LAMPAC MIDWEST 2017

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Ameren Illinois - Distributed Energy Resource Integration Project – Microgrid

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Technology Applications Center

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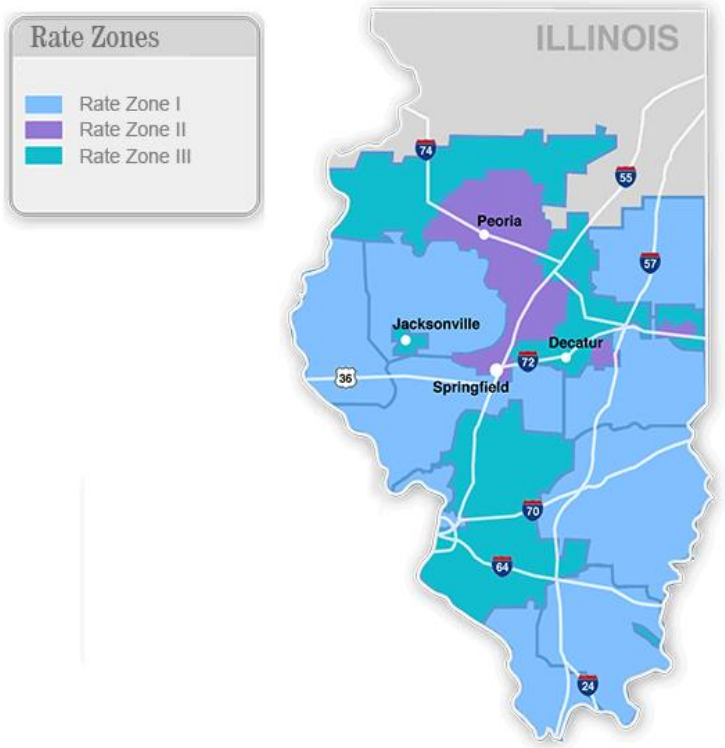
AMEREN ILLINOIS – FACT SHEET

Diversified regional electric and gas utility

- Serves 1.2 million electric and 816,000 gas customers in more than 1200 communities within a 43,700 square miles territory
- 4,500 miles of electric transmission lines.
- 46,000 miles of electric distribution lines.
- 18,200 miles of natural gas transmission and distribution mains.
- 12 underground natural gas storage fields.
- Employing more than 3,300 personnel



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Technology Applications Center - Background

On October 26, 2011, the Energy Infrastructure & Modernization Action (EIMA) was enacted which comprised a component requiring Ameren Illinois to construct or designate a Smart Grid Testing Infrastructure.

Technology Applications Center Services

• Ameren Illinois will provide testing infrastructure resources and services from which companies will be allowed to test programs, technologies, business models and other Smart Grid-related activities while connected to the grid.

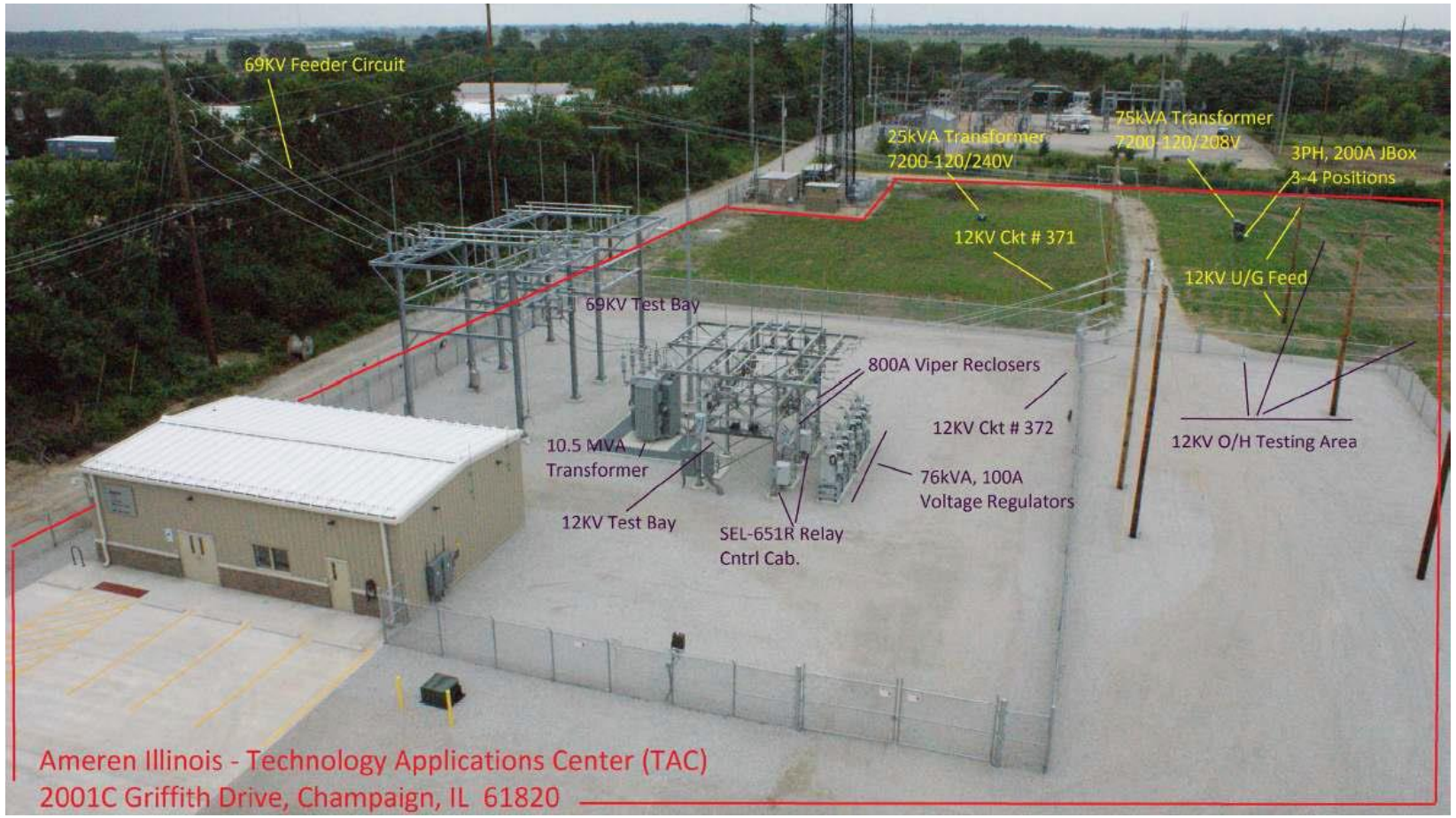
Requirements from EIMA for Technology Applications Center

