LBNL-50328

Do "Enabling Technologies" Affect Customer Performance in Price-Responsive Load Programs?

Charles A. Goldman, Lawrence Berkeley National Laboratory
Michael Kintner-Meyer, Pacific Northwest National Laboratory
Grayson Heffner, Lawrence Berkeley National Laboratory

Environmental Energy Technologies Division
Ernest Orlando Lawrence Berkeley National Laboratory
University of California
Berkeley, California 94720

August, 2002

In the *Proceedings of the 2002 ACEEE's Summer Study on Energy Efficiency in Buildings.*

The work described in this study was funded by the Assistant Secretary of Energy Efficiency and Renewable Energy, Office of Power Technologies of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098

Do “Enabling Technologies” Affect Customer Performance in Price-Responsive Load Programs?

Charles A. Goldman, Lawrence Berkeley National Laboratory
Michael Kintner-Meyer, Pacific Northwest National Laboratory
Grayson Heffner, Lawrence Berkeley National Laboratory

ABSTRACT

Price-responsive load (PRL) programs vary significantly in overall design, the complexity of relationships between program administrators, load aggregators, and customers, and the availability of “enabling technologies.” Enabling technologies include such features as web-based power system and price monitoring, control and dispatch of curtailable loads, communications and information systems links to program participants, availability of interval metering data to customers in near real time, and building/facility/end-use automation and management capabilities. Two state agencies – NYSERDA in New York and the CEC in California – have been conspicuous leaders in the demonstration of demand response (DR) programs utilizing enabling technologies. In partnership with key stakeholders in these two states (e.g., grid operator, state energy agencies, and program administrators), Lawrence Berkeley National Laboratory (LBNL) and Pacific Northwest National Laboratory (PNNL) surveyed 56 customers who worked with five contractors participating in CEC or NYSERDA-sponsored DR programs. We combined market research and actual load curtailment data when available (i.e., New York) or customer load reduction targets in order to explore the relative importance of contractor’s program design features, sophistication of control strategies, and reliance on enabling technologies in predicting customer’s ability to deliver load reductions in DR programs targeted to large commercial/industrial customers.

We found preliminary evidence that DR enabling technology has a positive effect on load curtailment potential. Many customers indicated that web-based energy information tools were useful for facilitating demand response (e.g., assessing actual performance compared to load reduction contract commitments), that multiple notification channels facilitated timely response, and that support for and use of backup generation allowed customers to achieve significant and predictable load curtailments. We also found that 60-70% of the customers relied on manual approaches to implementing load reductions/curtailments, rather than automated load control response. The long-term sustainability of customer load curtailments would be significantly enhanced by automated load response capabilities, such as optimizing EMCS systems to respond to day-ahead energy market prices or load curtailments in response to system emergencies.

Introduction

The restructuring of U.S. electricity markets has created new opportunities for load serving entities, such as utilities, retail energy suppliers, or curtailment service providers (e.g., aggregators) to partner with customers in curtailing or altering their demand in response to either electric system reliability needs or high prices in electricity markets. A number of studies have argued that the benefits of allowing customers to manage their loads in response to system conditions or wholesale market prices are potentially large (Cowart 2001; Hirst 2001). Moreover, there has been a proliferation of demand response programs offered by independent system operators and utilities during the last several years. However, with few exceptions, these programs have not conducted or publicized results of impact, process or market evaluations (Neenan Associates 2001). Yet, there are numerous challenges to creating workable price-responsive load programs in current wholesale markets. Success in facilitating customer participation in day-ahead or real-time markets for power hinges on both the availability of enabling technologies and market/institutional requirements. From a policy perspective, technologies that facilitate price-responsive load are important because they introduce higher elasticity in the customer's demand curve, which can potentially reduce price volatility and average price levels in wholesale markets and mitigate market power of generators.

Enabling technologies for price-responsive load include, but are not limited to:

- interval meters with two-way communications capability which allows customer utility bills to reflect their actual usage pattern rather than an "average" load profile for that customer class;
- multiple, user-friendly communication pathways to notify customers of load curtailment events;
- energy information tools that enable near-real-time access to interval load data, analyze load curtailment performance relative to baseline usage, and provide diagnostics to facility operators on potential loads to target for curtailment;
- demand reduction strategies that are optimized to meet differing high-price or electric system emergency scenarios;
- load controllers and building energy management control systems that are optimized for demand response, and which facilitate automation of load curtailment strategies at the end use level; and
- onsite generation equipment, used either for emergency back-up or to meet primary power needs of a facility.

