Smart Grid Technologies Cut Emissions and Costs in Ohio

Successes from AEP Ohio's gridSMART® Demonstration Project

Introduction

Turning lights off in empty rooms, air-drying clothes, and unplugging devices when they're not in use are three of the many well-known steps residential customers can take to conserve electricity. With its Smart Grid Demonstration Program project, named gridSMART®, American Electric Power (AEP) Ohio demonstrated technologies that improve system efficiencies and benefit the customer at the same time. The project, which began in 2010 and will end in 2014, also provided insights into how smart grid technologies can increase the reliability of electricity delivery and decrease emissions. The service area selected for the project comprised approximately 150 square miles of urban, suburban, and rural neighborhoods, and included customers in Columbus, Ohio. Within the demonstration area, AEP Ohio deployed 100,000 residential smart meters and 10,000 commercial and industrial smart meters. Additionally, the utility applied distribution automation circuit reconfiguration (DACR) and volt VAR optimization (VVO) to 58 13-kV circuits from 10 distribution stations, and 12 34.5-kV circuits from six distribution stations within the demonstration area. The result was a secure and interoperable smart grid infrastructure.

> "If we're reducing the voltage by 2 to 3 percent, the customer is seeing a 2- to 3-percent reduction on their bill as well."

Lowering Customers' Electricity Bills

Two components of this smart grid infrastructure that showed promise for reducing customers' electricity use—and, consequently, electricity costs—were VVO and advanced metering infrastructure (AMI). VVO reduces consumption by controlling voltages and reactive power on

Time-of-Day Tariffs	AEP Ohio offered two tariffs. The first, **SMART Shift**, offered consumers a lower rate during off-peak summer hours. The second, **SMART Shift Plus**, worked similarly but divided off-peak hours into two differently priced blocks of time. In addition, SMART Shift Plus allowed AEP Ohio to declare annually up to 15 critical peak pricing events, during which rates were higher, and it allowed customers to use in-home displays and programmable communicating thermostats (PCTs) to control their thermostat settings.
Direct Load Control (DLC)	AEP Ohio's DLC programs both enabled the utility to directly control customers' electricity demand. The first, **SMART Cooling**, allowed AEP Ohio to remotely adjust customers' PCTs during up to 15 non-emergency DLC events and 10 emergency DLC events per year. Customers who did not override the adjustment received a bill credit. The second, **SMART Cooling Plus**, went further by allowing AEP Ohio to adjust not only customers' PCTs but also their water heaters, pool pumps, and hot tubs during non-emergency and emergency DLC events.
Real-Time Pricing with Double Auction	Customers who participated in AEP Ohio's **real-time pricing with double auction** program received an enhanced PCT and a home energy manager. Customers could manage their power use based on market prices, calculated at 5-minute intervals, and their own temperature preferences.

Table 1. The program that customers opted into determined what price incentives they would be exposed to. The program also determined how much control customers relinquished over their electricity use.

distribution lines, and AMI enables pricing programs that give customers an incentive to conserve electricity. According to Scott S. Osterholt, the project leader of gridSMART, circuits on which VVO technology was installed experienced energy-consumption reductions of 2 to 3 percent. "If we're reducing the voltage by 2 to 3 percent, the customer is seeing a 2- to 3-percent reduction on their bill as well," Osterholt adds.

AMI technology supplied a price signal to customers enrolled in one of five pricing programs (see Table 1): a two-tier, time-of-day tariff; a three-tier, time-of-day tariff with critical peak pricing; two direct load control programs, and a real-time pricing with double auction program.[1] As AEP Ohio's *Final Technical Report* states, customers enrolled in the programs reported an average savings of $20, or about 15 percent,[2] on their monthly electricity costs in summer.

Consumers in all programs reduced demand during thermostat adjustment events, with direct load control programs reducing this demand twice as much as the tariff and double-auction programs. Customer satisfaction ratings for the program ranged from 67 to 76 percent.

Improving Distribution Reliability

DACR, another demonstrated technology, made electricity interruptions shorter and rarer. Circuits on which DACR was deployed consistently had a lower System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI) than circuits without DACR did. By the project's conclusion, deploying DACR had reduced SAIFI by 25 percent and SAIDI by 20 percent.

DACR's impact on reliability is further illustrated by the reduction of customer minutes of interruption (CMI) during the course of the project. By using DACR, AEP Ohio was able to reduce CMI by 1.6 million in 2012. The following year saw even bigger improvements. In 2013, 2.6 million CMI were avoided.

"We're touting even higher numbers as we roll [DACR] out," says Osterholt. "We are learning, what are the impacts? How can we drive higher numbers?"

As AEP Ohio deploys DACR more widely throughout the service area, the utility will target circuits that DACR would benefit most dramatically. By carefully selecting where DACR is deployed, AEP Ohio aims to achieve a 30 percent reduction in CMI, says Osterholt.

"We can envision saving the customers 21 million outage minutes a year," he said. "That would save customers $1 billion in societal costs over a 15-year period."

