Getting Ahead of the Demand Curve

A Customer-Focused Approach to Energy Savings through Automated Demand Response

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ABSTRACT

This paper details how Open Automated Demand Response (OpenADR) technology and dynamic pricing tariffs can be applied to benefit both the electrical grid and utility customers. Electric grid reliability challenges, demand response alternatives, smart grid standards, OpenADR implementation processes and sample load shed strategies are discussed. A customer OpenADR deployment case study and actual energy savings are detailed.

The World of Electricity is Changing

Peak load challenges are nothing new. In the 1930's, insufficient snowpack left California hydroelectric dams unable to supply adequate power. Fast forward to 2000-2001, when California saw the perfect storm of a dot.com economic boom, a drought, power plant construction delays, and market manipulation create regular rolling blackouts. In 2011, extreme weather forced Texas to rolling blackouts during both winter and summer months. Challenges continue to emerge as new EPA rulings are driving the rapid closure of high-emission coal plans and the growth of renewable energy presents utilities the new challenge of balancing supply intermittencies caused by clouds and time-of-day wind patterns.

Yet like California, most Independent System Operators use their total capacity only a fraction of the year, leaving fossil fuel peaking plants, designed to rapidly ramp to address peak loads, inefficiently idling much of the time.

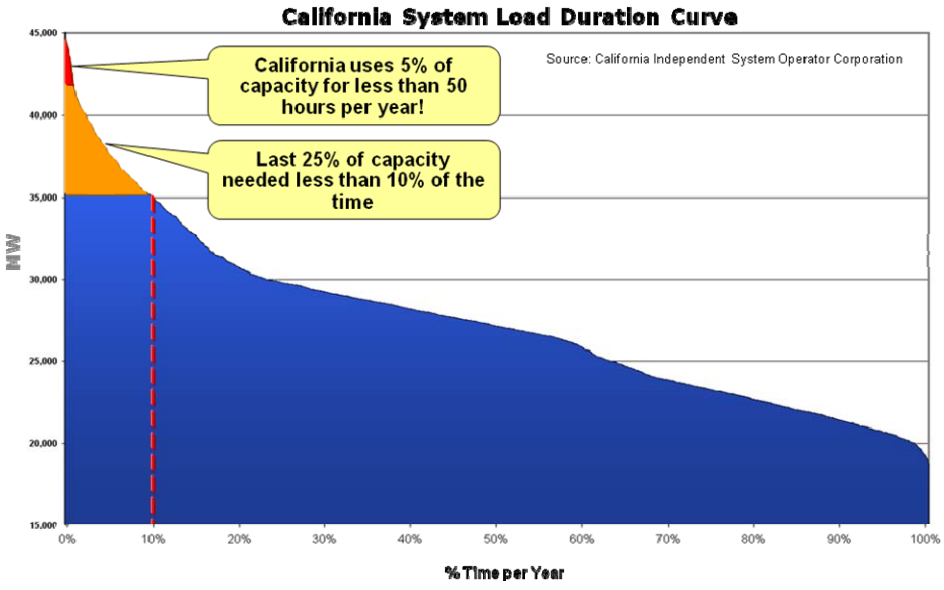

Figure 1: California System Load Duration Curve

In lieu of new sources of power, utilities are increasingly adding demand-side initiatives to lower, shift, and smooth peak load consumption. Energy efficiency initiatives address lasting load reduction, while demand response programs provide rapid, short term load relief.

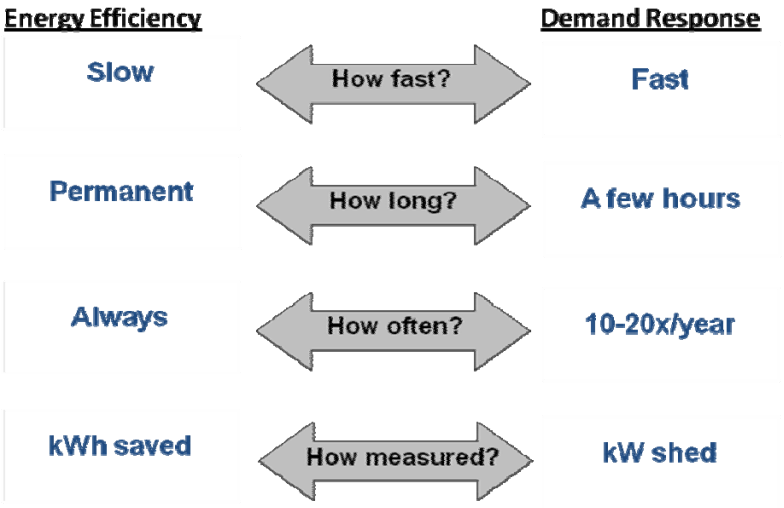

Figure 2: Energy Efficiency vs. Demand Response

Demand Response Options

To help level and shift peak demand, utilities worldwide are adding a range of demand response programs to their portfolio. Demand response programs vary widely in technology and impact:

