

## Duke Energy Business Services, LLC

### Smart Grid Deployment

#### Scope of Work

Duke Energy Business Services' (Duke's) Smart Grid Deployment project, a part of the Duke Smart Grid Program, involved implementing advanced metering infrastructure (AMI) and distribution automation systems in five states. The project included large-scale deployments of AMI and distribution automation in Ohio and North Carolina, and smaller limited deployments of distribution automation in Indiana, Kentucky, and South Carolina. Duke also initiated pilot programs for electricity pricing, including time-of-use rates, peak-time rebates, and critical peak pricing. Customers in these pilot programs used smart thermostats, web portals, and direct load control devices to reduce their electricity consumption and peak demand.

#### Objectives

Duke's overall Smart Grid Program included the development and implementation of a comprehensive end-to-end solution that transforms its five-state electric system (Indiana, Kentucky, North Carolina, Ohio, and South Carolina) and leads to products and services that increase the consumer's role in reducing energy use and carbon emissions. The Smart Grid Investment Grant project has provided significant enhancement of information technology systems supporting grid modernization; these systems support all of Duke's jurisdictions.

#### Deployed Smart Grid Technologies

- **Communications infrastructure:** An open, interoperable two-way network provides the backbone for AMI and distribution automation systems deployed as part of this project and allows for future integration with distribution automation, substation automation, smart appliances, and home area networks. The project installed 134,750 communication nodes to support the new AMI network, which utilizes a wireless mesh network and cellular backhaul, along with new cellular network infrastructure to support distribution automation.
- **Advanced metering infrastructure:** The project installed 1,062,169 smart meters and the required systems to provide automated meter reading, enhanced outage notification and

#### At-A-Glance

**Recipient:** Duke Energy Business Services, LLC  
**States:** Indiana, Kentucky, North Carolina, Ohio, and South Carolina  
**NERC Region:** Reliability First Corporation and SERC Reliability Corporation  
**Total Project Cost:** \$564,618,749  
**Total Federal Share:** \$200,000,000

**Project Type:** Advanced Metering Infrastructure  
Customer Systems  
Electric Distribution Systems

#### Equipment

- 1,062,169 Smart Meters
- 134,750 AMI Network Nodes
- AMI Communications Systems
  - Meter Communications Network (Wireless Mesh)
  - Backhaul Communications (Cellular)
- Meter Data Management System
- 46 In-Home Displays
- Customer Web Portals
- Distribution Automation Equipment
  - Cellular Distribution Automation Communications Network
  - SCADA Communications Network (Cellular)
  - Remote Fault Indicators
  - Automated Distribution Circuit Switches
  - Automated Capacitors
  - Equipment Condition Monitors

#### Time-Based Rate Programs

- Time of Use
- Critical Peak Pricing
- Peak-Time Rebates

#### Key Benefits

- Reduced Operating and Maintenance Costs
- Reduced Meter Reading Costs
- Deferred Investment in Distribution Capacity Expansion
- Improved Electric Service Reliability, Power Quality
- Reduced Costs from Distribution Line Losses, Theft
- Reduced Greenhouse Gas and Criteria Pollutants
- Reduced Truck Fleet Fuel Usage

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response, remote meter connect and disconnect capability, and

improved detection of theft. More detailed and timely data on peak electricity usage improves load forecasting and capital investment planning.

- **Time-based rate programs:** A variety of options were implemented in a series of pilot programs. The pilots measured customer load impacts, bill impacts, and customer acceptance and tested the capabilities of the billing software and smart meters. In Ohio, Duke completed a one-year pricing pilot, providing time-of-use rates to selected residential customers with certified single-phase smart electric meters. Rates were divided into winter and summer months and varied based on the time of day energy was used. The pilot measured customer bill impacts, the customer's experience, and the daily/hourly kilowatt and kilowatt-hour impacts; and enhancements to billing systems capabilities were leveraged.
- **Distribution system automation and energy efficiency improvements:** The project deployed automated switches, capacitors, reclosers, and sensors on the distribution system. This distribution system upgrade also included integrating the supervisory control and data acquisition system (SCADA), geographical interface system, outage management system, and work management system. The integration of these systems provides more efficient system management through a single operator interface and enables the benefits of the distribution automation devices. These devices allow power quality monitoring, voltage regulation, and power flow reconfiguration to limit the spread of power interruptions. This enhanced functionality improved power quality and electric system reliability. In addition, Duke is supporting plug-in electric vehicles with the distribution system improvements.

### Benefits Realized

- **Reduced operating and maintenance costs, truck fleet fuel usage, and greenhouse gas emissions:** The AMI system enables remote meter reading, which reduces the miles driven for meter reading operations, as well as lowering associated costs and greenhouse gases.
- **Improved electric service reliability and reduced operating and maintenance costs:** The AMI system also allows for remote monitoring and troubleshooting of meters on its system. AMI provides faster, more efficient outage detection and diagnosis, as well as reduced restoration times. System operators can ping meters to get a clearer picture of what is happening in the field and deploy restoration field crews more efficiently. In many cases, the AMI system identifies an outage, a crew is dispatched, and power is restored—all before any customers call the utility to report the outage. Distribution automation equipment such as automated switches, capacitors, and reclosers has also enabled more efficient operation of the grid, improving service quality and reducing costs.
- **Deferred investment in distribution capacity expansion:** In addition to improved utilization, the distribution automation assets have increased availability of data that can be utilized to more accurately forecast the need for capacity expansion investment.
- **Reduced costs from distribution line losses, theft:** The DA improvements deployed through the SGIG project have resulted in reduced losses in the utility's distribution network. In addition, AMI functionality has allowed for improved detection and prevention of electricity theft.

