Notes from the Field:
Identifying Demand-Response Measures Customers Will Actually Do

Julia K. Larkin and Dan Thomas, KEMA-Xenergy
Ed Jerome, Nexant
Mike Rufo, Quantum Consulting

ABSTRACT

Most businesses and facilities are ignoring significant energy and demand-reduction opportunities available through demand-responsive actions and investments in building automation. In addition, demand-response programs have difficulty attracting participants.

This paper discusses short- and long-term load-reduction strategies available through existing control systems in commercial and industrial facilities, as well as load reduction opportunities through investment in enhanced automation and control technologies. It presents key end uses and the magnitude of savings available through demand-response and control strategies and provides customer perspectives, shedding light on the critical difference between technical and realistic potential for demand-response actions and automation investments. It provides real examples from businesses, and discusses ways to address barriers customers face, including information, hassle and transaction costs, performance uncertainty, and lack of financing. Also, we present results of a study of nonresidential customers in California, addressing:

- Current levels of automation and capability to reduce demand
- Attitudes toward demand response and automation
- Relevance and capabilities for energy monitoring.

The site assessments and statewide study were part of the Enhanced Automation Campaign, funded by the California Energy Commission, which provided technical assistance to customers considering demand-response programs in California. These findings are also informed by demand-response potential forecasts conducted for two major utilities and lessons learned through implementation of the Energy Commission's Innovative Peak Load Reduction Program-Small Grants and the Enhanced Automation Initiative, funded by the California Public Utilities Commission.

Background

This paper presents findings from market research and technical assistance provided to large commercial and industrial customers in California regarding their potential for, and interest in, demand-responsive activity and long-term investments in building automation.

Definition of Demand Response

For the purposes of this paper, demand response (DR) or demand-responsive activity is any strategy that temporarily removes load, usually during peak electricity demand periods. DR ranges from actions as simple as manually turning off lights to centralized, computer-controlled building automation systems that ramp levels up or down based on preset criteria. While many approaches can be effective, the greatest benefits can usually be captured through planning and investing in upgrades to controls and automation systems.

The opportunities for DR depend on how a business uses energy and the type and sophistication of their energy management systems (EMSs). For commercial buildings, lighting, heating, ventilation, and air conditioning (HVAC) are usually the principal consumers of energy. For manufacturing and agricultural operations, process consumption is usually greatest. Industrial customers use a variety of specialized DR strategies to reduce or shift production processes.

Using energy-efficient equipment, installing insulation, and getting energy from alternative sources, such as photovoltaics, are also valuable methods for reducing load. Since they reduce load permanently, without regard to demand, they are defined as energy efficiency (EE) rather than DR. For example, replacing T-12 lighting in a 100,000 square foot (SF) office building would save energy and also reduce demand by about 100 kW all year. This would be EE, not DR.

Motivations for DR

Building DR capability is strongly linked to EE and vice versa. An initial investment in appropriate control technologies can provide:

- Reduced energy costs
- Lower operation and maintenance costs
- Ability to monitor and analyze energy use
- Improved occupant/customer comfort
- Long-term business benefits.

Consideration of other benefits, such as those relating to EE, is often necessary to justify DR under the current uncertain pricing environment. That is, since prices are not consistently high, there is usually insufficient motivation for customers to engage in DR activity, to participate in DR programs as currently structured, or to invest in system upgrades to increase their capability to respond.

However, businesses often ignore the opportunities provided through managing demand, either through investments in EE or DR capabilities. DR capabilities are especially likely to be overlooked. Some firms are so impressed with savings from controls originally installed to facilitate DR that they modify daily practices accordingly. This can result in reduced emergency DR potential over time, yet with long-term peak reduction.

Major barriers to capital investments to upgrade EMS and EIS systems include:

- Performance uncertainty—benefits are not predictable or are difficult to quantify
- Lack of access to capital/first cost to install upgrades

- High information search costs to determine appropriate technologies
- High hassle/transaction costs
- DR programs are not stable, creating uncertainty regarding financial benefits. Also, there are imbalances between DR program simplicity and flexibility
- Lack of perceived emergency now that the energy crisis has subsided
- Insulation from real-time market prices in retail energy markets.

