Peak Reliability[1] (formerly part of the Western Electricity Coordinating Council)

Western Interconnection Synchrophasor Program

Scope of Work

Peak Reliability (Peak) and eight of its member transmission organizations deployed synchrophasor technology throughout the U.S. portion of the Western Interconnection. The project installed or upgraded 584 phasor measurement units (PMUs) (393 using WISP program funding), 77 phasor data concentrators (PDCs) (57 using WISP program funding), a wide-area communications network to support PMU data transfer, information technology infrastructure, and advanced transmission software. Together, these systems increase grid operators' visibility into bulk power system conditions in near-real time, enable earlier detection of problems that threaten grid stability or cause cascading outages, and facilitate sharing of information with neighboring control areas.

Objectives

The main objectives of the Western Interconnection Synchrophasor Program (WISP) were to improve electric system reliability and enable better grid integration of renewable resources.

Deployed Smart Grid Technologies

- **Wide-area monitoring, visualization, and control systems:** WISP implemented advanced wide-area monitoring, visualization, and control systems not previously available to transmission owners in the Western Interconnection. These systems provide a more expansive view of the Western bulk power system and simultaneously reveal dynamic operating conditions.
- **Communications infrastructure:** The project included the design and implementation of a new dedicated, secure, and low-latency wide-area network that supports phasor data exchange between the transmission owners and the aggregation of data for the Peak Reliability Coordination offices. This effort included upgrading and deploying a new network infrastructure at the transmission owner level to connect 584 PMUs throughout the U.S. portion of the Western Interconnection.

At-A-Glance

Recipient: Peak Reliability

State: AZ, CA, CO, ID, MT, NM, NV, OR, SD, TX, and WA

NERC Region: Western Electricity Coordinating Council

Total Project Cost: $107,780,000

Total Federal Share: $53,890,000

Transmission Organizations: Bonneville Power Administration, California Independent System Operator (ISO)/California Energy Commission, Idaho Power Corporation, NV Energy, PacifiCorp, Pacific Gas & Electric, Salt River Project, and Southern California Edison

Project Type: Electric Transmission Systems

Equipment
- **393 Phasor Measurement Units**
- **57 Phasor Data Concentrators**
- **Transmission System Communications Network**

Advanced Applications
- **Angle and Frequency Monitoring**
- **Voltage and Voltage Stability Monitoring**
- **Post-Mortem Analysis**
- **Oscillation Energy and Mode Meter Monitoring**
- **Reactive Reserves Monitoring and Device Control**
- **Model Baselining, Validation, and Improvement**
- **Path Loading and Congestion Management**

Key Benefits
- **Deferred Investment in Transmission Capacity Expansion**
- **Reduced Ancillary Service Cost**
- **Improved Ability to Avoid Cascading Outages**
- **Improved Electric Service Reliability and Power Quality**

[1] The Western Electricity Coordinating Council bifurcated into into a Regional Entity (WECC) and a Reliability Coordinator (Peak Reliability). Effective February 12, 2014, Peak is now a wholly independent organization and manages the Western Interconnection Synchrophasor Program.

- **Advanced transmission applications:** At various stages throughout the project, Peak deployed advanced transmission applications that use synchrophasor system data to improve visibility into the bulk power system. These applications have enabled the following:
  - **Angle and frequency monitoring** to provide grid operators and engineers with detailed information about grid conditions and power flows
  - **Post-mortem analysis** to enable power system engineers and grid operators to analyze disturbances and large-scale system events to better understand their causes and improve future system models and operations
  - **Voltage and voltage stability monitoring** to provide grid operators and engineers with detailed information about grid conditions and system stability
  - **Oscillation energy and mode meter monitoring** to allow grid operators and engineers to observe power system disturbances and oscillations and to assess their impacts on grid reliability
  - **Reactive reserves monitoring and device control** to enable grid operators to better manage reactive power flows and to ensure greater voltage control and stability
  - **Model baselining, validation, and improvement** to increase the accuracy of power systems models for engineering planning and operations
  - **Path loading and congestion management techniques** to provide grid operators with more tools for identifying disturbances and preventing them from cascading into more serious problems or outages
- **Operations control room and training room infrastructure upgrade:** The Vancouver, Washington, and Loveland, Colorado, control rooms and training rooms were expanded to accommodate new synchrophasor applications.