• Provide companies with open unbiased opportunities for testing programs, technologies, business models, and other Smart Grid-related activities while connected to the grid.

• Provide companies with opportunities to test and showcase Smart Grid technologies and services, especially those likely to support the economic development goals of the State of Illinois.

• Facility will include a live MISO (Midwest Independent System Operator) signal to provide testing capabilities of new utility scale applications associated with distributed wind and solar resources.

Technology Applications Center (TAC) - Background



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Technology Applications Center (TAC) - Background

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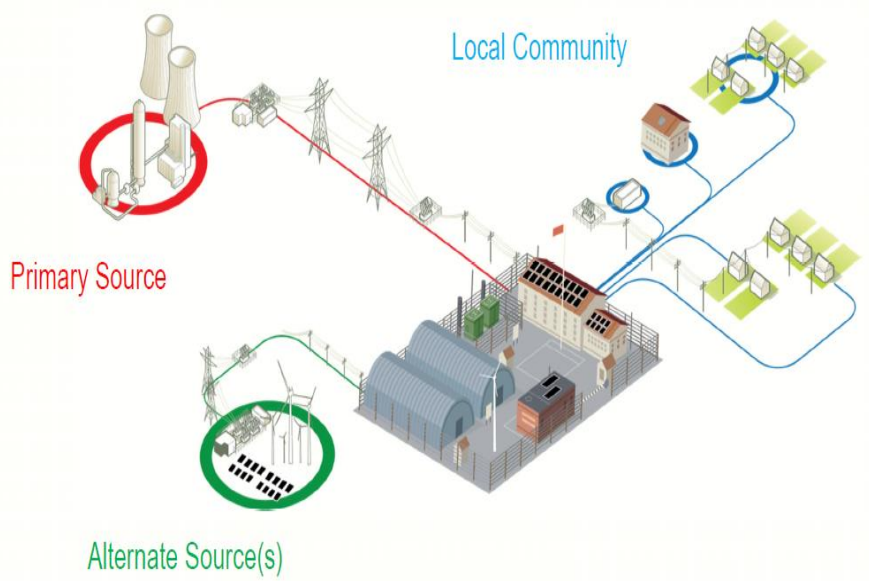
Technology Applications Center Research

Partners	Project Description
DOE, SEL, UIUC	**Software Defined Networking** – Demonstrate Network Switch & Load Flow Controller Capabilities
DOE, ABB, UIUC	**CODEF**: Collaborative Defense of Transmission and Distribution Protection and Control Devices against Cyber Attacks
Ameren	**LED** light testing to verify operational characteristics
Ameren	**Home Area Network** device testing to support Advanced Meter Infrastructure and Energy Efficiency programs
Ameren	**Volt Var Optimization** Pilots
University – SIUC	Developed **Reliability Improvement Assessment** tool to analyze effects of Distribution Automation deployments.
Industry	Reviewed industry research regarding effects of Distributed Energy Resources (Solar, Wind, Energy Storage) on electric Distribution systems.

Distributed Energy Resource Integration Project – Microgrid Definition

While there is no universally accepted definition for microgrids, the definition that is most commonly cited comes from the U.S. Department of Energy's (DOE's) Microgrid Exchange Group:

"A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected and islanded mode."



