Clean Coalition

The neighborhood of the future: An overview of the Alabama Smart Neighborhood Project

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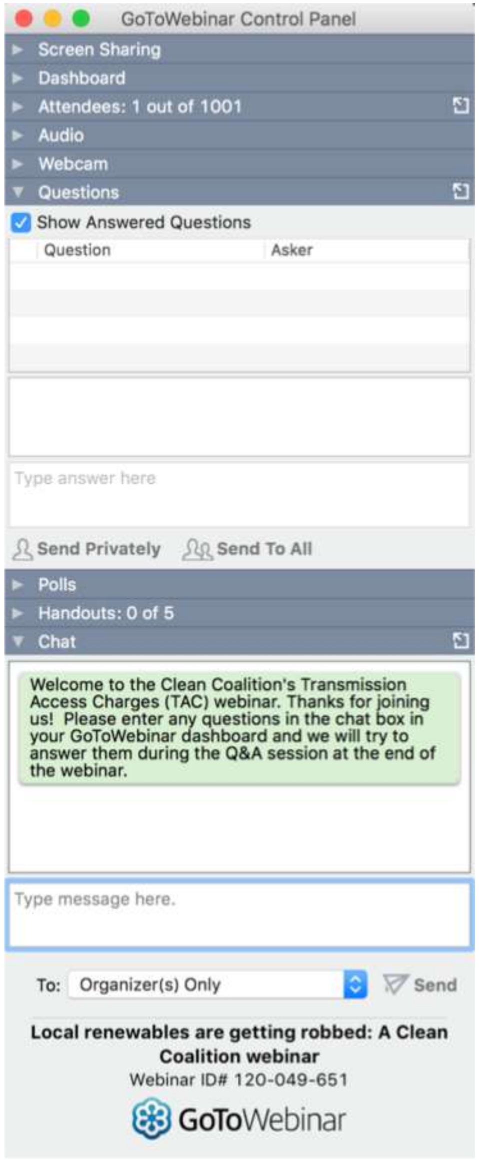
- Questions will be answered during the Q&A portion of the webinar
- Contact Josh for webinar questions: josh@clean-coalition.org



Community Microgrids are the grid of the future

Clean Coalition

A Community Microgrid is a new approach for designing and operating the electric grid, stacked with local renewables and staged for resilience.

Key features:

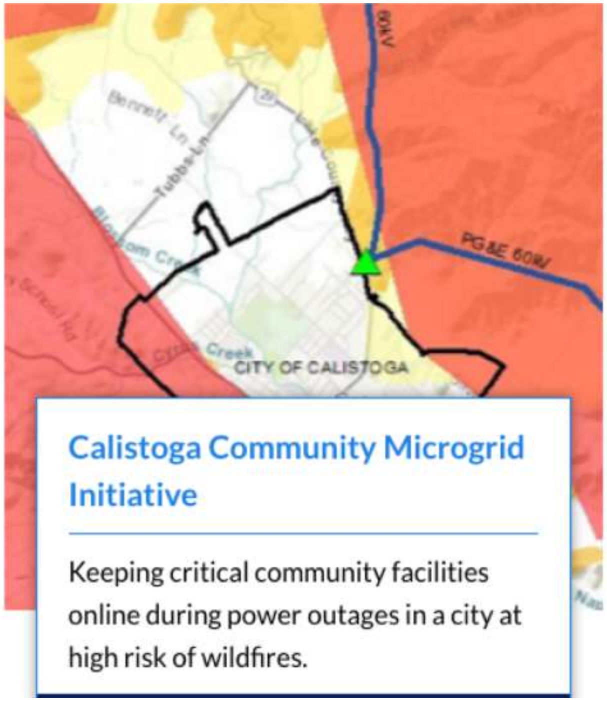
- A targeted and coordinated distribution grid area served by one or more substations.
- High penetrations of local renewables and other distributed energy resources (DER) such as energy storage and demand response.
- Staged capability for **indefinite renewables-driven backup power for critical community facilities** across the grid area.
- Can be readily extended throughout a utility service territory — and replicated into any utility service territory around the world.

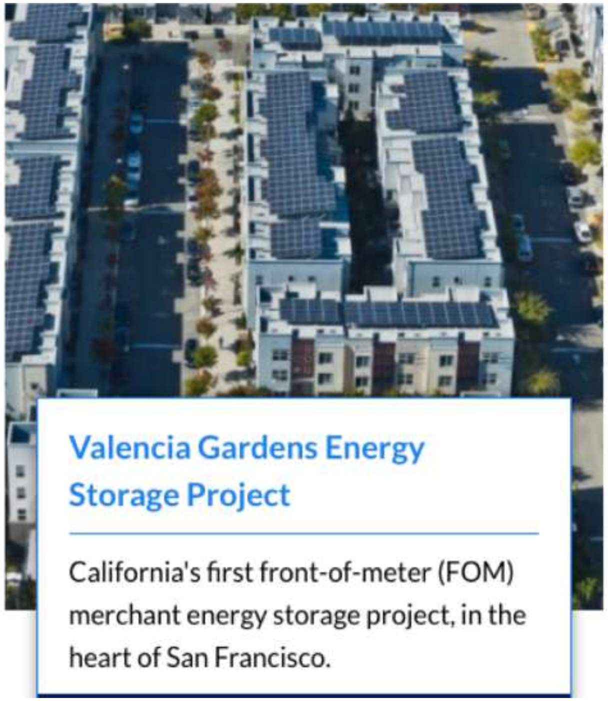
Community Microgrids deliver communities unparalleled economic, environmental, and resilience benefits.

Clean Coalition Community Microgrid Initiative

Clean Coalition

- Establishing policies and market mechanisms to proliferate deployment.
- Providing a standard methodology that any community can use.





- Goleta Load Pocket Community Microgrid
- Montecito Community Microgrid
- North Bay Community Resilience Initiative
- Calistoga Community Microgrid
- Valencia Gardens Energy Storage Project
- Hunters Point Community Microgrid
- Long Island Community Microgrid

Clean Coalition Community Microgrid Initiative

Clean Coalition

In staging Community Microgrids like these in California and elsewhere, the Clean Coalition is identifying the policy and market mechanisms needed to unleash the microgrid market:

- A reform of the Transmission Access Charges market distortion, which adds 3 cents per kWh to the cost of clean local energy projects in California.
- Utility transmission divestment — setting the stage for utilities to become distribution system operators (DSOs) and support clean local energy.
- Streamlined interconnection for commercial-scale solar and storage, which is currently costly and time-consuming.
- Effective procurement methods, such as Feed-In Tariffs (FITs) with Market Responsive Pricing and Dispatchability Adders.
- A standardized Value of Resilience (VOR123) for critical, priority, and discretionary electric loads.

Alabama Power Smart Neighborhood®

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December 2019

Southern Company

Research & Development

Distributed Energy Resources

Reynolds Landing

Alabama Power

SMART NEIGHBORHOOD®

Objective

Design and build a **first-of-a-kind smart home community** to understand and prepare for evolving customer expectations and future grid needs

Scope

Demonstrate **distributed energy resource (DER)** use cases optimizing cost, reliability, and environmental impact with a **community-scale microgrid**

Demonstrate **62 high-performance homes with connected home technologies** providing an improved customer experience

Demonstrate **buildings-to-grid integration** with real-time utility-to-customer interaction

