

INCREASING DEMAND FOR DEMAND RESPONSE



Issue Brief

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INTRODUCTION

Demand response programs are expected to play an increasingly critical role in reducing peak power demand, balancing intermittent renewable energy, managing electricity price spikes, supporting grid reliability, and managing power transmission congestion. To meet these challenges, demand response programs must be better designed to be more attractive to customers. Increasing participation requires that demand response programs align with customers' needs and capabilities and with the needs of utilities. It also requires raising awareness of demand response programs among customers with eligible resources that could benefit the grid. This paper will focus on non-residential demand response programs and how they can be designed to attract subscribers and achieve the optimum impact on supply-demand balance.

Potential customers look for three attributes in a demand response program:

1. Attractiveness of payment and incentives
2. Appropriate level of complexity
3. Ability to supply the resource requested

Different kinds of businesses will assign differing priorities to these attributes. For example, manufacturers, concerned about impact on their processes may be interested in short curtailments and adequate advance notice. On the other hand, offices that use electricity primarily for space heating and cooling may be more concerned about occupant comfort than about advance notification or curtailment duration. Sensitivity to different consumers' concerns and ways of using energy helps inform demand response program designers, marketers, and third-party aggregators as they seek to expand enrollment and participation.

The Role of Aggregators

In most markets today, aggregators play a role in bringing customers to the utility and helping those customers find the demand response program most appropriate for them. Aggregators benefit utilities and independent system operators (ISOs) by bringing multiple participants, provide the volume of resources those entities need. Depending on the resource needs of the regional marketplace, the aggregated demand resources are offered during regular market cycles. For example, in Electric Reliability Council of Texas (ERCOT) market, aggregators offer blocks of demand resources every four months, while in the PJM regional transmission organization, the bidding for demand curtailment occurs each year in May. Other products, such as short-term reserves and energy balancing, may be offered and procured a few hours before the need. When a request for a demand response resource (dispatch) is executed,

(continued)

The Role of Aggregators *(continued)*

the need for demand response is relayed from the grid operator to the aggregator, who then relays the dispatch to the participating customers. In the aggregated model, customers are compensated a portion of value of their demand reduction in exchange for participating. Some programs compensate at a flat rate, while others offer a variable rate based on market energy prices and performance. The analysis in this paper will focus on how programs are aligned with participating customer needs, but it is critical to remember that aggregators facilitate most transactions. Aggregators play a key role in helping to align grid operator needs and participating customer capabilities. Aggregators' matching efforts are constantly evolving as grid operator needs change in response to new and revised regulations and the integration of renewable resources. Participating customers' capabilities change as their businesses grow.

PARTICIPATING CUSTOMER TYPES AND THEIR DEMAND RESPONSE CAPABILITIES

Demand response program designers face the difficult task of trying to purchase and manage a demand side resource for the grid that their customers may not know they possess and can monetize. To design an effective demand response program, it is essential to understand prospective customers business and energy needs.

For this paper's purposes, there are four main categories of potential commercial and industrial demand response customers with eligible resources, as outlined in the chart below. Of note, the words 'large' and 'small' are used as a proxy for the level of energy management sophistication.

Figure 1. Four Electricity User Groups

		Use of Energy	
		Industrial	Commercial
Energy Management Sophistication	Large	<i>Examples:</i> <ul style="list-style-type: none"> Automated manufacturing Bottling Refrigerated warehouses Pumping Primary metal refining and production 	<i>Examples:</i> <ul style="list-style-type: none"> Institutional campuses Large offices Healthcare Critical data management
	Small	<i>Examples include:</i> <ul style="list-style-type: none"> Repair facilities Custom fabrication 	<i>Examples include:</i> <ul style="list-style-type: none"> Small to medium offices Commercial retail space

In the following section each of the four customer types are described in greater detail.

Industrial: Use energy primarily as part of an industrial process.

- **Large Industrial:** Examples include manufacturing, refrigeration, primary metal refining and production, bottling, assembly lines, and agriculture (irrigation pumping). These users are large enough that they typically manage energy actively with automated or semi-automated processes and sometimes use the services of energy management systems and professionals. Demand response participation may be automated.
- **Small Industrial:** Examples include manufacturing or repair facilities where a majority of power consumption comes from compressed air systems, welding, pumping, and other electrically intensive processes. These users typically do not have advanced energy management systems or automatic controls. If they participate in demand response, they typically do so manually by disconnecting machinery, reducing motor and pump power via variable frequency drives, or taking equipment offline.

Commercial: Use energy primarily for lighting, heating and cooling.