"Microgrid Definitions," Microgrids at Berkeley Lab, 2015, https://building-microgrid.lbl.gov/microgrid-definitions

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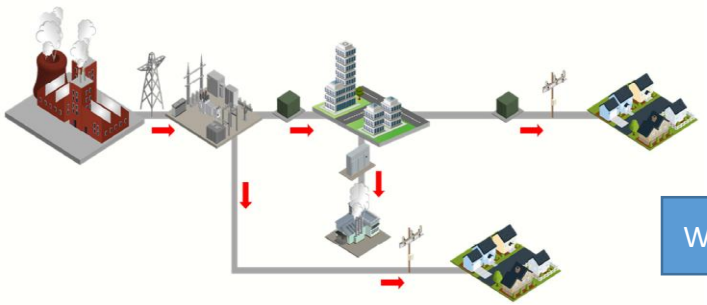
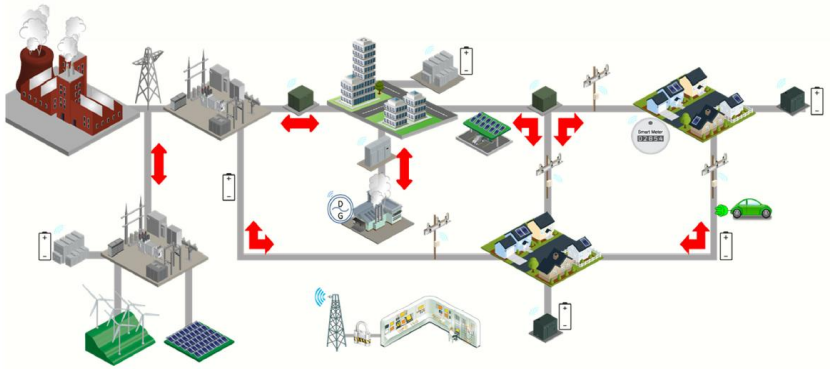
Distributed Energy Resource Integration Project - Motivation



The grid with central generation and one way power flow

Where the grid is heading



Grid of the future, with DERs and multi way power flow

- **Customer choice**
- **Customer behind the meter microgrid**
- **Community solar and community wind projects**
- **Growth in DER adoption and its deeper penetration**
- **Learning opportunities and building up internal expertise**

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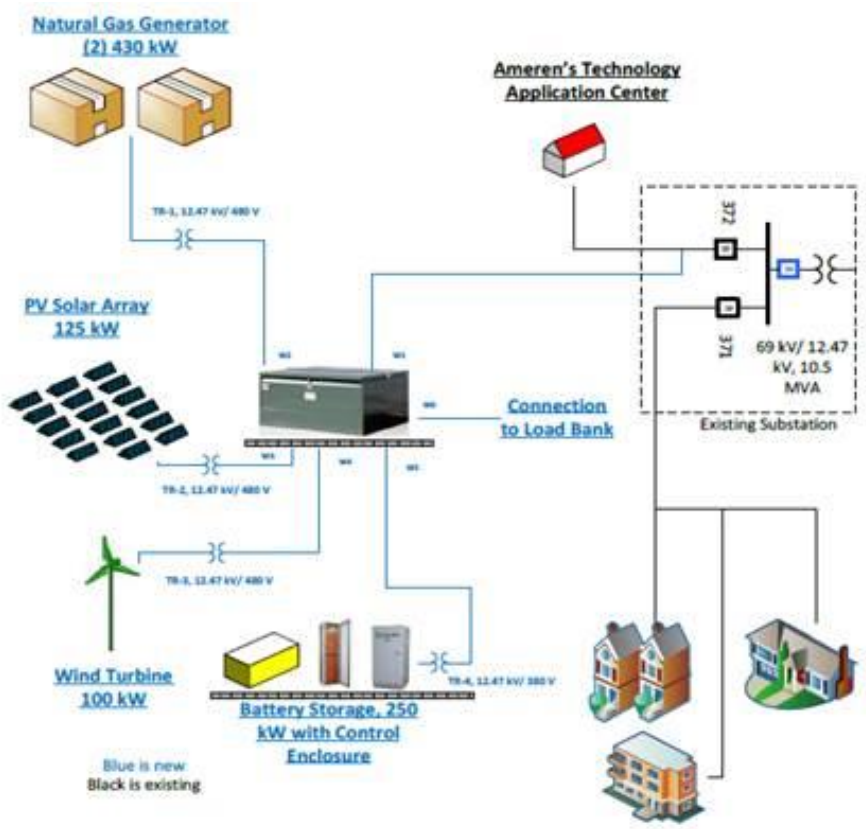
Distributed Energy Resource Integration Project - Objectives

- **Investigate the design, control and operations of Microgrid.**
- **Investigate resiliency and reliability improvements that microgrids provide our customers.**
- **Investigate the operations of DER's and energy storage on Ameren's systems and their interactions with customers.**
- **Investigate the complex interoperability, economic dispatch, islanding, ancillary services, frequency and voltage control aspects of microgrids.**
- **Investigate the demand response and energy choice concepts that microgrids offer our customers.**
- **Develop skills requirements necessary to construct, operate & maintain DER assets.**

Distributed Energy Resource Integration Project – Design and Use-Cases



Proposed DER	
Device	Size
PV (1 acre)	125kW
Wind	100kW
Natural Gas	1000kW
Battery Storage	250kW