Overview

Customer Insight

Energy Efficiency

Community-scale Microgrid

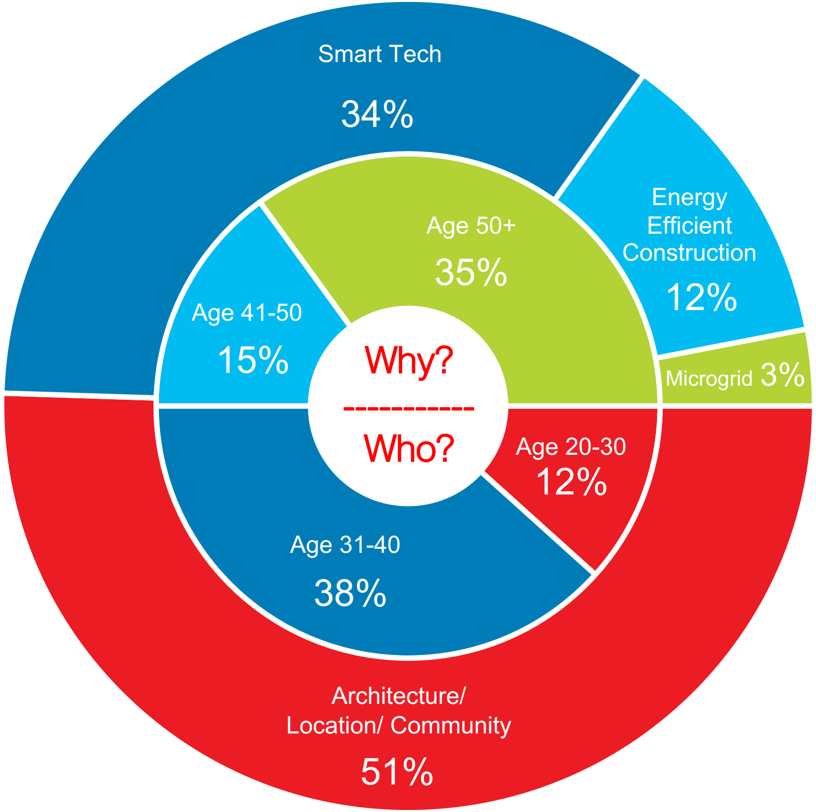
Transactive Control

Lessons Learned

Customer Insight

Demonstrate **62 high-performance homes** with connected home technologies providing an improved customer experience

Customer Insight

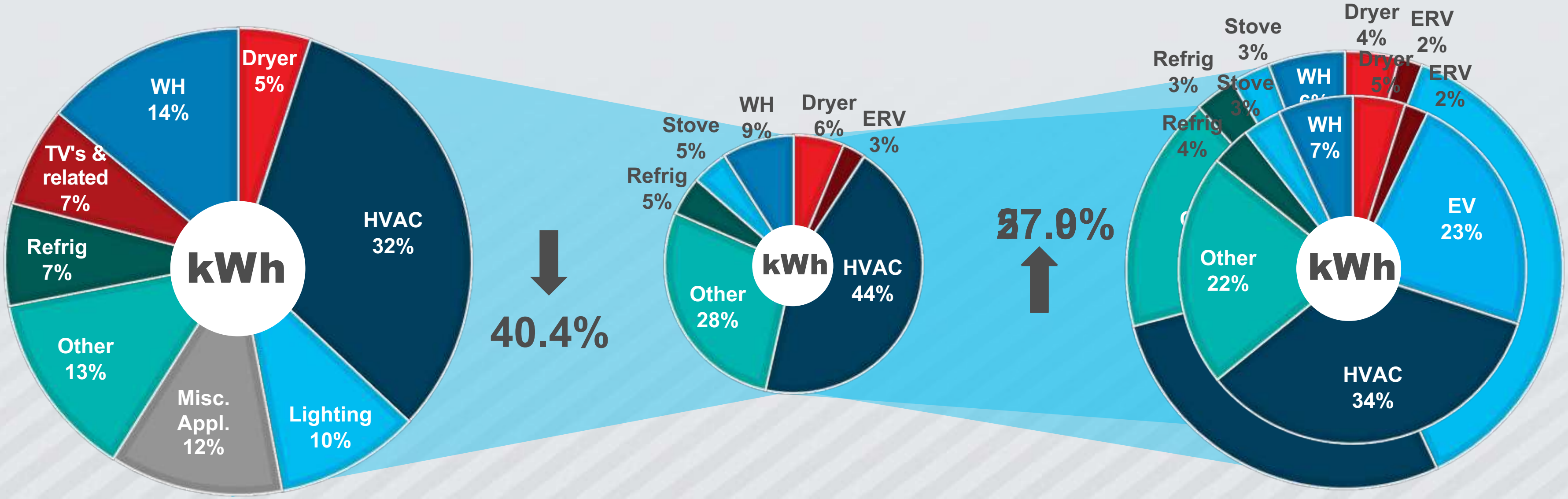


Connectivity
Relationships
Convenience Educating
Simplicity
Consistency
Platforms Valued
Technology
Stability

