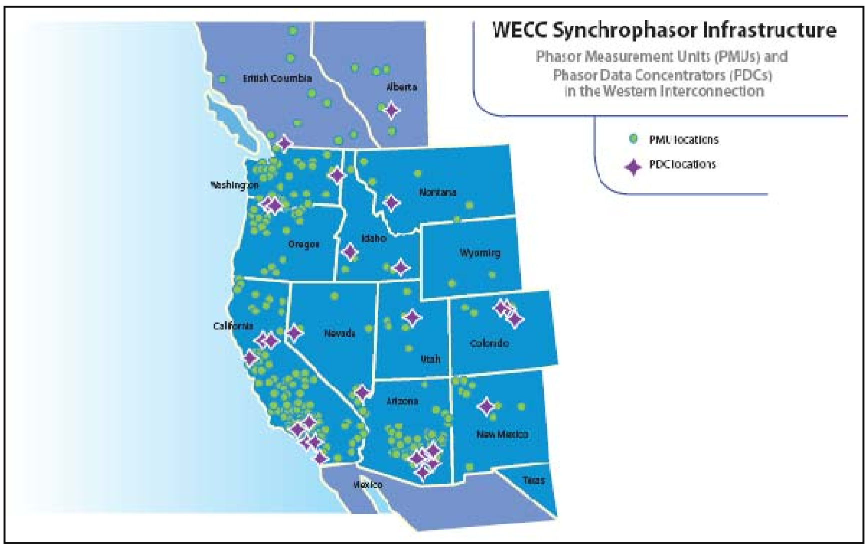
A Smart Grid Strategy for Assuring Reliability of the Western Grid

The Western Electricity Coordinating Council (WECC) is the Regional Entity responsible for coordinating and promoting bulk electric system reliability in the Western Interconnection. WECC and its members manage the operation and planning of the vast interconnected transmission system connecting generators and loads across almost 1.8 million square miles of territory. *The Western Interconnection Synchrophasor Program* (WISP), led by WECC and involving 18 partners, is an initiative to modernize operation of the transmission system in the Western Interconnection, increasing reliability and system performance, and enabling greater use of renewable resources such as solar, hydro, and wind.

The WISP Project

Funded partially with $53.9 million in American Recovery and Reinvestment Act of 2009 (Recovery Act) stimulus funds awarded by the U.S. Department of Energy (DOE), WISP partners are installing an extensive network of synchrophasor technology, including more than 300 phasor measurement units (PMU) and 60 phasor data concentrators (PDC), across the Western Interconnection. This technology deployment is revolutionary for two reasons: First, PMUs record power system data 30-to-120 times per second, which is more than 100 times faster than current technology. Second, each PMU time-stamps every measurement it takes, enabling all data to be synchronized. The WISP project is building a communication infrastructure that will tie all of these devices together and connect them to WECC's two reliability coordination centers.



The core technology of phasor measurement is not new. Grid operators and utilities have been using development-grade PMUs for some time. The key to WISP is that it is deploying networked, production-grade synchrophasor technology on a massive scale across the Western Interconnection. Engineers, reliability coordinators and grid operators must gain experience in using the advanced technology and the information it provides to improve grid operations and planning.

PMUs and PDCs provide the data, but it will be advanced transmission software applications that help grid operators, reliability coordinators and engineers use the new information that will be flowing in from across the Western Interconnection.

The earliest applications will focus on monitoring grid conditions and disturbances. The vast synchrophasor network will provide grid operators and reliability coordinators an unprecedented view of the Western Interconnection and dramatically improve situational awareness. Such applications will include monitoring of system frequency, voltage, and oscillations. Other applications will utilize synchrophasor information to control devices in ways that have been impossible in the past. Some applications will allow engineers to improve power system models and increase the operational efficiency of the grid.

