives, switched-mode power supplies, LEDs and other devices are increasingly prevalent in the grid today. Supraharmonic distortions caused by non-linear loads increase power losses — and ultimately compromise utility distribution systems and their components.

## A modern microgrid




[1] Power Magazine, Renewable Energy Future Includes DERs to Support Decarbonization," February 10, 2022

# Practical examples of devices that produce high frequency emissions

| Source | Supraharmonic frequency (range: 2 kHz-150 kHz) |
|---|---|
| Industrial-size frequency converters for equipment not operating at grid frequency | 9kHz to 150 kHz |
| Electric vehicle chargers (i.e., DC and inverter technology) | 15 kHz to 100 kHz |
| Photovoltaic inverters converting DC to AC when connected to the grid | 4 kHz to 20 kHz |
| Power line communication (intentionally injected to enable communications) | 9 kHz to 95 kHz |
| Industrial and household devices (from LED to HVAC, electronic lights and more) | 2 kHz to 150 kHz |
| Oscillations caused by DC commutators | up to 10 kHz |

# What's the real harm here?

Supraharmonics create problems that degrade power quality and potentially affect service to the end user.

### Overheating capacitors

Capacitors — used to even out power supply disruptions — can suffer from overcurrent, heating and protection trips when not designed for these high frequency emissions.

**Additional problems may include:**

- Audible noise
- Light flicker
- Tripping of low voltage residual current devices downstream
- Medium voltage and underground cable termination failure
- Critical power transformer failures
- Phase protection relay faults

### Compromised energy meter readings

Connections and accuracy may be severely impacted unless meters are specifically designed for immunity against supraharmonic frequencies. New standards for immunity testing are now available (IEC 61000-4-19).

### Interference in power-line communication (PLC)

PLC systems used in transmission and distribution systems communicate on frequency bands from 3 kHz to a few hundred kilohertz. This range coincides with emissions of switching devices such as inverters, which can substantially degrade reliability and jeopardize critical smart-grid services such as 2-way communication and smart-meter reading processes.

# Common supraharmonic effects on sensitive electronics:

**Premature failing** of data center computers and electronic circuits (even with UPS backup)

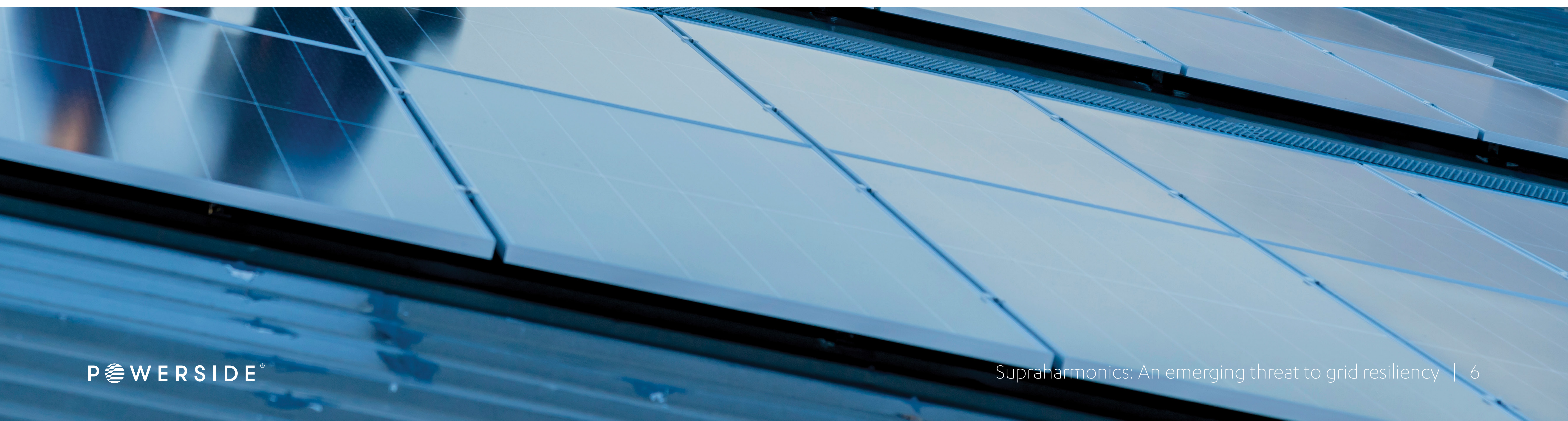
**Reduced lifespan** of LED lighting and other equipment