This study represents an initial effort to address gaps in our understanding of the role of enabling technologies in facilitating customer load participation in wholesale electricity markets. The LBNL/PNNL team worked with stakeholders in two states (New York and California) and conducted market research on the impact and role of various technologies that enable customers to participate more effectively in price-responsive load programs. We used a case study approach that involved interviews with 56 commercial/industrial customers that received demand response enabling technologies and program service offerings from one of two contractors who participated in the CEC Peak Load Reduction Program or three contractors who participated in the NYSERDA Peak Load Reduction and Enabling Technology Program Opportunity Notices (PON). These five contractors included utilities and their partners (San Diego Gas & Electric Company/San Diego Regional Energy Office, New York State Electric and Gas), a retail energy provider (AES/New Energy), and curtailment service providers (e.g., Global

Energy Partners, eBidenergy.com/Consumer Powerline). Our interviews focused on understanding customers' load curtailment strategies, motivations for participating in DR programs, and perception of the effectiveness of various technologies that facilitate load curtailment, as well as describing the relationships between contractors, customers, and program administrators.

The study is organized as follows. Section 2 describes our overall research approach and objectives and the customer market survey instrument. Section 3 briefly summarizes demand response programs offered by the CEC and NYSERDA and their relationship to price-responsive load programs offered by the ISOs and utilities in those states. Section 4 summarizes the technology and service offerings of the five contractors, and Section 5 summarizes customer's use of and reaction to various DR enabling technologies. Section 6 provides description and characteristics of customers that responded to our survey. Sections 7 and 8 describe the performance indicators developed to assess customer performance and discuss the results of our analysis of customer load curtailment data and customer surveys.

Approach

The overall goals of this project were to provide insights on three general questions:

- What end uses do customers target for providing quick load reductions in PRL programs (e.g., HVAC, lighting, elevators, process loads)?
- Does the presence of enabling technologies have a positive effect on the magnitude and persistence of load reductions that can be achieved by participating customers in buildings?
- What price and non-price attributes of contractor/program service offerings seem to contribute to higher levels of customer/end user compliance, performance, and retention?

We worked with CEC and NYSERDA program managers to identify contractors that provided innovative demand response technologies or service offerings and ensure diversity among types of service providers (e.g., utility, retail energy service provider, load aggregator). Contractor's willingness to cooperate was ultimately critical as they provided customer contact information and informed and urged customers to cooperate by being interviewed. Two contractors in New York pre-screened customers enrolled in their program and provided a sub-set of customers that were willing to be interviewed, while the other three contractors provided us with contact information for all of their customers. Table 1 summarizes customer response rate among the five contractors. Overall, we had a 51% response rate. Our customer sample was much smaller in New York although the response rate was somewhat higher (~61%), which we attribute to the pre-screening by the two contractors.

Table 1. Customer Survey: Response Rate

	Number of Participants	Number of Participants Responded	Response Rate
California			
San Diego Gas & Electric (SDG&E)	69	32	46%
Global Energy Partners (GEP)	16	9	56%
Subtotal	*85*	*41*	*48%*
New York			
AES NewEnergy	12	7	58%
eBidenergy.com/ConsumerPowerline	4	2	50%
New York State Electric & Gas (NYSEG)	7	6	86%
Subtotal	*23*	*15*	*65%*
Total	**108**	**56**	**52%**

Phone interviews were conducted with most customers using a structured survey; about 25% of the customers provided initial responses to the survey protocol via email. Participating customers were assured that responses would be treated as confidential and that results would be presented in aggregate so that customer-specific information would not be reported. Interviews with customers in California were conducted during October 2001, while customers in New York were interviewed during late November and early December 2001. For New York customers, market research information was combined and analyzed in conjunction with load data during the curtailment events of August 7-10, 2001. For California customers, because there was only one curtailment event (July 3, 2001), we used customer's reported data on subscribed load reductions or pilot test results.

Demand Response Programs in California and New York

California and New York have taken similar approaches to facilitate development of price-responsive load. Demand response programs administered by an Independent System Operator and/or utilities provide customers with payments in exchange for actual or committed load curtailments. Parallel to these programs, state agencies – the CEC in CA and NYSERDA in NY – provide funding to accelerate deployment of demand response enabling technologies.

