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Commercial & Industrial Demand Response Within Hawaiian Electric Company Service Territory

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Technical Update, June 2007

EPRI Project Managers

A. Rogers
R. Graham
C. Williamson

Cosponsor

Hawaiian Electric Company
PO Box 2750
Honolulu, HI 96840-0001

Project Managers

D. Ishimura
A. Tam
G. Willoughby

ELECTRIC POWER RESEARCH INSTITUTE
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com

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ORGANIZATION(S) THAT PREPARED THIS DOCUMENT

Rocky Mountain Institute (RMI)

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CITATIONS

This document was prepared by

Rocky Mountain Institute
1739 Snowmass Creek Road
Snowmass, CO 81654-9199

Principal Investigators
Kyle Datta
Joel Swisher
Kitty Wang

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REPORT SUMMARY

By reducing power usage during peak demand periods, demand response (DR) programs can help utilities manage power loads and complement energy efficiency activities while providing ratepayers an opportunity to substantially reduce their electric bills. This project assessed the costs and benefits of potential DR programs for Hawaiian Electric Company's (HECO's) commercial and industrial (C&I) customers.

Background

HECO's draft Integrated Resource Plan and rate case filing for 2004 include provisions for the company to define a commercial and industrial direct load control program (CIDLC), and HECO also plans to design a commercial and industrial voluntary load control program (CIVLC). This project looked at what lessons can be learned from current industry programs in C&I load management, scoped possible programs for HECO, and conducted a cost/benefit analysis of potential DR programs.

Objectives

- To define current industry programs and practices (both successes and failures) in C&I load management
- To define applicable programs for CIDLC and explore how they should be structured
- To evaluate the benefits and costs of demand reduction programs.

Approach

The project team examined current C&I load management programs in order to find out what types of demand control programs have worked best with specific C&I segments and to identify the critical elements of successful utility programs. The team defined programs for CIDLC that would fit HECO's needs, especially DSM bidding programs that enable rapid response to peak load conditions on Oahu. The team conducted a cost/benefit analysis of these potential programs.

Results

Load response programs such as direct load control, curtailable load, and interruptible load appear to hold the most promise for HECO. Price responsive programs such as real time pricing, demand bidding, and critical peak pricing will be difficult for HECO to implement since there is no power market in Hawaii and energy production costs do not vary significantly between peak and off-peak periods. Price response programs require strong price signals to induce customer behavior.

Current HECO DR programs seek to locate customer loads that can be interrupted, or shut off during critical periods. HECO should also consider programs that ask customers to flex facility

loads, for example, by raising thermostat set points or turning off lights in unoccupied rooms, rather than shutting system loads off entirely.

Hotels, condominiums, restaurants, and military facilities provide immediate DR opportunities for HECO. Retail and office facilities may provide additional opportunities in the medium term. Small (<200 kW) and medium (200 kW-400 kW) customers such as retail and restaurants may be particularly valuable targets for DR in Hawaii, where direct load control and curtailable load programs can be successful.

For small commercial customers, HECO should structure the program to pay for the cost of procuring and installing load switches, smart thermostats, or gateways systems instead of providing high incentives for their use. For medium and large customers, HECO should offer an integrated package of services to assist those customers through all stages of technology adoption, from awareness to implementation. HECO could outsource some or all of these services—partial outsourcing can be very efficient since it allows the utility to cost effectively retain responsibilities within its expertise while contracting out other responsibilities and duties.

EPRI Perspective

This assessment provides a basis for the design of a set of demand response programs appropriate to HECO's commercial customers. The report recommends that HECO consider three types of load response programs for its commercial customers:

- Direct load control (primarily air conditioning cycling) for small customers (<200 kW)
- Load response with advanced notification (primarily targeting HVAC and lighting) for small and medium customers (<400 kW)
- Curtailable load for large customers (>400 kW).

Keywords

Direct load control program
Voluntary load control program
Commercial and industrial
Demand-side management
Demand response

ABSTRACT

HECO's draft Integrated Resource Plan and recent rate case filing for 2004 include provisions for the company to define a commercial and industrial direct load control program (CIDLC), and HECO plans to design a commercial and industrial voluntary load control program (CIVLC). The proposed review work will provide lessons learned and inputs to the CIDLC and CIVLC programs. Our objectives for this work are to answer several key questions regarding C&I demand response.

Objectives are:

- Define current industry programs and practices (both successes and failures) in commercial and industrial (C&I) load management. HECO seeks to understand what types of load control programs have been successful for different C&I segments, the expected range of price response incentive packages and the critical elements of successful utility programs, especially those with flexible participation such as demand side budding. HECO is specifically interested in program qualification, enabling equipment such as advanced metering, type of incentive used, program results (customer and MW) and any unique terms or conditions. Further, HECO seeks to understand what type of C&I load management programs have failed and why.
- Define applicable programs for CIDLC and how they would be structured. HECO is particularly interested in DSM bidding programs, to enable rapid response to peak load conditions on Oahu. Beyond this type of program, other C&I load management approaches may be applicable to different segments of HECO's C&I customer base. This effort would build on the existing C&I research from HECO.
- Benefits and costs demand reduction. At a high level, HECO must evaluate the merits of a business case in support of or opposition to deployment of the proposed CILDC demand response programs. Comparison of potential program benefits and costs and evaluation of the basic business case will support a conclusion as to whether the utility should pursue pilot testing.

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EXECUTIVE SUMMARY

HECO Demand Response Programs for Commercial and Industrial Customers Project Overview

Rocky Mountain Institute (RMI) conducted a three-phase analysis to scope potential demand response (DR) programs for Hawaiian Electric Company's (HECO's) commercial and industrial customers. Demand response is a sophisticated approach to load management and is used to complement energy efficiency activities. If done correctly, demand response can provide a broad range of distributed benefits to the overall HECO system and ratepayers. The first phase involved a review of HECO's customers based on existing studies and interviews with HECO personnel. RMI assessed major customers by industry (e.g., hotels, restaurants, military) and their end use load profiles to identify preliminary opportunities and challenges. In the second phase, RMI reviewed existing commercial and industrial demand response programs and presented lessons learned from programs implemented around the country, including customer responses to various program offerings. Together with HECO, RMI identified direct load control for small and medium enterprises and curtailable load as the best program options to supplement HECO's existing CIDLC program. In the third phase of the project, RMI analyzed available technology options and the cost effectiveness of the recommended programs, and presented possible incentive structures for the recommended programs. This executive summary provides the major findings that emerged from each phase of the scoping process.

Customer Characterization and End Use Targets

HECO faces similar barriers to program implementation as other utilities. Customers lack automated response capabilities and are concerned about occupant comfort, impacts on customers, and the financial viability of participating in demand response. HECO is fortunate that surveys indicate their customers express a high degree of trust in and loyalty to HECO and a willingness to cooperate through program participation.

Opportunities that can be tapped into immediately exist in the following commercial sectors: hotels, multi-residential facilities (i.e., condominiums), restaurants, and military facilities. Retail and office facilities may provide additional opportunities in the medium term.

Small (<200 kW) and medium (200 kW-400 kW) customers (e.g., retail, restaurants) may be particularly valuable targets for DR in Hawaii, where direct load control and curtailable load programs can be successful.

Lighting and HVAC loads drive HECO's peak commercial demand and are the primary end-use targets of most DR programs. Additional end uses targeted by DR programs around the country include process loads, refrigeration, motors, miscellaneous plug loads and elevators. Even though HVAC load in office buildings is not currently coincident with HECO's peak, the peak

could shift over time from the evening to the afternoon as HECO's other energy efficiency and load management programs take effect. Therefore, it is important to be proactive in addressing the major customer end uses now.

Program Types

Current HECO DR programs seek to locate customer loads that can be *interrupted*, or shut off during critical periods. HECO should also consider programs that ask customers to *flex* facility loads (e.g., raising thermostat setpoints, and turning off lights in unoccupied rooms) rather than shutting system loads off entirely.

Load response programs (i.e., direct load control, curtailable load, interruptible load) appear to hold the most promise for HECO. Price responsive programs (i.e., real time pricing, demand bidding, and critical peak pricing) will be difficult for HECO to implement, since there is no power market in Hawaii and energy production costs do not vary significantly between peak and off-peak periods. Price response programs require strong price signals to induce customer behavior. Critical peak pricing programs, for example, require about three times the price between critical peak and average daily peak to be effective. There is, thus, not an economic justification on HECO's system for this level of price signal differential. Further, the administrative complexities of price response programs tend to drive away all but the largest customers.

RMI recommends that HECO consider adding three types of load response programs to its portfolio of DR programs for its commercial customers:

- direct load control (primarily air conditioning cycling) for small customers (<200 kW);
- load response with advanced notification (primarily targeting HVAC and lighting) for small and medium customers (<400 kW); and
- curtailable load for large customers (>400 kW).

Enabling Technologies

RMI recommends that HECO take advantage of control technologies such as energy information systems with response capability, communication systems, and load control devices (e.g., smart thermostats, load control switches) to capture a greater share of achievable demand response potential and to realize the full distributed value of these technologies. Two issues are important: automated response and two-way communication.

Automated response allows the instantaneous adjustment of load, enabling demand response to be used to control frequency and regulate voltage as a negawatt generator. Manual load control is unlikely to provide consistent and reliable load reductions.

Though not required for demand response, two-way communication provides the utility with instantaneous measurement and verification of actual customer load reductions during demand response events. When this capability is integrated into the control room energy management systems, demand response resources can be used by control operators in the same way as peak generation, only in reverse. Thus, demand response can provide much needed ancillary services such as "virtual spinning reserve," frequency control, and voltage control. Demand response

then becomes a valuable tool to use in concert with renewables; it gives the utility another approach to manage increased variability on the grid, particularly if curtailable load flexing is used for emergency situations rather than absolute interruptions. For customers, two-way communication also provides the added benefit of internal feedback for facility mangers to maintain acceptable operating ranges for equipment or to manage multiple facilities.

Economic Feasibility

RMI's economic evaluation was a cost-benefit analysis that looked at the net present value of annual cash flows over an assumed 15-year program life, using the total resource cost approach. Project costs included load response technology capital, customer O&M costs, utility O&M costs, and customer acquisition costs. Project benefits included avoided utility capacity and reserve costs, and avoided marginal energy costs. Economic evaluation showed that each of the three recommended programs proved economically viable.

Direct load control for small customers (<200 kW) using simple load switches or communicating thermostats targeting only central air conditioners are cost effective, requiring just 2 kW/site reduction to break even.

Load response for small customers using centralized lighting, HVAC, or combined lighting and HVAC controls is cost effective and requires 30 kW/site reduction to break even. Load response for medium customers requires 18 kW/site to break even.

Commercial customers generally require three-year paybacks or less on energy efficiency, which is the equivalent of a 30 percent discount rate. In contrast, HECO's weighted average cost of capital is 8.4 percent. If customers invest in control technologies, HECO has to provide a greater share of the total avoided costs as incentives (which means less money is available to lower costs for other ratepayers).

For small commercial customers, HECO should structure the program to pay for the cost of procuring and installing load switches, smart thermostats or gateways systems (as opposed to providing high incentives for their use). For medium and large customers, HECO should offer an integrated package of services to assist those customers through all stages of technology adoption, from awareness to implementation. HECO could outsource some or all of these services. This approach will be more cost effective for HECO, its ratepayers, and the commercial customers.