Manual demand response, which involves a utility contacting a participating facility to request that it reduce its energy load during a specific demand response event, when demand peaks. In response, the facility takes action to reduce load during the event, like turning off specific pieces of equipment or reducing lighting, for example. Manual demand response programs typically require notification far in advance of a demand response event, and also lack the visibility and control utilities need in order to effectively and predictably manage load. These types of programs can also increase the operational workload and costs for participating facilities.

Direct load control, which is typically applied to residential demand response programs but can be difficult to apply elsewhere. This type of program is cost-effective but lacks the predictability and scalability utilities need in order to apply it to larger commercial or industrial facilities to execute complex, tiered load reduction strategies.

Third-party aggregator-led efforts can deliver results. However, utilities and facility teams give up their direct relationship — as well as the full potential financial benefits of load reduction.

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A Customer-Focused Approach to Energy Savings through Automated Demand Response

Automated Demand Response (ADR) was created as part of ground-breaking research funded through the Public Interest Energy Research (PIER) program at the California Energy Commission (CEC) and developed by the U.S. Department of Energy's Lawrence Berkeley National Lab (LBNL) and Akuacom.[1]

Automated Demand Response

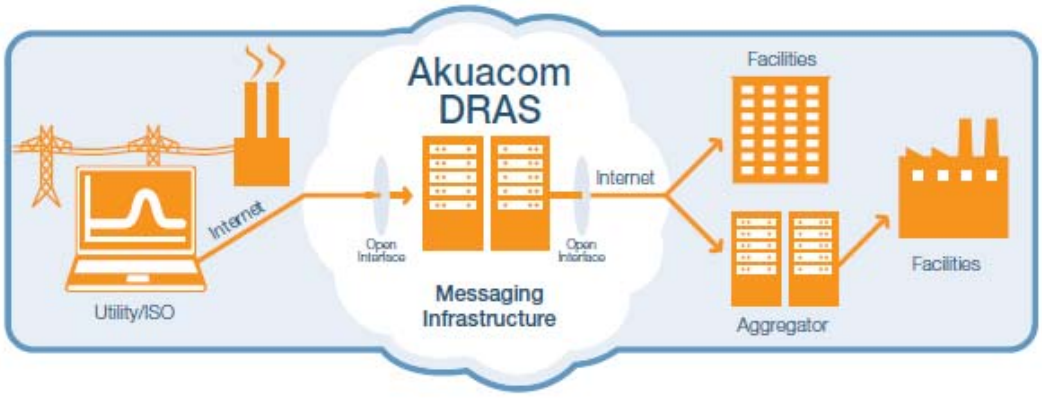

Figure 3: OpenADR Messaging Architecture

Open Automated Demand Response, or OpenADR, uses a two-way, internet-based, messaging infrastructure to automate a building's load reduction response to a demand response event. Utilities use software applications to drive execution of machine-to-machine communications, broadcasting price and reliability signals directly from the utility to pre-programmed load control devices at a participating facility and predictably reducing load in minutes rather than hours or days. As a result, both utilities and participating facility managers are empowered with direct visibility and efficient control of real-time energy use and gain more control over electricity costs.

The World of Electricity Tariffs is Changing Too

Just as demand response technology is changing, so are electricity rate structures. No longer are facilities buying power at simple, flat summer and winter rates. Instead, to drive peak load shifts and reductions, utilities are increasingly implementing dynamic pricing programs and demand charges.

Whether critical peak pricing (CPP), time-of-use pricing (TOU), or real-time pricing (RTP), these dynamic pricing tariffs link a customer's energy price to the utility's cost of delivering electricity. As a result, rates could increase by 10 or more times the normal rate during the highest-demand days of the year, such as during a heat wave.

