The OpenADR Primer

An introduction to Automated Demand Response and the OpenADR Standard

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Executive Summary

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Demand Response (DR) is the shifting or shedding of demand for electricity resources during times of electrical grid stress or when the price of electricity is high. Open Automated Demand Response (OpenADR) consistently conveys the DR signals to consumers (business or residential) from the system operator, facilitating a timely and predictable response, while allowing choices by the end consumer.

This primer provides an introduction to DR and OpenADR for a wide audience, from consumers of electricity to C-level executives. For those who want to learn more about Automated Demand Response and the OpenADR standard, there are links to numerous other sources throughout.

Key points:

- Demand Response (DR) allows electric utilities to accommodate short increases in peak demand without building expensive new power generation plants or imposing rolling brownouts or blackouts.
- DR allows consumers to super-charge their energy saving plans (and thereby save additional money!) through pre-planned reductions in energy consumption for short periods of time.
- DR allows system operators, such as Independent System Operators and Utilities to use customers' load as a resource to balance the electric grid.
- DR can be either discretionary in response to a temporary increase in pricing, or automatic as part of an existing arrangement between the customer and the utility, or both (with opt-out under non-emergency conditions).
- Automating DR provides consistency in communicating the DR event while facilitating faster responses that translate into greater energy savings and more options for combining energy resources, which helps keep prices lower for everyone.
- Automating DR also provides pricing continuity between wholesale (generation and transmission) and retail (distribution) markets.
- By automating DR, distributed renewable energy sources can be more effectively integrated into the Smart Grid.
- For electricity providers to be able to communicate DR and Distributed Energy Resources (DER) signals with each other and with customers, it is necessary to have a common language understood by all parties.
- The OpenADR standard provides both a common language and a common platform for all providers and consumers of DR through the functions and features of a Demand Response Automation Server (DRAS).
- As of this writing, the DRAS interacts with OpenADR software clients in the products of more than 60 vendors.
- The OpenADR Alliance, an industry coalition, is working to foster the development, adoption and compliance of the OpenADR standards through collaboration, education, training, testing and certification.

The Need for Automated Demand Response

Demand Response played a vital role in grid stabilization during the unusually hot Summer of 2011, easing severely constrained electrical grids from coast-to-coast. Future energy crises caused by electricity demand exceeding system capacity can be postponed or even averted through Demand Response. The U.S. Federal Energy Regulatory Commission (www.ferc.gov) defines DR as "changes in electric use by demand-side resources from their normal consumption patterns in response to changes in the price of electricity, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized." The ability of DR to avert an energy crisis is so promising that one FERC Commissioner has identified DR as the "killer application" for the Smart Grid.

To work effectively, DR needs two elements. The first is dynamic pricing options for both the wholesale and retail markets. Retail electrical markets serve commercial and industrial (C&I), and residential customers. Wholesale electrical markets serve the retail markets, and are now beginning to use Locational Marginal Pricing (LMP) to reflect the actual cost of delivering electricity via the transmission grid. In retail markets (via the distribution grid) several different dynamic pricing programs are being deployed. Recent advances in DR will also allow for real-time integration of Distributed Energy Resources (DER) such as solar and wind, as well as so-called load shifting to energy storage resources from the customer side of the market.

The second necessary element is automation, also known as Automated Demand Response or ADR. ADR helps system operators reduce the operating costs of DR programs while increasing DR resource reliability. For customers, ADR reduces the resources and effort required to achieve successful results from these DR programs. Automation is what also makes it possible to translate changes in wholesale markets to corresponding changes in retail rates, enabling customers to respond to DR signals in real-time to reduce demand.

The problem today is that there is no such harmonization between wholesale and retail markets. In virtually every other market, demand decreases as prices increase. But with electricity, the situation is just the opposite: Wholesale prices are at their highest when retail demand is at its peak. It is an unsustainable situation. Automation may provide a secondary benefit to offset this problem. Through the quick and predictable load reduction facilitated by automation, DR resources can be more readily integrated into the Smart Grid when needed through load adjustments to balance supply and demand dynamically.

Such end-to-end automation requires standardization. For ADR this means a common way for wholesale producers to communicate with utilities and aggregators, who in turn communicate with their customers, who can then reduce demand during peak periods. Without an ADR standard, automated DR would be difficult and costly to implement. System development, integration and installation costs could grow to prohibitive levels, and these proprietary and expensive assets could eventually become stranded. Simply put: Without a standard, it would be difficult for utilities to effectively implement this "killer application."

The OpenADR Standard

Open Automated Demand Response (OpenADR) is an open and standardized way for electricity providers and system operators to communicate DR signals with each other and with their customers using a common language over any existing IP-based communications network, such as the Internet. As the most comprehensive standard for Automated Demand Response, OpenADR has achieved widespread support throughout the industry. As of this writing, there have been over 60 vendor implementations of OpenADR.

