Getting Smart On the Electrical Grid

By Ed Koch and **Roy Kolasa,** Member ASHRAE

Utilities are transforming the way they manage the electrical grid and rewriting the relationship with their customers. The Smart Grid is helping catalyze this change through improved architecture and insight that enables utilities to avoid power disruptions by partnering with customers to better manage load. For buildings, this increased visibility and control means more insight into how they're consuming electricity — and how much utilities charge for it.

As a result, as more utilities embrace the Smart Grid, facility managers have an opportunity to reap its benefits, including detailed insight into changing energy conditions and costs, and more control to choose when and how to respond to these changes. Through automation and smart building controls, businesses and industries can maximize potential energy savings with minimal involvement.

Changing Landscape & Opportunities

Nationwide, the Smart Grid is enabling utilities to use dynamic pricing structures, which more closely link overall demand with the cost of delivering electricity, and facilities must take note. For commercial and industrial customers, rates could increase by 10 or more times the normal rate during the highest-demand days of the year. As these pricing structures become increasingly common, measures like automated demand response programs, which automate a building's response to energy prices and reliability signals, are becoming increasingly available to commercial and industrial facilities. These programs are repeatable, scalable and flexible and remove the human factor, helping save valuable personnel resources while improving the accuracy of energy reduction measures to maximize the amount of money a facility can save during peak pricing periods. By opting into these programs now, facilities have an opportunity to significantly reduce costs and ready themselves to leverage load control as a future revenue driver.

About the Authors

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Smart Grid standards efforts are helping to foster this adoption. The U.S. Federal Energy Regulatory Commission (FERC) and the National Institute of Standards and Technology (NIST) recognized the need for standardizing how demand response signals are sent to enable broader demand response participation.[1] To that end, NIST also issued a priority action plan (PAP 09) based on the need for standards for demand response signals. Several organizations have responded to meet the call, and among those is the Organization for the Advancement of Structured Information Standards (OASIS), a non-profit consortium driving the development, convergence and adoption of open standards for the Smart Grid. Specifically, OASIS is developing an energy interoperation standard currently in public review and awaiting adoption.

At the foundation of the OASIS energy interoperation standard is the OpenADR 1.0 specification, developed in 2002 as a joint project between the Demand Response Research Center (DRRC) and the state of California to establish an open communications specification to automate demand response.[2] The California Public Utilities Commission (PUC) and utilities began broadly adopting the specification in 2007. That same year, NIST identified the OpenADR 1.0 specification as a key specification for Smart Grid communications over the Internet as part of its roadmap.[3] Since that time, the specification has been adopted throughout the controls industry.

For example, one provider of OpenADR-based technology, offers a client development program in which vendors can develop, test and demonstrate their ability to receive and consume OpenADR-based signals. To date, that program has enrolled more than 100 vendors. The OpenADR message set is being further developed through NIST's Smart Grid-standards effort, and the OASIS Energy Interoperation standard.

Similar to standards development within the buildings industry, the trend points toward open standards for the benefits they bring—including interoperability and vendor neutrality. They also help ensure assets are not left stranded, future-proofing technology investments. This open standards approach helps ensure the necessary interoperability between technologies and software systems to deliver the promise of the Smart Grid to commercial and industrial business already managed by a range of building automation and control systems.

The OpenADR Alliance, a nonprofit group created to foster the development, adoption, and compliance of OpenADR, is supporting this trend through efforts to foster industry collaboration to lower the cost, improve the reliability and accelerate the benefits of Smart Grid implementations. Driven by founding members including Lawrence Berkeley National Laboratory, Pacific Gas & Electric Company, Southern California Edison and Honeywell, the alliance aims to ensure a solid technical foundation for Smart Grid deployments using the OpenADR specification.

A Setup for Success

Opting into an automated demand response program based on the OpenADR specification, which will establish a communications gateway over the Internet from the utility to the facility, is just the first step to a facility's involvement in the program. Facilities must also consider the necessary architectural prerequisites to ensure a building can receive and respond to the pricing signals received during an event.