Similarly, demand charges impose a demand threshold, per customer, based on maximum energy use during a defined time period. When actual electricity consumption exceeds the threshold, a higher rate is charged for the entire measurement interval.

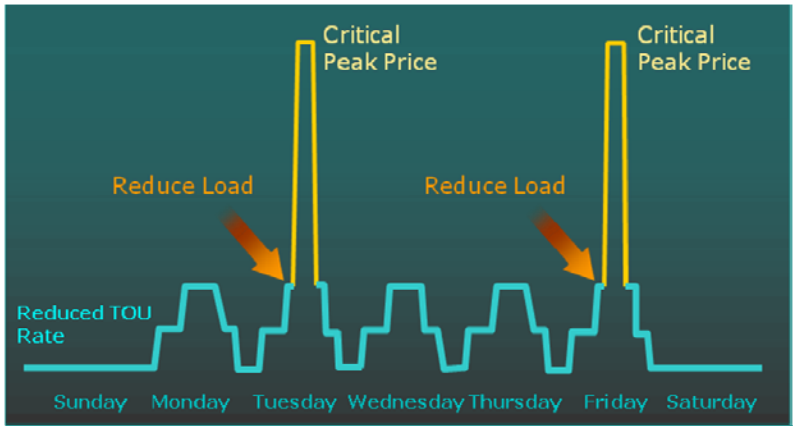

Figure 4: Critical Peak Pricing Concept

New Financial Opportunities

Time-based pricing tariffs and automated load reduction technologies make participation in demand response programs especially financially beneficial. Automated demand response shed strategies offer both the utility and customer repeatable, scalable and flexible load reduction -- and remove the human factor, helping save valuable facility personnel resources while improving the accuracy of energy reduction measures to maximize the amount of money a facility can save during peak pricing periods. Savvy facility managers can often also leverage utility incentive funding for automated demand response implementation to upgrade controls systems and automate load shed strategies at little or no cost. Early adopters have helped create a more reliable grid while creating affordable energy for themselves as well as others.

Open Standards

In 2010, NIST identified the OpenADR 1.0 specification as a key specification for smart grid communications over the Internet as part of its roadmap.[2] The utility industry's demand to lower the cost and improve the reliability and speed of automated demand response implementations has led to the rapid adoption of this open smart grid communication standard and the development of OpenADR 2.0. OpenADR 2.0 technology is based on the Organization for the Advancement of Structured Information Standards (OASIS) and builds on the successful OpenADR 1.0 specification supported by more than 60 companies worldwide.

Similar to standards development within the buildings industry, open standards offer facility managers interoperability and vendor neutrality to prevent stranded assets, thus future-proofing technology investments. Open standards ensure the necessary interoperability between software systems and controls in order to deliver automated load management capabilities to commercial and industrial facilities already managed by a range of building automation and control systems.

Implementing Automated Demand Response

Taking advantage of time of demand response opportunities requires being available to reduce consumption as needed by utilities to enable a more reliable grid. In almost all cases, facilities have the capacity and flexibility to meet the energy shed needs of the utility without impact to core business processes. All that is required is proper planning and execution of facility operation principles which most good managers use every day - responding with a proven solution to a challenge that presents itself with little to no warning. For skilled facility managers, implementing automated demand response is just another variable in the multi-variable equation of energy management and facility operations.

Energy Analysis

An energy audit is the critical first step to assessing the opportunity for both energy efficiency and demand response at a facility. Site auditing provides a better understanding of the dynamic nature of the building's energy use and enables data-driven decisions. An audit includes a thorough review of a facility's operations, including schedules, controls, and business critical energy needs. It also entails exploring potential load shed scenarios by analyzing a facility's power usage and identifying major energy consuming equipment and process opportunities. By coupling an energy load analysis with an assessment of available rate structures and demand response program opportunities, facilities can design a business-specific load reduction and cost savings strategy.

Figure 5 depicts the month-by-month load profile of a manufacturing facility. Its large peak load makes it an apparent candidate for demand response participation; however, its production shift ends at 2 pm to avoid the utility's peak pricing period, thus making the facility an unattractive candidate for demand response events called from 2-6 pm. As the facility's peak load increases during August and September, automated demand response does provide the opportunity to manage load to avoid demand charges.