Use Case Priority	Use Case
1	DER Monitoring, Control and Integration
2	DER Optimal Power Flow
3	Integration with existing ADMS System
4	Frequency Control
5	Volt/Var Control
6	Power Quality
7	Grid Connected Transition
8	Islanded Transition
9	Islanded Mode of Operations
10	Grid Connected Mode of Operations
11	Demand Response
12	EV Integration
13	Peak Load Shaving
14	Optimal Economic Dispatch
15	Storm Preparedness
16	Operational Standards and Procedures

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Distributed Energy Resource Integration Project
Installation Overview

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Wind Turbine

Manufacturer: Northern Power
Rating: 100KW @ 480 volts
Installation time frame: 2 Weeks

- 10 days for foundation and 2 days for tower

Tower Height to blade tip: ~160 feet
Estimate Annual Production: 190 MWHrs @ average wind speed of 11.7mph
Capacity Factors (Estimated 21.5%, Measured 15.1%)

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Solar

Manufacturers: Panels – Yingli (504), Inverters – ABB(5 string)
Rating: 125KW
Installation time frame: 2 Weeks
Area covered: ~0.8 acres
Estimated Annual Energy Production: 223 MWhr
Capacity Factor (Estimated 20.8%, Measured 24.1% March 1 through August 31, 2017)

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Natural Gas Generators

Manufacturer: Caterpillar
Ratings: 2 – 500KW/625KVA reciprocating engines @ 480 volts.
Installation time frame: 2 Weeks - 10 days for foundation and 1 day to set generators.
Inlet gas pressure: 2 psig
Applications:

- Voltage Source for Islanded operation.
- Reliable power source.

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Energy Storage

Manufacturers: S&C Electric – Storage Management System, LG Chem – Lithium Ion batteries.

Ratings: 250KW @ 2 hours, 5,000 full discharge-recharge cycles.

Efficiency: Round trip 90% and 80% depth of discharge.

Installation: Skid mounted to allow easy system relocation.

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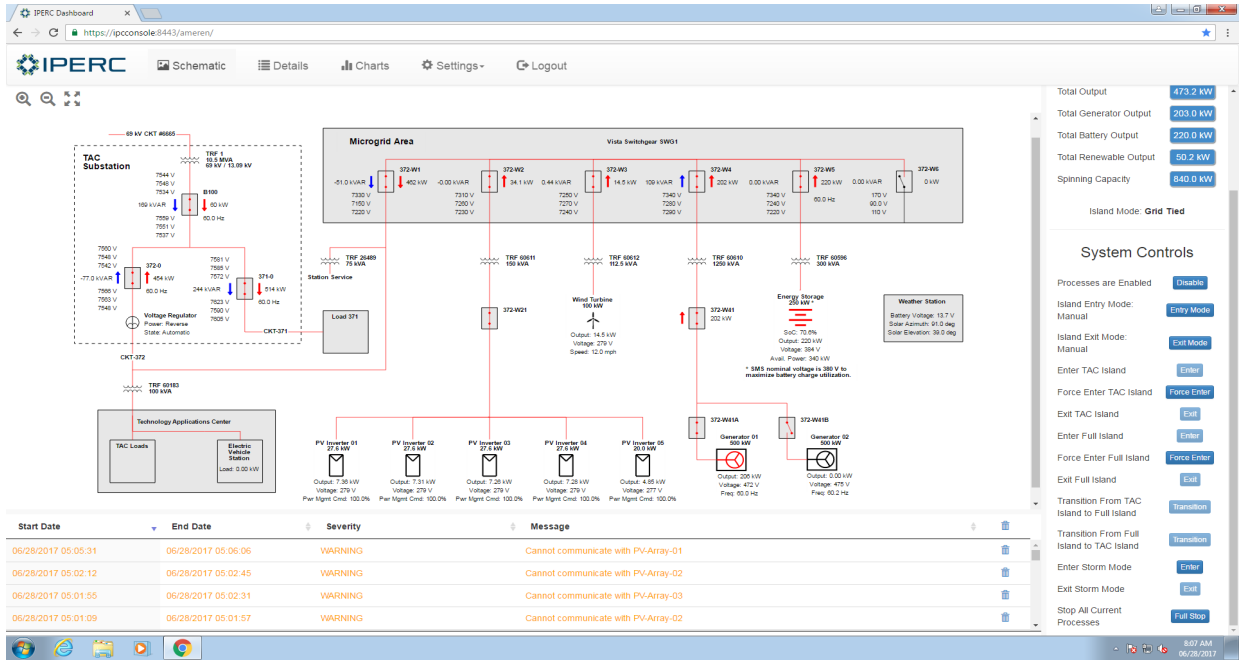
Controls – Secondary – IPERC Grid Master

- 9 – Distributed controllers manage DER & Distribution system assets.
- Manage process for seamless transitions (Grid to island, Island to Grid)
- Receive input signals from Tertiary controls to enable use case testing.
- **First military grade, Authority-To-Operate (ATO) certified microgrid controller on Utility scale installation**



