PXiSE
Advanced Control Technology (ACT)

“Advanced Grid Control Success Story”

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Agenda

• Introduction - PXiSE Energy Solutions
• Solving the Electric Grid Challenges of the Century
• Problems Identified
• Success Story
  – Summary of results and insights
  – Technology and Product Details
  – Implementation Details
  – Results Obtained and Business Impact
• Conclusion and Looking Ahead
PXiSE Advanced Control Technology (ACT):
Joint technology development between Sempra Energy & OSIsoft

PXiSE Energy Solutions, LLC

A superior, innovative alternative to traditional power systems control

- The electric grid is transforming, thereby creating new and changing grid operation challenges which PXiSE ACT has been designed to solve
- PXiSE ACT, a high-speed and precision electric control solution, can stabilize the renewable-based grids, and improve efficiency of poorly coordinated energy resources, applicable from behind-the-meters, to utilities, and regional grids

PXiSE ACT is a software-based control solution, with 7 licensed and 4 pending patents, specifically designed to manage the increasingly variable, less predictable supply & demand dynamics of the modern & future electric grid

\(^1\)PXiSE is a wholly owned indirect subsidiary of Sempra Energy
# Solving the electric grid challenges of the century

## Mission

A solution is needed to offer the most advanced control for the modern power grid to improve operational efficiencies and enable additional intermittent generation resources to be added to the grid.

## Challenges

Traditional control technology is slow, coordinates resources poorly, and involves longer more complicated integration & maintenance.

- Slow sampling rate
- Inadequate local “droop controls”
- Resources poorly coordinated
- Expensive proprietary hardware, complex and lengthy field integration & maintenance

## Solutions

An advanced solution that uses readily available but underutilized high-speed phasor data and advanced control algorithms to effectively control energy resources.

- Fast data from existing relays
- Adopted real-time advanced control technologies
- Built-in proven data platform
- Hardware agnostic, fast & simple integration & maintenance

## Value Propositions

Such solution can offer tailored value proposition:

- **Owner operator / utility / ISO** – addresses challenges stemming from renewables/DERs penetration.
- **Utility-scale renewables / large DERs** – the above, plus competitive price point and fast field integration to accelerate project implementation.
- **Microgrids / end users** – coordinates many diverse resources to improve utilization and reliability.
Existing island grid operation reached limits

Problem #1 (Sub-optimal Operating Efficiency of Energy Assets)

Problem #2 (Inability to integrate high % renewables and DERs)

- Under-frequency load-shed events
- Not able to achieve economic dispatch, and frequent wind energy curtailment at night
- Transition to higher % renewable stalled
Successful outcome and summarized results

- PXiSE ACT enabled integration of high percentage of renewables
- Improved efficiency of generating resources and reliability of electric system
- PMU-based control implemented quickly and cost effectively
Success factors in achieving objectives

1. PXiSE breakthrough use of PMU data with advanced feedback control and system models

2. High resolution grid visibility and precision control
   - OSIsoft PI System Infrastructure enhances operability and flexibility

3. Software - easy to implement and replicate
   - Hardware - proven and commonly available
Insights from the successful implementation

Validated ACT application in wind/solar farms and enabled broad applications from large to microgrids

A wind farm with energy storage and auxiliary load function like a microgrid

Speed and precision of control system is critical in managing performance of energy assets
PXiSE offers new control capabilities not possible before

Advanced Frequency Control (real power)
- Stabilizes frequency to integrate high % of renewable
- Allows better economic generators dispatch according to heat rate

Advanced Volt. / Var Control (reactive power)
- Addresses intermittencies from renewables
- Mitigates fast voltage excursions from grid disturbances

Frequency-based and State-based Control Options
- Adapts to frequency-based control for grids with spinning generators
- Can switch to state-based control in low or no inertia grids
What is PXiSE (a software-based solution)

An Innovative Alternative to Traditional Power Control

Unlock Efficiencies not Possible by Legacy Solutions
Enable Effective Integration of Very High % of Renewables in Modern Grids

Fast, Precise Control Decisions

Fast Input Data

1. Take Available High-speed Industry Standard Data and SCADA Data
2. Apply Patented Technologies with Software Algorithms inside an Industrial Computer
3. Optimize Value of Energy Assets through Real-time Operations

Continuously streamed in a fast, closed-loop feedback design

Unlock Efficiencies not Possible by Legacy Solutions
Enable Effective Integration of Very High % of Renewables in Modern Grids
The breakthrough in synchrophasor-based technology for real-time control provides complete vision and peak performance to electric grid assets.
High-resolution and high-speed data enable the control necessary for the modern, renewable, and DER-based grids.

Phasor Measurements are Superior to SCADA…

You can’t control what you can’t measure

SCADA misses this disturbance entirely. ACT can control it.

…like MRIs are Better than XRay
PXiSE integrating multiple enabling technologies into a solution - created new control capabilities not possible before

1. Time-synchronized, high-resolution, and high-speed data management

2. Advanced feedback control and decoupling technology

3. System modeling, optimization, and data analytics

Application of Modern, Broadly Available PMU Data

Provides New Capabilities Not Possible Before

Provides New Insights Not Available Before

Embedded PI Data Historian

Advanced Control Technology (ACT)
What is PXiSE Advanced Control Technology (ACT)?