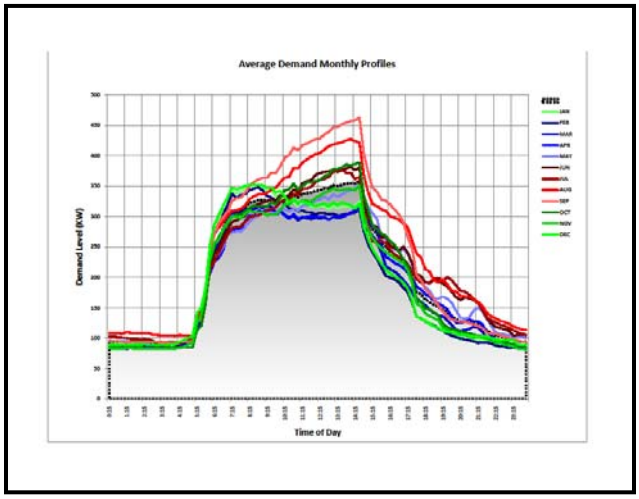

Figure 5: Monthly Facility Load Profile

Common Automated Peak Load Reduction Strategies

Load reduction strategies are as varied as the businesses to which they can apply. For example, if the price of electricity is most expensive from 2 p.m. to 6 p.m., an airport may opt to reduce the speed of its moving sidewalks, while a commercial office building can increase its air conditioning set point by two degrees. Both facilities will save on their energy costs.

Table 6 details a sample of automated load reductions strategies implemented as part of ADR programs.

Application Type	Solution Description	Shed Strategy
HVAC	HVAC system optimization	Adjust outside air intake dampers
HVAC	Pre-cooling	Pre-cool the facility
HVAC	Controls for packaged units	Global temperature adjustment for air-cooled package units
Lighting	Lighting controls / switching	Dim lights or shut off portion of the lighting
Manufacturing Process	Process optimization	Curtail or reset industrial operations by specific equipment
Other	Forklift battery chargers	Schedule to off-peak hours
Other	Pump controls	Turn off fountains
Other	Elevator controls	Reduce speed or number of elevators available

Table 1: Automated Load Reduction Strategies

Technical Implementation

ADR implementation requires a communication and controls architecture to enable the utility to send signals directly to pre-programmed load management controls at the customer site. Programs based on the OpenADR specification use the internet for communications between utilities and facilities. A participating facility uses an OpenADR gateway that continuously polls for utility price changes or demand response event signals. When the utility issues a new signal, the controller, in turn, interprets the message and initiates pre-programmed load reductions in select control systems, overriding the system's current setting to a pre-defined, more energy-efficient settings. Figure 7 depicts a typical utility-to-facility ADR communications and control architecture.