Reducing Emissions

AEP Ohio also showed that the demonstrated technologies reduce greenhouse gas emissions and pollutants. Through VVO alone (see Figure 1), AEP Ohio kept 2,679 metric tons of carbon dioxide from being emitted by coal-fired generation over the course of the project. To put that into perspective, removing 564 cars from the road would save the same amount of carbon dioxide.

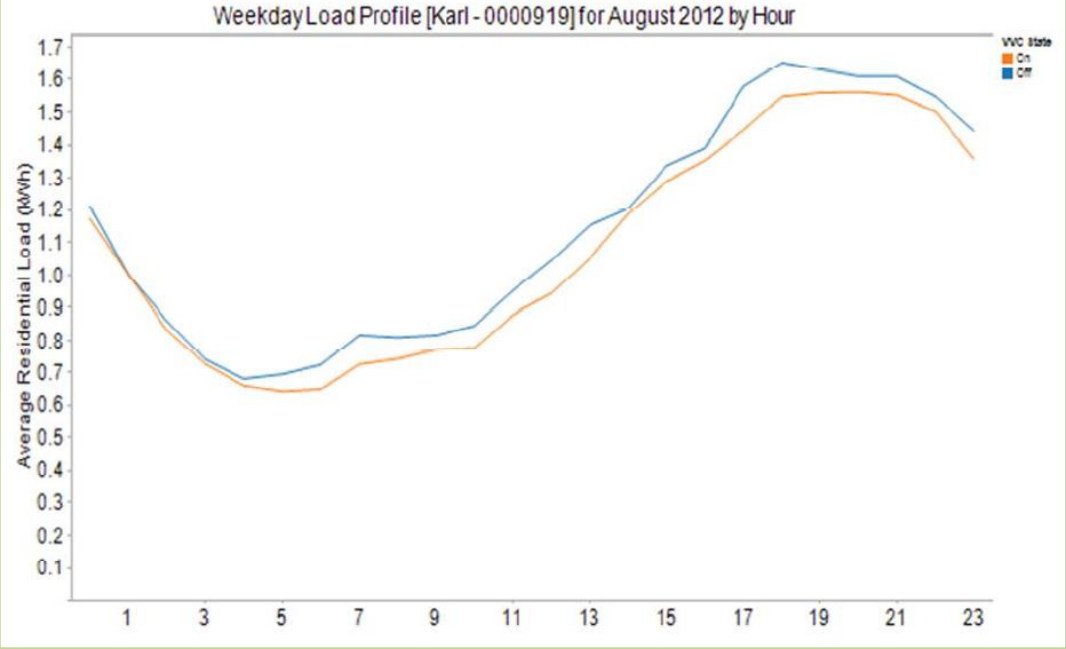
But VVO's environmental benefits don't begin and end with carbon dioxide reductions. Reduced coal-fired generation leads to decreased nitrogen oxides, sulfur dioxide, and particulate matter. In deploying AMI, AEP Ohio eliminated 187 meter reading routes—out of a total of 994—and kept 29 metric tons of

[1] During a double auction, consumers submit bids while sellers simultaneously submit their asking prices. In the context of this project, consumers submitted bids by adjusting a home energy manager; locational marginal prices were simultaneously set by PJM Interconnection, the independent system operator.

[2] Based on AEP-reported averages of 1,000 kW monthly usage and $120 in monthly electricity costs.

carbon dioxide from service trucks out of the atmosphere. By reducing the number of customer-service-related truck rolls, AMI kept 211 metric tons of carbon dioxide from being released to the atmosphere. Emissions of nitrogen oxides, sulfur dioxide, and particulate matter were also lowered.

Figure 1. As this graph from AEP's *Technical Performance Report* shows, turning volt VAR control on (represented by the gold line) produced lower average loads than when volt VAR control was turned off (represented by the blue line). *Image courtesy of AEP Ohio.*



Next Steps

Based on the demonstration's successes so far, AEP Ohio has submitted a plan to the Public Utilities Commission of Ohio for the next project phase of smart grid deployments. The next phase will extend elements of the project throughout AEP Ohio's service territory. In particular, AEP Ohio has proposed to install AMI for nearly 900,000 customers in cities and suburbs, deploy DACR on approximately 250 circuits, and begin using VVO on approximately 80 circuits. The next phase of the project will also include offering consumer programs to more customers across the service area.

Further Reading

For more information about AEP Ohio's project and the technologies it encompassed, read AEP Ohio's *Technology Performance Report* on the SmartGrid.gov website, where you can also find more information about the Smart Grid Demonstration Program in general.

Under the American Recovery and Reinvestment Act of 2009, the U.S. Department of Energy and the electricity industry have jointly invested over $1.5 billion in 32 cost-shared Smart Grid Demonstration Program projects to modernize the electric grid, strengthen cybersecurity, demonstrate energy storage, improve interoperability, and collect an unprecedented level of data on smart transmission, distribution operations, and customer behavior.