FirstEnergy Services Corporation

Smart Grid Modernization Initiative

Scope of Work

FirstEnergy Services Corporation's (FirstEnergy's) Smart Grid Modernization Initiative (SGMI) involved deployment of advanced metering infrastructure (AMI), distribution automation (DA), volt/VAR optimization (VVO), time-based rate programs, direct load control (DLC) devices, and customer systems in parts of New Jersey, Ohio, and Pennsylvania. SGMI's Ohio footprint covered a 400-square-mile area southeast of Cleveland. Smart meters were piloted in Ohio, and a statistically rigorous study assessed load impacts and customer acceptance of time-based rate programs. DA equipment deployed in New Jersey, Ohio, and Pennsylvania included reclosers, capacitor banks and grid sensing devices. VVO equipment, deployed in Ohio and Pennsylvania, included capacitor banks and load tap changer regulator controls. Advanced load control devices were deployed in New Jersey and Pennsylvania.

Objectives

FirstEnergy aimed to enable customers' informed participation in electricity consumption management, improve power quality and operational monitoring capabilities, optimize asset utilization and operating efficiencies, evaluate wireless network technologies, and better predict and respond to abnormal system conditions.

Deployed Smart Grid Technologies

- **Communications infrastructure:** FirstEnergy deployed various network infrastructures to create a communications system within each deployment location. Each system consists of public code division multiple accesses (CDMA) technology, fiber optics, public and private spectrum networks, and radio frequency (RF) mesh network technology with pole-mounted concentrators. The various systems facilitate communications between centralized software systems and a wide range of AMI, DA, and DLC field devices.
- **Advanced metering infrastructure:** FirstEnergy deployed 34,309 smart meters for residential and commercial customers, enabling two-way communication between the utility, meters, and in-home technologies that provide customers with energy usage information. The smart meters provide FirstEnergy with data used for more detailed load profile analysis and demand forecasting.

At-A-Glance

Recipient: FirstEnergy Services Corporation

State: New Jersey, Ohio, and Pennsylvania

NERC Region: ReliabilityFirst Council

Total Project Cost: $115,383,649

Total Federal Share: $57,470,137

Key Partners: Cleveland Electric Illuminating Company, Jersey Central Power & Light Company, Metropolitan Edison Company

Project Type: Advanced Metering Infrastructure
Customer Systems
Electric Distribution Systems

Equipment

- 34,309 Smart Meters
- AMI Communications Systems (RF Mesh)
- Backhaul Network (Fiber and Cellular)
- Home Area Networks
- 720 In-Home Displays
- 535 Programmable Communicating Thermostats
- 37,721 Direct Load Control Devices
- Upgrades to 64 Distribution Automation Circuits
  - 172 Automated Distribution Circuit Reclosers
- Upgrades to 46 VVO Circuits
  - 187 Automated Capacitors
  - 4 Automated Voltage Regulators
  - 236 Equipment Condition Monitors
- Distribution Automation Communications Network
- SCADA Communications Network

Time-Based Rate Programs (a pilot study)

- Peak-Time Rebate
- Critical Peak Pricing (opt-in)

Key Benefits

- Reduced Operating and Maintenance Costs
- Improved Electric Service Reliability and Power Quality
- Reduced Distribution Line Losses

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- **Distribution automation and volt/VAR optimization systems:** FirstEnergy implemented a centralized software tool for DA system control of automated feeder devices for 64 distribution circuits. Technology upgrades included supervisory control and data acquisition (SCADA) displays for substation breakers and field devices. The tool enables integrated voltage control and reactive power from capacitor controllers, line capacitor switches, load tap changers, and regulators for 46 circuits and facilitates optimization of distribution circuit voltages, increasing efficiency and improving power quality.
- **Time-based rate programs:** Project partner Cleveland Electric Illuminating Company (CEI) offered peak-time rebates and opt-in critical peak pricing in conjunction with the AMI deployment. Peak-time rebates offer a financial incentive for electricity customers to lower their peak demand, while critical peak pricing provides a higher on-peak price signal to induce demand reductions. Both options involve day-ahead notifications of higher on-peak prices/rebate opportunities.
- **Advanced electricity service options:** CEI customers participating in the consumer behavior study were provided with in-home displays, programmable communicating thermostats, and direct load control devices (see Consumer Behavior Study below). These technologies facilitate two-way information exchange and enable customers to better manage their electricity use and bills.
- **Direct load control devices:** FirstEnergy installed almost 38,000 units and supporting communications infrastructure throughout Jersey Central Power & Light Company's (JCP&L's) and Metropolitan Edison Company's (Met-Ed's) service territories, allowing the utilities to control air conditioner settings remotely. Participating customers received financial incentives in exchange for allowing the utility to raise thermostat set points by either six degrees or nine degrees.

Consumer Behavior Study

This study involves more than 34,000 CEI customers. Various rate and enabling technology combinations were tested to assess load impacts and customer acceptance in a randomized control design with treatment and control groups. Rate programs were two opt-out peak-time rebate options and an opt-in critical peak pricing option. FirstEnergy deployed enabling technologies to support the study: power switches, in-home displays, and programmable thermostats (either utility-controlled or customer-controlled, depending on customer preference). Customer energy usage information is available through a web portal. Notification methods included e-mail, phone, and text messaging. Deployment for the study is complete, but the project is still conducting results analysis.

Benefits Realized

- **Improved distribution system reliability:** The distribution automation capabilities include remote restoration, which reduces the number of customer minutes interrupted. The interaction between the energy management system (EMS), automated reclosers, and grid sensors enables the EMS to model grid status and evaluate potential power restoration options. The EMS can automatically select and execute the optimal restoration plan to improve distribution system reliability and decrease outage duration.
- **Improved power quality:** The distribution management system coordinates the operation of automated capacitor banks and voltage regulators to optimize power quality and to reduce energy losses in the distribution system.
- **Lowered peak demand:** Pennsylvania and New Jersey have lowered peak time power usage with direct load control devices adpoted by their customer through their voluntary integrated distributed energy resource (IDER)/direct load control program. During forecasted peak demand times, the load control devices cycle appliances that are heavy energy users, such as air conditioners.

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- **Increased customer engagement:** Direct load control and a pilot time-based rate program provided service options to customers, providing information they could use to assess their energy usage and associated costs.

Lessons Learned

Through the grant-funded deployment, FirstEnergy identified many best practices and opportunities for improved implementation experience in the future. Examples include:

- Test alternative baseline calculations.
- Employ a smoothing strategy to reduce snapback on company-controlled devices.
- Test network communications design rigorously before equipment installation.
- Collaborate with vendors to modify design and operations.
- Be prepared for integration of real-time solutions (e.g., integrating DA and volt/VAR control systems onto the existing EMS system), as this effort is often more complex than initially anticipated.

Future Plans

FirstEnergy will continue its smart grid efforts through the following:

- Substantiate operating impacts, including maintenance cost reductions, improved reliability, and reduced carbon emissions.
- Complete analysis of pilot network communications technologies (DA, VVO, AMI, and IDER), and assess them for potential cross-cutting applications.
- Evaluate scalability of all tested smart grid technologies to larger customer populations.
- Rank order capital projects to modernize the utility distribution system.
- Continue assessing cyber security risks and developing suitable mitigation plans in accordance with industry standards.

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