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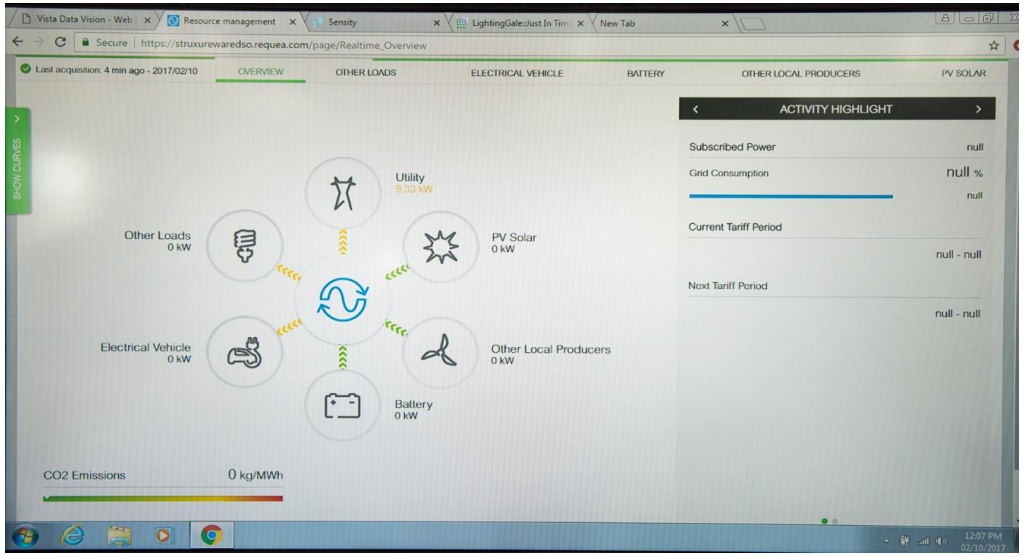
Controls – Tertiary – Schneider Electric - EMA

- **Provides a platform to enable Microgrid and DER optimal dispatch and operations based on a financial model.**
- **Provides load and generation forecasting as part of operational model.**
- **Includes local weather data as input to Forecast/Predictive model.**
- **Developing tariff management criteria based on Ameren Illinois tariff's.**
- **Provides input signals to secondary controls for use case testing such as demand response/peak load shaving, etc.**



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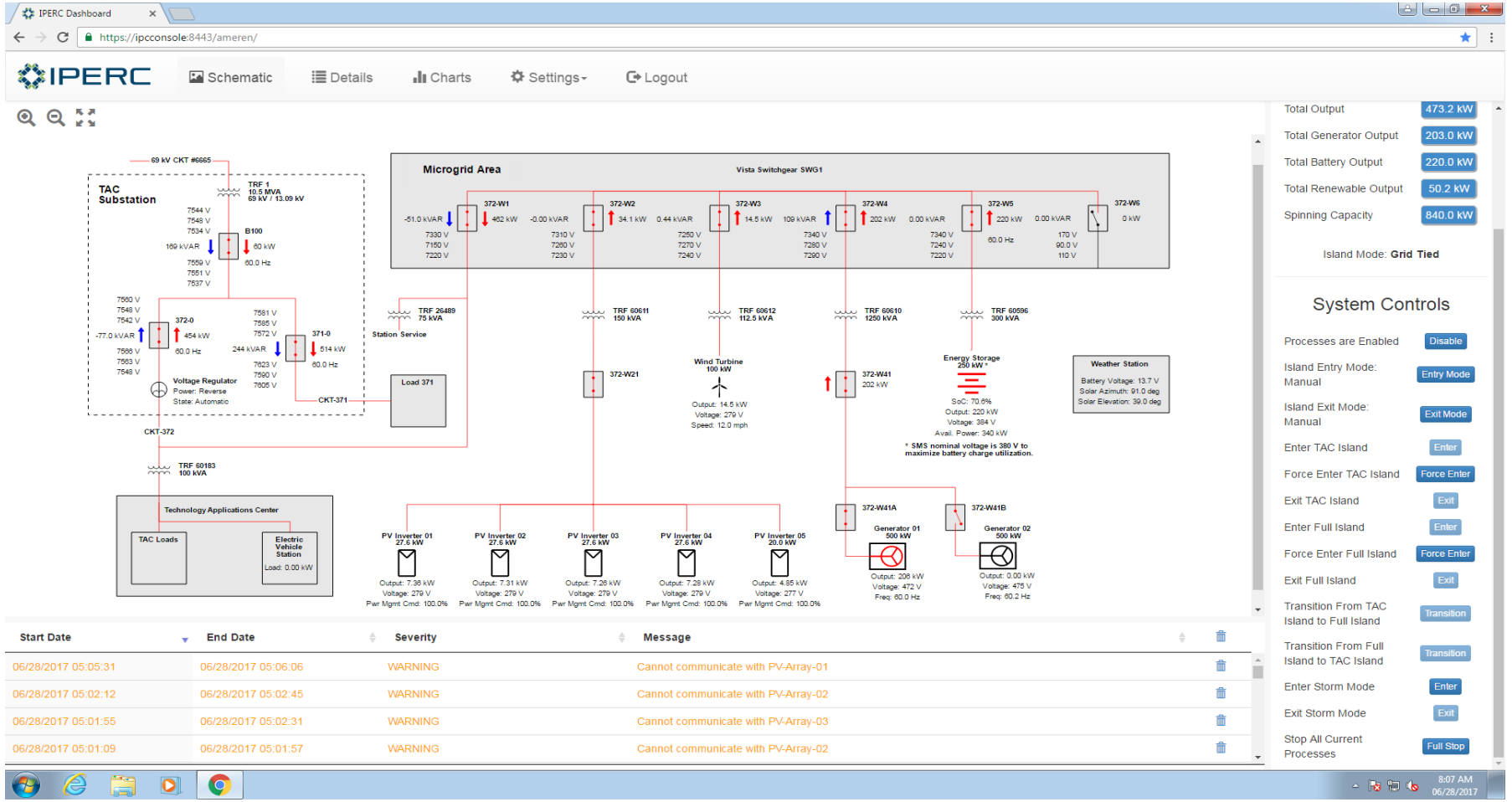
Distributed Energy Resource Integration Project – Modes of Operation