- **Large Commercial:** These are typically large office buildings with active energy management capabilities. These customers have advanced building automation systems capable of modulating demand and energy use in equipment such as lighting systems, fans and pumps. They often have access to sophisticated energy management expertise.
- **Small Commercial:** These customers lack advanced building automation or demand response equipment. They do not actively manage daily energy use and typically have simple temperature controls. They may employ constant-speed pumps and fans and often rely on manual load reductions.

These definitions do not perfectly represent all potential demand response participating customers, as some small industrial customers have low energy management sophistication, and not all large offices have advanced building automation systems. But the categories are helpful for analyzing how best to attract customers to demand response programs.

Matching program types to user groups can improve demand response participation. Individual grid operators and utility program managers generally lack the resources and bandwidth to craft customized demand response solutions, but program aggregators and technology vendors may be fully able to align the needs of the grid with the willingness and ability of customers to participate. Alternatively, enrollment could be increased by shifting users between groups – for example, a small energy user given increased energy management sophistication or incentives to install automated control equipment may be able to participate in more complicated programs in the same way a large energy user does.

Successful demand response programs rely on voluntary enrollment. Industrial or commercial customers evaluate the benefits of participating against the perceived or actual costs to the business. A well designed demand response program provides a valuable service to the grid, offers customers clear and compelling benefits, clearly communicates the terms of participation, and supports expansion and retention of the participant base. Our research, completed through interviews with many market participants, revealed that

three demand response program attributes are critical to align with customer capabilities and needs if that customer is going to participate. These three program attributes, each of which will be discussed in turn for each customer type in the following sections, are:

1. Attractiveness of payment and incentives
2. Appropriate level of complexity
3. Ability to supply the resource requested

ATTRACTIVENESS OF PAYMENT AND INCENTIVES

Payment for demand curtailment must both be large enough to make it economically worthwhile and simple and certain enough so that the user can accurately forecast of the benefits of participation. Payment methodologies can vary by program type and utility.

The most obvious requirement for any demand response program is that the payment for demand curtailment be greater than the cost (or value of service loss) to the business. Costs come in the form of forgone business when demand is curtailed, disruptions to the business even when production is not affected (such as reduced space conditioning) and the cost of maintaining the staff and technological capabilities required to participate in the program. Large industrial customers may know the exact amount of energy required to produce a single unit and therefore can compare the payment for demand response to the cost of lost production. Small industrial customers may need help evaluating that cost. Office buildings may not see a cost from curtailment if they can pre-cool a building overnight before a demand response event or shift the timing of plug loads, but they still have a cost to maintain the staff and technological capabilities to participate. There may be an impact on worker productivity – significant although difficult to quantify – if a participating office is inadequately cooled on hot days. Demand response program managers should help participating customers evaluate and lower their participation costs.

Regular capacity or reservation payments (payments made to a participant in return for the standby ability to offer demand curtailment) are attractive to many customers. Price certainty is also attractive. Programs that offer energy-only payments (payments for electricity the participant did not consume when asked to curtail) and that have little or no advance notice of a curtailment may not be perceived favorably by all customers.

In addition to payment for participation, financial incentives to install enabling technologies can help lower participation costs and make demand response programs more attractive. Individual equipment can be tracked and controlled, allowing more targeted demand curtailment within a customer's load. Advanced metering infrastructure and improved automation may provide a more dynamic and faster-acting resource for the grid. Incentives for installation of these technologies, which increase customers' ability to participate, can increase the pool of resources, broaden enrollment, and reduce the risk of customer fatigue. For example, Pacific Gas & Electric's ADR Technology Incentive offers a \$125/kW to \$400/kW incentives up to the total cost of the project for enabling technologies that upgrade customer facilities to semi-automated or automated and fast-acting demand response.

APPROPRIATE LEVEL OF COMPLEXITY

The demand response program’s operational complexity must fit the users’ level of sophistication. The size of the expected energy reduction, the incentive structure, penalties, and contract length need to be easily understood across all program offerings. Some customers will accept more complexity than others.

Smaller businesses that do not actively manage their energy use may prefer regular reservation payments in exchange for being available to curtail demand occasionally. Additional flexibility in participation can be helpful to small businesses. Some programs, like PG&E’s PDP program, are hybrid tiered rate/demand response programs and operate more as carrot and stick – customers are opted in to the program, and as rates raise substantially during the 12th through 15th curtailment events, customers then have the option not to participate, though they need to pay the higher electricity rate during those times.

