Exploring the Relationship Between Demand Response and Energy Efficiency: A Review of Experience and Discussion of Key Issues

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Note: Appendix A is available for download for free along with the main body of this report, while Appendices B through D are available only in hard copy, along with the main body and Appendix A.

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EXECUTIVE SUMMARY

Demand-Response Program Experience

"Demand-response" programs and technologies have been heralded in recent years as a great advancement in providing customers new options for managing their energy costs and use along with providing energy suppliers new options for assuring reliable supply at reasonable costs. Proponents of demand-response programs tout numerous benefits from such options, including improved system reliability, cost avoidance, greater market efficiency, improved risk management, reduced negative environmental impacts, improved customer service, and market power mitigation. Crisis and near-crisis conditions and events have spurred the development and practice of demand response in many states and regions.

The electric utility industry generally has shown a great deal of interest in expanding the use of demand-response programs and technologies. Utility regulators at the state and especially the federal level have shown strong support for expanded use of demand-response resources.

Demand-response programs and options have arisen in conjunction with both market and technological innovations over the past decade. Such programs and options seem to be natural developments within restructured, deregulated markets. Coincidental developments with communications, information, and control technologies have opened up a new world of possibilities for energy customers under new market structures, allowing customers access to detailed, real-time (or near real-time) energy use data and providing them options—both manual and automatic—to respond to pricing information and other communications about market conditions, such as system emergencies.

In this project we examined experience with demand-response programs in the United States to capture a comprehensive picture of the state of this practice to date. We reviewed program experiences and also identified gaps in available knowledge about such programs.

A key objective of this project was to examine the relationship between energy efficiency and demand response. Demand-response programs seek to reduce peak demands during times when reliability may be threatened or wholesale market prices are high. However, reducing demand is not the same as saving energy, although there are clearly relationships between reducing peak power demand (kilowatts [kW]) and saving energy (kilowatt-hours [kWh]). There may be "spill-over" impacts on overall, non-peak energy use from demand-response programs. Programs also may target both objectives.

Despite the wealth of information available on the theory and practice of demand response, relatively little research had been done on the relationship between demand response and energy efficiency. As we conducted the study, we were somewhat surprised to discover how little attention has been focused on that issue. We found this to be a major area in need of research, testing, and analysis.

In our review we have observed that experience to date with demand-response programs has generally been positive. Scores of the different types of demand-response programs have

been offered and are in place across the United States. Many have their origins in the practice of utility demand-side management from the 1980s and 1990s. Certain states and regions have been especially active in developing and offering demand-response programs, notably California, New England, the Northwest, and New York and other Middle Atlantic states, but programs can be found in most states.

Demand-response programs are generally divided into two broad categories, "load-response" programs and "price-response" programs (PLMA 2002), a convention we follow in this report although there are clearly overlaps. Most demand-response programs offered to date have been load-response programs, which focus on providing load relief to maintain system reliability. Load-response programs comprise the largest demand-response resource in terms of their contributions to peak-load reductions. This is not surprising as these types of programs are well established and have been successfully used for decades. Interruptible and curtailment programs are the primary examples of load-response programs.

"Price-response" programs have been the focus of many recent programs and initiatives, especially dynamic pricing such as critical peak pricing and real-time pricing. There is widespread conceptual support for exposing electricity customers to prices that reflect actual market conditions and associated prices.

Despite the growing interest in price-response programs, experience with such programs to date shows mixed results. Dynamic pricing—particularly real-time pricing—is the category of price-response programs that has garnered the greatest attention and focus in recent years, although there have been a handful of such programs with a much longer history. Experience with real-time pricing (RTP) programs is mixed, however. Participation in and impacts from these programs varies widely. With a few noteworthy exceptions, only a few have achieved significant absolute or relative impacts in terms of load reductions achieved. In a recently published comprehensive review of 43 RTP programs offered to commercial and industrial customers, a surprisingly high fraction of RTP customers appear to not be very price sensitive (Barbose, Goldman, and Neenan 2004).

