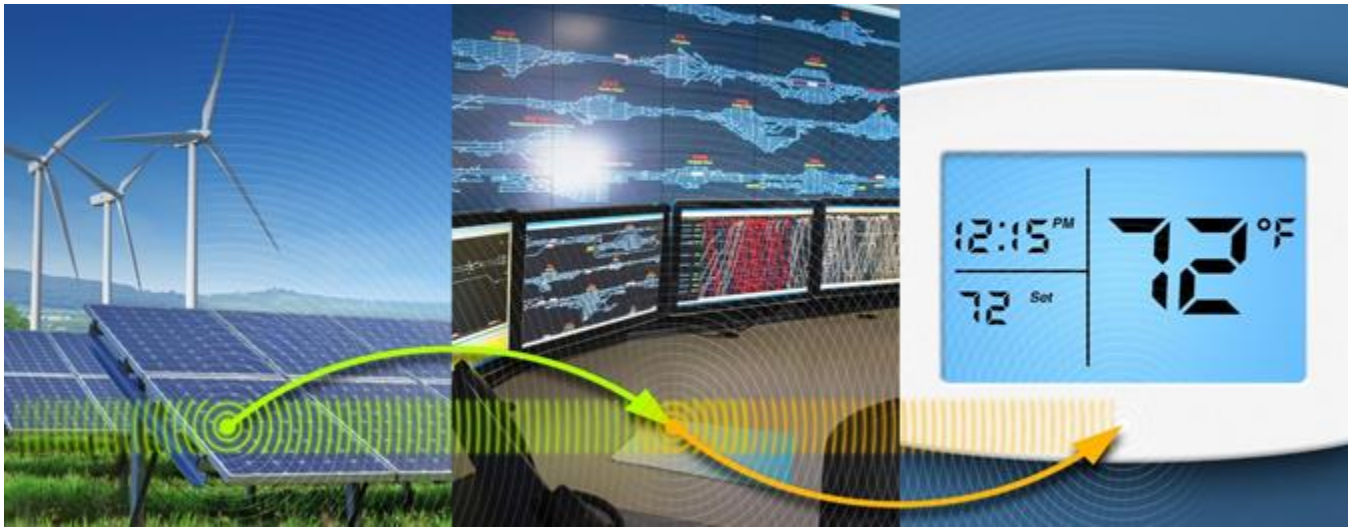
Feature—Opening the Door to Automated Demand Response



Field Demonstrations Show Effectiveness of Communications Language, Reveal New Applications

By Matthew Hirsch

Computer operating systems, web browsers, and even breweries have tapped the open-source process to enhance product design through collaboration. Now EPRI has completed an open-source collaboration to improve how grid operators manage energy demand and supply.

EPRI has created software based on the OpenADR 2.0 specification and made it openly available for modification and enhancement by software developers at utilities, equipment vendors, demand response aggregators, and other organizations. The software enables developers to set up secure networks so electrical appliances and energy management devices can automatically reduce consumption during peak demand. For example, grid operators can use the software to signal appliances to turn off, which in turn can signal operators that the actions were completed. Since EPRI released the software in February 2014, developers in dozens of countries have downloaded it more than 2,000 times. By enabling many independent programmers to test and debug the software, the open-source approach offers the potential for quicker innovation and a more reliable product.