Large commercial facilities can cost effectively participate in curtailable load programs, assuming they have an existing energy management system (EMS). Additional capabilities of demand response include monitoring and recording real time energy use data for analysis of building operations, billing analysis and reporting to detect errors, and the ability to automatically respond to a curtailment signal from the utility. These capabilities are provided by energy information systems (EIS), which can be overlaid on top of existing EMS. Upgrading is inexpensive, and is cost effective from just an incremental 12 kW/site reduction However, few facilities in HECO's service territory have these full EMS systems.

Unless the existing EMS is already equipped for demand response, the large commercial facility will need upgrades including, at a minimum, the ability to: alert or notify the building operator of load curtailment requests; prepare, evaluate, and respond to load-curtailment requests; and analyze the effects of operational changes made in response to an event. EMS systems for office

buildings and campuses are expensive, and would require to 157 kW/site reduction to break even.

It is not cost effective for medium and large facilities to install an EMS solely for use with demand response. For new EMS installations to be cost effective, facilities must also be interested in energy efficiency for the long term. Considering only energy efficiency savings, a new EMS break even at 7 percent efficiency savings for the average medium customer and 24 percent for the average large customer. The combined economics of efficiency and load response should be used to determine if this technology suite will be viable. For example, if efficiency savings are only 20 percent for a large facility with a new EMS, 140 kW must be available for load reduction per site in order to break even.

Program Incentives

For direct load control programs, utilities often pay for the technology and pay a nominal, fixed monthly incentive plus an optional one-time participation payment ranging from $50 to $100. Variations of the fixed monthly incentive include payment per ton of air conditioning committed for reduction and payments based on the actual air conditioning cycling strategy employed. Additional optional credit may be given when customers participate in a load reduction event without overriding. Customers participating in direct load control programs are often more interested in the free technology than the incentive payments.

Curtailable load programs target medium to large customers, and incentives vary more widely. Typically, utilities give combinations of performance-based incentives ($/kW and $/kWh reduction) and (severe) penalties for non-performance. One utility, Cinergy, gives a two-part incentive structured as an option, which HECO should consider.

System Value of Advance Notification

Most commercial demand response has some form of advance notification from the utility. While system emergency programs provide no advance notification, nearly all price responsive programs are either hour-ahead or day-ahead programs with advance notification. For U.S. utilities, DR is given full reliability value, before adjustments for diversity, overrides, and duration. However, utilities recognize that short notification programs are more valuable operationally and often give higher incentive payments.

From HECO's perspective, the existing CILDC program is designed as an emergency program. Therefore, no notification is given and these programs receive full capacity credit. HECO should consider the capacity value of DR programs in the same way that they value capacity from generation resources: according to their start up time. For shorter advance notification (within the hour), DR is comparable to quick-start emergency diesel (1.5 minutes) or fast ramping units (<15 minutes). These generation units are critical for system reliability, and demand response should be treated identically.

For day-ahead notification, the resource is similar to unit commitment of an IPP. Penalties can be used to provide a level of contractual "firmness" for programs with advance notification equivalent to the "firmness" of an IPP contract. Thus, DR with day-ahead advance notification and financial penalties is comparable to acquiring day-ahead IPP capacity.

Who Should Implement the Programs

Outsourcing small-scale demand can provide many benefits for HECO, its ratepayers, and its customers. Other utilities regularly outsource implementation of demand response programs to specialists, and have begun to offer contracts for negawatts rather than megawatts to curtailment service providers. These companies take responsibility for customer marketing, equipment procurement and installation, payments, and settlement. They receive a negawatt purchase agreement from the utility.

This form of partial outsourcing can be very efficient, since it allows the utility to cost effectively retain responsibilities within its expertise, while contracting out other responsibilities and duties. Specifically for direct load control programs, DR specialists can help aggregate small loads to a more "utility friendly" scale. As a public company, HECO is subject to strict rules of fairness, requiring HECO to offer a few programs on an equal basis to all customers. A contractor or aggregator, on the other hand, can tailor marketing messages and programs to subclasses of customers. DR specialists serve as an intermediary; they agree to implement programs in exchange for utility payment to cover fixed costs and a share of the savings. Leaders in the industry providing DR directly to small commercial customers on behalf of utilities include: Comverge, Honeywell, Cannon, Carrier, GoodCents Solutions, and Distribution Control Systems. Examples of utilities who regularly outsource demand response or work with aggregators include: Long Island Power Authority, Florida Power and Light, Gulf Power, New England ISO, Utah Power, Southern California Edison, and Commonwealth Edison.

HECO should retain the program implementation for large customers, since these programs are synergistic with other DG, efficiency, and load management options.

2
REVIEW OF HECO PRIOR EFFORTS IN COMMERCIAL & INDUSTRIAL SECTOR

Preliminary assessment of commercial targeting and design goals for demand response programs for HECO

This task was to detail our understanding of HECO's system loads and constraints, identify opportunities and challenges in developing and implementing demand response at HECO, and discusses the importance of considering facility characteristics when identifying appropriate commercial demand response programs for HECO. This assessment will feed into RMI's subsequent work to recommend a set of demand response programs appropriate to HECO's commercial customers, along with guidelines for program design. The ideas developed in this memo are a result of review of HECO's prior efforts with Commercial & Industrial (C&I) load control, gathering of existing data on commercial sector from integrated resource plan (IRP) demand side management (DSM) materials and existing market research, and interviews with HECO management to understand key issues facing HECO's commercial customers.

Key Findings and Program Implications

- HECO's demand response potential is concentrated in military, office, and hotel customer segments. This raises important program challenges because contractual issues and/or business requirements have made these difficult (but not impossible) segments to capture the load response potential. Hence, lessons learned from Nevada, California, and Florida will be particularly relevant.

- There may be hidden demand response potential in the small (<200 kW) and medium (200 kW-400 kW) enterprise customers (e.g., retail and schools) through an alternative set of programmatic measures that HECO has not currently explored. Customers with demand greater than 400 kW are classified as large accounts in HECO. This is not significantly different from customer classifications elsewhere in the country, where utilities typically consider accounts larger than 500 kW as "large".

- From an end use perspective, backup generation, lighting, and to a lesser degree, cooling are the primary end uses that HECO seeks to tap for demand response. Backup generation may have permitting (air, noise) and electrical engineering issues that ultimately create additional capital costs that must be invested to utilize this resource. Additionally, capital investment in lighting and cooling controls technology at a minimum will be needed to access the inherent load flexibility of these end uses in facilities. Up to 10% of HECO's facilities have energy management systems already in place. Costs of necessary upgrades to existing energy management system (EMS) as well as new EMS installations in facilities (e.g., national retail chain) to be used for demand response should be investigated.

- Although HECO is currently focused on the evening peak, as the current programs are successful, HECO will need to manage the afternoon peak as well. Hence, demand response programs should be designed with a shift in end use priorities in mind. The 2005 system load profile appears to indicate that the evening peak is growing relative to the afternoon peak, not decreasing. This may be because HECO's current programs are not fully implemented yet, but it may also indicate that it may take longer before the afternoon peak meets or exceeds the evening peak.

- Current utility focus for demand response is to locate customer loads that can be *interrupted*, or shut off during critical periods. EPRI./RMI believe that HECO should include in its portfolio of commercial demand response programs, ones that ask customers to *flex* facility loads rather than shutting loads off (e.g., raising thermostats or cycling), which would make participation more palatable.

- Customer concerns raised in focus groups and surveys are typical of issues raised elsewhere. If anything, customers have a more favorable impression of HECO and a greater desire to help maintain system reliability than other utilities, which favors demand response programs.

- It is important to look at facility-specific characteristics within market segments to identify good targets for demand response programs. For example, facilities with dedicated energy managers and advanced building controls may be interested in different demand response programs than those without a facility manager or have only simple building controls.

Understanding HECO's Load Profile

The peak period remains centered on 19:00 hours for the near future. Note that residential load is the primary driver of the critical peak hours.

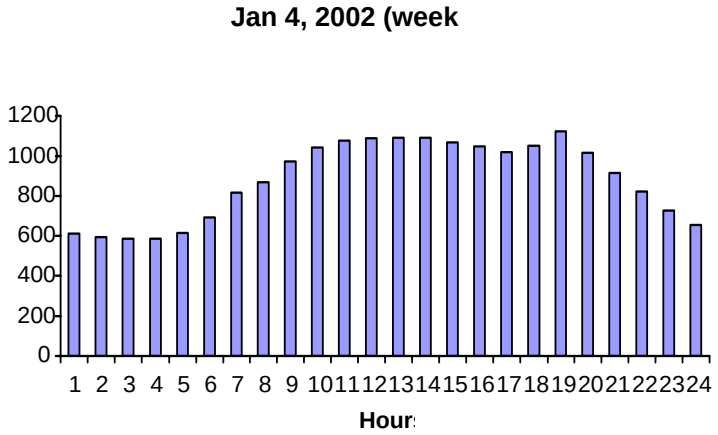
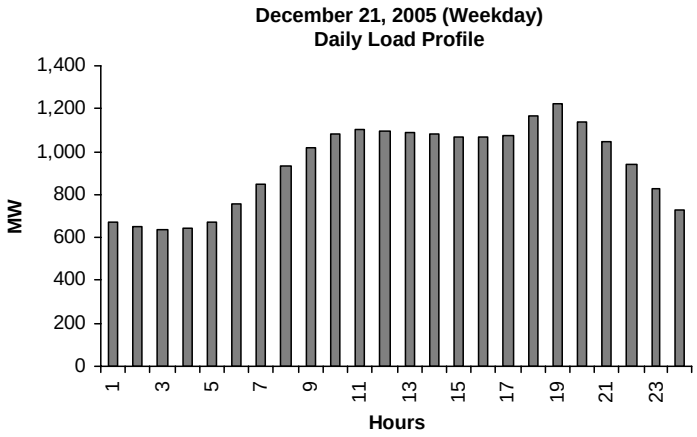


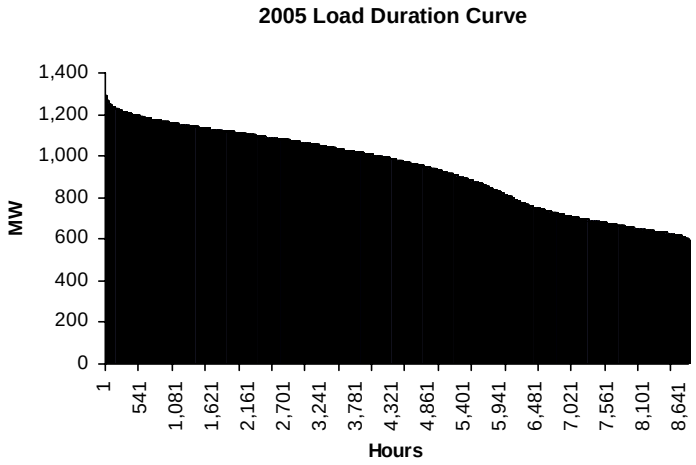
Figure 2-1
HECO's System Daily Profile 2002



Source: Draft 2002 Sales and Load Forecast

Figure 2-2
HECO's System Daily Profile Forecast for 2005

The load duration curves for HECO more clearly show that the critical peak hours occur only for a short duration during the entire year. For example, by 2005, load will be greater than 1,200 MW for less than 500 hours of the year (as shown on the load duration curve below). The implication is that load management programs will be valuable in reducing peak requirements for the first 30-40 MW. After that, the shoulder peak hours may create the new daytime peak, due to the high proportion of temperature dependent commercial air-conditioning loads.