A Brief History of OpenADR

The California energy crisis of 2002 served as the impetus for the effort that ultimately led to the creation of version 1.0 of the OpenADR standard. The Demand Response Research Center (http://drrc.lbl.gov), which is operated by Lawrence Berkeley National Laboratory (LBNL), created the standard with funding from the California Energy Commission's (www.energy.ca.gov) Public Interest Energy Research (PIER) program. Shortly after 2002, the DRRC worked with the California IOUs (SCE, SDG&E and PG&E) to jointly develop this technology through pilots and actual program implementations.

In 2009, OpenADR was included in the Smart Grid Interoperability Standards Framework, and FERC identified OpenADR as a key standard for Demand Response. Additional standards work was performed by the Smart Grid Interoperability Panel (SGIP), which is being tasked by the U.S. National Institute of Standards and Technology (NIST) to oversee standardization of the Smart Grid (www.nist.gov/smartgrid and http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/OpenADR/). The North American Energy Standards Board (www.naesb.org) contributed to the effort by developing a set of requirements.

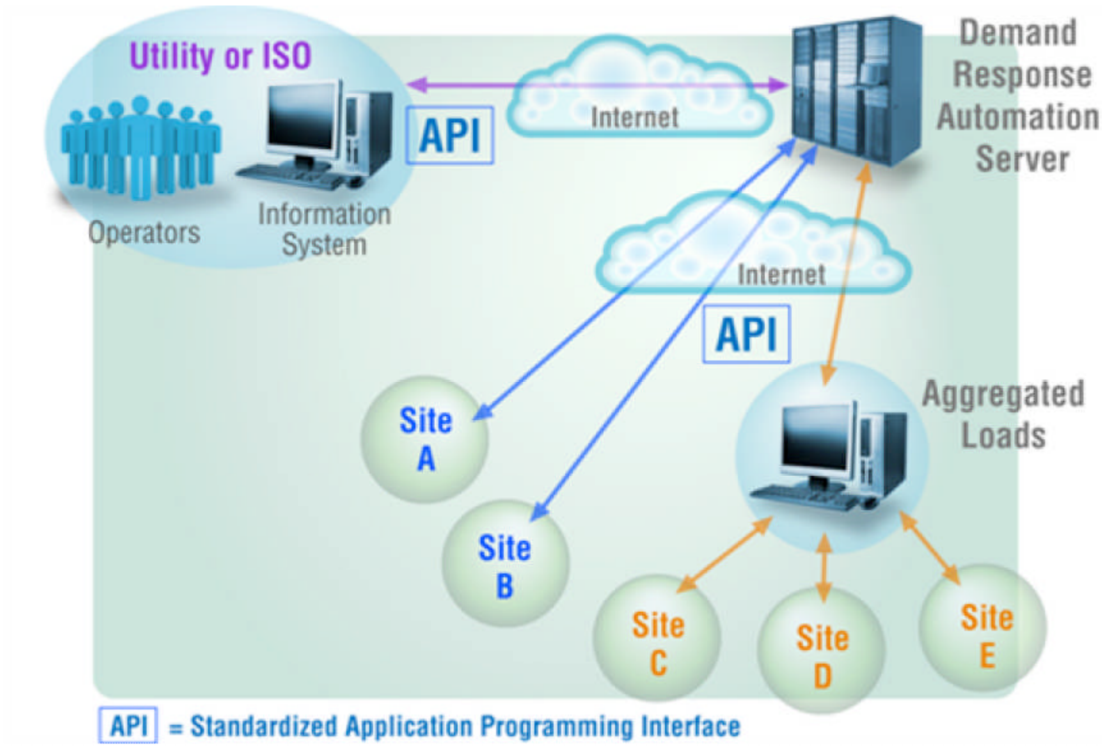
In that same year, the OpenADR specification was released as an official California Energy Commission (CEC) document, and the DRRC donated version 1.0 of the OpenADR standard to the Organization for the Advancement of Structured Information Standards (www.oasis-open.org) and the UCA (Utilities Communication Architecture) International Users Group (www.ucaiug.org). The work to create version 2.0 of the OpenADR standard is being performed by OASIS through its Energy Interoperation (EI) Technical Committee (www.oasis-open.org/committees/energyinterop/) with assistance from the UCAIug OpenADR Taskforce.

Once work is completed on OpenADR version 2.0, with its expanded and complete set of DR and DER signals, the standard will be submitted to the International Electrotechnical Commission (www.iec.ch) in Europe for adoption worldwide. IEC is the world's leading organization for international standards for all electrical, electronic and related technologies.