For years, utilities have designed DR programs to induce businesses to reduce load using price signals or program incentives as motivators. To participate, businesses usually agree to reduce load under certain situations—according to price signals, to receive a reduced rate and/or incentives, and/or when emergencies are declared. Examples include interruptible power agreements, air-conditioner cycling programs, and scheduled load-reduction programs. Utilities are also experimenting with critical peak pricing (CPP) programs where customers pay high rates during peak periods, but receive reduced energy rates at other times.

The motivation (incentives) needed for businesses to reduce load depends largely on whether they are readily capable of adjusting their consumption. To take full advantage of DR opportunities requires the appropriate technology, information, and automation.

Few DR programs promote the infrastructure investments businesses need to cut demand without substantial effort or impact to building occupants. This missed opportunity means that even businesses familiar with DR programs may not have the equipment they need to participate efficiently and effectively. If it is difficult to reduce consumption, only large price increases, hefty incentives, or emergencies will prompt businesses to reduce load.

California Snapshot

In response to the California energy crisis and skyrocketing wholesale prices for electricity, the California State Legislature passed Senate Bill X1 5 (SB 5X) and Assembly Bill X1 29 (AB 29X), which provided $859 million in funding for EE programs. The Energy Commission administered several programs, managing some with internal staff and subcontracting others.

Overall, there was a moderate level of interest and activity by end users, driven primarily by reliability concerns. Customers usually responded with short-term manual actions, such as raising the temperature on air-conditioning thermostats or lowering some lighting levels. As the energy crisis faded, many lost interest in peak-load reduction activities, either in continuing the short-term actions they had taken or in pursuing long-term capital investments in their control systems to more efficiently respond.

As a result, our research in California shows that significant energy, demand, and temporary load-reduction opportunities remain untapped.[1] In addition, EMS and energy information system (EIS) enhancements often fall through the cracks of other EE programs. Yet the reliability of electricity supply in the long term still is a concern for California as it is for several other states. For example, the forecasted supply/demand balance in California from 2003 to 2008 relies on 1 GW in DR activity to meet expected shortfalls. (California Energy Commission 2002) The California Public Utilities Commission (CPUC) is also experimenting with CPP rates for residential and nonresidential customers.

[1] See, for example: KEMA-XENERGY. 2003, XENERGY. 2002, or XENERGY 2001.

Enhanced Automation Campaign

The California Energy Commission allocated $2 million of SB 5X funds for an educational campaign to increase the penetration of DR systems. The campaign, implemented by KEMA-XENERGY and Nexant, included market research, development and distribution of educational materials, and technical assistance.

The market research included focus groups and in-depth interviews with participants and nonparticipants of the California Energy Commission's DR programs.[2] The results showed that the major motivations for DR actions in 2000–2001 among California customers were to reduce blackout potential, help diffuse the energy crisis, and lower energy costs. As the news of the energy crisis faded, their interest and DR actions declined. The research also showed that there was substantial potential for expanding energy information and management systems to increase DR capability as well as gain other benefits.

As a result of these findings, the Energy Commission designed educational materials to promote "enhanced automation." Rather than focusing on short-term DR strategies, such as turning off lights or raising thermostat settings that businesses were already familiar with, the enhanced automation materials promoted increasing the capability of existing EMSs or EISs to help businesses manage both energy use and the comfort of building occupants.

Enhanced automation is defined as any improvement in technology that increases the capability of an existing energy or building management system. The more automated a building's lighting and HVAC systems, the better building management can respond to DR opportunities and manage overall energy usage. The most advanced energy information and management systems include both monitoring and control functions that can be programmed to respond to such external information as price signals and curtailment alerts.

The technical assistance provided by Campaign is discussed in more detail below.

Promoting Automation Investments

The right combination of capability and motivation is needed to induce businesses to temporarily reduce demand during times of shortage and high energy costs. DR tariffs or incentive programs can provide the motivation. DR Capability consists of technologies that allow businesses to reduce their level of energy easily and the knowledge of how to respond.

The technologies most appropriate for a business depends on their primary energy load. The needs of a manufacturing firm with a round-the-clock production line are very different from those of a data processing firm, or a grocery. However, even businesses with widely different functions can usually benefit from improving their lighting and HVAC systems. Table 1 lists common automated strategies for lighting and HVAC systems.