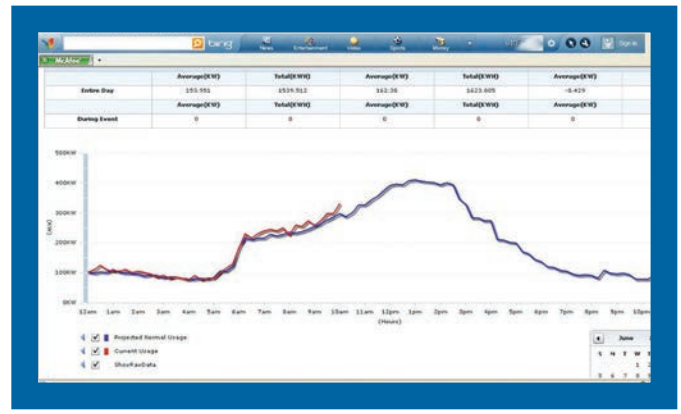

Figure 1: Real-time energy use (red) and baseline (blue) provided by demand response automation software for a fulfillment services company in California.

The right building controls architecture provides the critical link to facilitating automated load reduction in response to utility price changes and demand response events. Using the set OpenADR message, the utility uses demand response automation software to send price and reliability signals over the Internet to an OpenADR gateway controller at the facility. The controller, in turn, interprets the message and initiates preprogrammed load reductions in select control systems, overriding the system's current setting to a predefined, more energy-efficient setting. Energy service providers can help facilities audit their energy load and design and implement these two-way communicating control systems.

For example, if the price of electricity is most expensive from 3 p.m. to 4 p.m., an automated demand response-enabled controls architecture can curb usage on select pieces of building equipment based on established parameters and save the facility money. This might entail dimming lights, increasing temperature setpoints or cycling air conditioners. Energy service companies can help facilities establish shed strategies to help maximize savings and ensure business processes are not disrupted by the usage shifts. An ice cream distributor most likely cannot curtail usage of many chillers in its warehouse, whereas a paper warehouse might be able to do so without affecting regular business processes. Each, however, likely can increase their air conditioning setpoints by two degrees.

While many facilities currently lack the necessary building automation equipment, facility managers who opt into programs at this time can often receive low- or no-cost building system upgrades and expert implementation—a bonus for participating, on multiple levels.

The Internet connection a facility uses to receive the utility's signals can be established through a hard-wired connec-

tion, as well as a wireless or cellular connection. Each option has pros and cons, depending on the needs of the facility, and facilities must examine each option when working with an energy service provider. For example, a hardwired connection is typically more reliable, while a cellular connection could be more costly because it would require a cellular data plan for the system.

Facility managers are often advised to adopt systems that communicate through an open protocol that integrates utility OpenADR signals with onsite BACnet controls. The BACnet open protocol also offers the flexibility to make future upgrades or switch building controllers, helping to better future-proof the entire system. BACnet-enabled devices, like other ADR client devices, can manage the connected control system's energy usage and report back real-time consumption rates for facility managers to more accurately monitor and gain insight into a facility's overall energy consumption trends.

Another significant advantage to BACnet is that it allows facility managers to predefine the command priority level, with up to 16 levels support-

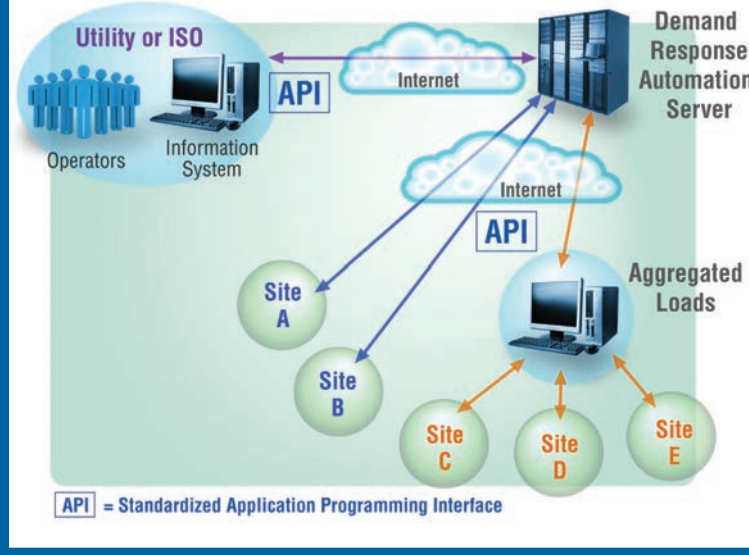

Figure 2: The OpenADR specification enables utilities to use demand response automation software to send price and reliability signals over the Internet to existing customers using a set OpenADR message. (courtesy: Demand Response Research Center/Lawrence Berkeley National Laboratory)

ed to easily accommodate various load sheds automatically. This provides facility managers with more options to respond to utility signals.