Energy Efficiency

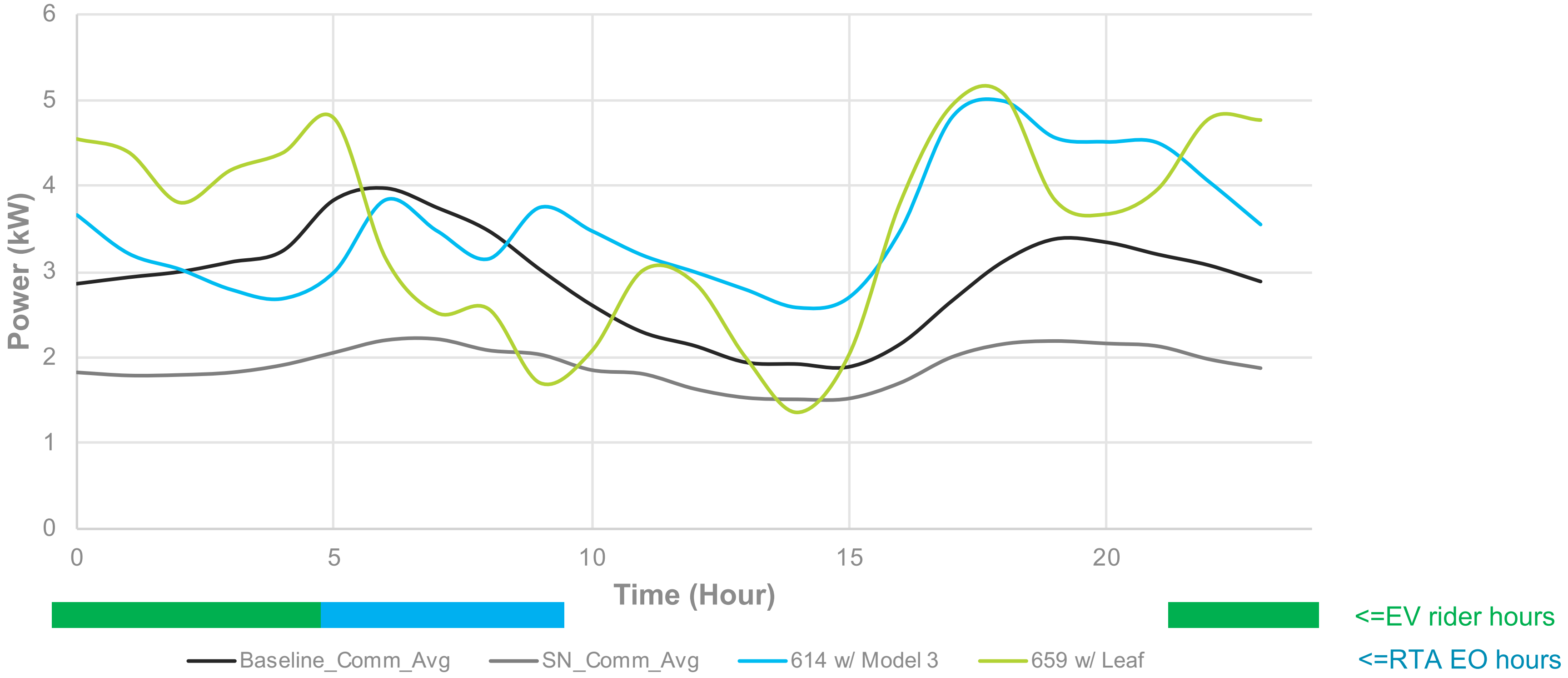
Monthly Energy Usage

	AL Home	SN w/o EV	SN w/2 EV
Total (kWh):	1323	789	1209



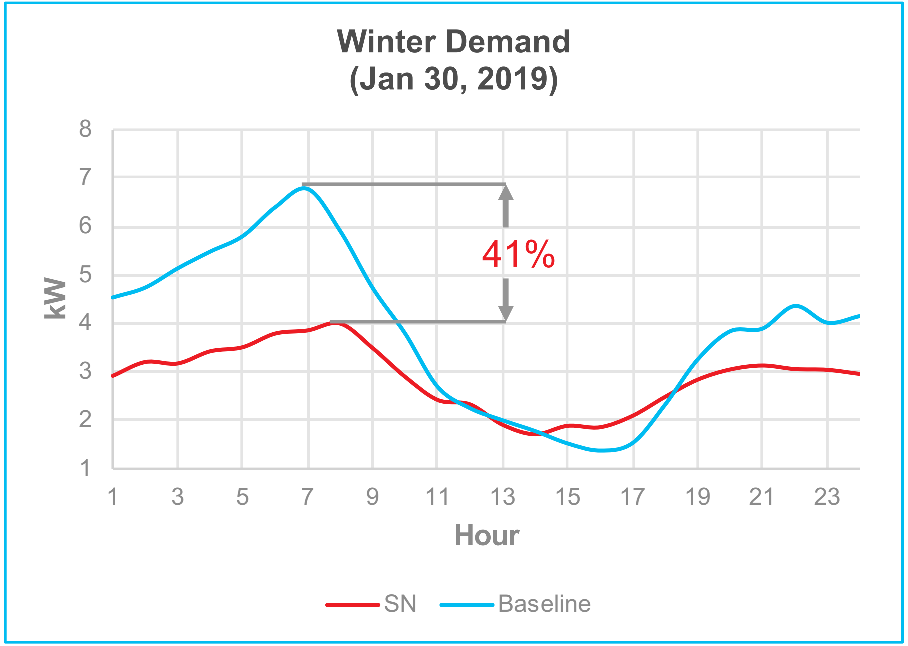
*SN home has been normalized to show equivalent sqft of AL home

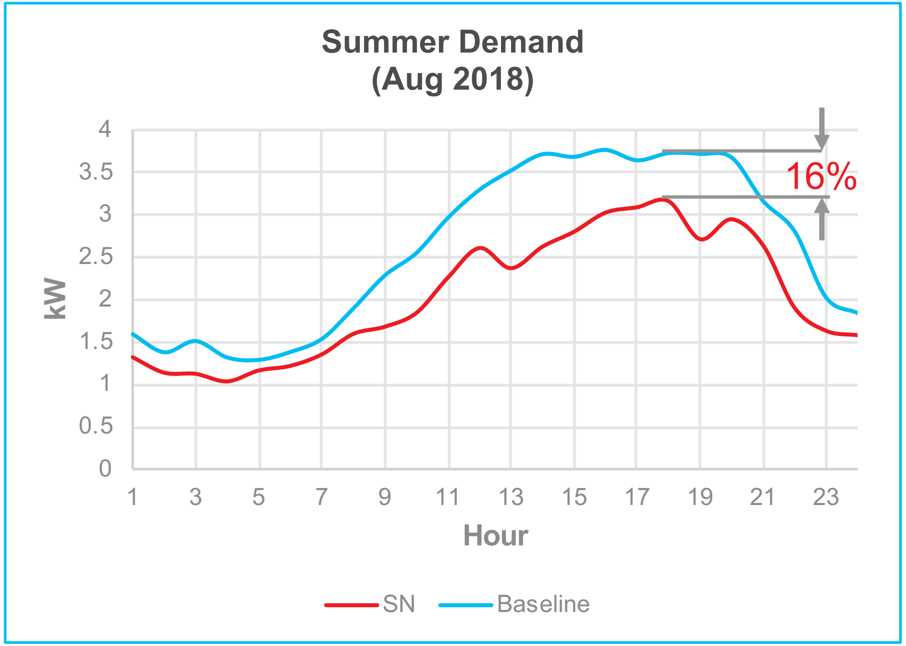
January 2019 – Average Electric Demand (kW)



Advanced Heat Pump Impacts

> **$1,000** in savings to the customer over life of equipment





Community-scale Microgrid

What is Needed to Make a Microgrid Successful?

Defined Functionality

- **Clear functionality expectations**
  - Should the microgrid be able to island successfully without a blackout?
  - Are blackouts ok? Is blackstart expected upon that condition?

Generation Capacity

- **Enough local and controllable generation and resource capacity**
  - Standard generators?
  - Power electronic resources (PV, energy storage, fuel cells)?

Coordinated Control

- **Multiple levels of controls**
  - Devices and controls that support the control and coordination to meet this functionality.
  - Communications to support optimization and device coordination.

Demonstrate **DER** use cases optimizing cost, reliability and environmental impact with a **community-scale microgrid**

Total DER output used by the neighborhood:
Annual production: 538,000 kWh
Annual SN consumption: 688,000 kWh
SN load from Microgrid: 189,000 kWh (27.5% of total neighborhood consumption)

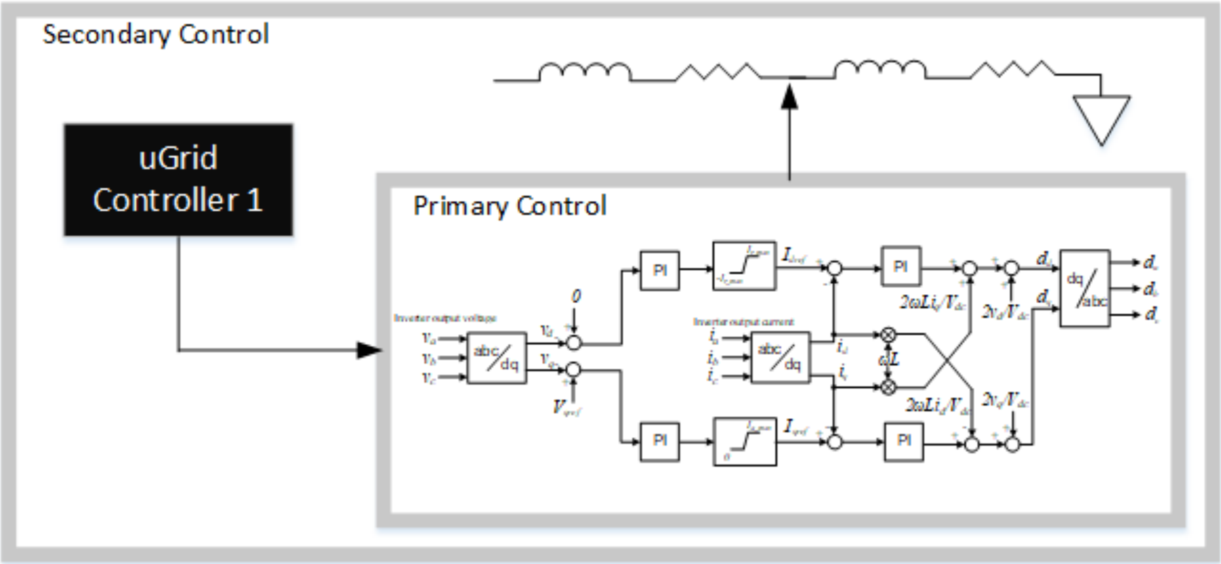
Layers of Inverter Controls

Primary Control

– Converter and generator system-level controls respond automatically to measurements
– Typically fast in nature

Secondary Control

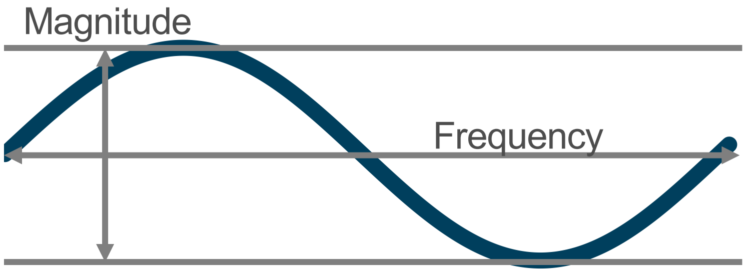
– Works with assets to ensure voltage and frequency of system are regulated
– Typically slower in nature