Source: Draft 2002 Sales and Load Forecast

Figure 2-3
Load Duration Curve Forecast for 2005

Candidates and end use targets for commercial demand response

HECO's commercial customers demand 651 MW or just over half (51%) of the utility's total 2004 system demand. Figure 2-4 presents the breakdown within the commercial sector according to a demand response potential study conducted by Global Energy Partners (GEP).[1] Figure 2-5 presents the breakdown within the commercial sector of its largest customers only, according to an interruptible load and standby generation potential study conducted by ASW Engineering for HECO.[2] Both studies seem to indicate that the largest opportunities for demand response are with large offices and large hotels, each making up about 10% of the commercial system demand. Retail appears to be another sector that is a good candidate for demand response. The retail sector alone comprises 15% or 124 MW of total commercial demand, according to the GEP study, but over two-thirds of which appears to be small to medium facilities. Similarly, schools and small offices each make up 10% of HECO's commercial demand (shown in Figure 2-4) but are comprised primarily of small to medium-sized facilities. Together, these businesses make up almost 55% of the commercial sector. Although the military in ASW Engineering study is shown as the largest HECO customer segment by far, in reality it and other government facilities (state and Federal) are diverse facilities that function as offices, hotels, etc. in the commercial sector. As such, military and government customers were split up according to the more generic building types in the GEP study. Although making up just 6% of commercial load, grocery should not be ignored because of the handful of "big box" facilities with considerable demand.

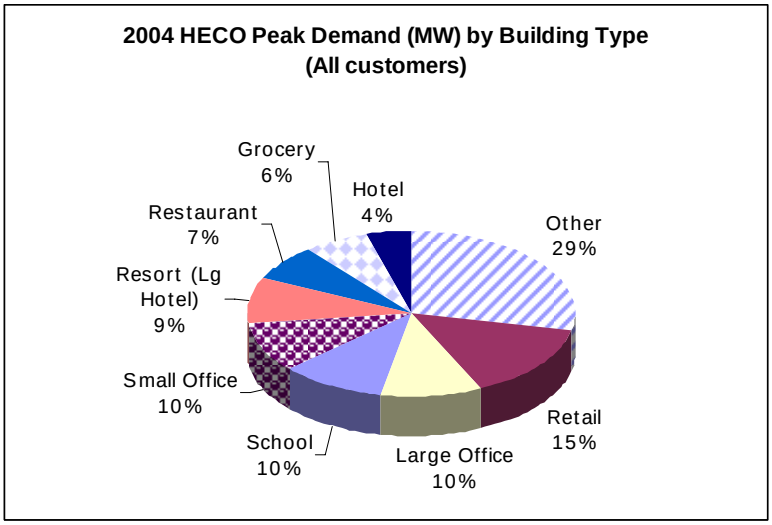


Figure 2-4
GEP breakdown of HECO's commercial sector by demand, 2004

[1] Global Energy Partners, LLC (GEP). *Assessment of Energy Efficiency and Demand Response Potential: Volume 1 Report*. February 2004. HECO 2005 Rate Case Filling T-11 Exhibit 2 of 5 and Exhibit 3 of 5, docket no. 04-0113.

[2] Hawaiian Electric Company (HECO). *Commercial and Industrial Standby Generation and Interruptible Load: A Site Survey of Large Customers*. July 8, 2003. Prepared by Market Research and Evaluation Division.

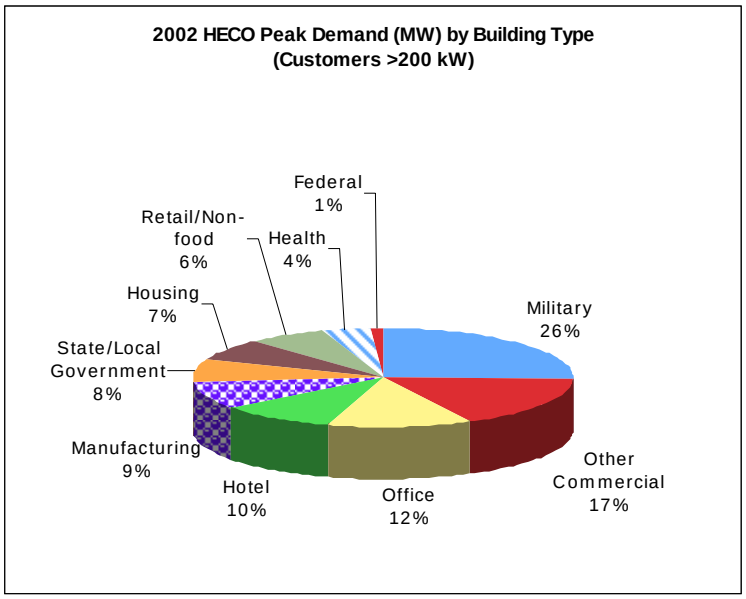


Figure 2-5
HECO's breakdown of its commercial sector by demand, 2004

HECO's commercial accounts include approximately 450 major customers, comprising approximately 50 percent of the company's revenues and 60 percent of the commercial sector demand. Major customers own facilities that with demand 400 kW or greater, and are approximately distributed in the following manner in Table 2-1:

Table 2-1
Approximate Distribution of HECO's Major Account Customers, 2004*

Facility size range (kW)	Number of facilities
400-600	150
600-900	100
900-2000	125
>2000*	75
Total	450

*Estimates provided by Rich Lee< Director of Marketing Services, HECO during phone conversation April 15, 2005.

Given the size of the commercial sector (651 MW) and strong growth of the residential sector that continues to drive HECO's system peak in the near term, commercial demand response must be implemented in combination with other programs including those targeted at the residential sector.

Commercial Consumption

Observations using existing demand analyses seem to correspond well with energy consumption data provided directly by HECO,[3] as shown in Figure 2-6. Office facilities and facilities located on military bases consume the largest portions of system energy by far, followed by hotels, education, and retail.

At most of these facilities, outside temperature in Hawaii can be a good predictor of customer loads.

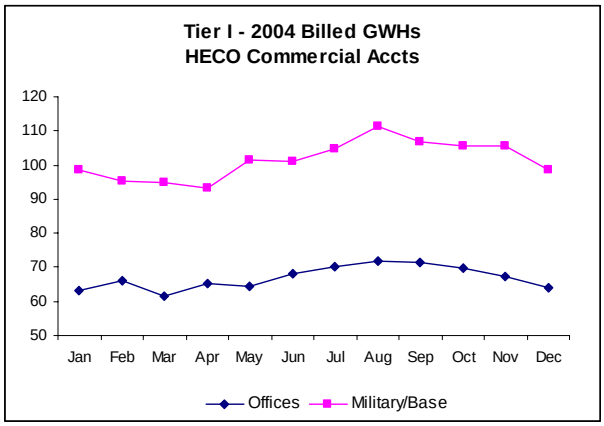
Seasonal patterns

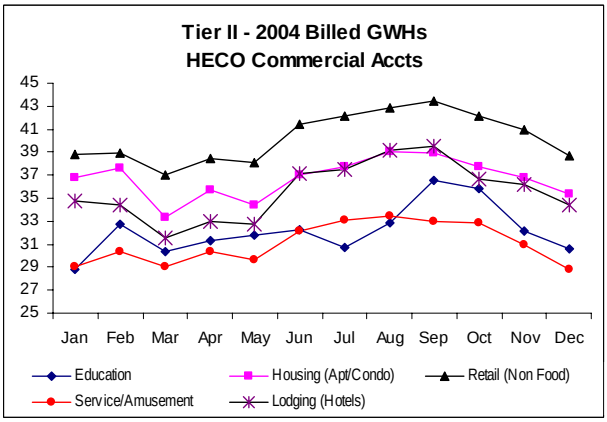
Viewing consumption on a monthly basis also reveals a seasonal pattern to commercial loads. Commercial consumption in 2004 increased during June and peaks in August or September. This pattern correlates well with historical temperature variations in Honolulu shown in Figure 2-6, which also peaks in August and September, on average.

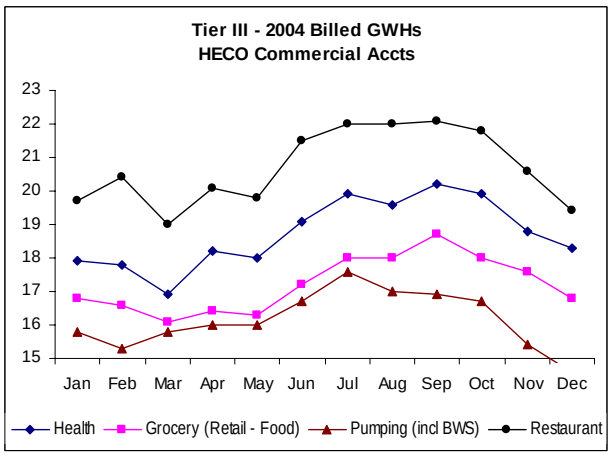
Daily temperature fluctuations

Intraday consumption patterns tend to follow temperature variations as well (not shown), in addition to occupancy patterns, which tend to peak during mid-day for commercial facilities.

[3]Without load factor data, RMI cannot estimate demand based on the monthly Gwh consumption data.







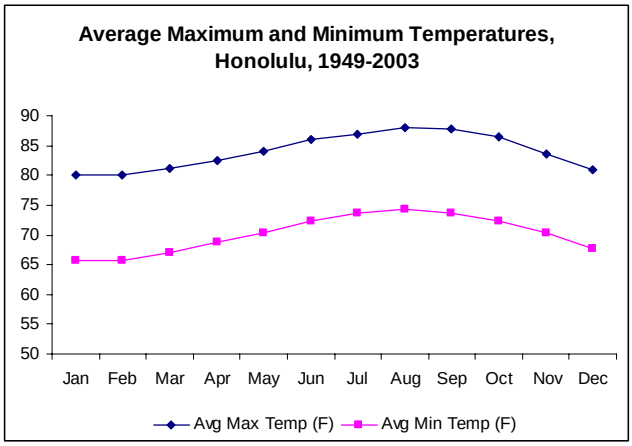


Figure 2-6
Monthly consumption, HECO commercial Accounts, 2004

Commercial Demand by End Use

The GEP study includes an analysis of demand by end use components of each commercial sector, shown in Table 2-2. An adaptation of GEP's end use demand to commercial sectors as

defined in HECO's interruptible load and standby generation potential study[4] is shown in Table 2-3.

Lighting

For five of the six most promising sectors (large offices, large hotels, retail, schools, and small office), lighting is by far the largest end use, comprising one-quarter to almost 100% of building end use. This lighting demand is significantly higher than the national average[5], which is reasonable considering Hawaii's mild climate. In terms of demand response, having such a large lighting load is also quite convenient, because next to cooling it is one of the most flexible and most targeted end uses of demand response. For lighting, there is a wide range of simple to sophisticated controls available to customers based on their motivation and budgets. Note that schools have zero heating and cooling and are almost entirely comprised of lighting.

Cooling

Cooling makes up the next largest single end use. With the exception of schools, cooling makes up one-fifth to one-third of total building loads.

Miscellaneous

Miscellaneous end uses make up 40%-50% of total loads in resorts and hotels. While resort and hotel operators are understandably concerned about effects of turning off equipment on their customers, we hypothesize there is a significant portion of loads in the miscellaneous category that are non-critical uses that can be flexed during a demand response event.

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[4] Hawaiian Electric Company (HECO). *Commercial and Industrial Standby Generation and Interruptible Load: A Site Survey of Large Customers*. July 8, 2003. Prepared by Market Research and Evaluation Division.

[5] e.g. compared to generic end use breakdown compiled by EPRI.