For example, a facility manager could choose to modulate energy use in correlation to different utility pricing rates, and could also indicate which loads correlate with these events. In most cases, top priority loads, like security and life-safety systems, would remain untouched and unaffected in the event of changing rates.

Finally, facility managers need a way to monitor the impact of an automated demand response program on overall energy use. The proper implementation architecture can help facility managers identify energy consumption trends in their buildings and potentially find other opportunities to improve energy efficiency. A building that already has a capable BAS may only need an open protocol driver and temporary override control logic. Or, it may be as simple as installing an ADR client with output relays and commissioning a stand-alone DDC device.

Automation at Work

Southern California is a prime example and current hot spot for automated demand response activity. The region boasts an aggressive automated demand response program that is enabling the local utility to increasingly rely on automation to help drive greater shed opportunities. As a result of these efforts, the utility currently controls more than 160 MW of customer load. One of the involved customers is a South Orange County, Calif.-based fulfillment services company.

When the utility implemented a new tiered pricing structure that could see rates rise from $0.13 per kWh to $1.49 per kWh during peak periods, the company enrolled in an automated demand response program. Through the program, the fulfillment firm worked with an energy service provider to help curb its electricity consumption and lower operating costs within its 235,000 ft^2 (21 832 m^2) facility. The energy service provider applied funds from a Department of Energy Smart Grid Investment Grant, and the fulfillment firm coupled these funds with local utility rebates to implement the technology upgrades necessary for automated demand response participation at little cost.

Preparatory work also included designing a control system and load reduction strategies that matched its business needs. Prior to the program, the firm lacked an automated building control system and handled any equipment adjustments manually. Its different control systems operated independently of each other and lacked monitoring capabilities, so facility man-

agers were not aware of any high consumption rates or opportunities for improvement.

For example, the facility's HVAC control system was comprised of 45 HVAC rooftop units connected to 45 individual programmable thermostats. The facility separated the thermostats into banks of 17, 12 and 16, all dispersed throughout the facility, which made for a great exercise program during demand response events. The facility's 29 forklift battery charging units ran independently, and required manual intervention for load reduction. A panel controlled some of the facility's T5 and T8 lighting; however, system changes required manual intervention. And individual light switches controlled other lights, requiring employees to manually turn them on and off.

As part of the automated demand response program, the firm was able to work with its energy service provider to identify opportunities for upgrades and integration. The firm then developed load reduction strategies that did not impact core business processes. Close inspection revealed that the facility's lighting and HVAC systems, along with its forklift battery chargers, were among the top energy consumers and offered the most significant opportunity for energy savings.

Next steps involved integrating a number of smart building control technologies, including an OpenADR gateway controller and an Energy Management System (EMS). These controls centralize management of the different systems and manage the load reduction actions during the utility's automated demand response events without intervention of the facility manager. GRFS also opted to install remote input/output modules to oversee forklift battery chargers and commercial thermostats for the facility's HVAC systems. This solution provides the company's facility manager with a single system for control and visibility of the building's energy consumption and historical baseline throughout the day, in real time.

The upgraded controls and technology enabled building temperatures to automatically rise slightly during peak pricing events. The firm preset the forklift battery chargers to turn off during critical peak pricing events. Finally, the upgraded technology enabled the majority of the facility's lighting in the operations area to automatically shut down during non-production hours when a demand response event occurred.

In the summer of 2010, the firm saved about $8,000 by implementing these shed strategies during 12 utility demand response events. During a demand response event on a hot summer day, the firm's automated demand response implementation quickly and automatically reduces its demand by at least 146 kW and sustains that reduction throughout the four-hour event—far exceeding the expected 96 kW of load reduction measured during initial commissioning of the shed strategies immediately following the implementation.

The initial technology upgrades and real-time energy usage data have spurred the firm to seek more opportunities to further expand its energy savings. For example, the firm is planning to install economizers to use outside air to cool parts of the facility, and it is investigating using natural lighting to illuminate areas of the facility to further reduce its lighting system load.

Ensuring a Sustainable Future

Knowledge is power, and facility managers are making more informed energy management decisions based on the additional insight enabled by the Smart Grid. As a result, cost-saving opportunities are plentiful, including those available through efforts like automated demand response programs—if facility managers know how to take advantage of them.

With investment costs at a minimum due to government and utility incentives, now is the time for facility managers to take advantage of these programs. It will place them ahead of the curve and help secure a more sustainable future for their businesses.

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