How OpenADR Works

In the *Open Automated Demand Response Communications Specification (Version 1.0)*, LBNL describes OpenADR as "a communications data model designed to facilitate sending and receiving DR signals from a utility or independent system operator to electric customers. The intention of the data model is to interact with building and industrial control systems that are pre-programmed to take action based on a DR signal, enabling a demand response event to be fully automated, with no manual intervention. The OpenADR specification is a highly flexible infrastructure design to facilitate common information exchange between a utility or Independent System Operator (ISO) and their end-use participants. The concept of an open specification is intended to allow anyone to implement the signaling systems, providing the automation server or the automation clients."

The specification also describes the scope of the OpenADR standard: "The Open Automated Demand Response Communications Specification defines the interface to the functions and features of a Demand Response Automation Server (DRAS) that is used to facilitate the automation of customer response to various Demand Response programs and dynamic pricing through a communicating client. This specification, referred to as OpenADR, also addresses how third parties such as utilities, ISOs, energy and facility managers, aggregators, and hardware and software manufacturers will interface to and utilize the functions of the DRAS in order to automate various aspects of demand response (DR) programs and dynamic pricing."



The OpenADR standard specifies the application programming interfaces (APIs) to, and the functions of, the Demand Response Automation Server (DRAS), which serves as the common platform between all providers and consumers of electricity.

During a Demand Response event, the utility or ISO/RTO provides information to the DRAS about what has changed and on what schedule, such as start and stop times. A typical change would specify one or more of the following:

- PRICE_ABSOLUTE – The price per kilowatt-hour
- PRICE_RELATIVE – A change in the price per kilowatt-hour
- PRICE_MULTIPLE – A multiple of a basic rate per kilowatt-hour
- LOAD_AMOUNT – A fixed amount of load to shed or shift
- LOAD_PERCENTAGE – The percentage of load to shed or shift

Note that in the first three cases, it would be up to the customer to determine how best to participate in the OpenADR event. For example, commercial customers might be notified of a change in Time-of-Use pricing during a peak period, and the Energy Management System (EMS) might be programmed to temporarily offset building temperatures by several degrees and dim or turn-off non-essential lights. The last two cases normally shed load automatically based on an existing arrangement. If prices continue to climb higher the EMS may escalate the DR program by reducing or turning off rooftop air handlers during the same peak period.

The standard also specifies considerable additional information that can be exchanged related to DR and DER events, including event name and identification, event status, operating mode, various enumerations (a fixed set of values characterizing the event), reliability and emergency signals, renewable generation status, market participation data (such as bids), test signals, and more.

Relationship with Other Standards

The OASIS Energy Interoperation Technical Committee is working with both the OASIS Energy Market Information Exchange (EMIX) and the OASIS Web Services Calendar (WS-Calendar) Technical Committees to coordinate development of the full set of standards needed to exchange pricing information using a common schedule across energy markets (www.oasis-open.org/committees/emix and www.oasis-open.org/committees/ws-calendar). EMIX defines a standard way to exchange pricing and other information among ISOs and utilities. Because the price of electricity varies with the time of delivery, EMIX conveys the necessary time and interval data using WS-Calendar as a common clock. Both EMIX (Common Price Communication Model) and WS-Calendar (Common Scheduling Mechanism) take advantage of the SGIP Priority Action Plan (PAP) assessment and recognition process.

OpenADR Features

Continuous, Secure and Reliable – Provides continuous, secure, and reliable two-way communications infrastructures where the clients at the end-use site receive and acknowledge to the DR automation sever (DRAS) upon receiving the DR event signals.

Translation – Translates DR event information to continuous Internet signals to facilitate DR automation. These signals are designed to interoperate with Energy Management and Control Systems, lighting, or other end-use controls.

Automation – Receipt of the external signal is designed to initiate automation through the use of pre-programmed demand response strategies determined and controlled by the end-use participant.

Opt-Out – Provides opt-out or override function to participants for a DR event if the event comes at a time when reduction in end-use services is not desirable.

Complete Data Model – Describes a rich data model and architecture to communicate price, reliability, and other DR activation signals.

Scalable Architecture – Provides scalable communications architecture to different forms of DR programs, end-use buildings, and dynamic pricing.

Open Standards – Open standards-based technology such as Simple Object Access Protocol (SOAP) and Web services form the basis of the communications model.

Energy Interoperation also interacts, although less directly, with the NAESB Energy Usage Information Model and the ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) Facility Smart Grid Information Model. The Energy Usage Information Model supports load curtailment, load shaping and energy market operations, all of which pertain to Demand Response. The Facility Smart Grid Information Model will create a standardized data exchange that enables control systems in the customer premises to manage electrical loads and generation sources in response to communications from utilities, and other electrical service providers or market operators.

OpenADR will also need to interoperate directly or interwork indirectly with other popular protocols now used for energy management, including BACnet (www.bacnet.org), LonMark (www.lonmark.org) and the Smart Energy Profile (www.zigbee.org). Depending on the protocol, this is expected to be accomplished either with enhancements to these standards, or with separate software or systems, such as a gateway function capable of translating between protocols.

