Smart Grid Implementation in Sacramento

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http://smartgrid.ieee.org/august-2012/647-smart-grid-implementation-in-sacramento

With little prior experience to draw from other energy companies, the Sacramento Municipal Utility District is trying out a wide array of smart grid technologies. The goal is to develop a roadmap for large-scale deployment. Prominent elements include smart metering, time of use and peak pricing, microgrid islanding and energy storage.

The Sacramento Municipal Utility District (SMUD) is an electric-only municipal utility with a service territory covering 900 square miles in the heart of California. SMUD serves over 600,000 customers, including six cities and the County of Sacramento.

Awarded almost $150 million in grants for smart grid projects with a total budget of $360 million, SMUD is beginning large-scale smart grid deployment projects that include advanced metering infrastructure (AMI), distribution automation, enhanced cyber security, electric vehicle infrastructure, customer applications and demand response initiatives. Research and development projects include energy storage, dairy digesters and a microgrid. The project, trademarked SmartSacramento, is the first step in what will be an ongoing deployment of smart grid projects and features at SMUD.

SMUD's AMI is already fully deployed and utilizes Silver Spring Networks and Landis+Gyr meters. One of the many benefits provided by AMI is the ability to provide dynamic rates—both time of use (TOU) and critical peak price (CPP). Prior to AMI implementation, dynamic rates could only be provided through commercial meters and were not available to residential customers.

The new meters allow for the two-way flow of information that allows SMUD to retrieve meter data at regular intervals and to provide signals or messaging through the meter. Should SMUD adopt dynamic rates on a wide commercial basis, TOU structures can be programmed into the system and CPP signals can be sent to all customers, both residential and commercial. Such special rates will prompt customers to reduce peak energy usage, reducing stress on the electrical system.

SMUD has implemented pilot TOU/CPP rates, with almost 3,000 customers receiving a CPP or TOU/CPP combination and another 5,100 customers a TOU rate. The CPP has a ten-to-one price ratio between critical peak periods and off-peak periods. The off-peak price is about 7.2 cents/kWh and the critical peak price is 75 cents/kWh. The CPP rate will be implemented up to 12 peak times per summer, 4-7 PM, Monday-Friday. Randomly selected customers were sent information on the pilot and some were allowed to opt in while others were selected to participate, but allowed to opt out.

The trial rates were introduced in June 2012 and will remain in effect through the summer of 2013. The pilots will be evaluated and the results used to determine the next steps. The expectation is that customers will cut peak-period energy use to some degree; we are conducting the pilots to determine how much. SMUD has reviewed other utilities' pilots, which have shown wide-ranging results. One major study showed that customers lose interest in TOU rates and ultimately stop responding, while customers on CPP rates tend to shift loads when they get notification of an event and have a large differential between peak and off-peak prices.

AMI also facilitates automatic connect/reconnect, voltage reads throughout the service territory, transformer loading information (once meters are mapped to transformers), outage notification and transmission of improved energy data

to customers. The automatic connect/disconnect feature alone has reduced "truck rolls"—dispatch of personnel to connect or disconnect customers to or from SMUD's system—by over 55,000 in less than one year.

With well over a century of experience, most utilities continue to be informed about power outages through customer telephone calls. A small number of calls generally means a small outage; many calls indicate a large outage. Customer service representatives take information and troubleshooters are dispatched to find the outage and make the necessary repairs. A crew may be dispatched if there is significant work required to restore power. Smart meters have a "last gasp" feature that allows system operators to immediately see when and where outages occur. Appropriate line personnel can be dispatched before customers even call.

Specialized software will eventually be able to analyze the location and number of meters that are without power, make a determination as to which piece of equipment caused the outage and dispatch personnel to the precise location of the outage. This will reduce the duration of outages. With large outages, there are often smaller, embedded outages. Imagine, if you will, a scenario where 5,000 customers lose power due to a downed line. Within that outage event, a tree branch causes a smaller outage that is not restored when the original outage is restored. With automation, the utility can see both events and knows it needs additional work to complete the restoration. Otherwise, the utility won't know about the smaller outage until customers complain. With AMI, the utility can "ping" the meters once power is restored to verify that all meters are registering and there are no embedded outages. This approach also saves truck rolls.

In all, SmartSacramento consists of 8 project areas with over 50 subprojects. Examples include:

- *A microgrid,* in which the critical element will be testing a smart switch designed to island the grid from the larger utility system. The microgrid as a whole consists of three 100 kW gas engines, 10 kW of photovoltaic generation, a 760,000 gallon chilled water thermal energy storage tank, an absorption chiller, a central utility plant and battery energy storage.

- *Energy storage* systems will be tested in a solar subdivision with over 280 homes, each with PV rooftop systems ranging in size from 2-4 kW. Of these homes, 42 are partially powered by batteries: 15 by means of 10 kW/8.8 kWh lithium ion batteries installed at each residence; 27 by being linked to one of three community energy storage systems, rated at 30kW/30kWh and installed next to distribution transformers. A 500 kW flow battery is scheduled for installation at the substation. The storage will be used to smooth the flow of energy from intermittent renewables, reduce peak load and improve reliability.

- *Dairy digesters*—popularly known as "poop to power"—will generate electricity by converting cattle waste to a methane-rich biogas. The biogas is piped to a biogas engine and electricity generator. Two projects are underway that will jointly generate 1.2 MW from the waste of 2,400 milk cows.

Since many smart grid technologies are new and expensive, little information on technology benefits, cost-effectiveness and reliability are available from actual project implementations. SMUD's smart grid projects will be evaluated individually and collectively to help determine project benefits—cost-effectiveness, utility benefits (such as reduced duration or frequency of outages, reliability improvements and energy savings) and customer benefits (for example, better control of energy usage, energy savings and general satisfaction). The evaluation results will be used to develop an implementation plan that will guide future smart grid deployments.

Contributor

Jim Parks, an IEEE member, is a program manager in the smart grid department at the Sacramento Municipal Utility District. His current focus is on determining smart grid benefits in order to develop a long-term roadmap for SMUD. He also oversees the utility's commercial customer smart grid projects. Prior to his current assignment, he worked on emerging energy efficiency technologies, electric transportation, energy efficiency program development, energy efficiency implementation and transmission planning. He has a bachelor's degree in electrical and electronics engineering from California State University, Sacramento.