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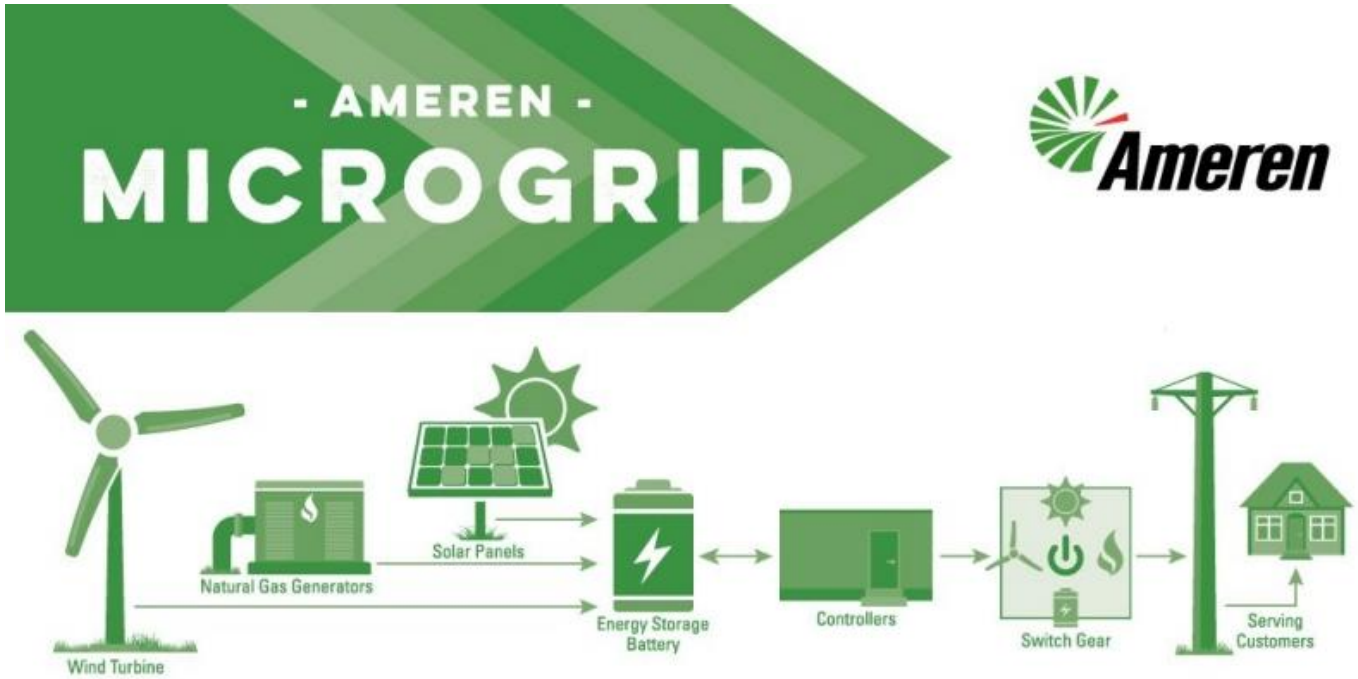
Distributed Energy Resource Integration Project - Timeline

- **6 months of engineering design**
- **7 weeks of construction**
- **Placed in service 12/22/2016**