Power Quality

Research & Development

- A measurement of the ‘fitness’ of the power delivered
- Voltage sine wave operating at 60Hz for US electric grid
- Many standards are available to support defining power quality and technology solutions

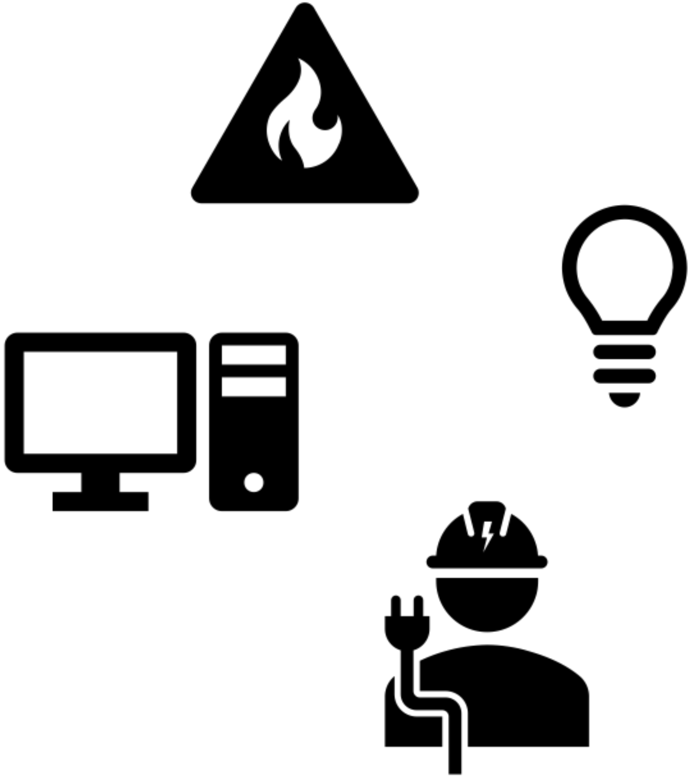


IEEE/IEC	NFPA/NEMA	UL
IEC 61000 IEEE 519 IEEE 1159 IEEE 1433 IEEE 1531 IEEE C2 IEEE C62.41 IEEE 1433 IEEE 1564	NEMA LA 1 NEMA LS 1 NEMA PE1 NFPA 70 NFPA 780	UL 96A UL 1283 UL 1449

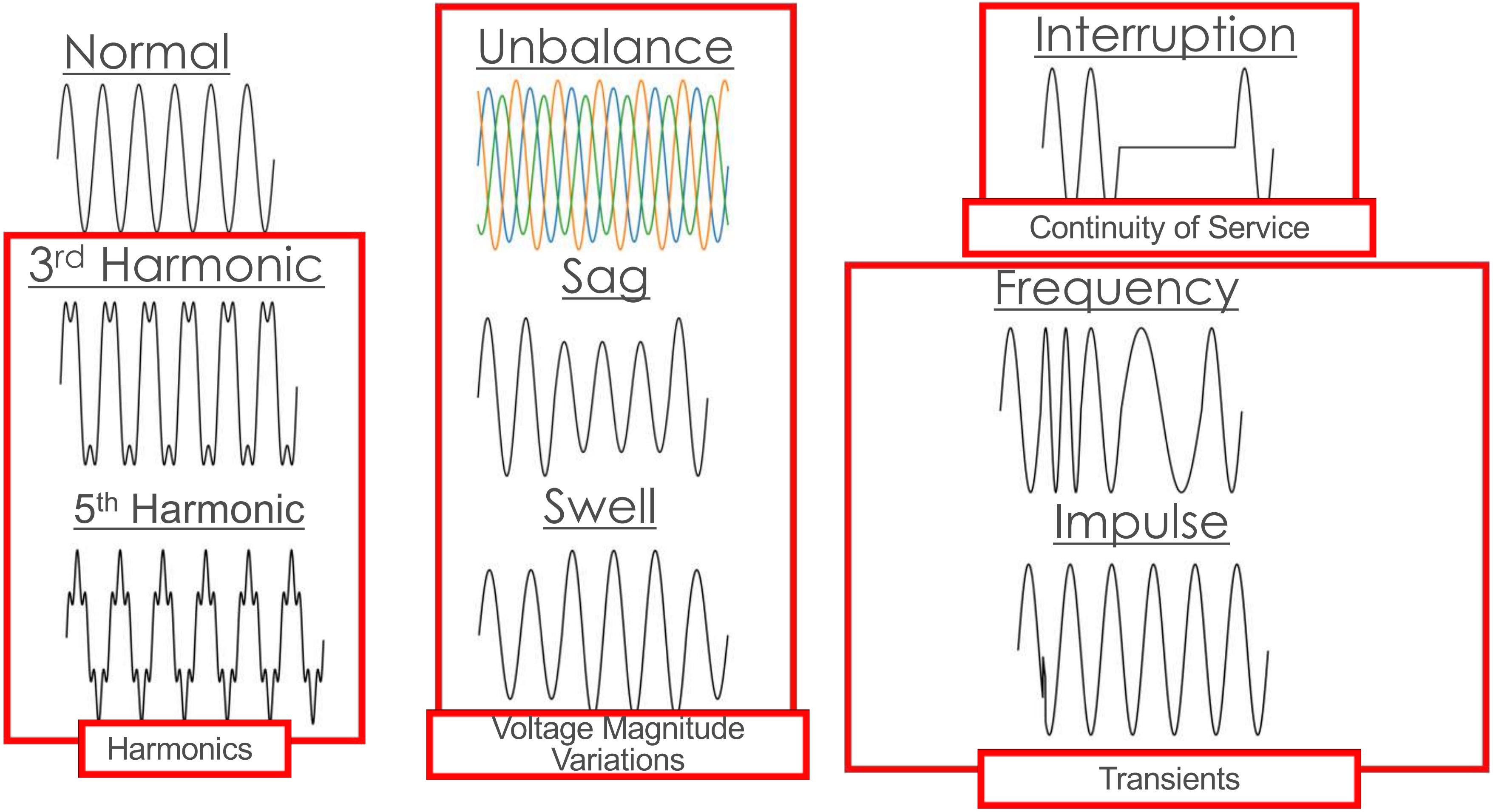
Theo Laughner, Intro to Power Quality, TVA Presentation, 2017

Why is Power Quality Important?

- **Poor Power Quality Impacts:**
  - Premature failure of devices
    - » Capacitors
    - » Motors
    - » Transformers and cables
  - Energy efficiency with increased heating and losses
- **Can Trip Devices**
  - Computers
  - Relays



Electrical Power Quality Signatures

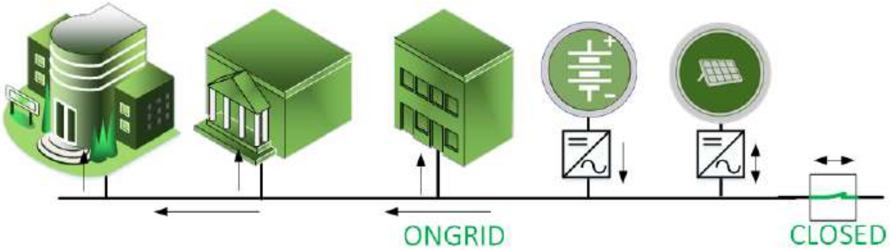


Power Quality Challenges in Microgrids

Research & Development

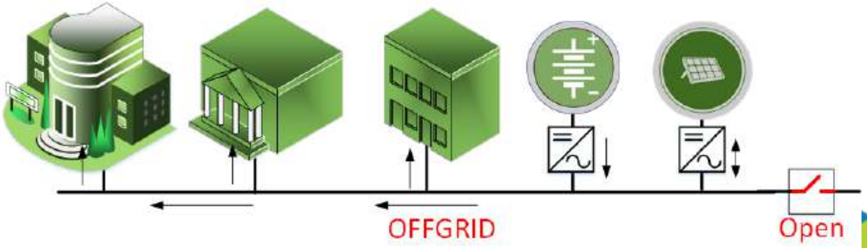
On Grid:

- Voltage support focused
  - Control reactive power of assets
- Supporting the grid for use cases such as demand reduction and local electricity cost reduction
- Power quality issues can come from main grid



Off Grid (Island Mode):

- Voltage control and frequency focused
  - Control reactive power for voltage
  - Control real power for frequency
- Must deal with system imbalance locally
- Power quality issues are generated locally



What Can Cause Power Quality Issues within Microgrids?