WISP's Smart Grid Investment Grant (SGIG) Advanced Applications

1. Angle and Frequency Monitoring
2. Voltage and Voltage Stability Monitoring
3. Oscillation Energy and Mode Meter Monitoring
4. Reactive Reserves Monitoring
5. Alarm Management
6. Improved State Estimation
7. Remedial Action Scheme - control of reactive devices for California-Oregon Intertie
8. Remedial Action Scheme - control of primary and secondary reactive for wind generation
9. Steady-state model baselining, validation, and improvement
10. Dynamic model baselining, validation, and improvement
11. Power system restoration
12. Post-mortem analysis
13. Archival data mining
14. Island detection and restoration
15. Fault detection
16. Congestion Management

The Evolving Challenge of Operating the Western Grid

Managing large regional power systems has always been challenging. These systems are composed of numerous large generators operating synchronously and can be connected by thousands of miles of transmission lines. Over the past two decades the Western Interconnection has evolved in ways that have increased the challenge for grid operators and engineers. High temperatures and a growing residential and commercial population have increased the demand for electricity, and shifted load from industrial processes to air conditioning. The same high temperatures that drive air conditioning load also cause transmission lines to sag more, limiting the amount of power they can safely carry. In addition, generators in the West are often located far away from population centers and load, and new sources of supply – including wind and solar – behave differently than traditional central station generation. "This is not your mother's power system anymore," said Vickie VanZandt, WISP Program Manager.

Western Power Oscillations and Synchrophasor Technology

Each large generator has a control system that governs its power output so that the generator can help maintain system frequency and voltage. When a disturbance occurs, generator control systems attempt to rebalance the grid with proper frequency and voltage. Since the generators are all connected, they interact with each other, and power oscillations between different parts of the system can occur. Under conditions of high grid stress, the oscillations can grow, resulting in a breakup of the system and a potential blackout.

A coordinator at one of WECC's reliability centers

Unfortunately, the grid monitoring technology most commonly used today does not allow grid operators and reliability coordinators to see these oscillations, making it difficult to tell when the system is operating in a way that could lead to problems. "If you can't see what's wrong, you can't fix it," said Mark Maher, WECC's CEO. Conventional technology provides grid operators with snapshots of the power system every two to four seconds. This is a problem because the snapshots are too slow to show the oscillations and snapshots being taken across the Western Interconnection are not time-synchronized. The current process is like trying to build a complete and clear picture out of a group of misaligned, low-resolution pieces. According to VanZandt, "what we need are high-frequency measurements of the grid, and for those measurements to be synchronized and visible."

Managing Power Disturbances on the Western Grid

A key example of how the WISP project will benefit the West is found on the California-Oregon Intertie (COI), a critical transmission pathway in the Western Interconnection that delivers available power from the northwest to meet demand in California. Presently, grid operators have set an upper operating limit for power flow on the COI to meet reliability standards determined through various engineering studies. Real-time information and automated controls available from synchrophasor technology will permit grid operators to eventually raise operating limits on the COI. This will be accomplished by using the synchrophasor technology to detect oscillations very quickly, and switch on capacitor banks to dampen these oscillations before they can grow to dangerous levels. VanZandt said that the technology is "expected to allow at least 100 megawatts of operational capacity on the California–Oregon Intertie, conservatively estimating." That is enough power to supply over 100,000 homes. The project intends to monitor and test the COI operating scheme for at least two years (beginning in early 2013), before permitting automatic control in early 2015. The advanced capability of synchrophasor technology will be used to support numerous similar solutions throughout the US, which would not have occurred for many years without funding from the Recovery Act.

Expected Benefits of WISP Project

Reliability

In the near term, WISP and other projects like it will help grid operators, reliability coordinators and engineers better understand the complexities of a dynamic power system. The new information and tools should reduce the frequency and scope of outages in the bulk power system. Given the huge economic impact of blackouts, the reliability benefits are expected to be significant.

Operational Efficiency

With a better picture of real-time grid conditions, WECC operators will be able to more fully use the capability of the transmission system enabling it to be operated closer to its dynamic limits. Better use of the existing grid will allow transmission owners to defer other investments to increase system capacity or build new lines, yielding significant financial savings.

Renewable Resource Integration

The West has rich wind resources, but the variability of these resources poses operating challenges as penetration has increased. High frequency monitoring of these plants and real-time grid conditions should enable better regulation and coordination of generation and load in the West.

Learn More

The American Recovery and Reinvestment Act of 2009 (Recovery Act) provided DOE with $4.5 billion to fund projects that modernize the Nation's energy infrastructure and enhance energy independence. For more information about the status of other Recovery Act projects, visit www.smartgrid.gov. To learn about DOE's Office of Electricity Delivery and Energy Reliability's national efforts to modernize the electric grid, visit www.oe.energy.gov.

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