Many businesses pursue enhanced automation investments save energy long term. For example, a recent series of studies by Lawrence Berkeley National Laboratory showed 20 to 40 percent of the cooling demand on hot summer days was saved by implementing a precooling strategy that cooled the building to 67 ºF at night, and allowed it to drift up when occupied by 1 ºF per hour to 76 ºF. (Peng Xu, et al 2004 and Braun 2004) The absence of occupant complaints is likely due to the gradual change in temperature.[3]

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[2] For more details on the first two phases, refer to earlier publications available. See, for example, Larkin 2002 and McElroy 2002.

[3] For this strategy to be effective on the hottest days, the cooling equipment must be appropriately sized.

As part of the Enhanced Automation Campaign, the Energy Commission produced case studies of several success stories from customers who invested in substantial upgrades as part of DR program, which are summarized in Table 2.[4] (XENERGY, 2002) While these projects focused primarily on DR capability initially, three of the businesses have now altered their daily practices to save energy and demand every day, while also maintaining additional curtailable load. In one case, a California county upgraded its building automation systems for a 2 million square-foot, five-building county complex. The increased flexibility through upgraded chiller controls allows the county to shed 1.4 MW of load from a peak of 6.8 MW. In another example, a retail chain connected 119 of its stores through a web-based system that allows them to reduce lighting and HVAC loads by up to 2.8 MW. Similarly, a California community college district can now curtail 1.7 MW of its 4.6 MW peak by using a new web-enabled automation system.

Table 1. Sample Measures to Increase DR Capability for Lighting and HVAC

Lighting Systems	HVAC Systems
Zoned On/Off Control (sweep)	Raise Zone Temperature Setpoints with/out precooling
Special Fixture Control	Raise Chilled-Water Temperature Setpoint
Dual-Level Control	Limit Ventilation Based on Occupancy
Multi-Level Control Lighting - Dimming	Cycle AC Units or Compressors
Centralize Control of Lighting Systems	Control VSD Fans or VSD Pumps
Occupancy Sensors and Controls	Limit Chiller Maximum Demand

Table 2. Summary of Enhanced Automation Case Studies

Building Type	Technology	Project Cost	Annual Savings	Curtailable Demand
Municipal Buildings	Chiller control via EMS/EIS	$280K	$70K	1.4 MW
Office Campus	Lighting, pumps and fan control via EMS and CO_2 sensors	$285K	N/A	1.5 MW
Office High Rise	Dimmable ballast and HVAC control via EMS and internet	$358K	$114K	65 kW
College Campus	HVAC on/off and set-point control via EMS/EIS	$282K	$30K	1.7 MW
Retail Chain	EMS control of HVAC and lighting via pager-based EIS	$320K	$140K	2.8 MW
Hotel	Standard EMS control of HVAC	$48K	$64K	200 kW

From the six "Enhanced Automation Case Studies," prepared for the California Energy Commission by XENERGY Inc. in 2002.

Estimating Energy Savings

Since each project is unique, it is difficult to produce savings estimates that will apply across sites. To help customers estimate average costs and savings for controls upgrades, the Enhanced Automation Program developed the Technical Options Guidebook. (XENERGY 2002). Table 3 presents information excerpted from the Guidebook on the benefits of HVAC

[4] All projects also installed capability to receive 15-minute interval utility data via an EIS on a real-time or next-day basis. Savings described here are from actual system tests compared to a multi-day baseline. Calculations are based on demand charges of up to $15.90 per kW for large buildings and $6.70 per kW for smaller sites.

automated controls measures. The publication also includes cost and savings estimates for EMS, EIS, and lighting controls upgrades.

Table 3. Benefits for HVAC EMS Measures

Measure	Energy Savings	Notes
Shut-off with a High Limit	20%-40%	Compared to full-time operation at occupied temperature setpoints and for typical 9-to-5 building
Night Ventilation	0.1%-2% of cooling energy use	May reduce morning demand on the HVAC system
Optimal Start	5%-10% of fan and heating/cooling costs	Saves hundreds of hours of fan and cooling system operation compared to fixed start-time strategy
Variable-Capacity Control	10%-30% of fan or pump energy use (might translate to 5%-15% of total building energy use	Benefits are highly site and application specific; peak demand savings tend to be lower because variable-capacity systems have more impact on efficiency during part-load operation
Demand-Responsive Ventilation	20%-70% of ventilation use, 2%-7% of total building energy use	Compared to outside air flow rates in normal operation
Thermal Storage	10%-50% of cooling use, 2%-10% of total building energy use	Compared to conventional, non-storage operation

From "Enhanced Automation Technical Options Guidebook," prepared for the California Energy Commission by XENERGY Inc. in 2002

Notes from the Field on Providing DR Technical Assistance

The Enhanced Automation Campaign offered customized technical assistance to large commercial and industrial businesses that wanted more information on both manual and automated DR actions available with their current systems and/or capital investments they should consider to increase their energy management capability. In Phase I, detailed technical and design services were provided to six very large businesses, including a university student housing organization, a large retail chain, and two large office complexes.

