Duke Energy Carolinas, LLC

PMU Deployment in the Carolinas with Communications System Modernization

Scope of Work

Duke Energy Carolinas, LLC's (Duke's) project focused on the modernization of the existing serial-based communications infrastructure across the Carolinas. Upgrades to 52 substations included installations of phasor measurement untits (PMUs) and centralized phasor data concentrators (PDCs). Existing energy management systems were also upgraded, and visualization software was deployed to provide enhanced situational awareness for grid operators.

Objectives

Synchrophasor technology enables high-resolution grid monitoring that improves operational efficiency, service reliability, and power quality. Advanced transmission applications leverage synchrophasor data to provide wide-area monitoring and visualization capabilities that significantly enhance grid operators' ability to prevent local disturbances from cascading into regional outages.

Deployed Smart Grid Technologies

- **Communications infrastructure:** Existing serial communications systems were upgraded to internet protocol-based communications at Duke's substations to deliver PMU data to PDCs and then to Duke's grid control center.
- **Wide-area monitoring and visualization systems:** Duke deployed these systems to enable a more expansive view of the bulk transmission system, while revealing dynamic operating details. Observing the nature of grid disturbances earlier, and more precisely, helps grid operators quickly respond to disturbances and improve service reliability. Enhanced monitoring and diagnostic capabilities provide greater precision in daily operational decision making and improve overall system utilization and efficiency.
- **Advanced transmission applications:** The synchrophasor system has been enhanced with the following:
  - **Angle and frequency monitoring** provides grid operators and engineers with detailed information about grid conditions and power flows.
  - **Post-mortem analysis** enables power system engineers and grid operators to analyze disturbances and large-scale system events, providing better understanding of their causes. This information also supports continual improvements to system models and operations.
  - **Improved state estimation** addresses parts of the transmission grid that lack angle measurements to improve accuracy of power systems network analysis calculations for operations.
  - **Steady-state model benchmarking** increases the accuracy of power systems models for planning and operations.

At-A-Glance

Recipient: Duke Energy Carolinas, LLC

State: North Carolina, South Carolina

NERC Region: SERC Reliability Corporation

Total Project Cost: $7,653,910

Total Federal Share: $3,826,955

Project Type: Electric Transmission Systems

Equipment

- Synchrophasor Communications Network
- 103 Phasor Measurement Units
- 2 Phasor Data Concentrators

Advanced Transmission Applications

- Angle/Frequency Monitoring
- Post-Mortem Analysis
- Improved State Estimation
- Steady-State Model Benchmarking

Key Benefits

- Improved Electric Service Reliability and Power Quality
- Improved Ability to Avoid Cascading Outages

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Benefits Realized

- Significantly expanded situational awareness, system state estimation, and security monitoring.
- Improved reliability of the Carolinas' transmission system.
- Implemented the capability to understand system reactions and interactions.
- Provided communications capabilities to support transmission resources.
- Provided upgraded secure communications from Duke to the transmission substations.
- Prepared the transmission network for distributed renewable power sources.
- Increased bandwidth across the network and reduced communications bottlenecks.

Lessons Learned

- Data quality plays a defining role in the effectiveness of synchrophasor technology. As the project moved from the installation phase to active use of PMU data in applications, it became increasingly important to test equipment to ensure that measurements were accurate and that time stamps were being placed appropriately.
- To fully capitalize on the infrastructure investment system, operations personnel must be sufficiently engaged, trained, and committed to working with the new applications and data outside of the post-event analysis framework. The project team must communicate a clear value proposition for embracing the new technology at the operational level.

Future Plans

Realizing that data sharing and systems interoperability will play a major role in obtaining maximum benefits from synchrophasor systems, Duke is interested in working with the U.S. Department of Energy to ensure that common visualization tools, language, and metrics are broadly disseminated throughout the industry. Duke participated in meetings with the other synchrophasor projects funded by the American Recovery and Reinvestment Act (ARRA) to discuss lessons learned, impacts, and benefits from installing PMU systems, thereby increasing overall industry knowledge and effectiveness of synchrophasor technology. These meetings will continue as PMU users become increasingly familiar with and begin to fully leverage the new technology.

Contact Information

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