Update on SGIG Synchrophasor Metrics & Benefits Reporting

- Build Metrics
- Impact Metrics
- Functions
- Case studies
- What’s Next?

“And then one day the grid went down and never came back up.”
© New Yorker Magazine
SGIG Synchrophasor Projects

*DOE and the grant recipients spent approximately $230 million on deploying synchrophasor technologies for these projects.*

<table>
<thead>
<tr>
<th>SGIG Recipient</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operators</strong></td>
<td></td>
</tr>
<tr>
<td>ISO-New England</td>
<td>Install PMUs and PDC across 6 states</td>
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<tr>
<td>Midwest ISO</td>
<td>Deploying synchrophasor technology throughout its service footprint. — optimize power plant dispatch and operations</td>
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<tr>
<td>NY-ISO</td>
<td>Deploying synchrophasor technologies and smart grid-enabled capacitors. Improve reliability and prevent spread of local outages</td>
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<tr>
<td>PJM</td>
<td>Deploying PMUs in 81 of its high-voltage substations. Improve reliability, prevent spread of local outages, restoration procedures</td>
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<tr>
<td>WECC</td>
<td>PMUs throughout the U.S. portion of the Western Interconnection. Improve reliability, prevent spread of local outages, restoration</td>
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<td><strong>Asset Owners</strong></td>
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<tr>
<td>American Transmission Company</td>
<td>Expands collection of synchrophasor data from 25 to 73 substations</td>
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<tr>
<td>Duke Energy</td>
<td>Installation of PMUs and phasor data concentrators 51 substations across the Carolinas. Visualization and improved operations</td>
</tr>
<tr>
<td>Entergy</td>
<td>PMUs, PDCs, and state of the art decision support tools</td>
</tr>
<tr>
<td>Florida Power &amp; Light</td>
<td>Synchrophasor and line monitoring devices to help increase reliability and security of the transmission system</td>
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<tr>
<td>Idaho Power Company</td>
<td>PMUs, increase monitoring capabilities and improve reliability</td>
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<td>Lafayette Consolidated</td>
<td>Advanced transmission system monitoring equipment. Improved reliability, reduced grid operations and maintenance costs, reduced outage duration, reduced peak loads, and reduced overall energy usage</td>
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<tr>
<td>Government</td>
<td>Deploying new smart relays at its Knoll transmission substation. These relays include synchrophasor measurement technologies that can increase grid operators’ visibility of bulk power system conditions</td>
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</table>
The SGIG build phase is almost complete

SGIG project participants (using SGIG funds and matching private investment) have installed over 1,000 networked PMUs.

The ARRA funding helped utilities achieve a “critical mass” of networked PMUs to support a variety of analytic functions.
What are grant recipients doing with PMUs?

PMU data are being used for numerous planning and operations functions.

Most projects are still early on the learning curve, with PMU data not yet used in real-time operations.
Current Activities Reported by Recipients

- Developing new applications
- Interfacing with existing systems and functions
- Improving data collection, transmittal, concentration, and analysis procedures
- Beginning to move technology from engineering to operations
- Documenting use of synchrophasors – case studies
Synchrophasor Metrics & Benefits Reporting

To measure progress and benefits of SGIG investments, many recipients agreed to report on a small but cogent set of metrics.

Deployment & System Description

Data Sharing & Procedures

Reliability Benefits

Data Flow & Management

Applications & Controls

Asset Utilization, Energy Efficiency, & Organizational Efficiency

Blue = Build Metrics

Green = Impact Metrics
PMU Data Lifecycle

Utilities and ISOs developing and sharing best practices to obtain reliable, accurate data

PMU Data Validation at ISO New England

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Abstract—A comprehensive ad hoc PMU data validation process is introduced. The proposed process includes data verification as well as diagnosis of common problems. The validation process utilizes data from PMU, SCADA and state estimation data sources. More than 18 months of deployment at ISO-NE has proven the efficiency of the process. This paper presents and discusses common data quality issues and their causes. A real-time monitoring tool is also proposed based on this process and is under development at ISO-NE.

- Calibration
- Data validation
- Operations and data curating
ISO-NE Oscillatory Stability Management (OSM) Deployment

The PhasorPoint system deployed by ISO-NE under the SGIG grant successfully detected a system oscillation.

- Inter-area oscillations in the bulk electric power grid can be a leading indicator of a cascading outage.
- ISO-NE's implementation of the PhasorPoint system successfully detected a 100 MW peak-to-peak oscillation at 0.12 Hz that persisted for about 3 minutes (Fig. 1 above).
- To deploy the PhasorPoint system, ISO-NE first identified all the normal oscillation modes for their system (Figure 2 above).
- ISO-NE then used statistical analysis to set alarm thresholds to detect only the potentially problematic oscillations, i.e. those that have large amplitudes and large decay times, so that actions can be taken in a timely manner.

Fig. 1. Time domain plot of power flow.

Fig. 2. Histogram of modes across all measurements in ISO-NE data.

WISP data used to calibrate BPA’s Columbia Generating Station models

Conformance improved significantly between predicted (red) and measured (blue) generator outputs after PMU-based model calibration and validation.

- Analyses using computer models of power system components drive long-term investment decisions and short-term operational processes.
- The results of these analyses are only as good as the models themselves.
- Maintaining models of large generating units is expensive; generators are required to be tested every 5 years.
- By using synchrophasor data now available as a result of the SGIG program, BPA successfully calibrated the Columbia Generation Station unit while it remained online, avoiding a $100K to $700K cost to bring the unit down (cost depends on the time of day and season unit is offline).

Source: WISP Project Update, 7 August 2012.
Where do we go from here?

- Case Studies
- White Papers
- Resources

https://www.smartgrid.gov
https://www.naspi.org

Source: Dominion Virginia Power.
Synchrophasor Technology for Transmission System Operations

To measure progress and benefits of SGIG investments, many recipients agreed to report on a small but cogent set of metrics.

**Deployment & System Description:**
- PMU Count
- PDC Count
- System Description

**Data Flow & Management:**
- System Performance (PMU system including Comms)

**Data Sharing & Procedures:**
- Data Sharing
- Procedures (Operating and/or Planning)

**Applications & Controls:**
- Apps using PMU data
- Control schemes using PMU data

**Reliability Benefits:**
- System performance Indicators (power system)
- Apps and control schemes using PMU data
- Model Validation
- System Dynamics
- System Resiliency & Restoration

**Asset Utilization, Energy Efficiency, and Organizational Efficiency:**
- Transmission Capacity
- Organizational Efficiency / Effectiveness

Blue = Build Metrics  Green = Impact Metrics
Synchrophasor Technology for Transmission System Operations

Commercial vendors are actively creating software that uses SGIG-installed synchrophasor technology to provide high-resolution views into the power system on a wide-area basis. This allows system operators to detect and address operational problems that were previously undetectable with SCADA alone.

V&R Region Of Stability Existence (ROSE)

Psymetrix PhasorPoint

ABB PSGuard