Experience with dynamic pricing has been limited mostly to large commercial and industrial customers. There are, however, pioneering efforts with residential dynamic pricing in a few states, including California, Illinois, Florida, Washington and New York. Some of the initial results are promising, but it is still mostly too early to assess the full impacts of these programs. These programs should reveal a great deal about how residential customers respond to time-differentiated rates that reflect wholesale market prices and conditions.

The other major type of price response, or market-based, demand-response program is demand bidding. These types of programs have remained a relatively small share of overall demand-response portfolios. They are not nearly as widespread as load-response programs, but may be a potentially important resource in those states and regions that have them.

Demand Response and Energy Efficiency

Demand response and energy efficiency both affect customer end-use of energy. How exactly these primary objectives relate to each other was a primary focus of our research and analysis.

Unfortunately, we found that there is almost no published research on the issue of how demand-response programs affect energy use during off-peak periods and overall building/facility energy use and energy efficiency. There is some mostly anecdotal evidence that suggests certain types of technologies capable of enabling demand response during peak demand periods can also realize energy and demand savings in off-peak periods. We were not able to determine the extent that customers are using these technologies actively as a means of achieving broader energy savings because this simply has not been a research focus within the industry.

We found little quantitative analysis of energy efficiency and conservation impacts from demand-response programs.[1] These impacts would be improvements made to end-uses and operations that yielded greater energy efficiency, which could be targeted to reduce energy use during peak demand, but also yield off-peak energy savings.[2] We found limited anecdotal and qualitative information about such impacts, but we found almost no quantitative evaluation of demand-response program impacts that specifically focused upon estimating and understanding energy efficiency improvements made by customers participating in demand-response programs. This is a major gap in our understanding of the relationship between energy efficiency and demand response.

Yet understanding the relationship between energy efficiency and demand response is vitally important because there are many potential synergies, as well as potential conflicts, between these types of programs. Potential synergies include:

- Energy efficiency can reduce demand permanently, at peak as well as non-peak times;
- Focusing on peak-demand reductions can help identify inefficient and non-essential energy uses that could be reduced at other times, thus resulting in broader energy and demand savings;
- Technologies that can enable demand response also can be used effectively to manage energy use year-round;
- Experience from demand-response activities can lead to greater awareness of energy savings opportunities through improved energy efficiency;

[1] Evaluations of demand response reports do quantify energy and demand reductions (for example, see Neenan et al. 2004). However, these estimates are for reductions due to program "events"—either calls for curtailments/interruptions or for high electricity prices due to high market demand and constrained supplies. This is expected since such reductions are the focus of the programs.

[2] For example, installing more energy-efficient lighting would yield energy savings (kWh) at all times the lights were on—both on and off-peak. Such systems also would reduce peak demand (kW). However, customers participating in demand-response programs typically reduce lighting levels by selectively turning off lights during peak demand periods as a primary means to achieve desired demand reductions.

- Customers who participate in demand-response programs may be prime candidates for participating in other types of DSM programs such as energy efficiency (and vice versa); and
- Program marketing could be more effective at communicating with customers about their energy use by addressing integrated approaches to energy management.

Perhaps the most important potential synergy is simply the fact that participating in a demand-response program, particularly one that features monitoring and control equipment, helps a customer to better understand their energy use and associated costs, and that process may help encourage additional actions to reduce facility energy use and costs.

Unfortunately, the nature of demand response can also create conflicts with energy efficiency objectives. For example, there is room for confusion in marketing messages and other communications to customers about programs and services. Demand response targets reducing loads during a few brief periods over the course of a year, when prices are high or reliability is threatened due to supply constraints. Energy efficiency targets energy savings at all times throughout the year, whenever the affected end-use equipment is being used. This distinction can create some confusion as different building systems, program equipment, and energy decision-making strategies are involved.

Depending on the particular program design, there also can be potential structural conflicts between demand response and energy efficiency for certain types of programs and services. For example, if customers are paid on the basis of the amount of load they can reduce when called upon, measured from a business-as-usual "baseline," there can be a disincentive to take permanent energy efficiency actions that might lower the baseline. For pricing-based demand-response programs, the nature of the conflict is different. Measurement of baselines is not an issue for dynamic pricing—customers pay for energy costs based on the rates at the time of use. However, if off-peak prices are sufficiently low in the rate design scheme, that can act as a disincentive to pursue non-peak energy efficiency measures. Demand-response programs that feature rate discounts as an incentive could have the same effect.