In Phase II, the technical assistance services were re-oriented to serve customers who were considering participation in the new CPP Tariff. Pacific Gas & Electric (PG&E), Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E) provided information on the technical assistance services available through the Enhanced Automation Campaign to its customer service representatives. In addition, PG&E hired a subcontractor to promote the CPP to many of its unassigned accounts (under 500kW).

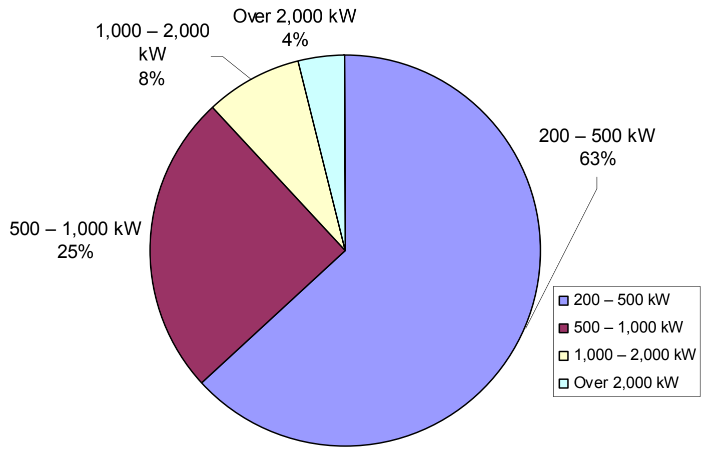
The Enhanced Automation Campaign provided CPP-related technical assistance to 47 businesses. Figure 1 shows the peak demand of the customers receiving technical assistance.

Most of the assistance was provided to unassigned accounts in the PG&E area. Three tiers of assistance were available, depending on the complexity of the facility. This customized assistance was a valuable tool in meeting diverse customer needs. Ultimately, 35 telephone consultations, 8 half day on-site visits and 4 full-day visits were conducted. About 46 percent of the requests were from commercial and 54 percent were industrial customers.

The Technical Assistance Process

Once a business made a request, a professional engineer reviewed the account rate analysis report generated by the utility, and contacted the business to discuss their building systems, equipment, and usage patterns. Additional telephone or on-site visits were provided as necessary, depending on the size and complexity of the facility.

Figure 1. Size of Customers Receiving Phase II Technical Assistance



Most customers requesting technical assistance already had ideas on how to reduce demand on a summer CPP day, but did not know what demand savings were possible. The engineers provided estimates of the demand-reduction potential of measures being considered and recommended any other DR strategies appropriate for the facility. Engineers addressed measures that could be implemented with existing systems, as well as measures requiring incremental system upgrades. The engineers also worked with the businesses to ascertain their actual willingness to implement measures that were technically feasible.

Customer Perspectives on doing DR

The most common measures businesses had already considered were rescheduling industrial processes, reducing lighting levels and/or plug loads, and raising thermostats 2 to 4 ºF. About 40 percent were willing to reduce lighting and 33 percent were willing to adjust the temperature. Approximately 45 percent of the industrial facilities were considering shutting off or rescheduling process equipment.

Almost all planned to manually implement the measures, at least at first. However, some reported that they might pursue capital upgrades to automate functions in the future. For example, 7 percent were willing to consider installing demand control ventilation (DCV).

The following examples are from sites ranging in size from 200 kW to 1 MW that received CPP-related technical assistance from the Enhanced Automation Campaign. All strategies mentioned would be manually implemented, at least initially.