Larger businesses with more active energy management may prefer to have access to higher payments available from an active demand response market. For example:

- **PJM’s** demand bidding offers incentive for customers that actively manage energy to curtail usage on an hourly basis. This program offers high incentive payments and requires active engagement and decision-making. Customers participating in this type of demand bidding often have skilled staff who can assess curtailment impact and make business decisions.¹
- **PG&E’s** Capacity Bidding Program enables customers to offer demand curtailments without fully exposing them to energy market volatility. Participants can choose from a list of incentives that vary based on the length of curtailment and the amount of demand curtailed. Customers can easily compare the curtailment incentive against their costs to select the one of four curtailment length options that best fits their business needs. This program structure works well for businesses that have flat facility operation costs; such customers can make intelligent and easy curtailment decisions.²

¹ <http://www.pjm.com/markets-and-operations/demand-response.aspx>

² <http://www.pge.com/mybusiness/energysavingsrebates/demandresponse/cbp/>

Users that understand “what they are getting into” and can respond to demand response requests perform better, avoid penalties, and ultimately stay with the program longer.

Figure 2. Summary of Appropriate Level of Program Complexity

		Use of Energy	
		Industrial	Commercial
Energy Management Sophistication	Large	More complicated programs and pricing are acceptable to larger users with more active energy management capabilities. This group of users may be engaged by programs that allow for frequent bidding, especially if electricity is a substantial portion of their finished product costs.	
	Small	Smaller users with less active energy management capabilities need easy-to-understand program structures with clear terms. They may not have access to the same energy decision-making tools or skills as businesses that use active energy management.	

ABILITY TO SUPPLY THE RESOURCE REQUESTED

There are three major types of demand response programs, and each type requests a different resources from customers. The resource requested must align with the customer's ability to supply that resource. In this section we will first give a more detailed description of the resource requested for each type of demand response program,³ and then discuss how that aligns with the capabilities of each type of customer. The three major categories, and the resource being requested by each are:

1. **Emergency/standby programs** help reduce peak demand during an event. These programs give little control to participants. Once they sign up, they generally have to curtail load when requested, although, many programs do give customers notice a day or more in advance, and customers can choose not to participate if to do so would cause undue burden to the business. The length of curtailment tends to be somewhat long – perhaps as much as a few hours during the hottest part of a summer day. However, the frequency of call is low: Participants usually are called only a few times per year.
2. **Price response bidding programs** help keep wholesale prices down on heavy-use days. They allow customers to choose when and how much energy use they are willing to curtail. These programs offer customers more flexibility by allowing them to choose when to curtail based on wholesale energy prices (either in connection with the grid operator's day-ahead market or the grid operators real-time market.)
3. **Ancillary services programs** provide ancillary services to the grid, including regulation and reserve services. These programs have short or no advance notice and require participants to achieve agreed upon curtailments in 30 minutes or less, and in some cases instantaneously. Customers are called more frequently, but each curtailment period is relatively brief.

³ For more details on how each of these program types works please see the Institute for Building Efficiency paper "Demand Response, A Market Overview" from February 2014.

Large Industrial

Large industrial customers that use energy primarily for manufacturing often need a high level of control over demand curtailment. They usually need significant notice so they can reschedule core business functions, including the labor and resources required. These customers are well suited to longer calls, as they can often take actions like rescheduling operations for a few hours at a time or pre-cooling refrigerated spaces, and so have no change in production or labor schedules during the event.

Some large industrial users with more sophisticated energy managers and technology may be able to participate in ancillary services if portions of their business can be quickly curtailed without unduly disrupting operations. In many manufacturing settings, such as thermal or chemical manufacturing, fast responses may be difficult given that energy use affects core business operations, and even a few seconds of operational interruption may interfere with production. For example:

- Southern California Edison's Demand Bidding Program⁴ offers flexibility for users that need to maintain control of their curtailment by allowing customers to bid in their demand reduction in advance with no penalties for non-performance. In order to capture enrollment of demand resources in the business operations/active management category, it is essential to offer timing flexibility and leave the majority of control in the hands of the customer. Demand bidding programs offer the flexibility to curtail demand as well, but volatility in energy market pricing may challenge the ability to schedule curtailment against other business operations.

⁴ https://www.sce.com/wps/wcm/connect/96702c0a-c759-4efe-b302-f874e4407c32/090217_Demand_Bidding_Fact_Sheet.pdf?MOD=AJPERES

Small Industrial

Small industrial customers share many of the challenges of large industrial customers. They need substantial control over demand curtailments because energy is critical to maintaining operations. They are also similarly sensitive to the number and length of demand response requests and the amount of notice given. They may be interested in programs that provide enough notice to allow them to alert workers and shift or reschedule the electric demand. These customers are more likely to participate in demand response using manual curtailment. If they are asked to curtail too often or for too long, fatigue may set in, threatening continued engagement. Many could likely participate in price response programs if an easy-to-use interface were provided. A sufficient degree of automation should be incentivized for these customers such that they could preset limits of tolerance for demand response participation, and then use a “set it and forget it” approach.

Large Commercial

Large commercial customers typically comprise buildings and campuses with integrated building automation systems. Offices that actively manage energy use are the most flexible demand response customers. For example, if they can pre-cool a space or store ice for future use in a chiller, then they can adjust demand as needed for demand response programs.