Table 2-2
End use breakdown of commercial sector, 2004

		Major End Uses (%) [1]					
Market Segment	**Total MW 2004**	**Cooling**	**Ventilation**	**Water Heating**	**Refrig-eration**	**Lighting**	**Misc.**
Other	241	17%	7%	1%	4%	42%	28%
Retail	124	19%	7%	1%	0%	52%	21%
Large Office	86	24%	14%	1%	0%	37%	23%
School	85	0%	0%	0%	0%	95%	5%
Small Office	83	33%	11%	1%	0%	45%	11%
Resort	78	27%	5%	3%	0%	26%	40%
Restaurant	59	8%	7%	2%	0%	8%	76%
Grocery	54	2%	7%	4%	41%	19%	28%
Hotel	38	18%	3%	3%	0%	21%	55%

[1] Source: Global Energy Partners, LLC (GEP). *Assessment of Energy Efficiency and Demand Response Potential: Volume 1 Report*. February 2004. HECO 2005 Rate Case Filling T-11 Exhibit 2 of 5 and Exhibit 3 of 5, docket no. 04-0113.

Hawaii's Unique Opportunities and Typical Challenges

HECO is in a position to take advantage of some unique opportunities and is likely to primarily face challenges typical to any demand response program.

Willingness to work alongside HECO

Customer surveys of interest in participating in demand response appear very positive.[6] Hawaii customers demonstrate a unique desire to collaborate with HECO and assist the utility during critical times of limited power supply. HECO's customers express a high degree of trust in and loyalty to HECO and willingness to cooperate through program participation. The generally good working relationships HECO has with its customers should allow HECO to roll out demand response without too much resistance or opposition.

Bill savings and avoidance of utility black outs appear to be the prime motivating factors for program participation. These responses are similar to customers surveyed elsewhere.

Common concerns about program parameters

Much like any other utility looking to implement a demand response program, HECO needs to address the technical details. Commercial customers have expressed the need for advanced notification of demand response events, outlining the frequency and duration of events, timing of

[6] Ward Research Incorporated. *Potential Participant Reactions to a Proposed Demand Response Program: A Qualitative Assessment*. Prepared for Hawaiian Electric Company. June 2003.

event, desire for favorable program incentives and fair penalties. These responses are similar to customers surveyed elsewhere. Customer participation levels will depend on how these guidelines are designed. All utilities interested in operating demand response must specify these parameters for its customers.

To flex or to interrupt?

Interviews with HECO representatives March 15-16 reveal that current utility focus for demand response is to locate customer loads that can be *interrupted*, or shut off during critical periods. With the exception of the GEP study,[7] HECO focused on assessments of interruptible loads for large customers and those customers with backup generators[8] that can transfer a portion of all facility loads (critical and non-critical) during demand response events, shown in Table 2-3. EPRI/RMI believes that HECO should include in its portfolio of commercial demand response programs, ones that ask customers to *flex* facility loads rather than shutting loads off. For example, this means changing temperature set points rather than directly cycling (or interrupting) HVAC systems in building or hotels. In load flexing the customer maintains greater control over the ambient building environment. While load flexing can be performed manually, it can also rely on use of equipment and building controls for both large and small customers. And is also more effective when it does rely on automated controls. HECO staff is currently experiencing challenges in leveraging existing controls in customers' facilities, let alone persuading customers to install more controls.

Assisting customers in enhancing their facilities' controls capabilities will need to be a primary goal for HECO in order to capture a larger share of demand response potential. Understandably, customers are concerned about the costs of retrofitting buildings with new controls. Subsequent reports will detail the costs and benefits of a variety of equipment-specific and whole facility controls. Included in this effort is defining what is "cost effective" level of investment in demand response. RMI will conduct an analysis of the value of demand response for HECO.

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[7] Global Energy Partners, LLC (GEP). *Assessment of Energy Efficiency and Demand Response Potential: Volume 1 Report*. February 2004. HECO 2005 Rate Case Filling T-11 Exhibit 2 of 5 and Exhibit 3 of 5, docket no. 04-0113.

[8] Hawaiian Electric Company (HECO). *Commercial and Industrial Standby Generation and Interruptible Load: A Site Survey of Large Customers*. July 8, 2003. Prepared by Market Research and Evaluation Division.

Table 2-3
Estimated Interruptible and Backup Generation potential for DR, 2002

					Major End Uses (%) [3]					
	Total MW 2002	# of Cust-omers	Potential Interruptible MW [1]	Potential Standby generation MW [1,2]	Cooling	Ventilation	Water Heating	Refrig-eration	Lighting	Misc.
Military	162.9	8	0	19.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other Commercial	109.5	223	13.9	14.5	17%	7%	1%	4%	42%	28%
Office	78.2	109	6.6	28.6	24%	14%	1%	0%	37%	23%
Hotel	62.8	60	4.6	14.7	23%	4%	3%	0%	23%	48%
Manufacturing	56.1	27	10.7	4.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
State/Local Government	48.3	15	5.4	7.2	24%	14%	1%	0%	37%	23%
Housing	47.5	99	4.5	9.7						
Retail/Non-food	41.0	64	4.9	3.9	19%	7%	1%	0%	52%	21%
Health	26.1	26	1.2	8.8						
Federal	6.9	5	1.9	2.7	24%	14%	1%	0%	37%	23%
Total	639.3	636	53.7	114.5						

[1] Source: HECO, 2003, Commercial and Industrial Standby Generation and Interruptible Load: A Site Survey of Large Customers

[2] 40-50% of estimated MW of standby generation would be available during the priority peak hours from 5 - 9 pm; 60-70% would be available during the daytime peak hours from 11 am to 2 pm.

[3] End uses adapted from: Global Energy Partners, LLC (GEP). *Assessment of Energy Efficiency and Demand Response Potential: Volume 1 Report*. February 2004. HECO 2005 Rate Case Filling T-11 Exhibit 2 of 5 and Exhibit 3 of 5, docket no. 04-0113.

HECO's estimate of flexible load is lower than we would expect based on analyses performed in other service territories. For example, office buildings can typically flex 15-20% of their total peak load, not 8%. Nonetheless, we will use the HECO figures for purposes of this study.

Designing DR program to meet customer and facility needs

Facility-specific characteristics cut across the traditional commercial sector segmentation. The GEP study of energy efficiency and demand response potential revealed that lighting, cooling, and miscellaneous loads are three primary end use targets for almost all commercial facility types. On a facility-by-facility basis, the ability to carry out demand response also depends on factors such as:

- existence of a facility manager with energy responsibilities or a dedicated energy manager;
- existence of energy controls (typically ranging from no building controls to advanced building controls costing <$400/kW) and the ability of facility personnel to operate the controls;

- level of operational risk if loads are interrupted or flexed; and
- cost of retrofitting a facility with new/additional demand responsive technology.

A facility-specific analysis can, thus, overlay the sector analysis, and may be organized according to Table 2-4. As HECO goes forward, they will have greater insight into which type of demand response program designs are better suited to which end uses, business types, and facility types.

Table 2-4
Facility characteristics relevant to designing commercial demand response programs

	Load reduction potential per customer	Energy Management	Control Technology & $/kW site cost	Unmitigated Operational Risk
1	>200 kW	Dedicated Energy Manager	Advanced Building Controls <$100/kW	<Medium
2	>200 kW	Facility Manager with Energy Responsibility	Standard Building Controls <$200/kW	<Medium
3	>150kW	Facility Manager with Energy Responsibility	Simple Building Controls <$400/kW	Low-Medium
4	Varies	Varies, likely none	Varies >$400kW	High
5	>100kW	Varies	None >$500kW	Low -Medium
6	<100 kW	Varies, likely none	Simple Building Controls <$400/kW	<Medium

3
ASSESS UTILITY EXPERIENCE WITH C&I LOAD CONTROL

High-level review of ongoing demand response programs, including DSM bidding approaches at other utilities will be done. Information provided below is on program qualification requirements (e.g. minimize size), enabling equipment (e.g. advanced metering, controls, or networks), type of incentive used (fixed or market based), program results (customers and MW) and any unique terms or conditions. We will gain an understanding of the utility cost to administer these programs.

Lessons Learned and Demand Response Program Options

Task 2 Deliverable

April 29, 2005
HECO

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RMI has nearly completed a 3-step analysis to scope a potential demand response program for HECO's C&I customers

HECO Customer Assessment

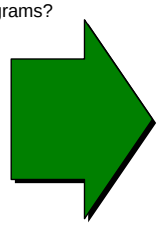
1) Who has peak coincident load that could be shed?
2) How much could be shed (and at what cost)?
3) What is the best way to segment C&I DR Programs?
4) Which customers should be targeted?

Review of Existing Demand Response Programs

1) What are the lessons learned from previous C&I programs?
2) Customer responses by type & end use?
3) Customer responses to program offerings?

DR Technology & Cost Review

1) What control technologies are available and what are their costs?
2) Which programs proved most cost effective?



Scope Potential C&I Demand Response Program

1) Which programs are cost effective for targeted customers?
2) Which DR programs are inappropriate for HECO?
3) How much potential value could be achieved?

Complete

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1

Agenda

I. Background Information and Best Practices

- Demand Response Programs
- Lessons Learned
- U.S. Program Profiles

II. Designing a Demand Response Program for HECO

- HECO Customer Base
- HECO Program Design
- Next Steps
- Appendix

Demand Response Program Types

Price Response

- Time of Use
- Dynamic Pricing
  - Real Time Pricing (RTP)
  - Critical Peak Pricing (CPP)
- Demand Bidding

Load Response

- Direct Load Control
- Curtailable Load
- Interruptible Load
- Scheduled Load

Demand Response Program Components

- Participation Criteria
  - Voluntary or mandatory
  - Customer eligibility
- Operations Criteria
  - Event trigger: reliability or economic
  - Utility or customer controlled load reductions
  - Advanced notification (e.g., 1 hour, 24-hours)
  - Enabling technology (e.g., smart thermostat, interval metering)
- Settlement Criteria
  - Structure of incentives and/or penalties
  - Baseline estimation
  - Billing system changes
  - Method of incentive disbursement and other financial arrangements

Different criteria trigger price and load response “events”

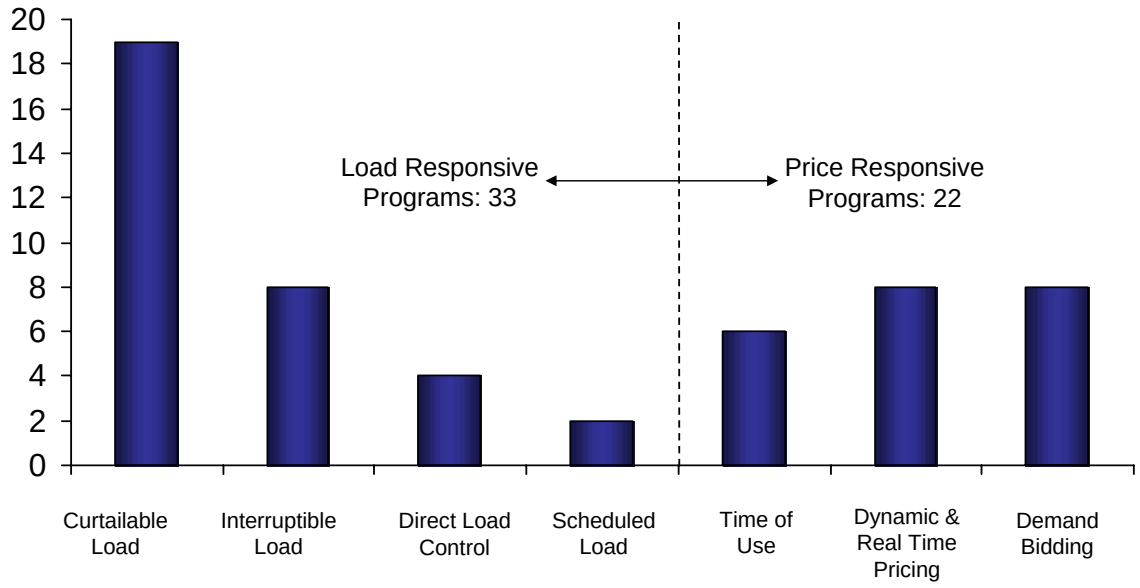
	Load Response	Price Response
Reliability*	Direct Load Control Curtailable Load Interruptible Load Scheduled Load	Demand Bidding Critical Peak Pricing
Market/ Economic**		Demand Bidding Time of Use Pricing Critical Peak Pricing Real Time Pricing

- **Reliability** - Demand response programs that operate in response to system contingencies. Usually utilized during emergency conditions, such as generator shortages, or when price levels are above allowable caps.