### Lessons Learned

**Duke Energy Business Services, LLC** (continued)

- **Smart meter “opt out” programs:** Duke found that extensive customer outreach, combined with sensitive and personal responses to individual customer concerns, obviated the need for a formal smart meter “opt out” program. Duke did not offer such a program during deployment. Only 300 customers ultimately refused smart meter installation.
- **Component interoperability:** Duke defines interoperability as the capability to substitute one supplier’s component or capability with a different supplier’s component or capability with no deterioration in performance and minimal or no difference in cost. Duke implemented an interoperability policy requiring that two or more suppliers’ solutions be selected for each critical smart grid component. The benefits from the policy included increased ongoing competition between selected suppliers, reduced risk of product obsolescence, and reduced impact of supplier bankruptcy.
- **Component testing:** Duke encourages utilities to fully test a complete solution set (sensors, switches, communications, software, etc.) for any capability before moving on to full deployment. Sometimes equipment used in combination performs differently from the same equipment when tested in isolation.
- **Time-based rates:** Duke found that time-based rates delivered significant reductions in peak demand. A controlled study found peak demand reductions ranging from 8.5% to 23.5%, depending on rate design. These findings are consistent with the existing body of research available on time-based rates. Unfortunately, Duke also found customer interest in time-based rates to be very low. Duke conducted many recruiting campaigns to achieve a study group of statistically significant size; in one of these campaigns, only 20 of 6,300 targeted customers could be convinced to participate.
- **Energy theft:** Duke determined that the smart meters’ tamper detection feature delivered a high number of false-positive alerts; for example, alerts often resulted from premise remodeling or electrical work being completed by customers. Duke developed exception reporting software to detect theft by analyzing detailed customer usage data offered by smart meters, and the utility has had positive results with this software.
- **Company organization and operations:** Duke learned many lessons about the impact of smart grid capabilities on company organization and operations. Duke advocates the use of a dedicated project management function during deployment to minimize impact on ongoing operations. The project team employed a formal change management process during the design and implementation phases of smart grid deployment, deeming it “absolutely critical to capability optimization.” The utility’s change management process incorporates early end-user input, business process re-design, transition planning, training/organizational capability development, and transition sign-off (including end-user capability testing and the use of “punch lists” to hold project managers accountable for delivering promised functionality).
- **Cybersecurity:** Duke encourages all utilities to build fundamental cybersecurity features into smart grid designs from the outset, and discourages utilities from perceiving cybersecurity as a bolt-on, after-the-fact consideration. Duke also recommends the use of independent experts to periodically review cybersecurity as the basis for making ongoing improvements, as cybersecurity is not a “set-it-and-forget-it” capability.
- **Distribution automation deployment timelines:** If the primary deployment challenge of AMI is scale (i.e., one activity—meter replacement—repeated thousands of times), the primary deployment challenge of distribution automation is variability. Each distribution circuit satisfies different types of customer loads and covers different geographies, and is therefore designed differently with different types of equipment and configurations. Distribution circuits have different ages, with evidence of different design standards and even the idiosyncrasies of different engineers’ design habits and preferences. As a result, the process of distribution automation design is complex and

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lengthy. Each solution must be designed to fit specific physical, logical, and electrical constraints. In the case of fault isolation, new rights of way and building permits were often needed, with new lines to be laid or raised. Relying on engineers with day-to-day operating responsibility to accommodate the additional time required for distribution automation design leads to delays. Using distinct engineering resources dedicated to the project—guided by circuit-specific experts—yields the best result in terms of cost, timeliness, and quality while minimizing management distractions and adverse impacts to ongoing operational responsibilities.

**Future Plans**

- **Innovating new benefits from smart capabilities:** Duke has established an ongoing innovation program to identify new ways to benefit from smart grid capabilities. Customer-facing ideas currently being evaluated include customer prepay, improving customer outage communications, using meters to verify post-storm service restoration, improving detection of tiny (1–3 premise) service interruptions, and offering home energy management solutions. The innovation program is also employed internally to identify how smart grid data and capabilities can be used to streamline utility operations or improve business process outcomes.
- **Pilot pricing programs:** Duke is considering a variety of pilot pricing programs for other states that could explore flat pricing with peak-time rebates, critical peak price, and critical peak price “lite,” as well as additional programs as approved by the individual state regulatory commissions.
- **Enhancing data analytics and grid modeling:** While capabilities delivered by the smart grid are proving valuable to utilities and customers today, the data produced by associated equipment can be even more valuable in the long run. Day-to-day operating data can be aggregated over time into semi-permanent data models of a distribution network. These data models describe a distribution network in its normal, optimized state—topology, equipment settings and ratings, impedances, voltages, etc. When temporary issues (storms, outages, etc.) cause the distribution network to change, the data model can be used as a goal to which to return. And when conditions change more permanently—such as when a new industrial plant or photovoltaic solar generation system is added to a circuit—the data models can be used for scenario planning, determining optimum configurations leading to a new normal state. As customer-sited generation and other distribution challenges grow, the value of modeling cannot be understated.
- **Continuing grid modernization in other states:** Duke is anxious to leverage the lessons learned from its Smart Grid Investment Grant projects for the benefit of its customers in other states. The company is currently developing deployment plans and securing regulatory approvals for additional smart investments in several states.

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