- A custom paper products company was willing to reschedule the use of a high-power laser cutter but did not know how much demand this would save. Engineering calculations determined that the laser consumed 20 percent of their peak demand. Upon the recommendation of the engineer, they also planned to shut off some lights and air conditioning, which will result in additional savings.
- A school district reported that they could shut all equipment off by noon on peak days during summer school in July and August. During the regular class year, they must wait until the students go home. Engineers also recommended adding sweep controls to the EMS to shut off the lighting and HVAC after the scheduled class hours. Occupancy sensors could also be added to classrooms to ensure that lights and air conditioning are

off in unoccupied rooms. DCV is now being considered as well, especially for gymnasiums and auditoriums, to reduce unneeded outside air use in times of low occupancy,

- A museum has a large skylight ringed with incandescent floodlights above a two-story atrium. On sunny days, these floodlights are not necessary but cannot be shut off as the lighting controls also control other darker areas. This 100,000 SF museum is now considering additional controls for the ring of lights around the atrium. By shutting off these lights when not needed they could shed about 4 kW.
- A 42,000 SF office building has three-lamp, three-way lighting. Building management plans to turn off one lamp in each fixture on a CPP day, which could shed about 20 kW. Also, they will ask employees to turn off unneeded PCs and close the blinds on the south and west sides of the building. In addition, they plan to experiment with precooling by turning down the thermostats the night before and turning them up at noon on CPP days.

What Customers Say They Will Do: California Statewide Survey

This section presents results from a survey of California businesses conducted as part of the Enhanced Automation Campaign evaluation.[5] The survey addressed:

- Barriers, attitudes and participation in DR Programs
- DR capabilities and recent DR actions
- Relevance and capabilities for energy monitoring
- Familiarity with the Enhanced Automation Campaign.

Survey respondents included 500 nonresidential customers representing a wide variety of commercial, institutional, and industrial business types and ranging in size from 100 kW to 2001 kW and larger.[6] The responses were weighted back to the entire eligible non-participant population based on the energy consumption (kWh) at the facility or similar facilities where appropriate.

DR Familiarity and Recent Actions to Reduce Peak

Roughly 45 percent of California businesses surveyed were very familiar with the concept of DR; another 47 percent said they were somewhat familiar with DR. As might be expected, the larger the business size, the more likely they were to be familiar with DR.

Half of the businesses that reported being on time-of-use (TOU) rates reported that they had taken actions in the past to shift demand as a result of the price differences. Table 4 lists the actions the businesses reported having taken to reduce peak demand charges.

[5] Quantum Consulting is conducting an evaluation of new DR tariffs being implemented by PG&E, SCE, and SDG&E. Since there was substantial overlap in the baseline surveys planned for the EA Evaluation and the DR tariff evaluation, KEMA, Quantum, the utilities, the CPUC and the Energy Commission agreed to cooperate on the study. Quantum Consulting took the lead on designing and fielding the survey. Full survey results will be published by Quantum Consulting in Fall 2004 as part of their evaluation report.

[6] The Customers are located within PG&E, SCE, and SDG&E service territories. SDG&E customers were 100 kW and larger; PG&E and SCE customers were 200 kW and larger, due to program eligibility differences.

Table 4. Actions Taken to Shift Demand under TOU rates

	Extra Large (2000+ kW)	Large (1000 - 2000 kW)	Medium (500 - 1000 kW)	Small (100/200 - 500 kW)	Percent of Premises
Reschedule staff/equipment to off-peak	64%	69%	42%	54%	53%
Reduce use of certain equipment	8%	26%	7%	41%	22%
Reevaluate program eligibility, change use rates	6%	0%	24%	0%	6%
Other	22%	6%	34%	4%	20%
Respondents	*32*	*34*	*27*	*27*	*120*

Attitudes and Motivations Influencing DR and Automation Investments

Roughly 70 percent of businesses reported that they were very concerned about energy costs relative to other costs of doing business. Thirty-eight percent of the businesses reported that energy costs represented over 10 percent of their annual operating costs, and one-quarter said that they monitored electricity prices and markets very closely. Retail establishments were most likely to closely monitor energy prices, at 46 percent. In addition, 54 percent of the survey respondents believed that electricity prices would increase over the next 3 years. Over two-thirds believed that it was very or somewhat likely that California's power supply would not meet demand over the next 3 years.

When asked about their attitude toward critical peak tariffs generally, 37 percent of the businesses were somewhat or very positive. Two-thirds were somewhat or very positive toward programs that allowed voluntary demand bidding. Only one-quarter of businesses said that they didn't like these programs because they couldn't reduce or shift demand.