Benefits Realized

The U.S. Department of Energy Smart Grid Investment Grant (SGIG) funding of $54 million leveraged $71 million of private funding from the cost-share partners and more from 10 additional participants to deploy and begin using the WISP synchrophasor system architecture. WISP resulted in an interconnection-wide system with 584 PMUs installed or upgraded and 77 PDCs installed, 57 using WISP program funding, to concentrate and time-align the measurements. They are networked via a dedicated, secure, and low-latency vendor-provided wide area network. DOE's funding served as a catalyst resulting in an infrastructure that would have taken at least 20 years to deploy absent the grant. Immediate benefits so far have included significant improvements in generator modeling, saving costs and improving accuracy over previous validation methods, while improving system reliability through more accurate power system behavior simulation studies which were used to set path limits. An example of an operational benefit is the use of phase angle monitoring to accelerate the reclosing of an important tie line between the Desert Southwest and Southern California, thus improving system stability. As part of the project, WISP developed a Universal Data Sharing Agreement, executed by all the reliability entities in the west, that resulted in unprecendented data sharing among peers and allowed access and protection of data shared through the West's reliability portal PEAKRC.org—home of the registry, data archives, next-day studies, the Westwide System Model, and the Wide Area View. Such wide-area data sharing is essential to realize the full benefits of synchrophasors. Finally, the infrastructure for a response-based control system has been implemented. Following an appropriate monitoring period, the automatic control system, using synchrophasor measurements as input, will switch reactive devices and allow up to 100 megawatts (MW) of operational capacity to be more frequently usable on the AC California–Oregon Intertie (COI).

WISP’s successful implementation has also resulted in many general benefits to the Western Interconnection:

- Large-scale outage avoidance and faster system restoration due to improved situational awareness of operators in the Western Interconnection
- Increased transmission transfer capability and improved congestion management
- Reduced costs due to a more efficient transmission system, resulting in less need for additional high-voltage transmission investment
- Improved and more cost-efficient integration and utilization of intermittent renewable energy generation, with corresponding environmental benefits, such as reduced greenhouse gas emissions
- Improved interconnection reliability by faster detection of and response to disturbance phenomena
- Optimized asset usage and operating efficiency by allowing the Western Interconnection to reliably operate at high transfer levels
- Resiliency to attacks and natural disasters by enabling wide-area control and protection technology
- Jobs creation for the deployment, management, and monitoring of synchrophasor infrastructure and applications
- Building a foundation for the support of next-generation, smart grid technologies

Lessons Learned

- Common language for effective operation - all project participants must agree to naming standards for measurements.
- When adopting new technologies, operations personnel should be brought into the process as early as possible.
- Network-wide view - select a WAN communications vendor that will manage the entire network end to end.
- Off-the-shelf hardware should be used whenever possible to improve system integration capability and improve cost efficiency.
- Use standard, currently adopted and supported communications protocols whenever possible to improve integration with existing systems and streamline ongoing maintenance and support.
- Factor in additional time and cost when in the planning stages to ensure vendors are or can be prepared to meet security requirements and handle exceptionally high data volume requirements.
- Simulating real-world synchrophasor data network loading is extremely difficult.
- A comprehensive standard for PDCs should be developed. The original NASPInet (North American SynchroPhasor Initiative Network) design needs to be modernized.
- Project teams should schedule adequate time for partnership agreements. Executing comprehensive data sharing agreements was harder to accomplish and longer in duration than expected.

Future Plans

Use of this infrastructure going forward will further benefit from improving data quality from the PMUs; ensuring the availability and accuracy of the time sources; and developing additional applications to take advantage of good-quality, frequent, and time-synchronized snapshots of the power system to improve its efficiency, reliability and capacity. It will be important to continue data management efforts and synchrophasor application development to take full advantage of the infrastructure enabled by the SGIG funding. The WISP partnership is using a follow-up grant to support the Peak Reliability Synchrophasor Program (PSRP), which will build on the momentum in synchrophasor system development made possible by the WISP project. Peak's future plans include major initiatives to improve data accuracy and availabililty; perform additional model calibration and validation; conduct interconnection baselining; improve data transmission through the use of true publish/subscribe messaging to minimize wide area network traffic and latency; and conduct pre-commercial development in modal analysis, voltage stability, and wide area view applications.

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