Memphis Light, Gas, and Water Division

Implementation of Smart Grid Technology in a Network Electric Distribution System

Scope of Work

Memphis Light, Gas, and Water Division (MLGW) implemented smart grid technology in a network electric distribution system. The installed technologies included new intelligent relays and sensor equipment to provide remote switching at the transformer level as well as vital information to aid in the design, operation, and preventive maintenance of the complex electric system. The project deployed a communications system that facilitates the flow of real-time data from intelligent electronic devices and sensors installed in the field with MLGW's control systems.

Objectives

The overall objectives were to install a high-speed communications system throughout the area served by MLGW's Network Power Distribution System. This provided support for distribution automation (DA) and future Smart Grid applications at MLGW such as an advanced metering infrastructure (AMI). The upgrades also reduced restoration times and the need for truck rolls for grid maintenance, improving reliability and reducing operating costs and pollutant emissions. Additional objectives included enhancing the safety of MLGW's construction and operations personnel and the public; improving the efficiency of MLGW maintenance and repair efforts; integrating the DA system with MLGW's existing supervisory control and data acquisition (SCADA) system and enhancing the existing outage management system (OMS); initiating a new level in the state of the art and standardization of distribution automation equipment by demanding vendor use of industry standard protocols and an enhanced data set; and lastly, demonstrating a system with ready scalability for other utilities' network systems.

At-A-Glance

Recipient: Memphis Light, Gas, and Water Division

State: Tennessee

NERC Region: SERC Reliability Corporation

Total Project Cost: $11,483,935

Total Federal Share: $5,063,469

Project Type: Electric Distribution Systems

Equipment

- **Distribution Automation Equipment**
  - **Distribution Management System**
  - **Fiber Optic and Copper Instrumentation Cable**
  - **Mesh Distribution Automation Communications Network**
  - **Additional Capacity for the SCADA Communications Network**
  - **220 Equipment Health Sensors**
  - **489 Intelligent Relays**

Key Benefits

- **Improved Electric Service Reliability and Power Quality**
- **Reduced Costs from Equipment Failures**
- **Reduced Operating and Maintenance Costs**
- **Reduced Truck Fleet Fuel Usage**
- **Reduced Greenhouse Gas and Pollutant Emissions**

Deployed Smart Grid Technologies

- **Communications infrastructure**: The project deployed fiber optic and copper instrumentation cable networks throughout MLGW's network power distribution territory. Initially, four substations received connections through these new networks, which enable remote monitoring and control of network distribution feeder switching. This communications network integrated the new automated distribution equipment with the existing SCADA system and a new distribution management system (DMS). The system also allows MLGW to monitor key facilities for unauthorized access, addressing public safety. In total, the project installed 224,000 feet of innerduct, 121,000 feet of copper cable, 107,000 feet of fiber optic trunk cable, 129,000 feet of fiber optic branch cable, 68 routers and

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power supplies, 240 environmental enclosures, a communications network management system, and a fiber cable monitoring system.

- **Distribution automation systems:** The project developed and installed new intelligent relays for the network electric distribution system that supplies the Downtown and Medical Center districts. MLGW has upgraded its network protector switches by installing 489 intelligent relays (intelligent electronic devices, or IEDs) with communications capabilities across 40 distribution circuits out of the four substations that support the network system. The relays, in collaboration with new automated monitoring and sensing devices, enable remote monitoring, improved fault isolation, and reduced disturbances on the grid. This automated distribution management reduces maintenance costs and improves distribution system reliability by providing rapid and coordinated response to grid outages and disturbances as well as improved preventive maintenance of key equipment. Specific capabilities of the automated distribution management system include the following:
    - Reports real-time operating parameters (current, voltage, etc.)
    - Notifies staff of the operation and position of network protectors
    - Reports malfunctions of equipment, including pumps, fans, and other devices
    - Facilitates preventive maintenance of network transformers, cables, and support facilities
    - Detects water intrusion and unauthorized access to transformer
    - Provides remote control of network protectors for the protection of MLGW personnel

Benefits Realized

The communications system that Memphis built for this project now provides the ability to connect with smart power distribution hardware and monitoring systems throughout the Downtown and Medical Center areas of the city. This vital backbone will support both current and future implementations of Smart Grid technology in this area. The first of these applications is the DA portion of this project for Memphis's network power distribution system, which gives the utility unprecedented knowledge about system operation and allows for better system design, safer and more efficient use of personnel, and better response to issues affecting the reliable supply of power to the customers in this area. Benefits have already been realized in the first year of implementation, with more than $500,000 in reduced troubleshooting and maintenance costs and a reduction of 8,000 miles of vehicle usage per year. In addition, the new DMS promises to extend similar benefits beyond the boundaries of the network system as more automated equipment is installed throughout the remainder of Memphis's power distribution systems in the future.

Lessons Learned

Memphis overcame several major challenges presented by this project.

- The entire system was designed and built by existing MLGW personnel. The time schedule demanded by the grant was a tough one to meet and required innovative approaches to efficiently tackling the logistics of installing an unprecedented amount of conduit, cable, and equipment. Despite the challenges, the implementation was done safely, without a single lost-time incident.
- The project involved the application of internal resources not typically available for this work. To meet deadlines and address the lack of commercially available devices, MLGW's own shops manufactured some components, and staff applied inherent creativity to develop innovative electronics used in the utility's monitoring system. Central to the success of the DA component, Memphis's engineers worked closely with manufacturers to develop a first-of-its kind design for network protector relays that uses both an enhanced data set and an open

communications protocol, allowing the future interchangeability of these devices from a variety of manufacturers. Making these relays available to the utility industry was a major accomplishment, especially considering the technical challenges that had to be overcome to meet the schedule of the grant.

Future Plans

MLWG will build on the foundation laid by this project to apply Smart Grid technology, including smart meters and distribution equipment, to gathering and applying improved intelligence about the condition and operation of MLWG power distribution systems. Utility personnel will use this information to better diagnose issues with the power system and efficiently route personnel to perform work.

In addition, the new communications and control systems will allow vastly improved data collection and analysis far beyond those currently provided. As MLWG and the industry become more adept at applying this knowledge, customers will continue to see improved reliability of service, as well as increased availability of tools to assist customers in managing their energy usage.

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