Current Energy Management Capabilities

Whether they actually take advantage of the capability, businesses reported substantial capabilities to review energy usage and automatically control demand, such as the ability to automatically control energy load or view hourly demand on an in-house EIS (See Table 5). These capabilities were most often found at sites with over 2000 kW.

DR Potential with Existing Capabilities

To help assess DR potential, survey respondents were asked a hypothetical question on what percent of normal summer afternoon peak demand their company would be willing to reduce for a few hours on four weekdays in the summer, provided they were notified the day before and had sufficient financial motivation. Twenty-six percent said they would not be willing to reduce at all, while another 26 percent reported they would be willing to reduce over 10 percent. Overall, the mean reduction was 13 percent of peak demand. As shown in Table 6, the willingness to temporarily reduce demand varied substantially by business type.

Respondents were also asked about their willingness to do some common manual DR actions, given sufficient motivation. Most were willing to allow temperatures to rise, shut off the AC in low-occupancy areas, or reduce lighting levels. As shown in Table 7, results varied by business type, for example offices were the least willing to adjust AC levels. In addition, a surprising number of industrial facilities were also willing to reduce production processes.

Table 5. Current Energy Information and Management Capabilities

	Extra Large (2000+ kW)	Large (1000 - 2000 kW)	Medium (500 - 1000 kW)	Small (100/200 - 500 kW)	Percent of Premises
View hourly demand on utility website	61%	43%	34%	25%	60%
View hourly demand on an EIS	83%	64%	57%	34%	42%
Automatically control energy load	58%	47%	60%	49%	54%
Respondents	*114*	*133*	*127*	*126*	*500*

Table 6. Percent of Demand Willing to Temporarily Reduce if Sufficient Motivation

	Office	Retail/Grocery	Institutional	Other Commercial	Transportation, Communication, Utility	Petroleum, Plastic, Rubber and Chemicals	Mining, Metals, Stone, Glass, Concrete	Electronic, Machinery, and Fabricated Metals	Other Industrial and Agriculture	Percent of Premises
0 percent	22%	28%	29%	26%	21%	39%	10%	31%	27%	26%
1 to 5 percent	19%	26%	10%	14%	3%	11%	19%	25%	17%	17%
6 to 10 percent	19%	21%	16%	21%	5%	10%	12%	17%	10%	15%
11 to 20 percent	10%	3%	8%	7%	14%	9%	7%	9%	7%	8%
20 to 50 percent	7%	11%	9%	3%	11%	14%	4%	6%	18%	9%
Over 50 percent	3%	1%	8%	10%	36%	15%	5%	2%	14%	9%
Don't Know/Refused	20%	10%	20%	18%	9%	3%	43%	11%	8%	15%
Respondents	*60*	*37*	*66*	*62*	*51*	*57*	*54*	*59*	*54*	*500*
Mean	0.09	0.08	0.13	0.13	0.34	0.19	0.09	0.07	0.19	0.13

Investing in Automation

In addition to investigating manual DR measures, the survey addressed long-term automation investments for load management. Almost 60 percent of respondents said that they have installed automation investments to improve their ability to manage their energy use. Medium-sized (500–1000 kW) retail establishments and institutional facilities were the most likely to have made recent automation investments. Of those who made investments, two-thirds had upgraded their EMS systems. Roughly 20 percent had installed a programmable thermostat or other timers. Eighteen percent had installed other energy regulation or analysis equipment. Over half of these firms had not pursued additional automation investments, usually due to the additional cost involved.

The most common reasons for considering automation investments were to save on energy costs, upgrade old equipment, and to increase the flexibility of control systems (80 percent, 20 percent, and 20 percent, respectively). Two percent reported having upgraded their controls to be better able to respond to dynamic pricing, the majority of which were in the transportation and communication or other industrial or agricultural industries.