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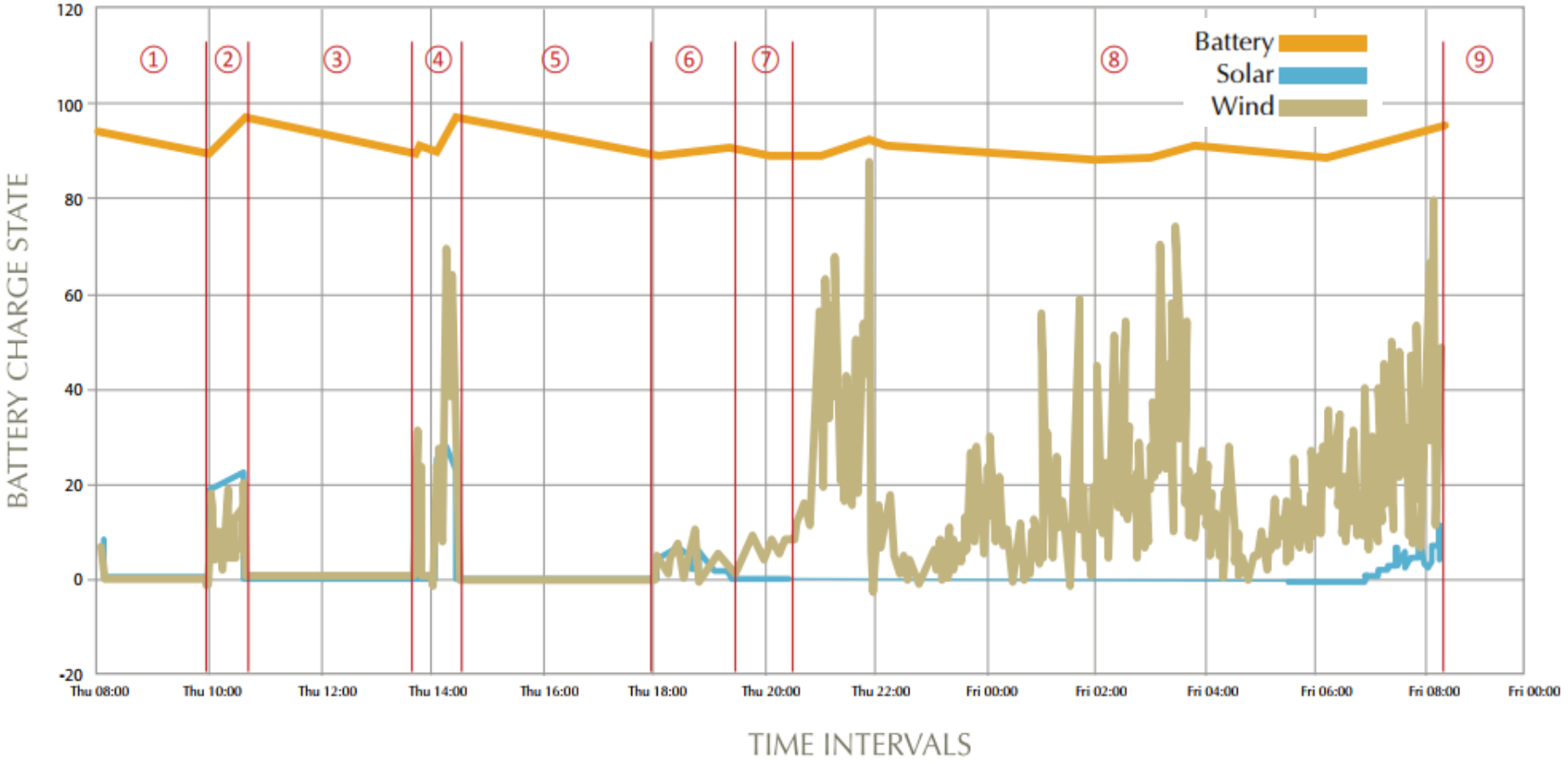
Distributed Energy Resource Integration Project - Challenges

- **Regulatory – Owning Generation Assets**
- **Operations – Seamless Transitions**
- **Operations – Phase Unbalance**
- **Operations – Fault Magnitude (Islanded vs. Grid Connected)**
- **Time Frame – Condensing 3 year project into 8 month project**

Technical Skills

- Develop engineers knowledge of how DER/microgrid assets operate individually as well as in integrated systems.
- Develop knowledge of how DER/microgrid assets can be utilized to improve the operational characteristics of electric distribution systems.
- Develop operational knowledge of DER/microgrid assets to educate field work force on DER characteristics as well as develop procedures to address safety issues that DER assets create.
- Develop knowledge of required maintenance and operation activities to educate field technicians on how to trouble shoot future DER/microgrid systems.

Distributed Energy Resource Integration Project – Successful 24-Hour TAC Island Test