1. **Integrated on a Proven Data Platform**
   (Function Like an Intelligent High-speed SCADA)

   - PMU data
     - Digital relays
     - Energy meters
   - Digital data in
     - SCADA sensors
     - Weather data

   - Fast data management & interfaces
   - ACT Server
     - Advanced Feedback, Modeling, & Optimization
   - PI Interfaces
   - PI AF Server
   - PI Data Server
   - With OSIsoft PI Embedded

   - Hi-speed control
     - Generation Resources
     - Controllable Loads
   - Digital data out
     - Alerts and displays
     - Reports and replays
     - Enables machine learning & system optimization

2. **Implemented on Field Proven Hardware**

   - Example hardware:
     - SEL 3355 (industrial computer)

3. **Software Designed for Fast Field Implementation**
Benefits of embedding a proven PI System data platform

PI Tools
Quick initial setup and configurations from system components to data structure

Data Services
Supports high-speed & big data management with events and control actions recording & analysis

Asset Framework
Enables faster and easier implementation of similar applications supporting a diverse portfolio of energy assets
PXiSE ACT has broad applications

ACT’s software-based horizontal technology has applications across the full power grid and precisely automates and synchronizes the control of many energy assets.
Fast 2-week implementation at Auwahi Wind Farm

Wind Farm Commissioned in 2012
- 24 MW Wind Turbines (3MW x 8)
- 11MW / 4.4 MWh Li-ion Battery Storage
- Existing SEL Relays with built-in PMUs
- Hardware added 2017: PXiSE Computer & I/O Controller

Control Capabilities
- Existing Controller (2012 - Industrial PLC/Computer):
  - Ramp Control of Real Power Only
- PXiSE ACT (2017):
  - Ramp Control of Real and Reactive Power
  - Advanced Frequency and Volt./Var Control
PXiSE PMU-based high-speed feedback control at Auwahi Wind Farm with battery storage

69kV POI

9 Units of Battery: 1.2MW / 0.5MWh Each

PMU

Two 34.5kV Circuits 9 Miles

3MW x 8 Wind Turbines

SOC Ref: 71.0%

Controller: 16,020,106 (154,303)

Ovation: 69.1%

Ovation: 69.8%

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9 Miles

Two 34.5kV Circuits

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High-speed precision real and reactive power control

- Real Power scheduling and curtailment management
- Reactive power volt. / var management
Paradigm shift needed – let each type of resource contribute according to its natural advantages & characteristics

1. Renewables produce power to the grid as available based on desirable mix

2. Use coordinated batteries as the primary tool to stabilize frequency (manage the dynamic changes from intermittency of renewables and variations in the grid as a single disturbance)

3. Enable large thermal generators to operate in a steady speed and dispatch in coordinated steps thus improving thermal efficiency (speed governor action avoided due to frequency changes addressed by ACT)
Demonstrated result: Operational value with ACT + battery

**BEFORE**
Ramp Control

**AFTER**
Advanced Frequency Control

**IT NEEDED**
- Seven regulating generators
- Three existing batteries

**TO ACHIEVE**

**VALUE TO AN ASSET OWNERS:**
1. Reduce generator capital, O&M, and fuel costs
2. Enable further increase of renewable mix to lower energy cost

**PXiSE USED**
- One battery
- One coordinated generator

**TO ACHIEVE**

1. Variable Solar PV
2. Variable Wind
3. PXiSE Advanced Control

Stable Frequency

Fluctuating Frequency
Business impacts: Utilization of electric grid energy assets can improve significantly with PXiSE ACT + battery

**BEFORE**
Traditional Control

**AFTER**
Advanced Frequency Control

Battery sized to cover for largest contingency

Fuel savings from heat rate improvements
Less renewable curtailment (less fuel use)
Maintenance savings from generators on standby
GHG benefits from fuel savings
Energy cost savings from additional renewables
Conclusion and implications

Successful implementation in an island demonstrated the benefit of an advanced PMU-based, high-speed, and precision control alternative to legacy controls.

Such advanced control technology can improve efficiency and reliability of electric energy assets significantly.

High % renewables integration can be achieved cost effectively and intermittencies can be addressed.

PXiSE ACT enables new control capabilities with a huge potential to benefit large and small electric grids worldwide.
PXiSE ACT has broad applications to ensure smooth, reliable, and cost-effective operations of energy assets in an modern grid.

Control Microgrids and Integrate in Power Systems

Multi-objectives Energy Dispatch – Timed Demand & Flow Control

- Enhanced Hybrid Turbine – Ramp & Frequency Control
- Intermittencies and Power Output Schedule Management
- Optimal Control of All Resources – Improve Efficiency and Reliability

Energy Storage + Gas Turbine

Wind Resources + Solar Resources

Energy Storage + Thermal Generation
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Questions

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谢谢
Спасибо
ありがとうございます