1. Transient conditions such as that of an islanding event due to a grid problem.

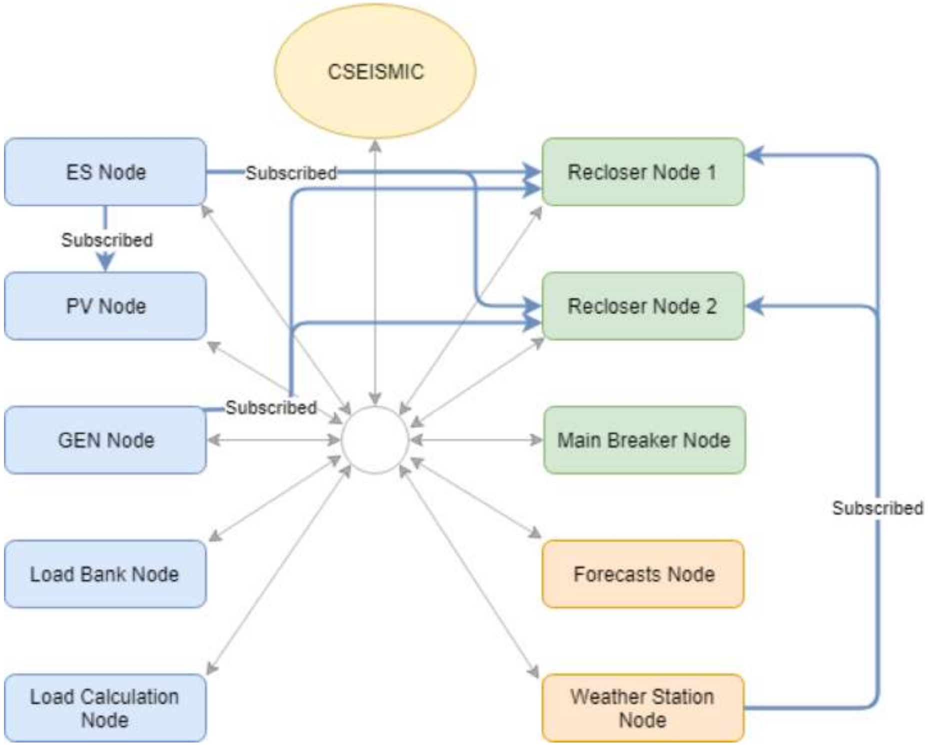
2. Renewable generation due to transient changes in weather.

3. Increased non-linear loads or rectified loads.

4. Increased loading on one phase over another during an island.

Distributed Control Features

- Generation assets support multiple control modes (on grid/grid forming/voltage-frequency source)
- Energy storage system and generator can detect system issues and transition to grid forming controls.
- Microgrid control can also coordinate islanding and resynchronization.



Protection and Controls

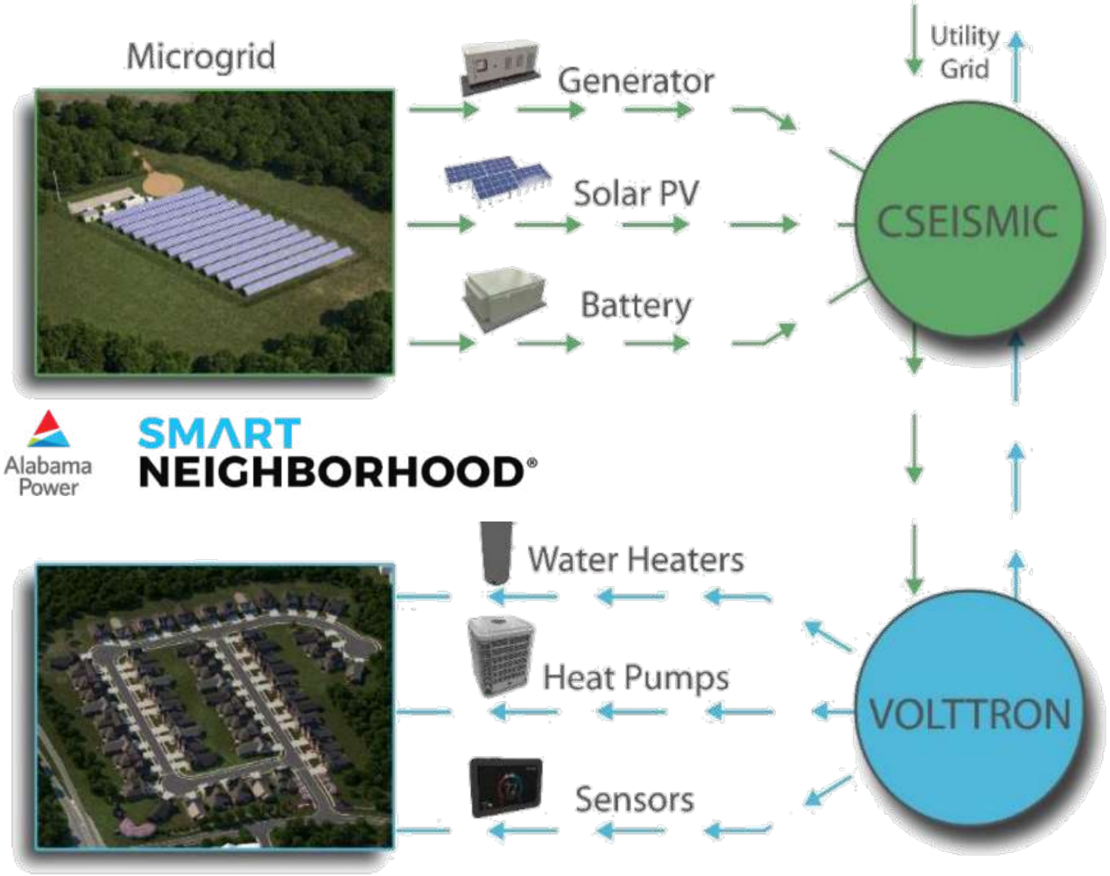
- Protection settings for the Shannon-Oxmoor Microgrid:
  - Overcurrent-sensing primarily for grid-connected events
  - Voltage-sensing primarily for islanded events

- Settings allowed the microgrid to island safely and respond appropriately to grid events

- The islanding recloser was adjusted to a more sensitive setting to island faster and improve rates of successful islanding events