The OpenADR Value Proposition

Widespread adoption of OpenADR will accelerate the successful implementation of Demand Response programs and Distributed Energy Resources, thereby providing the following four major benefits for all stakeholders:

- *Lower Costs* – Standardization lowers development and support costs for vendors and, ultimately, their utility customers. Standardization also fosters technology innovation and competition, which expands product choices for both utilities and end users.
- *Assured Interoperability* – System operators, electricity providers and consumers alike benefit from being able to choose from among a wide range of different products and services without concern for any incompatibility or inevitable obsolescence.
- *Greater Reliability* – Products based on standards function dependably under normal circumstances and are able to recover from any anticipated error conditions to deliver dependable operation.
- *Enhanced Flexibility* – OpenADR is designed to work with standard control systems and gateways compliant with the OpenADR 2.0 standard.

Commercial, industrial and residential customers, and energy aggregators, will all be able to reduce costs, time and risk in the selection and deployment of products and systems based on the OpenADR standard. Work being performed by the OpenADR Alliance (covered below) will educate these stakeholders about the benefits of Demand Response, and will increase their confidence in the available solutions with rigorous testing and certification programs.

OpenADR Benefits

In the Open Automated Demand Response Communications Specification (Version 1.0), Lawrence Berkeley National Laboratory summarized the benefits as follows:

Open Specification – Provides a standardized DR communications and signaling infrastructure using open, non-proprietary, industry-approved data models that can be implemented for both dynamic prices and DR emergency or reliability events.

Flexibility – Provides open communications interfaces and protocols that are flexible, platform-independent, interoperable, and transparent to end-to-end technologies and software systems.

Innovation and Interoperability – Encourages open innovation and interoperability, and allows controls and communications within a facility or enterprise to build on existing strategies to reduce technology operation and maintenance costs, stranded assets, and obsolesce in technology.

Ease of Integration – Facilitates integration of common Energy Management and Control Systems (EMCS), centralized lighting, and other end-use devices that can receive a relay or Internet signals (such as eXtensible Markup Language [XML]).

As a result, DR equipment vendors and systems integrators will be able to accelerate the time-to-market for, and lower the development costs of, innovative products and services, while electric utilities, ISOs and RTOs will gain faster access to the market, experience lower capital and operational expenditures, and achieve greater success with Demand Response programs. Even regulatory agencies will benefit from knowing that the introduction of new pricing policies and tariffs will not be undermined by incompatibilities or other end-to-end impediments in the marketplace.

For customers or end-users, OpenADR will be embedded directly into energy management systems, lighting control systems, energy system interfaces and other equipment. This will enable customers to leverage existing infrastructure for both ADR and energy management, allowing single- and multi-site businesses to maximize the benefits of the Smart Grid. These systems can be pre-programmed to react to an OpenADR message, giving customers more granular control over how different events are managed.

The Role of the OpenADR Alliance

The mission of the OpenADR Alliance (www.openadr.org) is to foster the development, adoption and compliance of the OpenADR standards through collaboration, education, training, testing and certification. The Alliance will also promote the worldwide market acceptance of the OpenADR standard.

Work being performed by industry coalitions like the OpenADR Alliance is critical to the success of new Smart Grid standards. No new standard is ever 100% complete, and different interpretations can cause interoperability problems in early implementations. For this reason, the Alliance is supported by a broad cross section of utilities, independent system operators, regional transmission operators, regulators and vendors who share a common interest in the success and widespread adoption of the OpenADR standard.

In performing its work, the Alliance will adhere to industry best practices as detailed in the Interoperability Process Reference Manual (IPRM) created by the SGIP (http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/SmartGridTestingAndCertificationCommittee). The IPRM outlines the conformance, interoperability and cyber-security testing and certification requirements for Smart Grid standards recommended by the SGIP.

Conclusion

Demand response is critical to avoiding an energy crisis similar to what happened in California in 2002—so much so, that it has been dubbed the “killer application” for the modern Smart Grid. To work effectively, Demand Response must be both automated and standardized. As *the* standard for Automated Demand Response, OpenADR has gained widespread support throughout the industry. Utilities, ISOs and RTOs are now specifying OpenADR-certified products in their DR programs. As a result, manufacturers are now incorporating OpenADR functionality into their product lines, and aggregators and systems integrators are now adopting OpenADR to reduce the cost of implementing DR projects.

Although originally created in the U.S., the OpenADR Alliance has witnessed market momentum for this important industry initiative spreading worldwide. Utilities, vendors and integrators are joining the Alliance to have a role in its mission to ensure the success of the OpenADR standard.

More information about joining the OpenADR Alliance and participating in its efforts to promote interoperability and industry adoption is available at www.openadr.org.

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