California Demand Response Initiatives

With the onset of the electricity crisis in summer 2000, customers in load management programs were called upon to curtail with unprecedented frequency (23 times in 2000). As a result, many customers dropped out or refused to curtail when requested. Furthermore, the programs were used frequently during January 2001, which exhausted the annual limit of 100 curtailment hours for PG&E's participating customers. Due to the dramatic reduction in available curtailable load in the interruptible programs and the anticipated threat of rolling blackouts, the CPUC and CAISO scrambled to develop a set of new demand response programs for summer 2001 (see Table 2). Customers in our sample that enrolled in a utility or ISO program participated mainly in the CAISO Demand Relief Program (DRP) or the SDG&E Rolling Blackout Reduction Program (RBRP). The CAISO DRP provided participants with substantial capacity and performance payments for providing load curtailments during periods of low Operating Reserve Margins. The RBRP was offered uniquely by SDG&E and provided performance payments to customers for running backup generators during Stage 3 Emergencies.

The California Legislature authorized the California Energy Commission (CEC) in AB970 and SB5 to provide ~$44 million ($11M in phase one and $32M in phase two) to load aggregators, vendors, utilities, or customers in its Demand-responsive HVAC and Lighting Building Systems program. Program goals included: (1) accelerate installation of demand-responsive technologies in facilities of commercial/industrial customers who would reduce their power demands in response to price signals or system emergencies, and (2) facilitate customer participation in the ISO and utility demand response programs (Nexant 2001). This program was one of six elements in the CEC's Electricity Peak Load Reduction Programs. In phase 1, the CEC signed contracts with eight contractors and nine customer grantees that ultimately installed DR technology in about 650 facilities and demonstrated about 80-103 MW of peak demand reductions in pilot tests (Nexant 2001). Ironically, despite predictions of hundreds of hours of rotating outages, there was only one curtailment day called by the CA ISO during Summer 2001; thus customer performance during system emergencies was not really tested.

Table 2. CAISO and Utility Demand Response Program Offerings[1]

Administrator	Program	Operational Trigger	Minimum Size	Incentive	Financial Penalty
CAISO	Demand Relief Program (DRP)	Emergency	1 MW load reduction (aggregated)	$20,000/MW-month and $500/MWh	Performance-Based Capacity Payment
Utilities	Demand Bidding Program (DBP)	Economic	10% of average annual demand, at least 100 kW	Bid Options from $100 to $750/MWh	Must meet 50% of accepted bid to receive pmt.
Utilities	Scheduled Load Reduction Program (SLRP)	Pre-Scheduled	15% reduction from maximum demand, at least 100 kW	$100/kWh	None
Utilities	Optional Binding Mandatory Curtailment Program (OBMC)	Emergency	Must be capable of delivering 15% reduction on entire circuit	Exemption from Rotating Outages	$6,000/MWh
SDG&E	Rolling Blackout Reduction Program (RBRP)	Emergency	15% reduction from maximum demand, at least 100 kW	$200/MWh	None

[1] Several additional demand response programs were offered by CAISO and investor-owned electric utilities but are not shown in Table 2, because none of the customers interviewed for this report participated in these programs.

New York Demand Response Initiatives: NYISO and NYSERDA Programs

All regulated load serving entities in New York and numerous curtailment service providers offered programs under the broad umbrella of the New York ISO's two Price-Responsive Load programs: the Emergency Demand Response Program (EDRP) and the Day-Ahead Demand Response program (DADRP) [see Table 3]. Customers could also participate in the Special Case Resources/Installed Capability (SCR/ICAP) program, which allows customers to sell certifiable curtailable load to load serving entities (LSE) to cover their installed capacity requirements. Customers that participate in the SCR/ICAP program are required to curtail usage during NYISO system emergencies in order to receive ICAP payments from LSE and face penalties for non-compliance**.**

The New York State Energy Research and Development Authority (NYSERDA) administers the state's public benefits fund and, in 2001, decided to include several solicitations whose objective was to improve grid reliability and provide incentives for customers to reduce summer peak demand and become more price responsive. A number of program developers applied for and won supplemental funding from NYSERDA's Program Opportunity Notices (PON) 585 (Enabling Technology for Price Sensitive Load Management) and 577 (Peak Load Reduction program). Under PON-585, NYSERDA provided up to $150,000 each for five contractors to demonstrate technologies that would expand the capability of NYISO market participants to reduce load in response to emergency and/or market-based price signals. Eligible technology solutions for customers included real-time communications and metering capability, two-way communication protocol, web-enabled technology, real-time price forecasting capability, and technologies that automate load curtailment. The Peak Load Reduction program had four components: Permanent Demand Reduction efforts (e.g., EMCS upgrades, controls), Short-Duration Load Curtailment measures (e.g., radio-frequency controlled strategies, telemetry controls), Dispatchable Emergency Generator initiatives (e.g., installation of transfer switchgear, catalytic reduction technologies, dual-fuel options), and Interval Meters. NYSERDA made awards totaling $6.5 million to 86 projects in PON-577 that were completed by Summer 2001 and customers that received funding from NYSERDA accounted for about 28% of the NYISO EDRP participants (Neenan 2002).