- **Market** - Demand response programs that are triggered by wholesale market prices. Demand bidding and Real Time Pricing programs may be part of a daily energy market.

Utilities do not preferentially implement one class of DR programs over another, though load responsive programs are slightly more common

Categorization of U.S. C&I Demand Response Programs



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Load Response
Program Overview

Load Response: Utilities offer customers payments for reducing their demand for electricity for specified periods of time. Program participants can be considered "sellers," since they provide load reductions in exchange for various prices offered by the utility.

Type of Program	Brief Definition	Party Controlling Reduction	Typical Target Size	Voluntary/ Mandatory (No Overrides)	Incentives	Advance Notification	Need Enabling Technology?	Billing System Change?	Settlement
Load Response									
Direct Load Control	End use loads turned off for limited periods of time	Provider/ Utility	<200 kW	M	$0.014-0.40/ton of cooling	None	Load switches, 2-way commu-nication (opt)	No	Fixed credit on monthly bill
Curtailable Load	End use loads reduced or turned off for limited periods of time	Provider/ Utility or Customer	>100 kW	M or V	$0.15-0.53/kWh	Minutes to Hours	Interval meters, 2-way commu-nication (opt)	No	Monthly bill adjustments, penalties for non-performance
Interruptible Load	All or major portions of customer total load turned off for periods of time	Provider/ Utility or Customer	≥1 MW	M	$7-45/kW	Minutes to Hours	Backup generator (opt)	No	Reflected on monthly bills. Penalty for non-performance
Scheduled Load	Load reductions scheduled or planned ahead of time between utility and customer	Customer	All	M	$0.10/kWh	Months – Contractual	No	No	Reflected on monthly bills. Penalty for non-performance

Load Response

Direct Load Control programs

- Typically mass market programs directed at residential and small commercial customers (<200 kW).
- Customer agrees to utility control of specific end uses (primarily central air compressors and lighting, but also water heating, heat pumps and swimming pool pumps).
- Greater assurance for utility that loads can be curtailed when needed
- Requires shorter notice (less than 1 hour)
- Relatively simple and inexpensive to implement
- Requires load control technology (two-way communication preferred)
- Utility-customer agreement must specify number of events per year and duration of events.
  - Typically a maximum of 20 events lasting a maximum of 6 hours per event; 4-hour events more common
- Providing an override option of DLC programs increases program participation. Commercial customers are more likely to override than residential customers.

Load Response
Curtailable and Interruptible programs

- For large (>400 kW) customers, **curtailable load programs** are the simplest load response programs to administer and achieve high participation rates
  - Program administrator and participant have simple agreement.
  - Program may or may not have penalties.
  - Utility must specify maximum number of events and durations within a period defined by season and hours of the day.
  - Requires interval metering for participants.
- **Interruptible load programs** generally target customers > 1 MW, but also work for smaller customers (e.g., SDG&E, SCE)
  - Customer receives lower electricity bill overall in exchange for interruption when called. Entire portions of facility are interrupted rather than specific end uses.
  - Contracts are binding and severe penalties are enforced.
  - Facilities generally called only in dire emergencies, but contract obligates availability at any time.
  - Use of backup and distributed generation common

Load Response
Use of Backup Generation and On Site Generation

- BUGs are eligible for both price and load responsive programs
  - BUGs may be implemented in other DR programs (e.g., interruptible load) or as a stand alone program.
  - Incentives are comparable whether BUGs are incorporated into other DR program or on its own.
- Minimum required reduction typically 100 kW, but a lower limit is possible. SDG&E's Rolling Blackout reduction program only requires 50kW or 15% of peak demand reduction for its participants.
- Transferring load to a BUG is not curtailing load. Back-up or customer generation is a load-shifting strategy.
- BUGs must comply with environmental and noise regulations.
- BUGs need to be "tested" on a monthly basis to ensure that they are reliable in the event of a real emergency.

Load Response
Benefits and Challenges of Backup Generators

Benefits

- Commercial and industrial customers are comfortable with BUGs because they offer a simple way to transfer load.
- Customers view on-site generation as having additional value beyond emergency backup:
  - Backup for life safety and security systems
  - Receive utility payments for using BUGs to cut peak load in demand response programs
  - Commands higher rents and lower tenant turnover; BUGs provide:
    - Reliability
    - Ability to provide "premium" power for technology intensive businesses

Challenges

- Outfitting BUGs to operate more hours can be complex. Increasing BUGs operating hours may require:
  - Greater maintenance and operation needs
  - Additional noise, vibration, and emissions controls
  - Addition of automatic transfer switches, controls, switchgear
- The savviest customers will acquire their own technical consultants; otherwise, utility assistance is needed

Price Response
Program Overview

Price Response Definition: Demand response programs in which customers voluntarily reduce their demand in response to economic signals.

Type of Program	Brief Definition	Party Controlling Reduction	Typical Target Size	Voluntary/ Mandatory (No Overrides)	Incentives	Advance Notification	Need Enabling Technology?	Billing System Change?	Settlement
Price Response									
Time of Use	Load management based on stepped rate structure including peak rate, off-peak rate, and sometimes should peak rate	Customer	All	M or V	5% bill reduction premium + payment per event	None	TOU meters, real time or prior day energy information via Internet	Yes, TOU/CP P rate structure	Monthly bill adjustments
Dynamic Pricing (Critical Peak or Real Time Price)	Load management based on dynamic tariff	Customer	All	V	Locational marginal price, $0.10/kWh	Day ahead	Interval meters, 2-way commun-ication, real time energy information via Internet	Yes, RTP or dynamic tariff	Monthly bill adjustments
Demand Bidding	1) Customers bid load reduction based on provider proposed price, or 2) customer bid load reduction at certain prices	Customer	All*	V	Locational marginal price, $0.15-0.50/kWh	Hours or Day ahead	Interval meters, web-based trading/market, spot price information via Internet	No	Separate payment based on bid price, additional reductions beyond bid paid locational marginal price

Price Response
Real Time Pricing

Real Time Pricing (RTP) programs provide customers with day-ahead hourly prices. Facility managers are free to maintain operations as planned or adjust operations to take advantage of higher or lower rates.

Advantages

- RTP is a tool to achieve demand reduction without bilateral contracts.
- RTP exposes customers to similar variations and volatility in market price signals that utilities and LSEs face.
- RTP is effective when customers can exercise the embedded option of on-site, back up generation or have made the investment to understand their load flexibility.

Disadvantages

- A handful of the largest customers have high price elasticity and account for most of the demand response, with a significant portion using back up generation.
- RTP is expensive to implement, particularly for utilities without the regulatory requirement for retail competition. Implementing RTP requires automated metering, sophisticated demand response technology, new operating systems, and billing system costs.

Price Response
Critical Peak Pricing (CPP)

- CPP is a rate that includes increased prices during limited hours (typically four) of limited days (10-20) each year and reduced prices during non-critical-peak periods.
- Price levels are established ahead of time and known. Customers are notified 24 hours in advance, and utilities call events based on forward-looking criteria affecting balance of generation supply and demand such as weather.
- Critical peak rate needs to be high enough to induce participant response, recommended ratio of 3:1 minimum between peak and critical peak price level
- Requires interval metering
- CPP can be a feasible compromise between time-of-use rates (TOU) and real-time rates.
  - CPP has a dynamic component where the timing of the critical peak price is unknown.
  - CPP can be added to either standard or TOU rates.
  - Applicable to both large and small commercial customers.
  - Can often induce significant additional reductions to customer peak load relative to standard or TOU rates.
- Does not guarantee that all participants will reduce their utility bill overall. Passive/indifferent participants, low consumption participants may actually see their bills *increase.*

Price Response
Demand Bidding Overview

	NYISO	PJM	ERCOT	PG&E, SCE, SDG&E
System Trigger*	Economic	Economic	Economic	Reliability
Price Signal	Market LMP**	Market LMP**	Market clearing price for energy/capacity	Day-ahead price >$0.15/kWh for 4 consecutive hours from noon-8 pm
Energy Acquisition (day ahead)	Open Market	Open Market	Bilateral contract with REP† or QSE ††	Open Market
Program Administrator	ISO	ISO	RTO	ISO + IOUs
Incentives/ Performance Payments	Higher of bid or LMP	If LMP <$75/MWh: day ahead LMP minus T&D charges If LMP >$75/MWh: LMP minus retail rate	Contract specific	Market +$0.10 until >$0.35, then market price
Penalties	Higher of day-ahead LMP or real-time price	LMP + balancing operating reserve charges	Contract specific	None: voluntary

*In an economic program, end-user reduces load because it costs less than buying energy from the utility.
In a reliability program, end-user reduces load to relieve generation and/or transmission/distribution capacity constraints

**LMP - Locational Marginal Price

† REP - Retail Electricity provider. Responsible for scheduling traditional generation for ERCOT

†† QSE - Qualified scheduling entity. Responsible for all financial settlements with ERCOT, including those supplied by REPs and involuntary customer load curtailments if REPs are short

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Demand Bidding program structure

- Demand bidding programs currently exist only in deregulated markets.
- Bids for load reduction are placed based on day-ahead or spot market prices.
- An ISO chooses between diverse generators of different fuel sources, heat rates, and committed load reductions to meet demand.
- Tends to attract the top one percent of utility accounts
  - Customers who can reduce 100 kW minimum
  - Requires interval data meter
  - Previous experience directly interacting with real-time power markets
  - Have sophisticated load management tools and strategies
- Requires intermediary between customer and ISO to place bids or “pool” smaller loads
- Binding contracts and penalties deter all but the most stalwart from participating.

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Lessons Learned
Customer Participation

Motivations to participate	Reasons for dropping out
▸ Monetary savings ▸ Avoidance of blackouts ▸ Sense of corporate responsibility ▸ Financial and technical assistance for installation of control technologies	▸ Inadequate incentives ▸ Unable to shift load within required time frame ▸ Delays in receiving incentive payments

- Accommodate small participants, since they represent a significant fraction or remaining market potential.
- Provide customers with a choice of programs, and allow them to participate in more than one.
- A lengthy enrollment process can be a barrier to participation.

Lessons Learned
Program Operations

- Design programs to fit customer needs and utility capabilities.
- Enable customer decision-making.
- Preferred mode of communication is email, followed by phone.
- Give customers more of the total system value (e.g., higher incentives) to induce higher levels of of total response and participation.
- With the exception of direct load control, participants need advance notice of DR events.
- Customer (and stakeholder) participation in program design is highly correlated to program success.
- Early program design and customer education greatly improve participation and results.
- Develop technical capabilities and relationships with customers for the long term.

