

NSTAR Electric Company

Grid Self-Healing and Efficiency Expansion

Scope of Work

The NSTAR Electric Company (NSTAR) Grid Self-Healing and Efficiency Expansion project involved deployment of two-way communications infrastructure and distribution automation (DA) equipment on 400 circuits. New switches, sectionalizers, reclosers, and condition monitors were installed to enable automatic detection and isolation of power outages, followed by rapid restoration of functional portions of the circuits.

Objectives

NSTAR expanded DA on its system to improve grid reliability and efficiency. The project aimed to demonstrate automated “self-healing” technologies that reduce grid outage impacts on customers. Efficiency is achieved through phase balancing and supported through real-time data acquisition and analysis, and power factor is improved through upgrades to capacitor banks.

Deployed Smart Grid Technologies

Communications infrastructure: The project deployed a private wireless network using 900 MHz (both unlicensed and licensed spectrum) radio and cellular for DA system communications. Upgrades to the communications and control interface allow grid operators to more precisely observe and manage the new equipment, leading to more effective response to and avoidance of power interruptions, thereby enhancing system reliability.

Distribution automation: Automated switches, sectionalizers, monitors, and capacitor banks were deployed to enable rapid and effective response capability to destabilizing grid events, thereby reducing the duration and extent of power fluctuations and outages. The new equipment allows NSTAR’s system to automatically isolate faulted sections after a pre-programmed sequence of algorithms has determined that a portion of the circuit is available to be re-energized. The automated capacitors were integrated with a power quality monitoring system to enable more effective phase balancing and volt/volt–ampere reactive (VAR) control, improving power quality and increasing distribution capacity by reducing energy losses across the system.

Benefits Realized

- **Improved service reliability and power quality:** With the new technologies, NSTAR has averted roughly 20% of what would have otherwise been customer service disruptions. Of the disruptions that did take place, power was restored in less than five minutes in about 45% of cases; and on average, NSTAR responds to 16 events each month before customers call to notify the utility of the outage. In addition, the project has reduced distribution losses by about 30 megawatt-hours per month.

At-A-Glance

Recipient: NSTAR Electric Company

State: Massachusetts

NERC Region: Northeast Power Coordinating Council

Total Project Cost: \$20,265,677

Total Federal Share: \$10,061,883

Project Type: Electric Distributions Systems

Equipment

- Distribution Automation Equipment for 400 out of 1,950 Circuits
 - Distribution Automation Communications Network (900 MHz Radio Network, cellular)
 - 360 Automated Distribution Circuit Switches
 - 109 Automated Capacitors
 - Equipment Condition Monitor System

Key Benefits

- Improved Electric Service Reliability and Power Quality
- Reduced Costs from Equipment Failures, Distribution, and Line Losses
- Reduced Truck Fleet Fuel Usage

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- **Reduced operating and maintenance costs:** Enhanced capacitor bank switching has saved NSTAR roughly \$5,425 per month through reduced line losses and increased distribution efficiency. NSTAR has also saved costs through fewer truck rolls due to automated sensing, remote operation of capacitors, improved fault location due to sectionalizing, and fewer high-amp alarms and associated field investigations. An average of 55 truck rolls—which translates into 280 miles—are avoided each month, reducing NSTAR’s labor costs, vehicle maintenance costs, and greenhouse gas emissions.

Lessons Learned

- Before installing DA switches that rely on a two-way network, a robust communications infrastructure should be deployed and tested.
- Collaborative projects and exchanges with other utilities allow all participants to benefit from each other’s experience.
- Supporting “smart” DA equipment requires a fully secure and properly sized information technology (IT) infrastructure. The complexity of implementing such an infrastructure should not be underestimated. Utilities tackling similar projects should consider expanded IT needs early and account for them in schedule, budget, and personnel planning phases.
- Any project team implementing advanced grid technologies must be aware of and plan for associated cyber security concerns.

Future Plans

Before receiving federal funding, NSTAR had plans to implement a five-year smart grid project. The grant allowed NSTAR to accelerate their implementation plan from five years to three years. NSTAR plans to continue to deploy DA equipment outside of the grant, including pole top capacitor banks and additional switches at a rate of approximately 60 per year.

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