Table 3. NYISO Demand Response Program Offerings

Administrator	Program	Operational Trigger	Minimum Size	Incentive	Financial Penalty
NYISO	Emergency Demand Response Program (EDRP)	Emergency	100 kW reduction per zone (aggregated)	Greater of real-time LBMP or $500/MWh	None
NYISO	Day-Ahead Demand Response Program (DADRP)	Economic	1 MW reduction (aggregated)	Greater of day-ahead LBMP or bid	110% of the greater of real-time or day-ahead LBMP

Contractor's Service Offerings and Enabling Technologies

Intermediaries/aggregators have a critical role in the successful development of price-responsive load, because of technical, institutional, and market barriers that limit customers' interest in and ability to participate directly in wholesale electricity markets. In our case studies, we were particularly interested in the relationship between the program design of contractors (who acted as load aggregators) and the performance results of customers. By program design, we mean the contractor's total "package" or bundled offering which includes the nature of the offer and the enabling technologies that accompany the offer. The nature of the offer includes price features such as the structure and level of financial incentives offered by the contractor as well as non-price features which may include training, facility audits, and promotional materials recognizing good corporate citizens. In this study, we focus primarily on assessing the impact of enabling technologies on customer performance.

Table 4. Contractor Service Offerings and Enabling Technologies

Enabling Technologies	GEP	SDG&E/SDREO	AES NewEnergy	eBidenergy.com/ ConsumerPowerline	NYSEG
Technical Audits of DR Potential	O	X			X
Interval Meters	X	X	X	X	X
Energy Information Tools					
Real-time access to load data during curtailment events	O	X		X	X
Day-after access to load data for non-curtailment days	O	X		X	X
Baseline data	O	X		X	X
Aggregation of energy usage data from multiple sites		X			X
Curtailment payment estimation	X	X		X	X
Load Curtailment Notification (Phone, FAX, Pager & Email)	X	X	X	X	X
Automated Load Control Devices	X				
Support for using Back-up Generation (BUG)		S	S	S	

X = all customers received service/feature
O = optional service/feature for customers
S = some customers had existing back-up generation equipment that was used for curtailment

Aided by funding from the CEC and NYSERDA, contractors recruited customers, installed, tested and verified interval meter reading and various notification schemes at customer sites, provided web-enabled data hosting capabilities that allowed customers to track their loads on a day-after or near real-time basis, and offset a portion of the cost of automated load control equipment. Table 4 summarizes service offerings of the five contractors and/or enabling technologies utilized by customers to curtail load.

Customer Feedback on DR Enabling Technologies

Respondents were asked about the technology features and services offered by their contractor and whether they used them. In particular, customers were asked how frequently they monitored their load data (for those respondents who had this feature), what type of notification they preferred, what type of automation of load control they employed, and inventory and availability of on-site generation. Results from the customer surveys included:

- web-based near-real time load monitoring was useful for achieving load reduction targets & educating senior management;
- about 30% of 36 respondents checked their web-based energy profile online software daily, 40% of the customers checked it on a weekly basis; and ~20% of customers checked only during system emergencies;
- some customers have quickly adapted their control systems and/or meter and visual displays of energy profiles provided for load curtailment purposes for other applications such as end use or equipment load analysis and goal generation in advance of re-scheduling various processes;
- almost all customers were satisfied with the notification and communication technologies; customers prefer multiple notification channels (e.g., phone, pager, fax) and pager technology is increasingly popular;
- few customers utilized automated load curtailment strategies (e.g., 60% of our sample relied on manual approaches during load curtailments); and
- back-up generation was a popular load curtailment strategy, particularly in “Emergency” DR programs.

Characteristics of Participating Customers

The customer survey included several questions on customer facility characteristics: type of facility, building and equipment vintage, operational schedule, ownership characteristics, and typical summer monthly peak electricity demand. Table 5 summarizes self-reported information on monthly summer peak demand and demand reduction goal, grouped by customer’s facility type or use.

Based on our limited sample, there is heavy participation in DR enabling technology programs from industrial and government customers. Participation levels among various market segments reflect the marketing strategies adopted by individual contractors as well as customer receptivity to DR programs. The ISO and utility DR programs often target the biggest electricity users, as evidenced by fact that the median summer peak demand was 1.4 MW per facility in our sample of 56 customers.