Lessons Learned
Program Operations

- Lack of appropriate incentives can often be a barrier to program success
  - Price signals serve as incentives in and of themselves.
  - Pricing incentives allow for alignment of usage with cost by exposing customers to market prices.
  - Without regular participation payments, customer retention may be difficult if few curtailments are called.
  - Monetary incentives must be high enough to attract customer attention.
    - Primen study revealed 20 percent rate reduction elicits interest.
    - Balance incentive payment with utility value.
    - “Pay when called” policy can be too uncertain for customers planning their utility budgets.
    - Built in long-term agreements where customers are paid, at least in part for the option to call can encourage greater participation and investment by buyers and sellers.

Lessons Learned
Settlement Issues

- Well defined and executed utility back office processes are as important as program design itself:
  - Seamless integration of legacy programs and technologies
  - Integrated data collection, storage and transfer. Consolidated databases improve processing efficiencies.
  - Timely feedback of demand response performance and financial compensation (within 30 days is usually good).
- Back office issues that can raise program costs:
  - Inconsistent terminology used for classifying activation status
  - Lack of business protocols delineating staff responsibilities
  - Handling of customer inquiries and error
  - Incomplete customer information collection
  - Poor database management
- Standardized processes and automated software capability are key to back office success.

Lessons Learned
Settlement Issues

- Baseline Load is load that would have existed if there had been no reduction.
- Utilities must define a reliable baseline to allow proper comparison and compensation for load reductions.
- Consistent baseline estimation methods can encourage greater participation in demand response.
- Numerous baseline calculation methods exist, based on any number of the following criteria:
  - Simplicity and ease of use/understanding - transparency to utility and customer
  - Verifiability
  - Accuracy
  - Minimization of gaming
  - Ability to fairly handle weather-sensitive accounts
  - Ability to be known prior to customer commitment to a particular curtailment amount and event
  - Implementation costs for participant and operator

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Program Profile 1
Long Island Power Authority (LIPA) Edge Program for small commercial and residential customers

- LIPA serves nearly 1.1 million customers, with 967,600 residential and 115,200 commercial.
- Active since 2000, the program has been open to residential customers with central a/c and small commercial customers with less than 25 tons of central a/c. Customers with more than one central air conditioner may get more than one thermostat.
- 30 MW of curtailable load from 27,875 points of control
  - 21,624 residential a/c units
  - 3,064 commercial a/c units
  - 2,547 pool pumps
- Marketing channels: bill stuffers, dedicated web site, utility newsletter, and home show exhibits

Program Profile 1
Long Island Power Authority (LIPA) Edge Program for small commercial and residential customers

- Control technology offered free to participants and consists of:
  - Carrier Energy Management Interface (EMi)—programmable thermostat with two-way communications between utility and customer.
  - Itron Internet software allows customers to remotely program thermostat settings and utility interface for triggering curtailment events and specify curtailment criteria. Customers can also monitor facility temperature or HVAC equipment status via the LIPA sponsored Web site.
  - Skytel paging network for broadcasting individually addressed pages from the utility to the customer to initiate curtailments or status inquiries. LIPA has committed to underwrite the communications costs of providing customers with year-round Internet access to their thermostats, not just during the curtailment period.
  - Honeywell DMC – Recruit, train and supervise the locally hired installation crews.
  - Keyspan – Implements all program marketing and administration through contractual agreements with LIPA.

Program Profile 1
LIPA Edge Program

- Seven control scenarios during curtailment events managed by utility personnel:
  - On/off switch
  - 15-minute cycling and 30-minute cycling
  - 2ºF and 4ºF thermostat setback
  - Resending curtailment signal after hour 1 of event or after hour 2 of event
    - Found that many customers override without realizing they are in a curtailment event
    - Reduces override rate to 7%, significantly lower than the 20%-25% rate observed in similar programs elsewhere
    - Two-way communications system allows utility to monitor override activity.
- Events are triggered based on reliability criteria (when demand reaches within 300 MW of total available capacity).
- No more than seven events are called per year from June 1 through September 30. Events last two or four hours from 2pm to 6pm.
- Commercial participants are offered one-time participation payment of $75, but main attraction for participants was the Internet programmable thermostat technology.

Program Profile 1
LIPA Edge Program

- Extremely well received: oversubscribed at program inception with backlog of installation requests
- Marketed program as way to support for Long Island community as a whole rather than helping the utility specifically.
- Utility cost: $530 per point or about $120/kW installed cost. Total of four events are needed per year to recover cost over long term.
- Average load curtailed per unit averages 1.25 kW for commercial. Second point of control installed if commercial a/c unit exceeds 10 tons. Pool pumps average 2 kW reduction for 1-2 hp motor.
- Similar direct load control programs implemented elsewhere:
  - Florida Power and Light On Call for residential and commercial (1,000 MW callable in 2003)
  - Utah Power Cool Keeper for residential and small commercial
  - Southern California Edison Energy $mart thermostats for small commercial
- LIPA Edge contact: William (Bill) Jackson 516.222.7770

Program Profile 2
NYSERDA Energy $mart Peak Load Reduction Program

- Provides financial incentive for technologies installations to: mobilize DR capability; induce greater participation in NYISO's three DR programs; and increase curtailable load potential
  - Helps customers get "set up" so they can participate in NYISO DR programs
- Portfolio of various programs that combine efficiency with load management projects to capture both baseload and "callable" reductions:
  - Permanent Demand Reduction Effort (PDRE): efficient equipment replacements (lighting, motors, cooling systems) for long term demand reduction, minimum 20kW
  - Load Curtailment/Shifting (LC/S): identify and control discretionary loads for demand response (duty cycling, process shifting, lighting reductions)
  - Dispatchable Emergency Generator Initiative (DEGI): energy and environmental controls to improve operations and reliability of backup or distributed generators (switchgear, controls, test & tunes, dual fuel conversions).
  - Interval Meter (IM): required for LC/S or DEGI and participation in any of NYISO's DR program
- Financial incentives: 65% of project cost or incentive caps. Facility owner/operator must contribute no less than 35% of project cost (reduced from 70-30 in 2004).

Program Profile 2
NYSERDA Energy $mart Peak Load Reduction Program

PDRE		LC/S		DEGI	IM	
Con Edision Service Territory	Non-Con Edision Service Territory	Con Edision Service Territory	Non-Con Edision Service Territory	Con Edision Service Territory	Statewide PSC Approved	Statewide NYISO compliant
$475/kW	$225/kW	$180/kW 100% DLC	$40/kW 100% DLC	$120/kW DR $275/kW DG	$2,500 per meter	$1,200 per meters

Notes: [1] Incentives not to exceed 25 percent of program per contractor, 7 percent of program budget per facility. [2] Distributed generation projects not to exceed 20 percent of total program budget. [3] Direct Load Control (DLC) projects are reimbursed 100 percent or $180/kW in Con Edison territory if operable by April 28, 2006

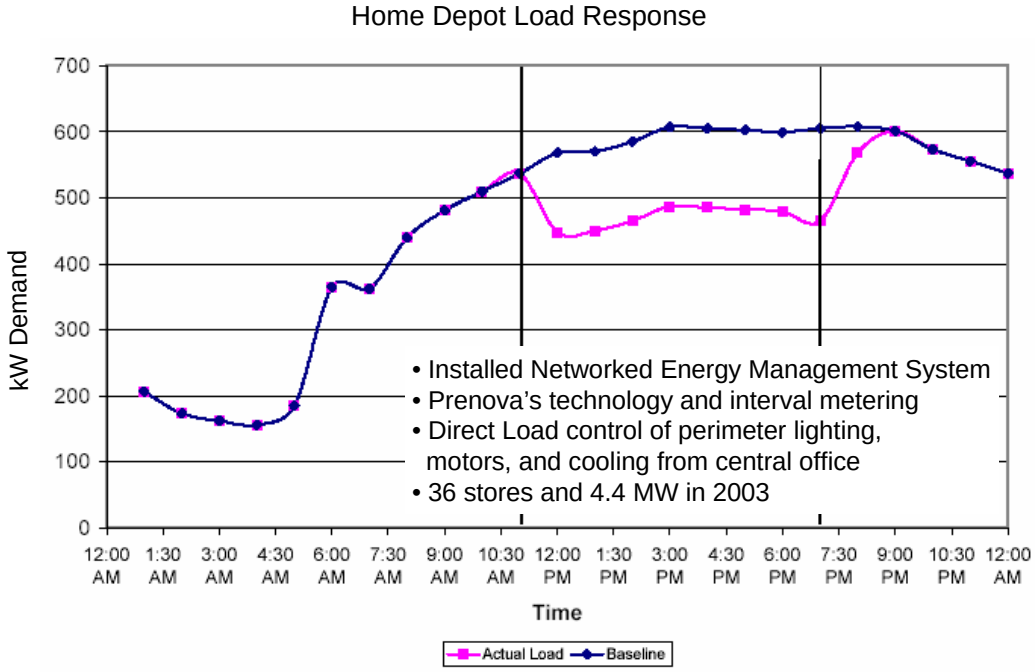
- LC/S partnership with NY retailers:
  - 36 Home Depot stores (4.4 MW)
  - 21 BJ' s Wholesale clubs (1MW)
  - 16 Stop & shop Markets (0.8 MW)
- Other projects:
  - LaFarge cement: $200,000 incentive confirmed curtailment capability of 22MW from central office
  - AT&T upgrades (new fuel injectors and turbo chargers) to 7 MW backup generator

Program Profile 2
NYSERDA Energy $mart Peak Load Reduction Program

- 2005 budget: $7.5 million
- Reduced/curtailable loads must occur between 11am and 6pm from May through October.
- Program procedure:
  - Customers/contractors propose projects, file application form along with estimate cost of implementation.
  - Independent consultant assigned to contractor reviews project and evaluates demand reduction resulting from project, works with contractor to submits Technical Assessment to NYSERDA.
  - If TA is approved, NYSERDA issues notice-to-proceed with project
  - Post installation site inspection, verification of load reduction
  - NYSERDA disburses incentives
- LC/S and DEGI customers receive additional incentives when successfully participate in events called by NYISO or Con Ed.
  - $11,000 per month participation incentive, $11.25/kW plus energy payment event incentive
- NYSERDA Program Contact: Chris Smith 518.862.1090 ext 3360

  Program application and forms: www.nyserda.org/funding/903pon.pdf

Program Profile 2
NYSERDA Energy $mart Peak Load Reduction Program



Program Profile 3
CEC Small C&I HVAC and Lighting Demand Response Program

- CEC sponsored program implemented December 2002 – March 2004
- Enhance curtailment capabilities: empower customers to reduce peak energy use when system reliability was threatened or when wholesale prices rose sharply
- Target: small commercial customers <200kW
  - Successful: National chain retail with central ownership (not franchises)
  - Unsuccessful: Municipal government
- Incentive: 75% of total installation cost plus $150 per kW demonstrated load reduction from 2:00pm - 6:00pm
- End use targets: lighting, HVAC, refrigeration, heat lamp, hot water controls
- Offered participants to choose from variety of vendors and technologies
  - Make sure vendors understood program
  - Make sure program staff understand their technology

Program Profile 3
CEC Small C&I HVAC and Lighting Demand Response Program

- Sales process: five stages
  - Target list of customers: databases
  - Awareness: mailings, website, conferences
  - Understanding: telephone calls, emails
  - Commitment: curtailment assessment
  - Decision: cost, incentive, payout, benefits
- Sales process: direct contact structure
  - Initial contact: visit
  - Assessment: eligibility criteria – hot, warm, cold
  - Intense follow through: hot prospects – identify and overcome barriers to decision-making
  - Periodic follow up: warm prospects – assess potential to become hot prospects

Program Profile 3
CEC Small C&I HVAC and Lighting Demand Response Program

- Value proposition:
  - Public spirit
  - Bill savings
  - Incentives
  - Revenue from load shedding
- National account energy managers very motivated but must overcome barriers:
  - Small C&I customers have diverse needs; program did not specify single type of technology or control system.
  - Tolerance for curtailment varies and is not well known.
  - Duration is more important than frequency.
  - Customers need to make the right choice to realize benefits every day.
  - Enterprise-wide energy management highly valued – provides centralized control in near-real time.

