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THE BRIDGE TO THE SMART GRID

Dialogue Summary

A discussion on the future of demand response, hosted by the Institute for Building Efficiency.

April 6, 2011

Johnson Controls

DIVERSE EXPERTS EXPLORE THE FUTURE OF DEMAND RESPONSE IN SMART-GRID WORLD

Electricity systems around the world are being upgraded with the communication, automation and metering technology that have come to be known as the "smart grid." The benefits are widely cited: An intelligent system that coordinates the aggregate impacts of both supply and demand promises to increase reliability, save money, and reduce environmental impacts by limiting capacity additions and enabling more clean-energy contributions.

While smart grid investments are underway, they are generally supply-side approaches.[1] Opportunities for energy consumers to participate in the larger electrical grid are confined to demand response programs offered by power system operators and utilities that encourage temporary changes in electricity usage. Some forms of demand response, such as interruptible power contracts for large industrial customers and direct control of air conditioners for consumers, have existed for decades. Others, such as aggregation of "negawatts" bid into wholesale markets by third-party suppliers, and automated demand response in commercial buildings, are more recent innovations. Together, demand response resources have come to play a notable role in the electricity systems of the United States. A recent estimate from the Federal Energy Regulatory Commission (FERC) reports that there are 58 GW of demand response resources enrolled today, representing 7.6 percent of peak demand.[2]

Demand response has grown significantly in recent years and is expected to continue evolving as the demand side of electricity markets becomes more intelligent, dynamic, and sophisticated. If the smart grid concept requires seamless interaction between producers and consumers of electricity, the next three to five years of demand response program evolution can be seen as a bridge to the smart grid, building on successes to date and moving steadily toward a more dynamic and interactive electricity system.

WORKSHOP: THE FUTURE OF DEMAND RESPONSE

To analyze this trend and explore the need for enabling research, the Institute for Building Efficiency convened a group of U.S. and international experts on April 6, 2011 in a workshop on the future of demand response. Targeting the important sector of commercial and institutional buildings, the group pulled from decades of collective experience and diverse perspectives to explore the question of how demand-side resources can best meet the needs of the grid.

The group met at the Johnson Controls offices in Washington, DC and included remote participants via web conference. In addition, a few individuals not present for the discussion provided input through separate conversations. Participants in the workshop include:

- David Kathan and Dean Wight – US Federal Energy Regulatory Commission[3]
- Dan Delurey – Demand Response and Smart Grid Coalition
- Jessica Strömbäck – Smart Energy Demand Coalition
- Susan Covino – PJM
- Phil Hanser – Brattle Group
- Chris Irwin – US Department of Energy
- Katherine Hamilton – Quinn Gillespie
- Clay Nesler – Johnson Controls
- Rich Sedano – Regulatory Assistance Project (separate conversation)
- John Moura – North American Electric Reliability Council (separate conversation)
- Jennifer Layke – Institute for Building Efficiency

[1] A recent estimate of the annual global spending on smart grid predicts that investment will grow from $10B to $35B US between 2009 and 2013. See Pike Research, "Smart Grid Technologies,"(4Q 2009). http://www.pikeresearch.com/research/smart-grid-technologies

[2] FERC "2010 Assessment of Demand Response and Advanced Metering" (2011).

[3] "The views expressed in this paper do not necessarily represent the views of the Federal Energy Regulatory Commission (FERC), any of its Commissioners or FERC staff and participation in the workshop by FERC employees should not be considered as FERC endorsement of the views expressed in this paper."

The discussion touched on the technology, policy and market issues that the group sees as important as demand response programs of today evolve to become a key component in the smart grid of the future. With a diverse group of experts exploring an exciting and timely topic, the conversation was both engaging and enthusiastic. Four key themes emerged, leading to a general consensus around the optimal areas of research focus for the Institute.

1. Demand response in every setting

Demand response has historically seen more adoption in restructured markets, where load reductions can be bid into auctions for capacity along with power generation. This observation sparked a discussion about the fragmented nature of electricity markets. Markets in the U.S. vary in the degree of government regulation and market organization; the variance is even wider when considering the diversity of markets around the world.

Despite the differences, demand-side resources in all of these market structures can deliver significant benefits. The group shared several examples of successful demand response programs operating in very different circumstances. It is not necessary to revamp markets to enable more demand response participation; however, there is a need for detailed research and sharing of cases to support the growth of demand response in every setting.

2. Demand response for every occasion

Several participants in the discussion mentioned an additional factor – the need for buildings to provide more services to the grid than peak relief during emergency events.

Almost all of the estimated $2 billion spent today on demand response in the U.S. is found in capacity markets. Under these programs, building operators commit to a specified level of load reduction and receive payments from the market for being ready to deliver. When events are called, they require significant actions, usually for six to ten hours. At industrial facilities, operators sometimes shut down entire processes and send employees home. Capacity programs have seen tremendous growth, but they do not represent a natural fit for buildings, particularly offices and other settings in the commercial sector.

In contrast, price-based demand response is emerging in the U.S. as an opportunity for more participation from buildings and facilities in the electric system. Under what are often called "energy" or "economic" programs, demand response resources can sell load reductions of even an hour or two into spot markets for energy. A recent ruling by the FERC provides a boost to these programs, ensuring that a unit of reduced load during peak times is compensated at the same rate as a unit of generated electricity.[4] Comparable programs have been demonstrated in regulated utility settings, as well. Overall, this trend toward more frequent participation on a voluntary basis (there are no penalties for failing to deliver reductions) aligns well with the characteristics of commercial buildings today.

