Wisconsin Power and Light Company

Smart Grid Distribution Automation

Scope of Work

Wisconsin Power and Light Company's (WPL's) Smart Grid Distribution Automation project installed a new distribution management system (DMS) and added intelligent communications and control modules to 32% of the existing switchable capacitor banks. WPL also deployed a volt/volt–ampere reactive (volt/VAR) control application and two-way data transfer infrastructure to enable real-time optimization of feeder voltages and reduce demand on the system.

At-A-Glance

Recipient: Wisconsin Power and Light Company

State: Wisconsin

NERC Region: Midwest Reliability Organization

Total Project Cost: $6,367,309

Total Federal Share: $3,160,651

Project Type: Electric Distribution Systems

Equipment

- **Distribution Management System**
- **Distribution Automation Equipment for 298 out of 906 Circuits**
- **Distribution Automation Communications Network (Capacitor Control Radios, Take out Radios, Routers, Hopper Radios)**
- **Upgraded and Automated 576 Capacitors**

Key Benefits

- **Improved Power Quality**
- **Reduced Greenhouse Gas and Criteria Pollutant Emissions**
- **Reduced Costs from Equipment Failures**
- **Reduced Operating Costs**

Objectives

The project's primary objective was to utilize new volt/VAR control capabilities to reduce reactive power flows throughout the distribution network. By optimizing the delivery efficiency on the distribution system using real-time information enabled by upgraded communications infrastructure, which relies primarily on new radio frequency devices, WPL sought to reduce peak demand costs and greenhouse gas emissions.

Deployed Smart Grid Technologies

- **Distribution management system:** The project deployed the underlying supervisory control and data acquisition (SCADA) infrastructure and DMS control system necessary to provide a platform for data acquisition and control of end-point devices. Using real-time data from distribution line voltage sensors, WPL can proactively respond to distribution load imbalances and prevent premature equipment failure.
- **Distribution system volt/VAR improvements:** WPL deployed an advanced volt/VAR control module that houses the distribution system electrical model and uses field data to determine feeder configuration, VAR requirements, and system voltages. WPL uses this application to control the capacitor bank switching that is necessary to keep the feeders and bus power factors optimized. Controllable capacitor banks that were part of the WPL system before project initiation were integrated into this modeling and control system. Other existing capacitor banks were targeted for upgrades based on communications network coverage and feeder and substation demand profiles. The upgrades included technology for remote switch capability and neutral sensors.
- **Communications infrastructure:** A packet radio system provides the connection between the capacitor bank control modules and the advanced volt/VAR control application. Additional radio takeout points and hopper radios were required to provide the necessary bandwidth and reliability for centralized control.

Benefits Realized

- **Improved power quality**: The upgraded capacitor banks now allow for new capacitor controls to sense and activate alarms for blown capacitor bank fuses and failed switches. The control system, upon sensing an alarm, attempts to switch other capacitor banks into a condition that eliminates the imbalance. This functionality has allowed for rapid restoration of power quality. Improved power quality has resulted in lower operating costs and greenhouse gas emissions.
- **Reduced Costs from Equipment Failures.** The capacitor bank alarm also provides visibility into the capacitor bank's operational status, which has enabled timely repair of deficient capacitor banks, increased capacitor infrastructure availability, and reduced costs from equipment failures

Lessons Learned

Capacitor banks have a higher failure rate than expected. Having the capacitor bank alarms has allowed for improved monitoring and proactive maintenance for increased availability; however, this has actually increased capacitor-related maintenance costs. Smaller capacitor banks are preferred—or at least a mix of smaller, medium, and larger capacitor banks on each feeder, which allows for more efficient power factor corrections. Additional capacitor banks are necessary on some feeders to keep the power factor within the acceptable range and should be a consideration for projects of this type.

Because of market and manufacturing immaturity, equipment delays should be expected and planned for. Additionally, the modeling and optimization algorithms are not mature, but improvements are occurring at a rapid pace.

The applications are data-intensive; robust communications networks are critical and can be costly to build, optimize, and maintain.

Future Plans

The project put in place the basic infrastructure for future smart grid enhancements such as conservation voltage reduction (CVR). As the communications network is strengthened and expanded into other parts of the territory, WPL plans to expand the capacitor control system as well. Work is underway to update WPL's smart grid technology roadmap, which outlines WPL's multi-year plan for grid modernization.

Contact Information

Megan Dyer
Manager, Distribution Engineering
Wisconsin Power and Light Company
608-458-3013
MeganDyer@AlliantEnergy.com