These customers can often delegate some control over demand response participation to the utility by pre-programming the building to curtail demand under certain conditions. They may be able to respond in real time or near-real-time and so participate in dynamic pricing or even ancillary services programs. By using sophisticated control strategies, they also can participate in scheduled curtailment programs (emergency/standby) with less concern for business interruption. The limiting factor for this group is not the number or notice of demand events, but the time of day of the call and the length of the curtailment. Calls starting before 3 p.m. are preferred, and shorter curtailment periods are often better than long ones. When energy is used for heating and cooling, a long demand response request is acceptable only if indoor temperatures can be maintained at a comfortable level during the building occupancy hours. If the curtailment period extends past 5:00 p.m., then the impact is minimized. If building occupants are regularly made uncomfortable from extended demand response events, continued program engagement is threatened, as worker productivity is more valuable than energy cost reductions. For example:

- PJM’s Economic Load Response (Synchronized Reserves)⁵ program calls on demand response in real time and allows customers up to 10 minutes to meet their curtailment obligation. The Economic Load Response (Day-Ahead Scheduling Reserve) program offers a 30-minute advance notice and a 30-minute period to reach the agreed-upon level of energy curtailment. These short-notice and fast-acting demand response programs offer grid operators another means to compensate for generation shortages in a short time. They provide an ideal means to manage the grid and stabilize short-term wholesale electricity pricing while supporting the grid’s overall reliability.

⁵ <http://www.pjm.com/markets-and-operations/demand-response/dr-synchro-reserve-mkt.aspx>

Small Commercial

Customers in this category often need to curtail load manually, so they likely need advance notice. They will not want to curtail frequently, and the length of curtailment will be limited by user comfort. They can participate in emergency/standby programs that give advance notice and require participation only a few times a year, usually by enrolling single end uses such as air conditioning and lighting. They are unlikely to participate in ancillary services programs that call demand response in real time or near-real-time without additional energy management tools or dashboards. Software dashboards can engage these customers and help them make curtailment decisions by simply presenting energy use options and the associated costs and program expectations.

Figure 3. Summary of Ability to Supply the Resource Requested

		Use of Energy	
		Industrial	Commercial
Energy Management Sophistication	Large	<ul style="list-style-type: none"> • Energy used for business process • Require total customer control over energy use and curtailment options • Require notice to reschedule labor and business resources. • Can sometimes take calls of longer duration • Infrequent calls better • Price response bidding suits this user group well 	<ul style="list-style-type: none"> • Energy used for space conditioning • May use automation to pass some control to the utility • When automated, little notice and more frequent calls may be acceptable • Length of call is limited by user comfort during thermal coasting • Flexible user may enroll in any number of demand response programs
	Small	<ul style="list-style-type: none"> • Similar to the group above, but could more easily participate if an easier user interface 	<ul style="list-style-type: none"> • Similar to the group above, but simpler programs such as occasional emergency curtailment will fit these users better unless automation technology or easy user interfaces were provided. They could more easily participate if an easier user interface were provided by the utility or aggregator

CONCLUSIONS

Demand response resources are needed to balance grid changes driven by increasing variable renewable generation, power plant retirements, high and volatile wholesale prices, and the need to alleviate transmission congestion. Demand response program designers, energy marketers, and aggregators will be more successful at attracting and retaining participants when the programs are designed to meet individual customer segment needs.

We have identified four customer segments with significant demand response potential and the three program attributes that should be used to design and implement attractive programs. The primary energy uses and the sophistication of energy management define these customer segments. Demand response program attributes including complexity; type, frequency, amount of incentive, the level of control the customer retains over energy curtailment, and the availability of technology incentives may be adjusted to target the participating customer segments.

Matching opportunities for demand response with the capabilities of participants supports grid reliability, establishes fully competitive wholesale markets, and transforms the customer from simply a rate-payer into an active market participant. Aggregators add value by, among other things, matching market needs with participating customer capabilities.

The analytical framework presented in this paper provides a starting point for identifying how to capture demand response resources not currently participating in demand response programs, sustain their participation, and grow programs to meeting future grid challenges.

A demand response program may be evaluated on how effectively program attributes meet customer needs by using a chart like the one below and rating attributes from 1 to 10, where 10 is the most attractive. Customer groups or program attributes can be subdivided as appropriate for a given market.

Figure 4. Framework to Analyzing the Degree to Which a Demand Response Program Aligns Utility Needs with Customer Capabilities

		Demand Response Program Name		
		Program Fit		
		Attractiveness of Payment and Incentives	Appropriate Complexity	Ability to Supply Resource Requested
Participating Customer Types	Large Industrial			
	Small Industrial			
	Large Commercial			
	Small Commercial			

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