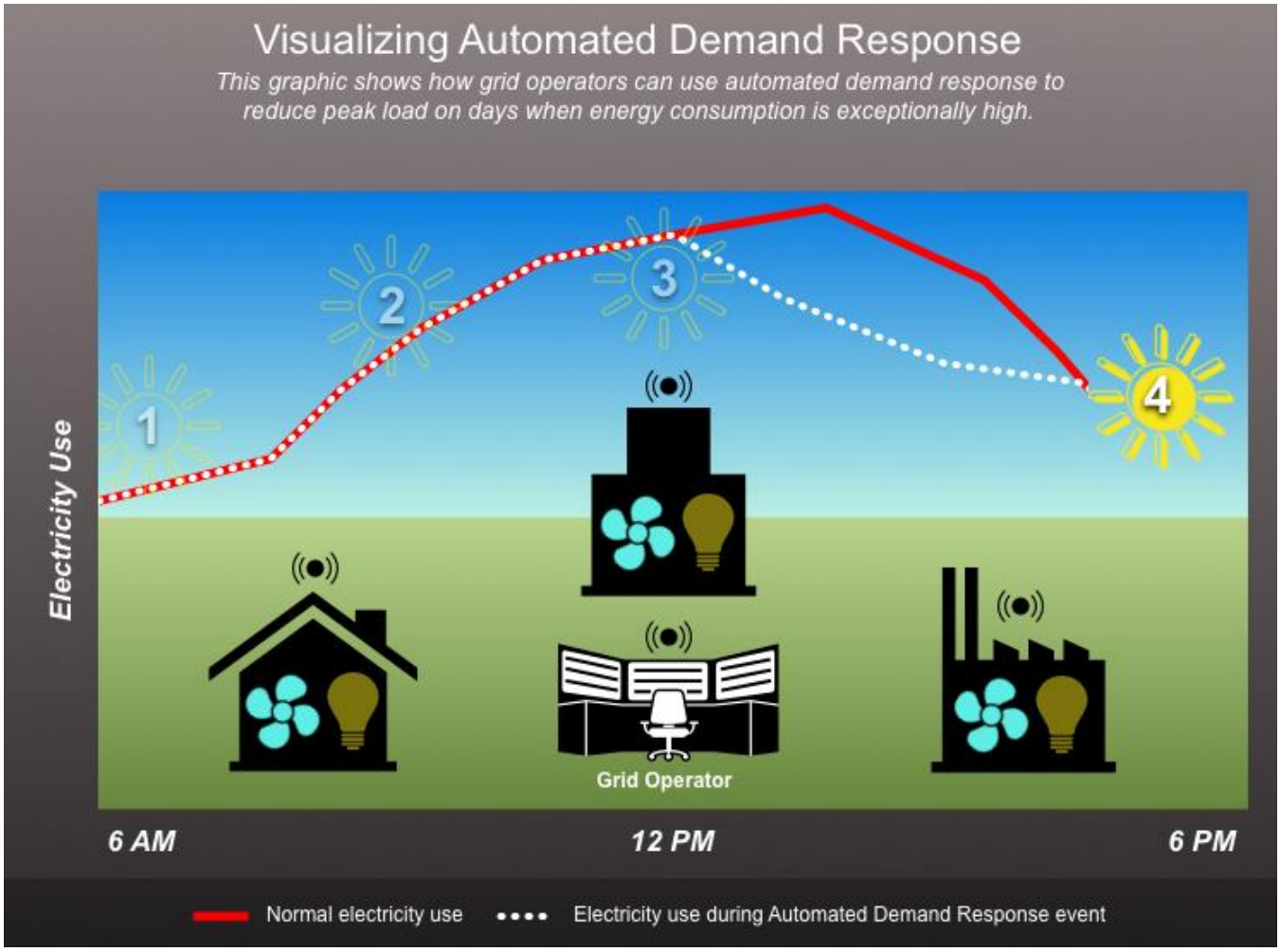
For the past four years, EPRI has led field demonstrations to advance adoption of the OpenADR specification, assess its effectiveness in automating demand response, and identify benefits for grid operators. Nine power companies and grid operators in the United States, France, Ireland, and Japan participated in the project, and four hosted field trials at their facilities.

A Young Language

OpenADR is still in early adoption. Lawrence Berkeley National Laboratory created it in response to California's rolling blackouts in 2000 and 2001, launching version 1.0. The nonproprietary language helped cultivate industry interest in demand response automation by enabling electricity providers to tell appliances when to reduce load. In 2010, the National Institute of Standards and Technology included OpenADR in a list of 16 recommended smart grid interoperability standards. The same year, a group of utilities and vendors started the nonprofit OpenADR Alliance to lower costs, ensure compliance with the specification, and improve reliability for OpenADR users.

OpenADR 1.0 was not suitable for widespread commercial deployment because it supported only one-way information flow. Appliances and devices could receive demand response signals but could not respond to grid operators. In 2013, the OpenADR Alliance completed version 2.0b with two-way communication and other features, such as frequency and voltage control. EPRI developed software in accordance with this version and released it for free to developers and programmers, facilitating software development for the commercial market. Utilities, transmission system operators, and third-party aggregators can use OpenADR server software to initiate requests for demand response, while electrical appliances and devices can use OpenADR client software and hardware to receive requests and respond.

This graphic shows how grid operators can use automated demand response to reduce peak load on days when energy consumption is exceptionally high.



1. In the morning, the grid operator observes a normal rise along the demand curve as people wake up and start operating home appliances while office buildings and industrial factories come to life.

2. Approaching midday, the grid operator forecasts that peak demand will be higher than normal as people run air conditioning to keep cool in the midst of a record heat wave. Instead of bringing additional generation online, the grid operator calls a four-hour demand response event starting at 12 p.m.

3. Using the OpenADR communication protocol, the grid operator transmits a signal instructing devices in hundreds of residential, commercial and industrial buildings to automatically turn down lighting, slow down cooling systems and take other measures to temporarily reduce consumption. Demand drops immediately and remains significantly below normal energy usage for the duration of the four-hour event.