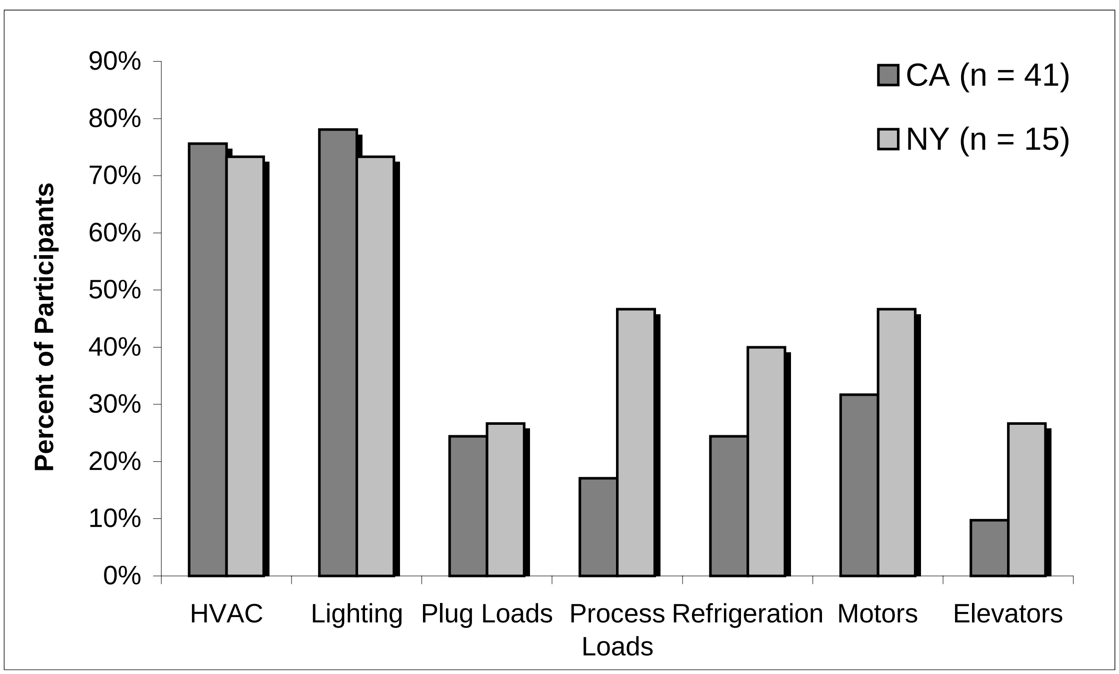
Table 5. Customer Size and Load Curtailment Goal

Facility Type	N	Max Summer Demand (kW)		Load Curtailment Goal (kW)	
		Range	Median	Range	Median
Agricultural	1	N/A	38	N/A	8
Government	17	219 - 230,000	1,507	31 – 10,000	500
Health	3	400 - 21,000	1,200	100 – 2,000	500
Industrial	17	166 - 30,492	1,800	25 - 4,500	500
Lodging	1	N/A	612	N/A	N/A
Office	11	140 - 19,000	1,499	14 - 764	176
Recreational	5	981 - 5,337	1,225	119 – 4,003	196
Retail	1	N/A	650	N/A	100
Total	**56**	**38 – 230,000**	**1,413**	**8 - 10,000**	**350**