Table 7. DR Actions if Motivation were Sufficient by Business Type

	Office	Retail/Grocery	Institutional	Other Commercial	Transportation, Communication, Utility	Petroleum, Plastic, Rubber and Chemicals	Mining, Metals, Stone, Glass, Concrete	Electronic, Machinery, and Fabricated Metals	Other Industrial and Agriculture	Percent of Premises
Allow the temperature to rise in the occupied space	57%	76%	70%	66%	68%	88%	93%	87%	66%	72%
Shut off a portion of the air conditioning system	47%	56%	62%	63%	68%	85%	79%	75%	60%	64%
Reduce the overhead lighting	77%	89%	71%	78%	74%	88%	92%	89%	68%	80%
Reduce or shut off some or all production processes	2%	15%	7%	13%	55%	43%	55%	16%	48%	25%
Respondents	*60*	*37*	*66*	*62*	*51*	*57*	*54*	*59*	*54*	*500*

Conclusion

California Businesses are willing to engage in manual DR actions if sufficiently motivated. Businesses of all sizes and types will allow temperatures to rise, shut off the AC in low-occupancy areas, or reduce lighting levels. In addition, a surprising number of industrial facilities will to reduce production processes, if it is under their control.

Businesses have also shown interest in more sophisticated methods of managing and monitoring energy usage. Yet the control methods used many facilities are often primitive and do not take full advantage of system capabilities. In addition, only a small subset of firms has invested in fully upgrading their control and monitoring systems. It is also clear that few businesses are aware of the full range of options available, or how to estimate savings.

The bottom line is that all types of businesses of all sizes and types should invest more system automation. Businesses should not limit themselves to only low fixed-cost manual DR with long-term uncertainty. They should consider capital investments that improve their capability to manage their building operations while reducing energy costs.

Financial motivation, along with information and education is necessary to promote large-scale investments in automation to increase DR capabilities. At a policy level, DR program strategies should balance between focusing on motivation and capability. Since the majority of current DR programs focus heavily on motivation without addressing capability, there is a bias toward low fixed cost, but high ongoing variable cost DR strategies. These missed opportunities cost businesses millions of dollars each year.

In addition, site assessments, such as those offered through the Enhanced Automation Program, should be packaged with DR programs and can be customized to help determine the most appropriate level and type of automation or DR capability for each facility. Policy-makers should also consider programs that directly promote automation investments. Large customers in particular, such as those over 1 MW, may be more motivated by financial incentives than educational materials or technical assistance.

For example, the Enhanced Automation Initiative is a new program being implemented by KEMA under the auspices of the California Public Utilities Commission, which provides incentives for EMS hardware and software upgrades. Using estimates in the Technical Options

Guidebook, we expect projects will have an average cost $0.30 per first-year annual kWh saved for hardware enhancements, with an average project cost of $50,000 per 200,000 square-foot building.

References

Braun, Jim. 2004 "Introduction to Load Shifting and Peak Load Reduction Using Building Thermal Mass." Purdue University.

Larkin, Julia K, Kathleen McElroy, and Rich Barnes. 2002. "Enhanced Automation: Stimulating Investment in Demand Responsive Capability." In *Proceedings of the Thirteenth National Energy Services Conference.* Tuscon, AZ.: Association of Energy Services Professionals.

KEMA, Inc and Nexant. 2004. Enhanced Automation Educational Campaign: Final Report. Prepared for the California Energy Commission.

KEMA-XENERGY. 2003. Forecasting Energy Efficiency & Demand Response Potential. Prepared for Southern California Edison.

McElroy, Kathleen and Rich Barnes. 2002. "Stimulating Investment in Demand Responsive Capability." *Proceedings from the 2002 ACEEE Summer Study of Efficiency in Buildings.* Washington, DC: American Council for an Energy-Efficient Economy.

Messenger, Mike. 2002. *A Proposed Action Plan to Develop More Demand Response in California's Electricity Markets.* Sacramento, Calif.: California Energy Commission.

Quantum Consulting. *Draft workpapers for the Evaluation of Demand Response Programs and Tariffs.* Prepared for Southern California Edison. Final Published Report expected in Fall 2004.

XENERGY, Inc., and Nexant, Inc. 2002. *Enhanced Automation Technical Options Guidebook, also Six Enhanced Automation Success Stories.* Sacramento, Calif.: California Energy Commission. Pub No.400-02-005F. Available for download at www.ConsumerEnergyCenter.org/enhancedautomation.

XENERGY, Inc. 2002. California Commercial Sector Energy-Efficiency Potential Study, prepared for Pacific Gas and Electric Company.

XENERGY, Inc. 2001. 2000/2001 Nonresidential Large SPC Evaluation Study, prepared for Southern California Edison.

Peng Xu, Philip Haves, James Braun, MaryAnn Piette. 2004. "A Case Study of Precooling with Zone Temperature Reset in a Commercial Office Building." Lawrence Berkeley National Laboratory.