Transactive Control

Transactive Controls



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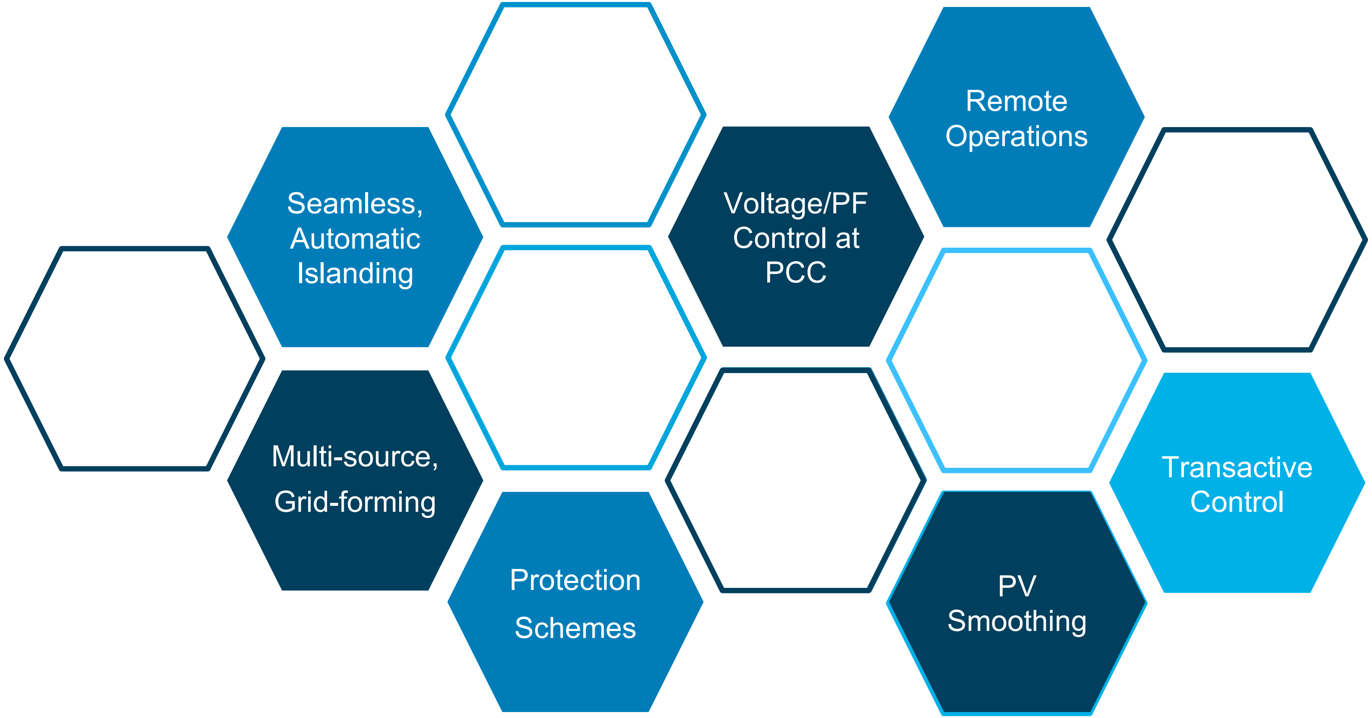
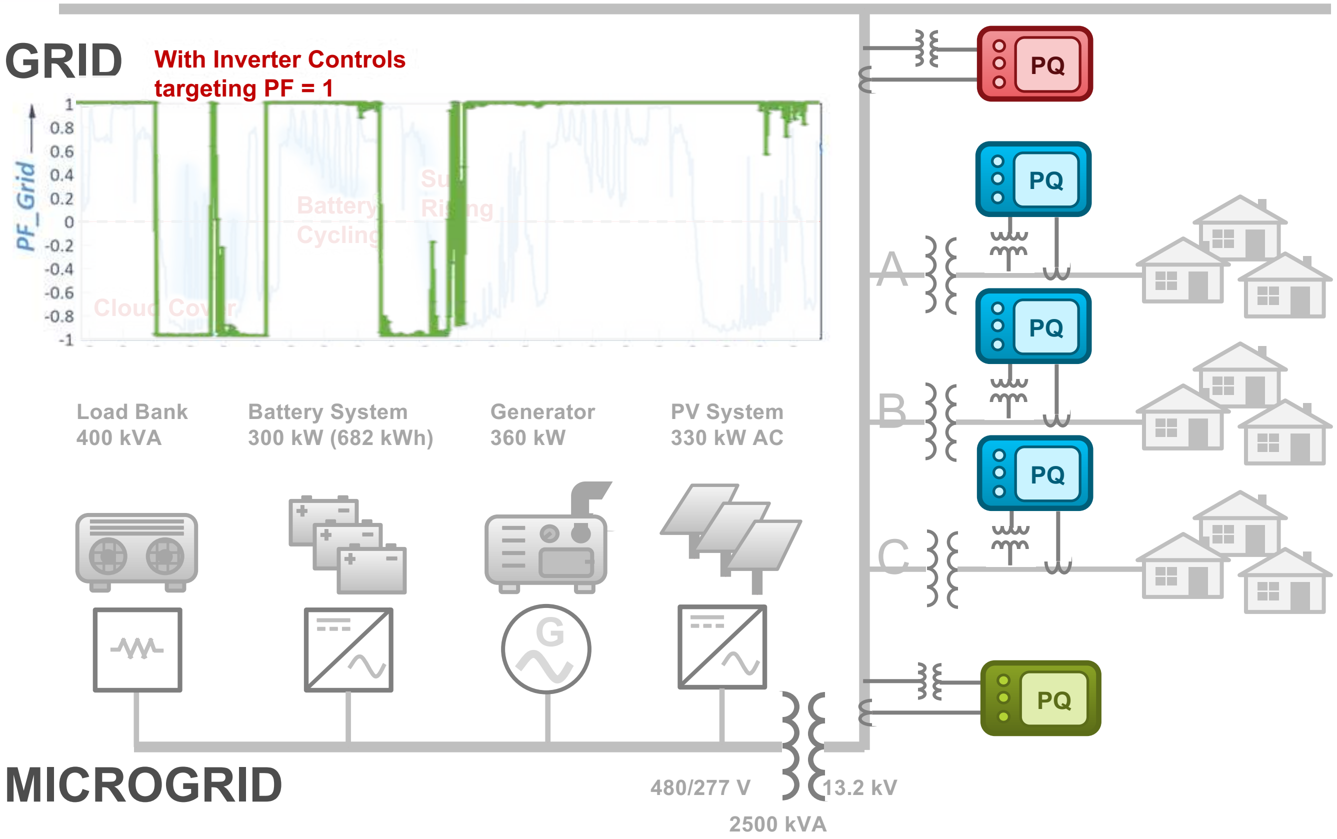
Oak Ridge National Laboratory