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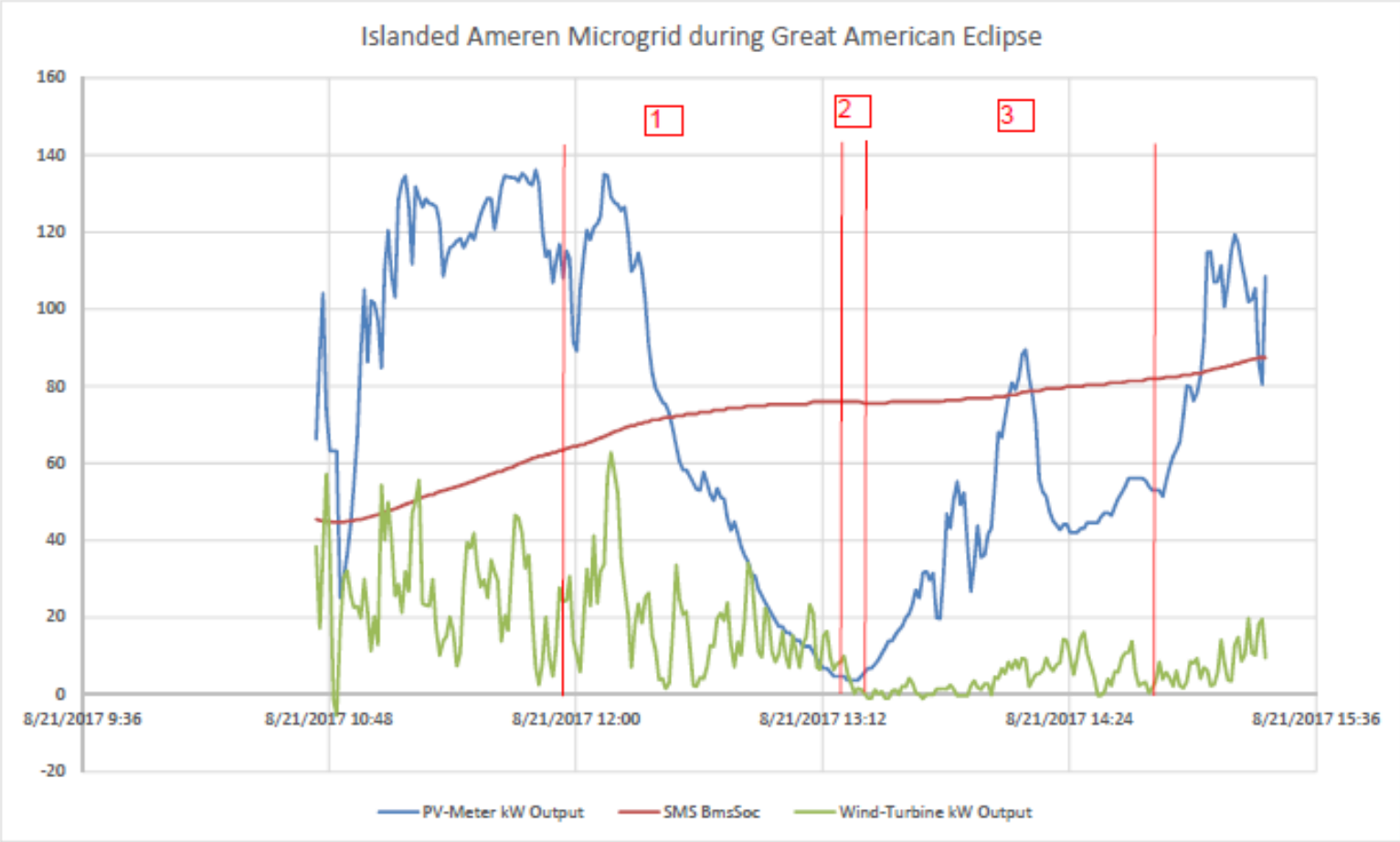
Distributed Energy Resource Integration Project – Islanded during the Great American Eclipse



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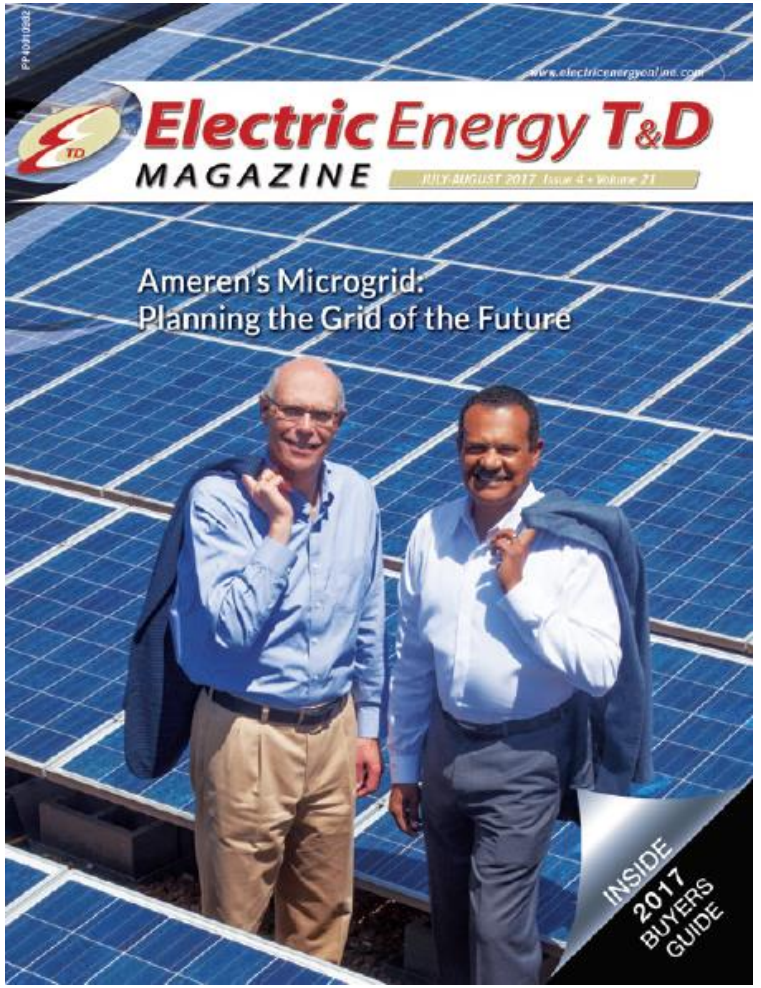
One of the most Technologically Advanced Microgrid's in North America

- **First Microgrid to serve the entire distribution Feeder**
- **Seamless Transition from grid-connected mode to islanded mode**
- **Most diverse DER mix**
- **First military grade, ATO certified microgrid controller on Utility scale installation**



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Questions??

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