Program Profile 3
CEC Small C&I HVAC and Lighting Demand Response Program

- Technologies installed or upgraded:
  - Third party direct load controls
  - Customer controls, including enterprise-wide energy management systems
  - Energy information system
  - Notification service and ability to act on alerts

Systems Controlled	# Sites	% of Sites*
HVAC Only	80	8%
Lighting Only	39	4%
HVAC & Lighting Only	671	65%
Refrigeration plus other	22	2%
Heat Lamp plus other	22	2%
Hot Water plus other	225	22%

*Total is greater than 100% because refrigeration, heat lamp, and hot water use categories are not implemented exclusively

Program Profile 3
CEC Small C&I HVAC and Lighting Demand Response Program

- Results and Findings
  - 17 projects implemented by 14 customers at 1,037 sites
  - Demonstrated ability to curtail 23 kW per site
  - Total curtailment capability captured: 24,146 kW
  - Autozone, Petco, and Blockbuster collectively produced more than 50% curtailment for the program.
  - Virtually no complaints received from shoppers during all of the curtailments where lighting levels were reduced by 50% and interior temperatures increased by 2 to 8 degrees during four hour curtailment periods. Most of the retailers have shoppers who spend no more than 10 to 30 minutes in stores. Total installation costs varied from $75 to more than $500 per kW load curtailed.
  - Total program cost per kW curtailment was $241.
  - Overall, small C&I in CA can provide demand response resources at a cost of less than $350 per kW peak load reduction.

Program Profile 3
CEC Small C&I HVAC and Lighting Demand Response Program

Lighting Curtailment Test

Normal Operation | Curtailment

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Program Profile 4
CEC Enhanced Automation Education Campaign

- CEC funded program in 2002-2004 to increase penetration of DR capability.
- Program budget: $2 million
- Major program components:
  - Market research
  - Develop educational materials
  - Market and distribute the materials
  - Provide technical assistance
- Target segment: >200 kW
- Target end uses: HVAC and lighting controls, EMS, EIS
- Campaign approach:
  - Shift from short-term focus on DR strategies to long-term focus on DR capabilities.
  - Integrate DR with energy efficiency: customers do not distinguish between the two.
  - Promote energy and non-energy benefits.

Program Profile 4
CEC Enhanced Automation Education Campaign

- Initial market research revealed that:
  - DR activities tend to rely on manual processes
  - Very little investment in improving building automation and controls
  - Most EMSs are underutilized (capabilities not programmed, too much data and not enough information)
  - Concerns about: financial viability, occupant comfort, internal organization barriers
- Barriers to investing in DR capability:
  - High information search costs
  - High transaction costs (especially for manual processes)
  - DR programs unstable
  - Lack of perceived emergency
  - Insulation from real-time market prices

Program Profile 4
CEC Enhanced Automation Education Campaign

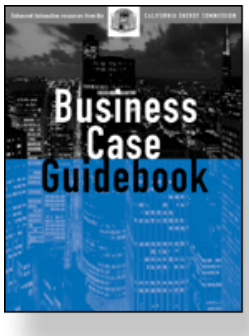
1. Awareness

Brochure

2. Interest

Case Studies

3. Intent



Financial Decision makers: Economic costs and benefits of investing in building automation

4. Implementation

Facilities Operators and Managers: Examine EA technologies and system options

http://www.consumerenergycenter.com/enhancedautomation/

Program profile 4
CEC Enhanced Automation Education Campaign

- Marketing and distribution

	Distribution Method				
Marketing Materials	Direct Mail	Utilities	Others (e.g. vendors)	Website	Cum. Total
Brochure and/or case studies	3233	1427	959	n.a.	5619
BC or TO Guidebook	3	752	797	n.a.	1546

- Phase I
  - Over 1,500 EA packets and guidebooks distributed to customers through utilities.
- Phase II
  - Direct mail campaign targeted 3,233 individuals representing 1,658 businesses across the state.
  - Brochure and one case study sent to both facility managers and financial managers.

Program Profile 4
CEC Enhanced Automation Education Campaign

- Technical Assistance (TA) services
  - EA component added to Building Operator Certification Program (Level I courses)
  - Detailed Design Assistance (targeted at >1MW, reached 2 customers)
  - Peak Load Reduction Assessments
- Levels of TA provided
  - Tier 1: Telephone consultation on response strategies
    - Most often sufficient for customers <1MW
  - Tier 2: Half-day on-site consulting visit
  - Tier 3: Two-day on-site assessment - 1 day on site, 1 day to write report
    - Needed for largest customers due to size of facilities and complexity of systems
- Most customers who requested TA already had ideas about what they could do to reduce demand, but did not know what kind of demand savings were possible.
- Interest driven by CPP tariffs recently instituted in state

Program Profile 4
CEC Enhanced Automation Education Campaign

- Marketing results
  - 37 percent of customers (>200 kW) aware of EA campaign.
  - 6 percent recall receiving materials or service from EA campaign.
  - 36 percent of those who recall receiving materials claimed EA influenced them to take action or make automation improvements. This equates to 2 percent of all survey respondents or over 500 customers (>200 kW) across the state.

- Technical Assistance (TA) results
  - 63 medium-sized customers (200 kW-500 kW) contacted the program for TA. Consultations were provided to 53 customers, with 10 customers ultimately declining service.
    - Customers were more interested in the technical consultations than larger customers.
    - Customers do not necessarily have relationships with vendors or utilities.
    - Customers particularly appreciated information on equipment load impacts and savings estimates.
  - Larger customers (>1 MW) were more interested in using their own consulting or in-house resources for TA. Some were skeptical and impatient with offerings and results.
    - These customers are more likely to pursue EA projects on their own.

Agenda

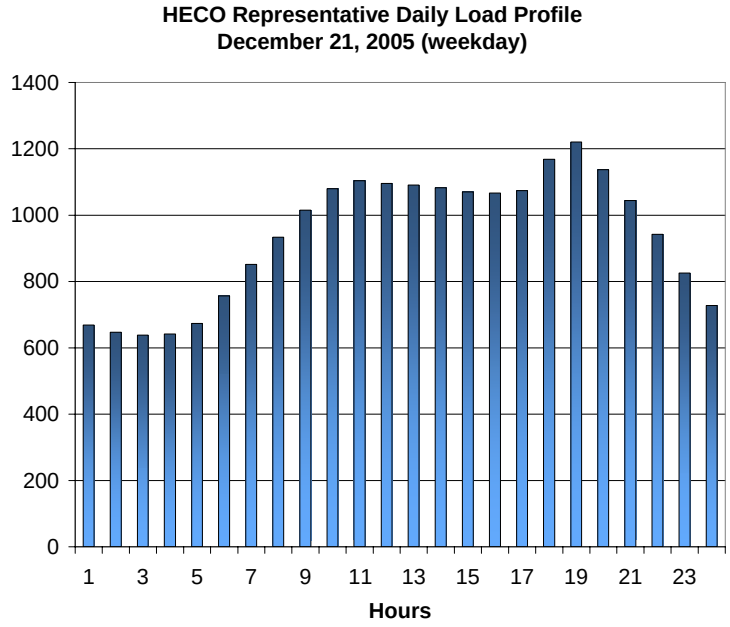
I. Background Information and Best Practices

- Demand Response Programs
- Lessons Learned
- U.S. Program Profiles

II. Designing a Demand Response Program for HECO

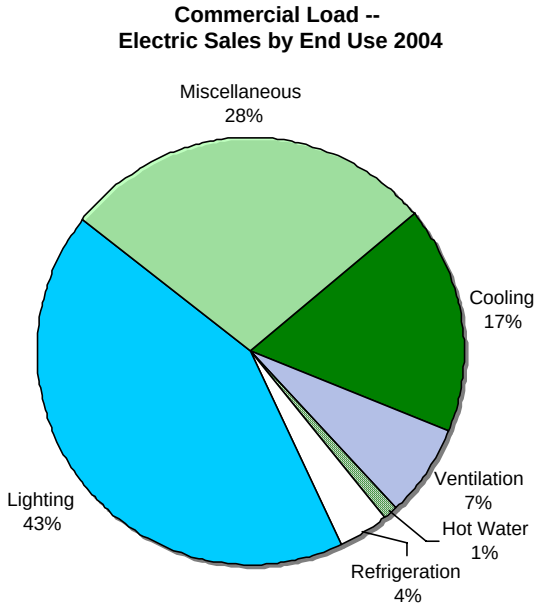
- HECO Customer Base
- HECO Program Design
- Next Steps
- Appendix

Residential load drives system peak in the near term, but could shift to a commercially-driven daytime peak if ongoing efficiency efforts succeed



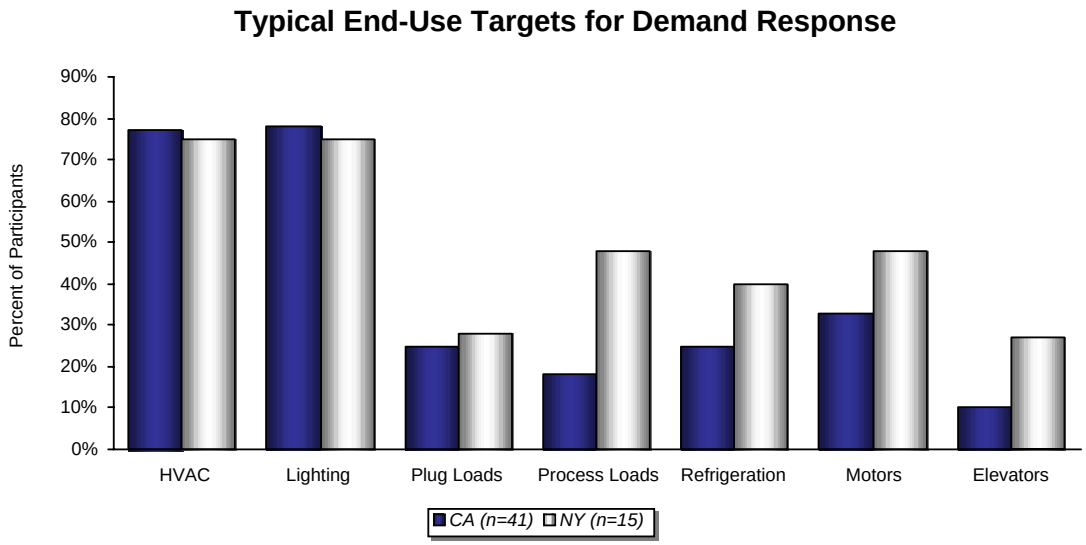
Source: Draft 2002 Sales and Load Forecast

In HECO's service territory, lighting and HVAC loads drive commercial peak demand



Source: Global Energy Partners, LLC (GEP). Assessment of Energy Efficiency and Demand Response Potential: Volume I Report. February 2004. HECO 2005 Rate Case Filing T-11 Exhibit 2 of 5, p. 69.