Pacific Northwest NATIONAL LABORATORY

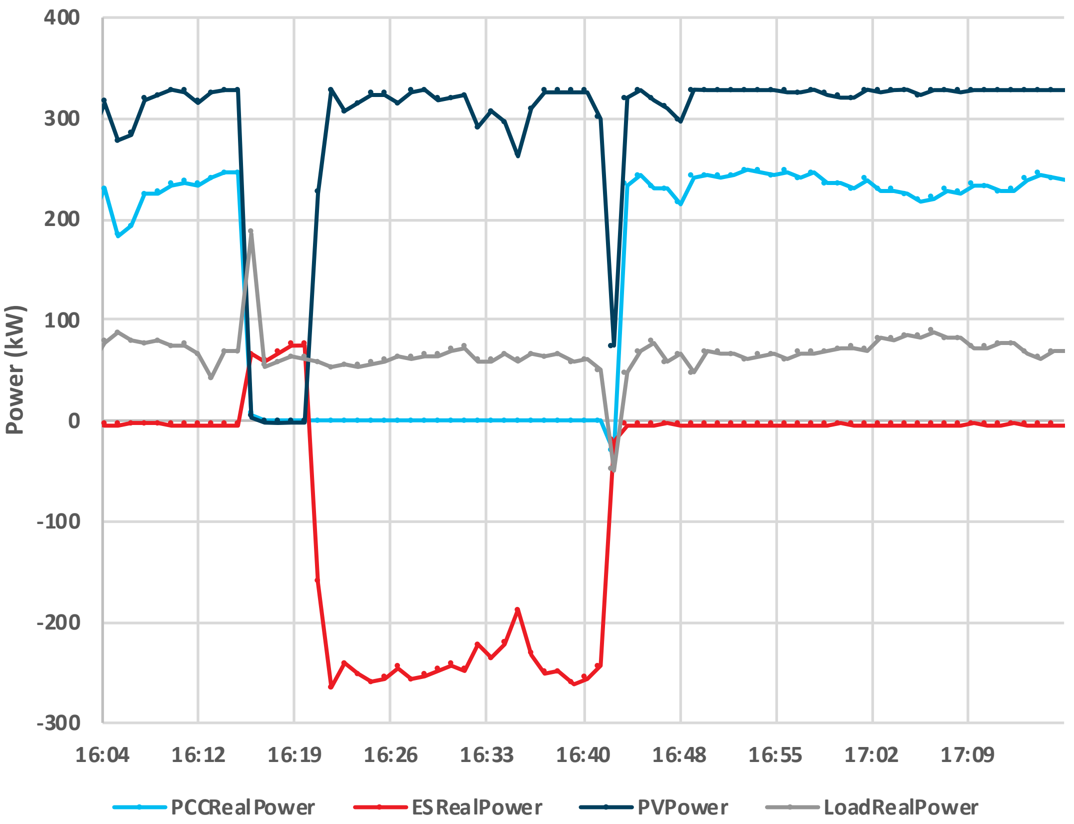
Microgrid – Lessons Learned



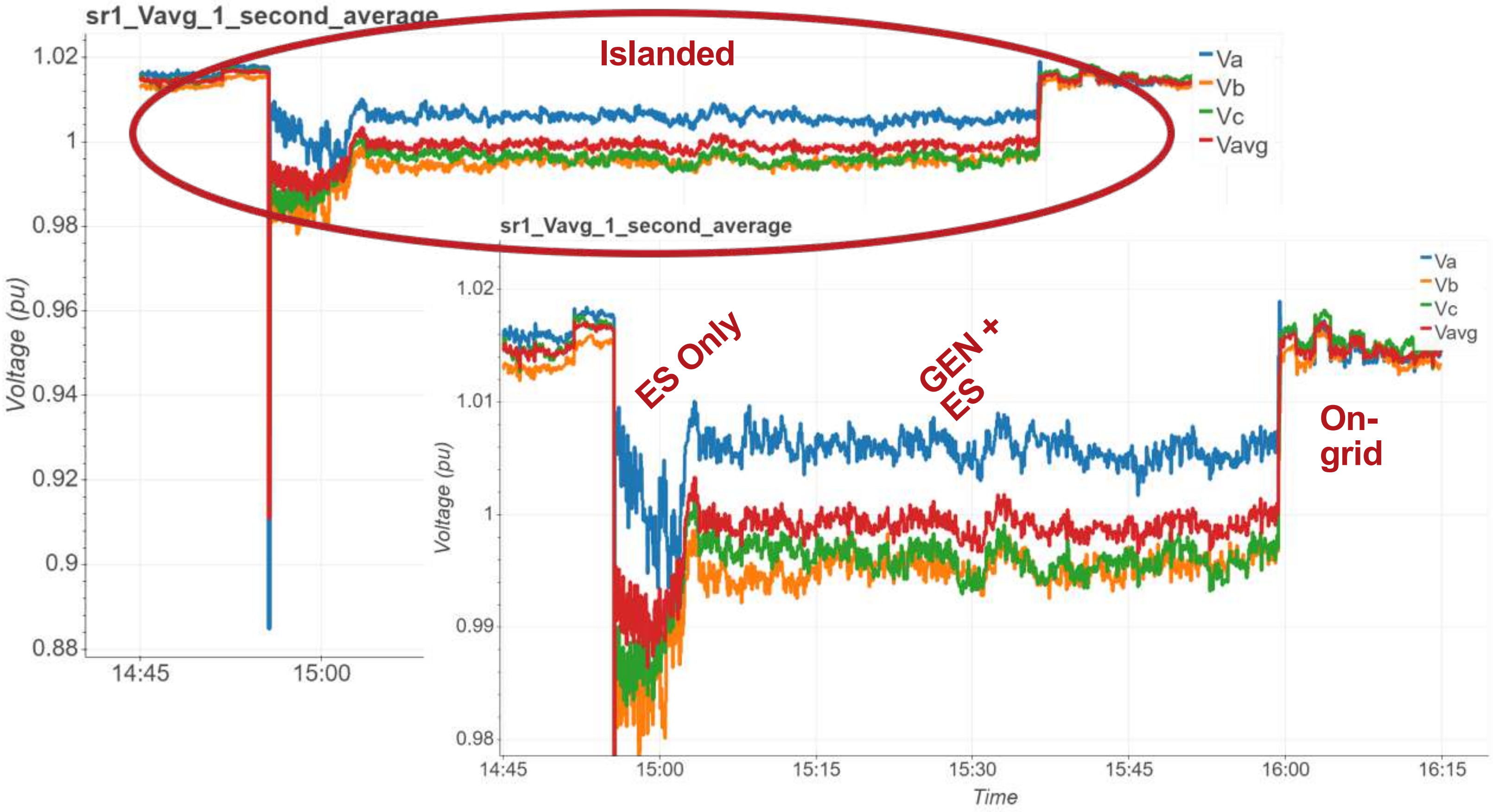
Power Quality



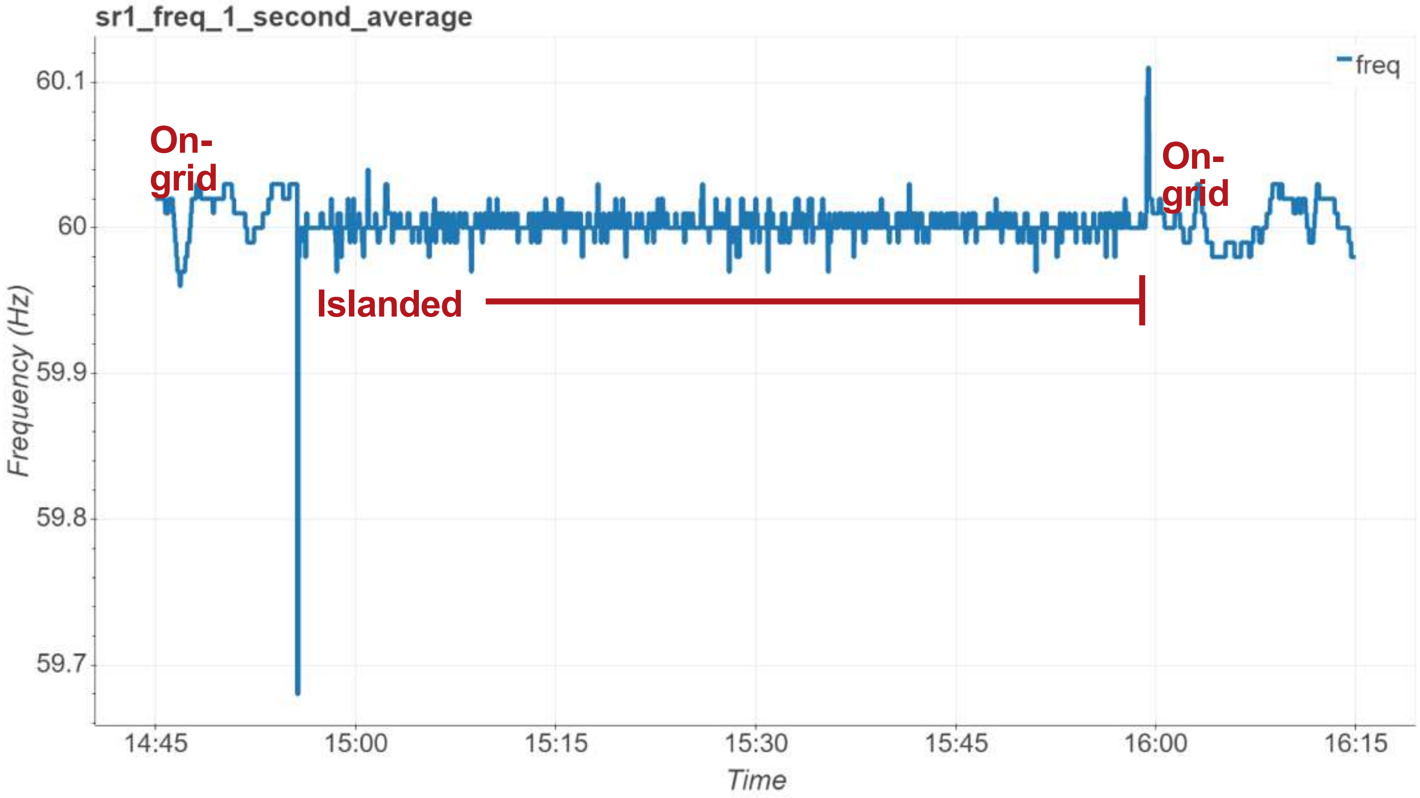
Unintentional Islanding Event



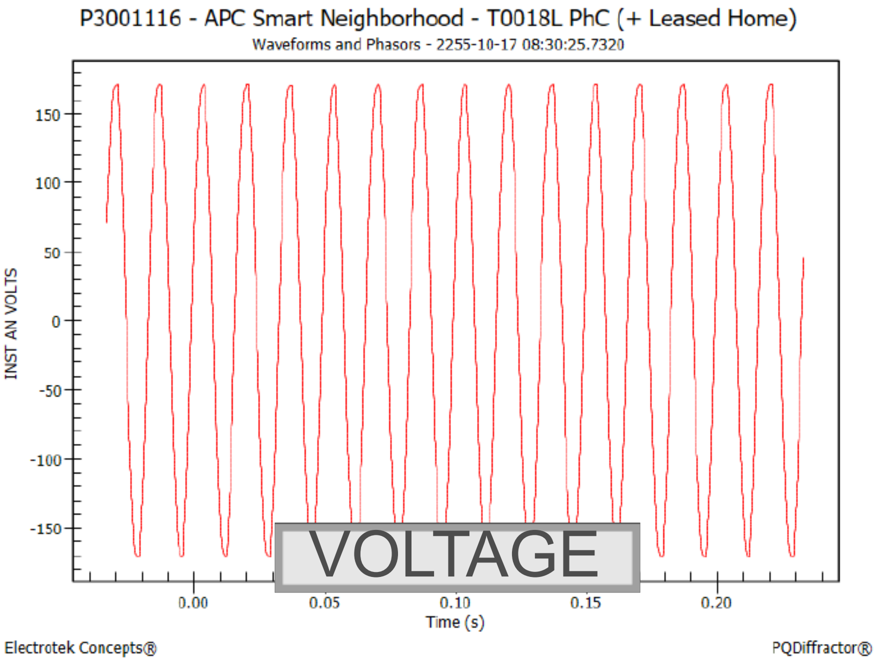
Islanding (Often Observe Short Duration Voltage Surge/Sags)

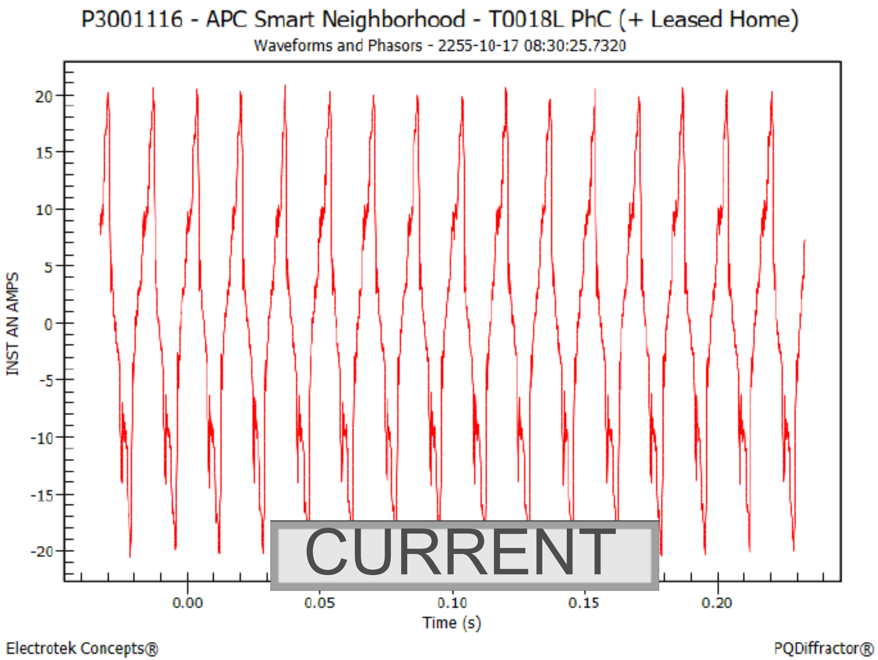


Microgrid Island Frequency

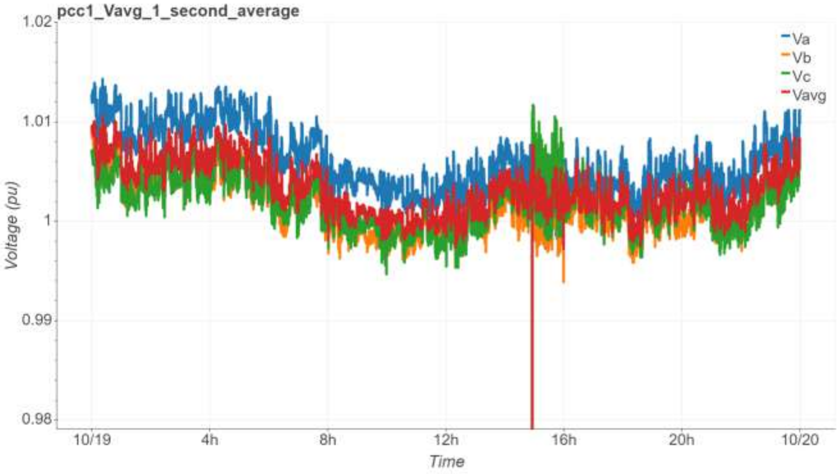


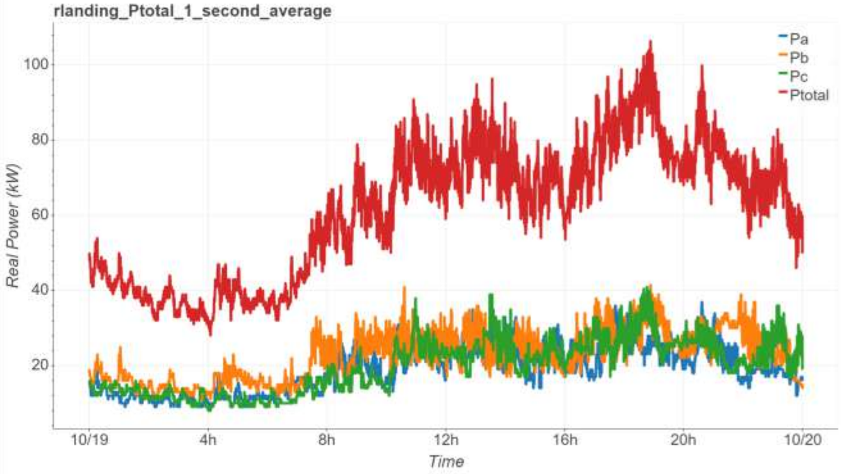
Post-Island Mode - Waveform Distortion





Island Mode - Voltage Imbalance





Voltage imbalance at the microgrid is consistent throughout the day at approximately 0.005 pu.

Load imbalance is inconsistent throughout the day but is somewhat balanced amongst phases.

Microgrid Successes

Facility to demonstrate commercial microgrid control systems and DERMS

▶ Tests successfully performed with ORNL's CSEISMIC

- PV Smoothing
- Economic Dispatch
- Power factor control
- Islanding

▶ Next Steps

- Dispatch with home loads
- Test long-term island capabilities
- Transition to permanent control system

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