**Protection device failures**

**Interruptions** in domestic appliances, medical equipment, semiconductor manufacturing equipment, transportation control systems and IEDs

**Thermal stress** on connected equipment

**Insulation breakdown** on cables



# Harmonics issues aren't a one-way street.

Supraharmonics aren't isolated to energy-producing sources. It's important to consider how power-consuming technologies on the end-user side contribute to resiliency of the grid.

**The influence of Industry 4.0**

The confluence of physical, digital and cyber systems is driving the broader implementation of power electronics and smart systems everywhere from the power grid to the industrial manufacturing line. Businesses are seeing the value of using big data and machine learning to drive automated processes, proactively manage assets, reduce greenhouse gas emissions, lower maintenance costs, strengthen financials and more. Standalone digital applications and sophisticated platforms generate heavy computing power that puts actionable information at users' fingertips.

**Electric vehicle (EV) growth: A chicken-and-egg situation**

Analysts project that by 2030, 40 million EVs will travel U.S. roads[2]. However, EV growth hinges on 1) abundant charging station capacity and 2) faster charging. The only way to address the latter is to incorporate switching circuits and power electronics which in turn can generate high frequency harmonics. Moreover, studies point to challenges around harmonics and unintended interruptions of charging processes due to poor power quality. As adoption increases, questions arise about whether utilities can maintain power quality within acceptable limits in future distribution grids.

[2] *USA Today, "Registrations for electric vehicles soar, signaling increasing mainstream acceptance," May 17, 2022*

# It's time to **turn on the lights** and see what's really going on with the grid.

You can't successfully address supraharmonic distortions without an expanded view of how new technologies impact grid stability in real-world conditions. You also need this visibility to capture certain data to meet Renewal Portfolio Standards for regulators.

Meanwhile there's another problem: As of 2022, the industry has yet to create comprehensive standards for supraharmonics limits. In fact, there's a dearth of research on supraharmonics mitigation primarily due to the lack of measurement technology or established data analysis procedures.

**Where there were blind spots, you now have real-time insight.**
Traditional metering and instrument transformer technologies have not been effective at detecting supraharmonic emissions due to frequency cut-off measurement limitations.

Powerside is filling that need with the PQube® 3 power analyzer — specifically designed to capture and record supraharmonics at the 2 kHz -150 kHz range.

# Powerside PQube® 3: The first monitoring solution to make the invisible visible.

The urgency to detect and manage supraharmonics is ever-increasing — but also in reach. The Powerside PQube® 3 power analyzer is **uniquely capable** of monitoring, measuring and recording these high frequency emissions, including on medium voltage lines. This frequency range has been invisible to traditional technologies used for this purpose...until now.

The PQube® 3 uncovers a wealth of insight that helps utilities proactively address issues, make informed decisions and reduce costs.

- **Improve** grid visibility and identify fault location faster
- **Identify** and diagnose power grid dynamics
- **Monitor and evaluate** power quality issues
- **Prevent** early equipment failure
- **Mitigate** grid disruptions caused by DERs


## Key features of the PQube® 3

Measures power quality and conducted emissions in 2-150kHz segments with minimum, average and maximum magnitudes of the rms voltage in each segment

Automatically emails data and graphs directly to operator's 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)

POWERSIDE®

# Green means go.

Shed light on supraharmonics — and keep reliable, sustainable energy flowing to your community.

## Contact us to learn more about Powerside monitoring solutions and services.

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