Customer Assessment of Demand Response Potential

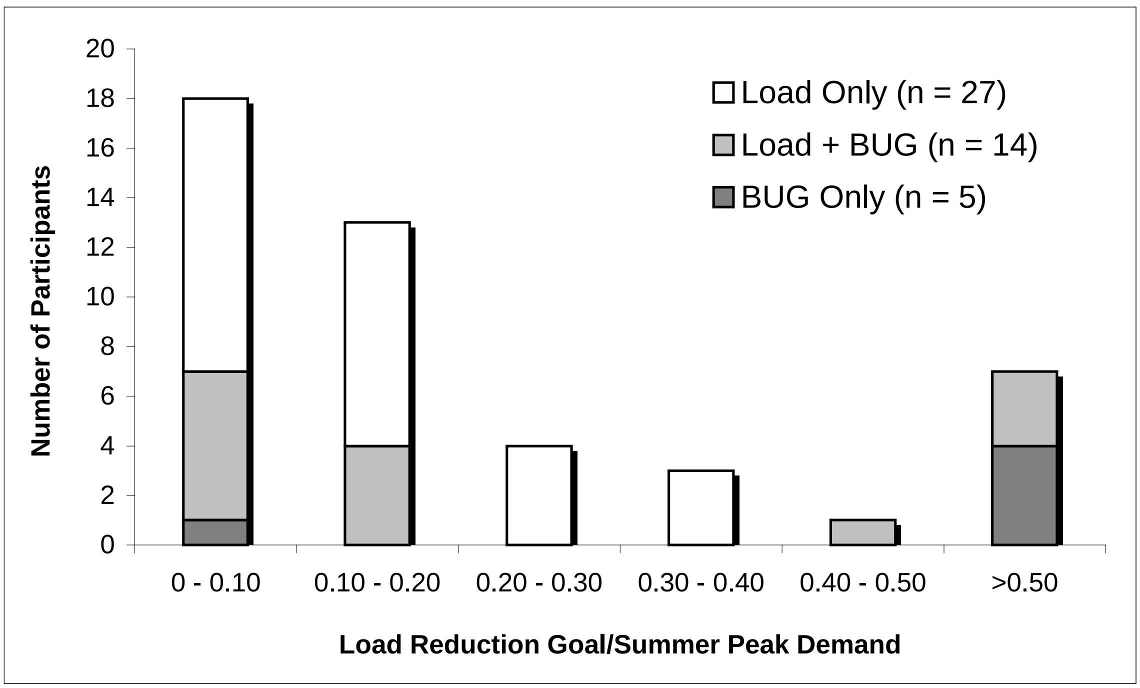
The total subscribed load curtailment potential was ~46 MW among the customers that answered this question on our survey. With respect to their load curtailment strategies, we asked customers to indicate specific technologies or operational strategies and targeted end uses. About 70% of our New York and California customer sample indicated that they intended to reduce HVAC and lighting electricity use during load curtailments (Fig. 1). About 40% of the customers in New York indicated that they would curtail industrial process, motor or refrigeration loads. In contrast, these end uses were indicated by about 20-30% of the customer sample in California, which may be indicative of the differences in types of commercial and industrial loads in the two states.

Figure 1: End Uses Targeted in Customer Load Curtailment Strategies



We also asked customers to estimate their monthly summer peak electricity demand and their load curtailment goal that they had committed to their contractors as part of the CEC or NYSERDA programs. From this information, we calculated the ratio of their load reduction goal to their summer monthly peak demand, which is an indicator of the customer's assessment of the existing technical potential for load curtailment at their facility. Figure 2 is a histogram of this ratio for customers segmented by type of load curtailment strategy (e.g., load reduction only, back-up generation equipment only used to reduce customer loads, and load reductions plus back-up generation). It is apparent that customers that relied solely on back-up generation equipment were willing and able to curtail a much larger share of their summer peak demand than customers whose curtailment strategies involved load reductions only (e.g., median values of 90% vs. 15%). About 40% of the customers in our sample indicated that their load reduction goal was 10% or less of summer peak demand.

Figure 2. Load Reduction Goal Divided by Monthly Summer Peak Demand



Customer Motivation

We asked customers to rank the relative importance of reasons for participating in the demand response program offered by their respective utility (e.g., SDG&E, NYSEG), retail energy provider (AES), or curtailment service provider (e.g., GEP) in order to assess customer motivations. Table 6 shows the average "scores" of these potential motivators on a 1 to 5 increasing scale of importance to their decision ("1" = not a factor to "5" = decisive). Among the New York customers, economic motivations were particularly important: desire to save money on their utility bill was ranked highest (4.4) and taking advantage of economic incentives was ranked second (4.1). Customers also were motivated by a desire to be or perceived as "good citizens." Among the California customers, the desire to aid the community/public interest in avoiding blackouts was ranked highest (4.3), while the economic motivators were ranked second and third (3.8 and 3.4). This result likely reflects the reality that, by summer 2001, many participants in California DR programs already had extensive experience responding to system emergencies during the preceding year and were informed by the local utility that rotating outages were a distinctive likelihood in summer 2001. Customers in both states found the voluntary nature of the programs to be an attractive feature, specifically that they retained control regarding decisions on whether and how much load to curtail.

Among the New York customers, we conducted exploratory analysis to assess whether motivation correlated at all with performance levels and found no significant differences in the average scores on motivation between the four subgroups. Results from our small sample suggest that none of the "motivating factors to participate" deemed decisive by individual respondents seemed to be particularly correlated with either good or bad performance (i.e., actual response during curtailment events).