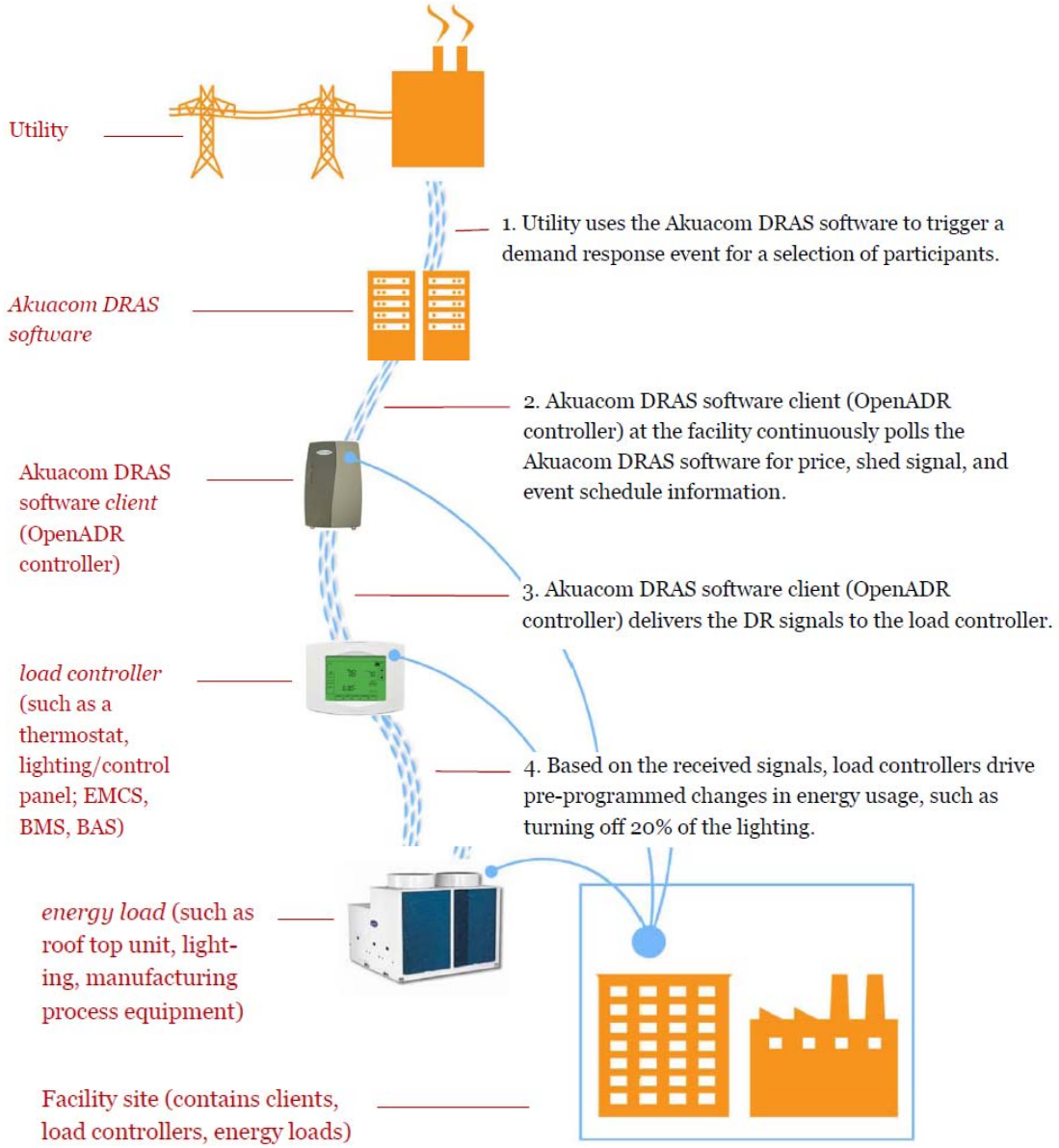

Figure 6: Automated Demand Response System Architecture

A Case for Automated Savings

When a utility recently implemented a new time-of-use tariff that raised electricity prices from $0.13 to $1.49 per kilowatt-hour during a demand response event, it provided its customers with $300/kW peak load reduction technology rebate to support ADR implementation to help curb energy use during times of peak demand and price.

Through the program, one 235,000 square-foot distribution warehouse implemented technology upgrades to enable it to automatically increase air conditioning set points, reduce lighting in non-critical areas, and lock out battery forklift charging when the utility signaled a demand response event. As shown in Figure 8, these technology investments provided the facility manager with a single system to control and view the building's energy consumption and historical baseline throughout the day, in real-time.

Figure 7: Real-Time Energy Usage

The facility's ADR program participation saved it more than $6,000 per summer month in rebated demand charges and more than $10,000 across the utility's 12 summer demand response events. The team has also recouped $3,000 in annual energy savings by permanently moving the majority of its forklift battery charging to the time of day when energy is cheapest. The facility's execute team is reinvesting the savings to repair inoperable economizers and implement daylight sensors to further improve energy efficiency.

Embrace the Change

The rise of utility demand-side management has led to demand response programs and dynamic pricing structures as tools to more effectively drive load reduction to loosen the strain on today's energy infrastructure. Facilities have an opportunity to get ahead of the curve by coupling their in-depth knowledge of their facility's operations and controls, their tariff structure, and technology incentives to automate load shed strategies and seize control of their energy spend.

About the Author

Clay Collier was a co-founder of Akuacom, Inc., a leader in Automated Demand Response software, acquired by Honeywell International in May 2010. Mr. Collier leads the Akuacom team and its business development activities. Clay began his career developing real-time processing software for high volume transaction systems at Teknekron in Berkeley, and then worked on robotic control applications at Telemecanique in France. At Navteq, he led the team that invented the first step-by-step route guidance system in North America. Clay founded Kivera, where as CEO he led deployment of the first wireless Location Based System application in the United States and enabled the internet application Triptik for AAA. Clay received his BA in Physics from University of California-Berkeley. Clay welcomes questions at info@akuacom.com.

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Footnotes

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