Institutional barriers may also create conflicts between demand response and energy efficiency. As electricity markets have been restructured and made more competitive, the respective responsibilities and incentives for certain types of actions have been fragmented among a new set of market actors. Independent system operators are most concerned with effective demand-response resources as they provide a valuable resource to ensure system reliability.[3] State regulatory commissions and/or state legislatures generally are the primary drivers behind energy efficiency programs and services. Therefore, the funding and structure of programs can occur independently—making it difficult to coordinate and integrate multiple program objectives.

Despite potential conflicts, however, there are conceptual reasons to believe that programs can be designed to target both demand response and energy efficiency. This can be accomplished by promoting either integrated or independent technologies. Some

[3] For example, the New York Independent System Operator (NYISO) has actively promoted and advocated for real-time pricing in its communications.

technologies promoted for their demand-response capabilities can also be used to achieve energy savings objectives (i.e., energy management and control systems). In most cases, however, promotion of specific energy efficiency technologies will be necessary in order to achieve true energy efficiency gains. Fortunately, most energy efficiency technologies also will yield at least some peak-demand reduction benefits. By coordinating demand response and energy efficiency elements in program design, customers could benefit from integrated solutions to their needs for energy cost reduction and related benefits, such as improved building management and control. Somewhat surprisingly, however, we were only able to find a handful of examples where this has been done to any degree. (These examples are discussed individually in the body of the report.)

Although we found that such integration of demand response and energy efficiency elements has rarely been attempted thus far, nearly all of the industry experts we interviewed felt that it was a concept worth testing.

Recommendations

Based on our observations from conducting this research, we have two principle recommendations for policymakers, regulators, and researchers interested in furthering effective demand-side policies and programs.[4]

- *Make it a research priority to study the effects of demand-response programs on overall energy usage.*

  To date, we found that almost no research has been done on this question and very little is known about this issue. We recommend research in this area that would encompass all types of demand-response programs, from load shedding to time-of-use rates, and which would both document the existence of, and make clear the reasons for, any apparent impacts on overall energy use and relative energy efficiency.

- *Make it a policy priority to design and test programs that explicitly combine demand response and energy efficiency objectives.*

  While there are some potential conflicts between demand response and energy efficiency, there are also a number of conceptual reasons why a well-designed integration of demand response and energy efficiency objectives could be a very effective strategy for capturing important demand-side resources.

Finally, it should be emphasized that while we see potential benefits from a more combined programmatic approach to achieving energy efficiency and demand response objectives, there will clearly be an ongoing role for specific program designs that target only one or the other of these objectives. While we focus on demand-response programs and their relationship to energy efficiency in this report, it is important not to overlook the fact that many utilities across the United States have offered and continue to offer effective,

[4] While we recognize that there are a few organizations that are showing some leadership in these areas, we encourage the industry more broadly to recognize these concerns.

successful demand-side management programs—typically distinct (non-integrated) load management and energy efficiency programs. Such programs are achieving significant levels of both peak-load reductions and energy savings—far greater than the estimated total national load reductions achieved by demand-response programs to date. The benefits and proven success of that type of dual-track DSM approach offers a very legitimate conceptual model for utilities to pursue, and we don't wish to discourage that approach. However, we still believe there are good reasons to consider some integration of energy efficiency and demand-response programs and services, and that integrated program designs warrant more research and testing.

In our research and review for this report, we prepared reference materials on demand response and energy efficiency. We provide these materials in the appendices of this report. In Appendix A, we present a catalog and summary information about demand response institutions, organizations, and initiatives. In Appendix B we provide an annotated bibliography of demand response references, with a focus on California and New York experiences as these two states have been at the forefront of research, development, implementation, and evaluation of demand response. Appendix C contains a comprehensive bibliography on demand response and energy efficiency. Appendix D contains a case study investigation that we performed of selected California Energy Commission demand-response programs.

Note: Appendix A is available for download for free along with the main body of this report, while Appendices B through D are available only in hard copy, along with the main body and Appendix A.