Table 6. Customer Motivations for Participation

Customer Motivation	CA	NY
Community concerns (e.g., blackouts)	4.3	3.6
Access to load data	2.9	3.1
Access to economic incentives	3.4	4.1
Voluntary nature of programs	3.6	4.0
Work with LSE/DR experts	2.8	2.4
Saving money	3.8	4.4

Load Curtailment Data Analysis & Performance Indicators

Load curtailment performance at the individual customer level is conventionally measured by a comparison of hourly actual customer loads against an assumed or calculated baseline load for a given hour. The baseline load may include adjustments for actual conditions such as weather or customer work/production schedules. Such a detailed performance analysis at the customer and hourly level is necessary for settlement purposes but difficult to generalize for comparison purposes. Using load curtailment performance data provided by program administrators, we developed two related performance indicators -- **the subscribed performance index (SPI) and the peak performance index (PPI) --** that broadly reflect how well customers performed during curtailment events and allow for easy performance comparisons across customers.[2]

[2] We recognize that the choice of these performance indicators is a departure from the implicit price elasticity concept traditionally used to denote a scale or measure of demand responsiveness. We deliberately chose not to use an elasticity framework because of an assumed lack of price diversity among the customer sample. Assuming a prevailing TOU rate schedule for most commercial and industrial customers through New York State with a summer peak energy charge of about 9-10 ¢/kWh (or $90-100/MWh), the remaining price differential between the avoided energy cost (assumed $100/MWh) and the EDRP energy payment in the amount of $500/MWh would not provide an appreciable price differentiation to attribute different levels of customer curtailment capabilities. In addition, energy costs for customers served by competitive retail energy suppliers was not readily available or likely to be provided.

The SPI is a ratio of the customer's actual hourly load curtailed averaged over all hours of curtailment divided by the customer's subscribed load. Therefore, an SPI of 1.0 indicates that the customer is performing "on target" compared to their contract goal established at the outset of the program. SPI values of less than one indicate under-performance relative to the customer's load reduction target.

Formally, the Subscribed Performance Index (*SPI*) is defined as:

$$SPI = P_{avg} / P_{sub}$$

where: $$P_{avg} = \frac{1}{N} \sum_{N}^{t=1} (CBL_t - P_{actual,t})$$

with: N : number of hours per curtailment event,
$P_{actual,t}$: facility demand in hour t, [kW],
CBL_t : customer base line , [kW][3]

and

P_{sub} : subscribed load curtailment as provided for each participating customer by NYISO.

The PPI has the same numerator but the denominator is the customer's non-coincident facility peak demand. The PPI focuses on performance relative to the technical potential of load curtailment for that customer. Thus, a customer that sheds 100% of their peak load demand over the entire curtailment period would have a PPI value of 1.0.

Formally, the Peak Performance Index (*PPI*) is defined as:

$$PPI = P_{avg} / P_{peak}$$

where

P_{peak} : non-coincident facility peak demand.

These two performance indicators are useful in differentiating among customers that adopted different participation strategies. Participants that enrolled in a DR program and took a conservative approach are more likely to meet their subscribed load reduction targets than those who are more aggressive. However, both an aggressive and a conservative participant can contribute the same kW of load curtailment to the reliability of the power system but achieve different *SPIs* if their curtailment commitment differs.

[3] The computation of the CBL is defined in the NYISO: Emergency Demand Response Program Manual. NYISO, revised 5/24/2001.

Results: New York Case Study Participants

Table 7 shows the average value and standard deviation for the sample of 14 respondents when sorted into subgroups according to whether they possessed and were able to use back-up generation (BUG) and whether they participated in the NYISO EDRP only or simultaneously participated in the SCR/ICAP program as well.[4] Based on our two performance indicators (SPI and PPI), we found that those customers with back-up generators and those who participated in the SCR/ICAP program had much better performance compared to customers that participated only in the voluntary EDRP program or did not have back-up generators. The reasons for these differences are straightforward:

- Customers with back-up generators have much more discretion and flexibility over how and how much they reduce their total load in response to curtailment events. As a result of possessing this strategic asset, these seven customers were able to meet, and often out-perform, their subscribed goals (i.e., SPI of 1.04) and their actual curtailed load represented about 46% of their non-coincident facility peak demand (see Table 3). The reliability and higher actual performance of EDRP participants is important to NYISO system operators for several reasons. First, more precise estimates of the ratio of actual performance to subscribed load means that price-responsive load resources are more reliable during emergency situations and can be counted on by system operators. Second, higher load reductions per customer means that fewer participants are needed to achieve an overall NYISO load curtailment, which may reduce transaction and administrative costs (Neenan 2002).

- The financial incentives offered to customers in the ICAP/SCR program were quite attractive, although they faced a performance penalty if they did not attain their demand reduction amount when called by the NYISO. For them, it was not a "voluntary" program and they had to consider the consequences of non-compliance when called to curtail. These eight customers, on average, performed near their subscribed load targets (i.e., SPI of 0.92).