4. By late afternoon, demand tapers off as office buildings and factories are shutting down, and people return home for the evening.

OpenADR Enables Reliable Load Reductions for California Grid Operator

One demonstration participant, California Independent System Operator (ISO), modified the building control system at its Folsom campus to accept OpenADR signals from Sacramento Municipal Utility District's (SMUD) PowerDirect Automated Demand Response program. During peak demand on designated summer afternoons, lighting is reduced and thermostats are adjusted by up to 4°F automatically in designated zones of the three-floor building.

In the summer of 2015, California ISO received 11 demand response event signals covering a total of 26 hours and exceeded its load reduction goal for all but four of those hours. "The OpenADR software enabled reliable, automated load reductions when SMUD requested them," said Jill Powers, California ISO Smart Grid Solutions Manager.

Because devices for controlling electricity consumption based on OpenADR version 2.0b were not widely available at the project's outset, California ISO used the older OpenADR version 2.0a, which provides one-way communication and includes fewer messages than 2.0b. The demonstration pointed to specific potential benefits of two-way communications. For example, because California ISO could not alert SMUD that its load reduction at certain times more than doubled expectations, the utility was missing important data about its demand response program.

For the most part, California ISO's automated load reductions did not bother building occupants. Powers said that the facilities team received only two complaints from small workspaces about higher-than-normal temperatures when load was reduced. No complaints were registered from the rest of the building with mostly large, open work areas.

Wind and Solar Applications

Through EPRI's demonstration, participants identified additional applications for OpenADR. Ireland's distribution grid operator ESB Networks used OpenADR 2.0b to design a two-way communication protocol with transmission operator EirGrid to help prevent distribution grid overloads that could result from excessive wind production. Because Ireland is small and relatively flat, EirGrid can forecast wind production reliably 5 to 15 minutes in advance. With OpenADR-enabled communications, EirGrid's proposed wind generation schedules are sent automatically to ESB Networks. ESB operators use this time to analyze grid-connected electric vehicle charging stations and thermal energy storage devices, feeder by feeder, to determine if there is sufficient load available to accept the power from EirGrid. Based on the analysis, ESB Networks also can use OpenADR to accept or reject EirGrid's dispatches.

Another participant, Électricité de France (EDF), is attempting to modify OpenADR 2.0b to deploy commercially available network devices that operate on power-line communications. EDF plans to connect an OpenADR-enabled server with a device that can control solar inverters, instructing them to supply local building loads, feed energy to the grid, or help stabilize the grid with voltage and frequency regulation when needed.

Long-Range Planning at Southern Company

In recent years, winter peak demand has grown across Southern Company's power system, due in part to increased adoption of electric heat pumps. In its Alabama, Florida, Georgia, and Mississippi service areas, the company traditionally meets this demand by deploying generation, without requesting large load reductions from business customers. Regulatory changes and increasing renewables are driving more demand response, according to Justin Hill, who manages Southern Company's demand response research portfolio. "In five to ten years, I see automated demand response having the potential to play a more central role in peak demand management," he said.

For the Southern Company system, participation in EPRI's OpenADR demonstration provided an opportunity to explore long-term demand response solutions. Southern Company's Alabama Power subsidiary has deployed an OpenADR 2.0b-enabled server that can send messages to identify target energy resources, request load adjustments, and schedule adjustments most convenient for the customer. Next will come software that enables customer lighting and temperature control devices to receive and respond to messages.

Hill said that the collaboration with EPRI has helped convince vendors to bring products to market. "There are a lot more devices certified by the OpenADR Alliance now than a year ago," he said.

The Future of OpenADR

EPRI's demonstrations are important in advancing OpenADR's ability to enable demand response on a large scale. While originally conceived for demand response, researchers now recognize that the language can support many transactions, such as the purchase and sale of electricity and grid-stabilizing ancillary services. One possible application: Grid operators can send OpenADR signals to all electricity generation and consumption devices, which respond automatically, based on financial incentives.

Because OpenADR can operate over many communication networks, it may be able to enable communications with distribution systems and distributed energy resources, and also perform demand response. Separate systems for these three applications would then no longer be necessary, saving utilities time and money. "The current OpenADR language already has about 90% of the functionality that you would need to do that," said Walt Johnson, a technical executive in EPRI's Information and Communication Technology program. "With these capabilities, you've got a key component of a self-healing smart grid. The only problem is that we would have to change the name of OpenADR to something that indicates that the language does more than just demand response."

Key EPRI Technical Experts

Walt Johnson