As an extension of this trend, a third market structure offers yet another option for building operators seeking to participate in the electric grid. Ancillary services markets provide stability and power quality for the system on short time scales – as small as minutes or seconds. In the view of some participants in the conversation, these types of markets may be best suited for demand response in commercial buildings because they require short performance periods –allowing the thermal mass of buildings to serve as energy storage – and have the most attractive economics. Even though demand response

[4] FERC Order 745. See commentary from Katherine Hamilton here: http://idc-insights-community.com/posts/d01e7a1dd7

plays a relatively small role in ancillary services markets today, there is widespread expectation for its ability to provide this function in the future. Two important enablers are end-to-end automation and visibility of information from grid operator to participating facility operator. Technology will therefore be crucial in allowing this trend to develop.

The discussion around ancillary services centered on the increasing need for grid stability with the addition of variable energy resources in many parts of the world. As one example, the targets cited and pre-authorized for funding in parts of Europe reach penetration for wind power as high as 50 percent of the total generation on the system. Considering the potential for unplanned changes in wind levels to disrupt the grid, the promise of demand response to deliver ancillary services is even more attractive.

Several comments in this conversation alluded to the benefits demand response can offer to transmission and distribution, in addition to generation. In many cases, load-serving entities like a utility have congestion issues targeted to a particular zone or substation. While today's demand response programs can help alleviate such constraints, they are typically spread out over the entire territory and therefore lack the surgical precision that could be provided in a world with more information exchanged between operators and participants, and with more automation and metering to provide the required performance certainty.

3. The human element in demand response

Demand response is unique when considered alongside traditional power generators such as a gas-fired power plant. While a power plant is "steel in the ground" and is viewed by grid operators as a callable resource, a demand response commitment today typically requires action from one or more people at a facility. In fact, many of the demand resources enrolled today require manual execution: not only must a facility operator receive notification of an event and plan a response, but the facilities staff must walk the facility, switching off breakers, turning off lights, and taking other curtailment actions.

The group frequently referred to the potential for technology to increase the reliability of demand reductions, but noted that the behavioral component is usually the dominant driver. A recent analysis of pilot programs in the residential sector identified marketing and communication with consumers as the strongest predictors of a successful program. This confirms the importance of planning demand response around the people who will participate. This will also be true in the commercial and industrial sectors, where the human element must be considered alongside a set of business policies.

There is a strong parallel between the human side of demand response and the increasing focus on behavioral energy efficiency. Whether managing the total energy consumption or the demand during peak times, performance depends heavily on the decisions made and actions taken by the people operating the equipment and control systems in the building. Regulation in the past year has allowed utilities and other administrators of energy efficiency programs to count savings through behavior modifications toward their total achieved savings.[5] In addition to the formally accounted energy and peak demand savings, there is an indirect effect that includes behavior. A customer monitoring its time-resolved electricity usage through demand response participation is more likely to invest in energy efficiency and achieve savings.[6]

[5] See summary of a discussion with Dian Grueneich of the California Public Utilities Commission here: http://www.institutebe.com/Existing-Building-Retrofits/behavior-based-energy-efficiency.aspx

[6] Kelly Smith, Institute for Building Efficiency, "Energy information, goal-setting, and action: You can't manage what you don't measure" (2010): http://www.institutebe.com/InstituteBE/media/Library/Resources/Existing%20Building%20Retrofits/Issue-Brief--Measure-to-Manage.pdf

4. Demand response, energy efficiency, and a fully integrated demand side

While discussing the interplay between information from the grid, energy usage data, and decision-makers at participating facilities, it is natural to turn to the opportunities for energy efficiency and demand response to work together.

- From a customer perspective, both categories contribute to the important goal of reducing spending on energy. In addition, there are synergies and interactions between the two. It is desirable to consider energy efficiency and demand response with a single approach.
- From a financial perspective, demand response and energy efficiency combine revenue streams from multiple sources (including bill savings and payments from power markets) to optimize cost-effectiveness.
- From a data perspective, demand response measurement and verification requires the collection of time-resolved electricity meter data. This information could also serve as the basis for energy information provided to customers, and for measurement and verification of energy efficiency projects.

Demand response and energy efficiency have the potential for successful integration as part of a trend toward more comprehensive energy management in a smart electricity grid. Perhaps surprisingly, several participants in the conversation pointed to past experiences in which structural and attitudinal barriers prevented successful cooperation. As an example, many organizations involved in demand-side management activities are set up with separate "silos" for energy efficiency and demand response.

MOVING FORWARD

The discussion on April 6 provided a venue for demand response experts from diverse roles and backgrounds to explore the transition to a truly smart grid built on seamless interaction between the supply and demand sides of the electricity marketplace. The future work required to facilitate this bridge to the smart grid are both intimidating and exciting, ranging from technology to policy to market issues. Through collaborative research and mutual exchange of ideas and information, the individuals and organizations supporting demand response and the smart grid can work together to drive meaningful change in the world's electricity systems.

The Institute for Building Efficiency is an initiative of Johnson Controls providing information and analysis of technologies, policies, and practices for efficient, high performance buildings and smart energy systems around the world. The Institute leverages the company's 125 years of global experience providing energy efficient solutions for buildings to support and complement the efforts of nonprofit organizations and industry associations. The Institute focuses on practical solutions that are innovative, cost-effective and scalable.

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