- The seven customers that relied on load reductions only typically employed a variety of conservation and operational strategies (e.g., turning off lights, re-setting thermostats, reducing pump and compressor loads). Their pledged curtailment as a fraction of facility peak demand was low, averaging 5% over our sample. There was no evidence of Customer Performance "fatigue" found over the limited number of curtailment events in Summer 2001. Customers in all subgroups performed as well or better on the second and third day of curtailment as on the first.

---

[4] In our 14 customer sample, customers with BUGs accounted for 2/3 or more of the total load reduction, which is much higher than the total sample of 292 EDRP participants in which customers with BUG accounted for ~15% of the total subscribed load.

Table 7. Customer Performance in NYISO EDRP Program: Impact of Back-up Generation (BUG) and ICAP Program Participation

Customer Group	N	Curtailed Load/Subscribed Load (SPI)	Curtailed Load/Customer Peak Demand (PPI)
Customers with BUG	7	1.04 +/- 0.55	0.46 +/- 0.37
Customers without BUG	7	0.32 +/- 0.30	0.05 +/- 0.04
Customers in EDRP and SCR/ICAP	8	0.92 +/- 0.61	0.41 +/- 0.37
Customers in EDRP only	6	0.35 +/- 0.31	0.05 +/- 0.05

Conclusions

We surveyed 56 customers that worked with five different contractors in California and New York. We combined the customer survey data with actual load curtailment data for the customers in New York and examined correlations between "early adoption" of technology features and customer performance. For customers in California, we compared and analyzed their survey responses with their load reduction goal because there were insufficient or no curtailment events.

We found preliminary evidence to support the view that DR enabling technology has positive effect on load curtailment potential. Specifically, many customers indicated that web-based energy information tools that facilitate demand response (e.g. near-real time access to load data during curtailment events, baseline data) were very useful, that multiple notification channels facilitate timely response, and that support for and use of backup generation allows customers to achieve significant and predictable load curtailments. We also found that relatively few customers automated their load control response, either through load controllers or programming of their existing EMCS system. It is not too surprising that most customers relied heavily on manual approaches for load curtailment, given that most of the customers were participating in DR programs that were relatively new or were pilots and often had limited time to install equipment or make operational changes during summer 2001. However, we believe that the long-term sustainability of customer load curtailments would be significantly enhanced by automated load response capabilities and investments. This could involve optimizing EMCS systems to respond to day-ahead energy market prices or load curtailments in response to system emergencies. Convincing customers of the economic rationale and justification for developing price-responsive load capabilities is challenging, given customer perception of risks and uncertainties (e.g., programs are new and rules keep changing, wholesale electricity markets are still evolving). Multi-year DR programs and stable wholesale electricity markets with well-defined products would encourage entry by various types of load aggregators, which is a key to harnessing the full DR potential.

Our case studies of customers in New York also illustrate the confounding influences of program design on customer performance. We found that customers that participated in both the EDRP and ICAP/SCR programs, which offered additional financial incentives with reduced revenues for non-performance, significantly increased the probability that customers met their contracted load reduction commitments during actual curtailment events, compared to customers that were enrolled only in the EDRP program.

Finally, given that the programs in California and New York that provided support for DR enabling technologies are relatively new and that it takes users some period of time to realize the full benefits of adopting innovative demand-response technologies, we recommend that NYSERDA and the CEC consider additional evaluation/case studies in order to document other benefits, besides load curtailment capability, that customers receive from enabling technologies supported by demand response programs.

References

Cowart, R. 2001. *Efficient Reliability: The Critical Role of Demand Side Resources in Power Systems and Markets*, prepared for National Association of Regulatory Utility Commissioners, June.

Goldman, C, G. Heffner, and M. Kintner-Meyer 2002 *Impact of Enabling Technologies on Customer Load Curtailment Performance: Summer 2001 Results from NYSERDA's PON 585 and PON 575 Program and NYISO's Emergency Demand Response Program*, LBNL-49858, February.

Hirst, E. 2001. *Retail Load Participation in Competitive Wholesale Electricity Markets*, Washington DC: Edison Electric Institute.

Department of Energy (DOE). 1996. *Climate Wise Case Study Compendium*, *Report 1*. Washington, D.C.: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.

Neenan, B. and D. Pratt 2002. *NYISO PRL Program Evaluation*, prepared for NY ISO. February.

Nexant 2001. *AB970, AB29X and SB5X Peak Load Reduction Programs: Annual Report*. Prepared for California Energy Commission. December.