Madison Gas and Electric Company

Customer Driven Design of Smart Grid Capabilities

Scope of Work

The Madison Gas and Electric Company's (MGE's) Customer Driven Design of Smart Grid Capabilities project involved the deployment of advanced metering infrastructure (AMI), a new distribution management system (DMS), and electric vehicle (EV) charging stations. MGE provided AMI meters to all medium-to-large commercial and industrial customers and a representative random sample of residential and small business customers within the utility's service territory. Under a pilot project, MGE also installed 19 public EV charging stations and AMI meters to monitor at-home vehicle charging at 25 locations.

Objectives

The MGE project aimed to improve grid efficiency, power reliability, and customer service. The project enabled MGE to gain insight into customer usage patterns over time to better forecast energy and long-term planning needs. This project is titled "Customer-Driven Design of Smart Grid Capabilities" because MGE intends to use the insights gained with respect to customer usage and acceptance of smart grid technologies to design successful strategies for subsequent projects.

At-A-Glance

Recipient: Madison Gas and Electric Company

State: Wisconsin

NERC Region: ReliabilityFirst Corporation

Total Project Cost: $12,597,081

Total Federal Share: $5,550,941

Project Type: Advanced Metering Infrastructure
Electric Distribution Systems

Equipment

- 4,346 Smart Meters
- AMI Communications Systems
  - Cellular Meter Communications Network
- Distribution Management System
- 19 Electric Vehicle Charging Stations

Key Benefits

- Improved Operational Efficiency

Deployed Smart Grid Technologies

- **Advanced metering infrastructure:** The AMI component of the project utilized an existing cellular communications network to pilot smart meter technology. A total of 4,346 AMI meters were deployed across MGE's service territory. All 3,823 medium-to-large-size commercial and industrial customers received advanced meters, while a representative random sample of 523 residential and small business customers were selected for AMI meter installation.
- **Distribution management system:** MGE deployed part of an integrated distribution management system (IDMS). The IDMS integrates data from MGE's supervisory control and data acquisition (SCADA) system, energy management system (EMS), geographic information system (GIS), AMI head end system, relay information database, and interactive voice response (IVR) system. The IDMS also provides system visualization, dynamic system modeling, online power flow analysis, and remote device control capabilities. Additionally, the IDMS includes tools such as an outage management system (OMS); fault location, isolation, and service restoration (FLISR); automated feeder reconfiguration (AFR); volt-VAR optimization (VVO); and improved switch order management. The first phase of IDMS implementation was completed under the SGIG program and included building the dynamic system model, visualization tools, the integration with MGE's existing EMS, and on-line power flow analysis capability.
- **Electric vehicle charging stations:** MGE installed 19 EV charging stations around Madison, Wisconsin, along with AMI meters at 25 home locations to study the impact of a growing population of EVs on the grid. At each home, MGE

replaced the legacy revenue meter with an AMI meter and installed a second AMI meter to isolate, track, and analyze EV charging patterns.

Benefits Realized

The new IDMS enables a long-term trend toward higher efficiency and reliability that is difficult for a highly reliable utility such as MGE to measure in the short run. Nevertheless, MGE is realizing incremental improvements.

- **Operational efficiency:** The IDMS provides detailed, real-time system condition and performance information to distribution operations personnel. This allows MGE to better manage the switching needed to maintain or expand the system. During emergency or excessive load conditions, MGE operators can make better decisions to relieve overloads and avoid damage to equipment and facilities.
- **Operations planning:** The IDMS's real-time tools and simulator allow MGE to better match field operations to load conditions, avoiding having work postponed because of higher-than-predicted load conditions.

Lessons Learned

- **Change management:** The breadth of tools and capabilities offered by a modern IDMS requires a large change management effort. Provide the distribution operators with sufficient training and time to adapt to the new tools. Avoid the temptation to force new procedures on operators too quickly and plan for the learning curve. Deployment of a real-time simulation tool introduces new time sensitivity to processes and systems that support the IDMS. For example, GIS required new time sensitivity to be able to provide up-to-date models for the IDMS power flow system.
- **Broader audience:** There are many cases in which IDMS functionality can be useful outside of the control center—in engineering, construction operations, and distribution planning, for example. Identify those opportunities and engage those groups early in the architectural design phase.
- **Pace of deployment:** Although IDMS has a long list of operationally significant functions that can be enabled to improve distribution system management, enabling too much, too soon, can overwhelm operators and other users of the system data. Balance incremental benefits against incremental costs and vigorously pursue those efforts that produce the most benefit, while being patient with others. Benefits will accumulate as more intelligent equipment is installed in the field.
- **Collaborate to succeed:** Collaborate with vendors continually during the project. Work with the IDMS vendors from the outset to ensure that that processes are adequately described and accounted for. There are a great number of decisions to be made regarding modeling, base assumptions, and business processes. Seemingly small changes to these decisions can reverberate throughout the project.

Future Plans

- **SCADA and IDMS upgrade:** In 2014, MGE will complete deployment of the OMS and advanced applications provided by the IDMS. MGE will be adapting its business processes and providing the training necessary to realize the full range of available benefits.
- **SCADA remote-operated devices:** Leveraging the IDMS technology, MGE will expand use of reclosers and automated switching capability (using AFR and FLISR), along with operator-initiated switching, to improve system performance and customer experience.
- **SCADA-monitored devices:** MGE intends to strategically deploy Fault Circuit Indicators (FCIs) to provide fault current, fault current magnitude, presence of voltage, and periodic current magnitude periodically to the IDMS.

Madison Gas & Electric Company *(continued)*

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