This is helpful, since HVAC and lighting are the usual targets of demand response



Source: Goldman, Charles, M. Kintner-Meyer, and G. Heffner. Do "Enabling Technologies" Affect Customer Performance in Price-Responsive Load Programs? Environmental Technologies Division, Lawrence Berkeley National Laboratory

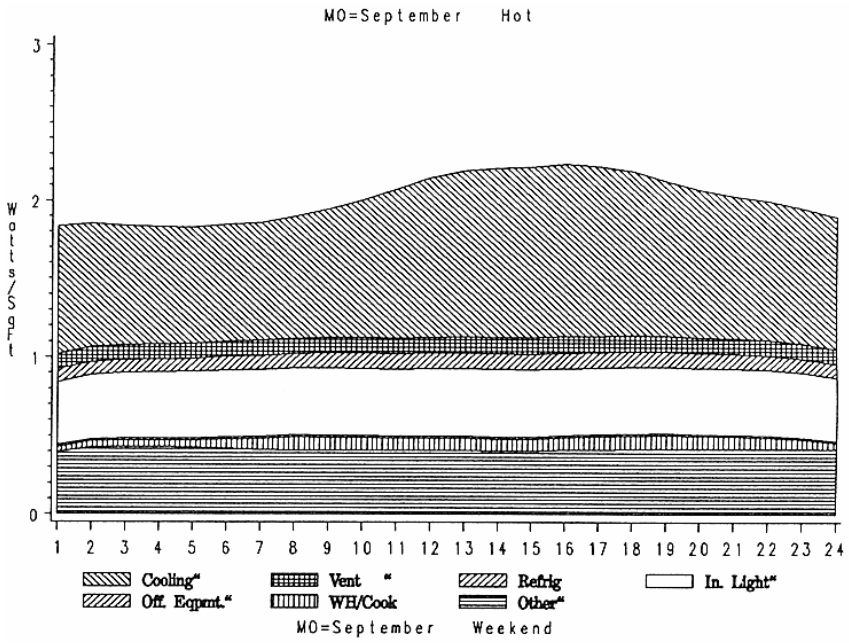
HECO could achieve 100 MW of demand reduction in the long term, based on conservative estimates

Maximum Potential C&I Demand Reduction

End Use	Total MW[1]	Technical Potential [2]	Market Acceptance Ratio [3]	Load Reduction Range (MW)
Lighting	359	10%	20%	7
Cooling	146	14%	20%	4
Miscellaneous/ Pumping	239	10%	20%	5
Interruptible Load[4]	54	100%	50% [4]	27
Back-Up Generation[4]	115	100%	50% [4]	57
Total	**904**			**100**

[1]Source: Global Energy Partners, LLC (GEP). Assessment of Energy Efficiency and Demand Response Potential: Volume I Report. February 2004. HECO 2005 Rate Case Filing T-11 Exhibit 2 of 5, Table 4-14. p. 69.
[2] Source: Global Energy Partners, LLC (GEP). Assessment of Energy Efficiency and Demand Response Potential: Volume I Report. February 2004. HECO 2005 Rate Case Filing T-11 Exhibit 3 of 5, Section 7.1.2. p. 7
[3] ibid., section 7.1.3 p.8
[4]Source: HECO 2003 Commercial and Industrial Standby Generation and Interruptible Load: A Site Survey of Large Customers.

Hotels exhibit relatively flat loads, largely driven by cooling



- Cooling drives an early evening peak at hotels that closely coincides with HECO's current system peak
- The hotel sector load shape is relatively flat, indicating underused areas of the property that could be targeted for load reduction throughout the day.

Source: *HECO, 1994 Commercial Energy-Use Survey*

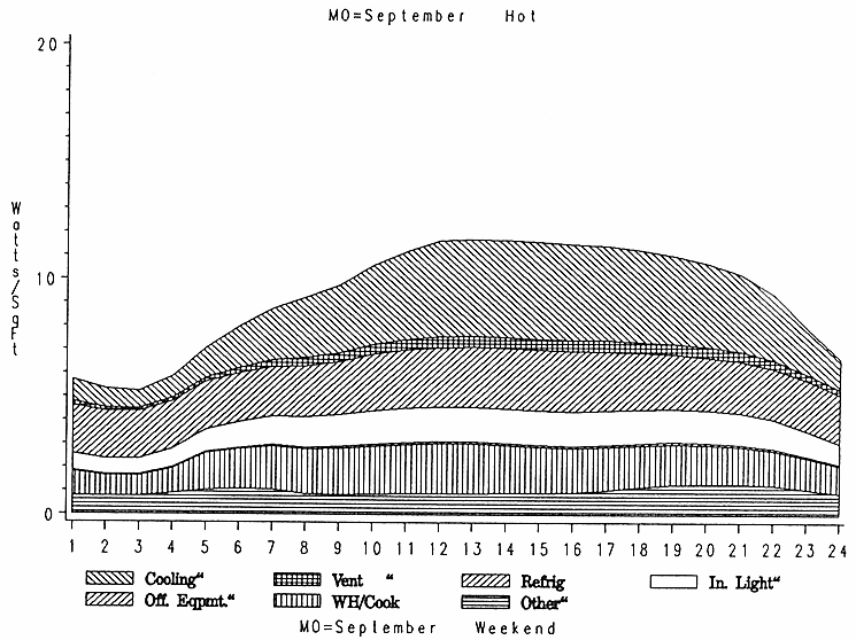
Hotels should segment among business units to capture a greater portion of their demand response potential

- Shopping areas offer a limited opportunity in light of the predominance of “shoppers” vs. “buyers,” where changes in indoor lighting and climate could negatively impact longer visits.
- Hotel rooms and ancillary areas are prime candidates for demand response if controllable through a central EMS.
  - Retrofits are a reasonable proposition in lodging through installation of smart thermostats and occupancy sensors to reduce cooling and lighting loads in unoccupied rooms.
- Miscellaneous loads in common areas (e.g., elevators/escalators, fountains, outdoor signage, exhibits lighting, pool lighting/pumps) can provide additional opportunities.
- Conference rooms and convention space are good targets for demand response:
  - Energy managers can coordinate with booking and event scheduling to pre-cool meeting areas in anticipation of use.

Demand response strategies for multi-residential facilities will resemble hotel strategies

- Multi-residential facilities have a similar load profile to the hotel sector, although the evening peak is delayed (7pm -10pm).
- End uses in individual units within apartment buildings are occupant controlled. This is similar to residential customers and should be treated as such in demand response programs (e.g. smart thermostats).
- Hotels have a central reservation system; apartment building managers do not. Hotels can alter individual room temperature loads more easily as part of a demand response event.
- End uses in common areas within apartment buildings are centrally controlled and better candidates as commercial demand response.

Restaurants also exhibit low daily fluctuation, providing good opportunities for coincident peak reductions

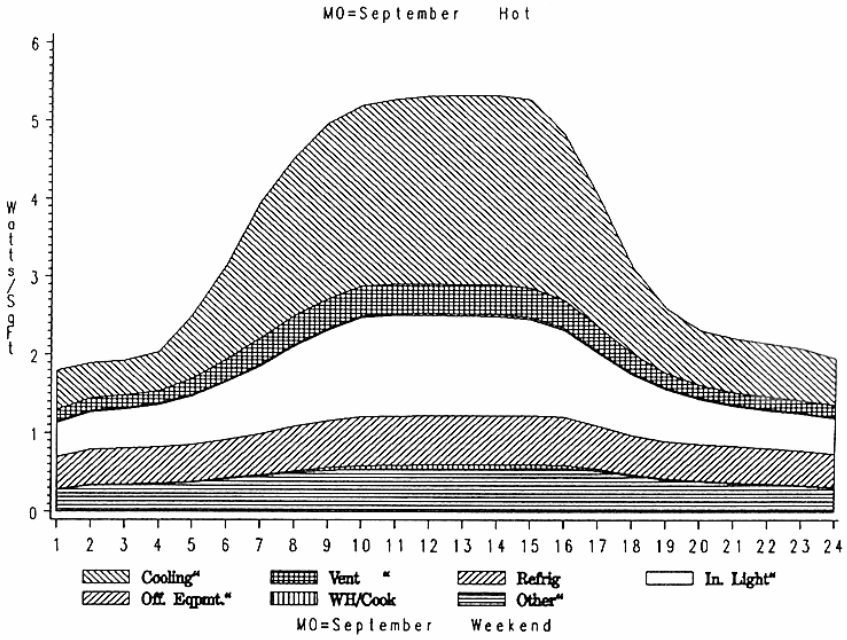


- Restaurants are the most energy intensive of all segments studied (>10 Watts/ft^2).
- Restaurant load is driven by cooking demand and is highly dependent upon patron volume.
- While most cooking loads probably cannot be shifted or curtailed, heat lamps and other "food warming" equipment can be turned down/off during slow midday hours.
- Lighting and HVAC loads can be more easily adjusted. Raising indoor temperatures a few degrees could actually enhance comfort for some customers.

Source: *HECO, 1994 Commercial Energy-Use Survey*

Offices loads do not coincide with current system peak, but offer promising demand response if system peak shifts to daytime hours

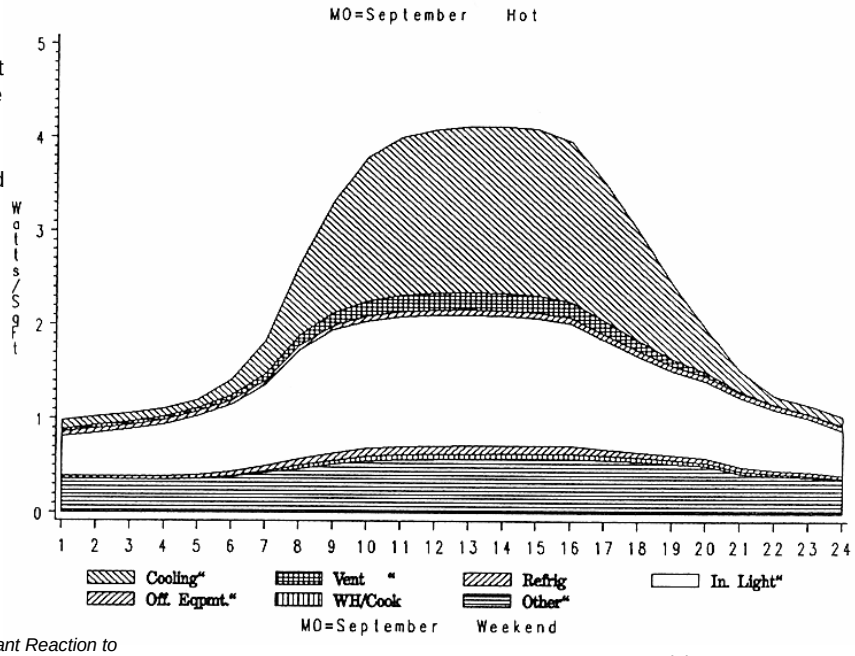
- Lighting and HVAC and other end uses offer promising demand reduction potential
- Slight adjustments in lighting and temperature set points should not negatively impact employee productivity.
- Offices could employ basic controls relatively easily or more sophisticated enhanced automation technologies to curtail these loads, but will likely need utility assistance to implement.



Source: *HECO, 1994 Commercial Energy-Use Survey*

Retail operations also exhibit considerable lighting and cooling loads primarily during the day

- Though some retailers have expressed concerns that load interruption could negatively impact business,[1] RMI believes there are untapped opportunities.
  - Curtailable loads (e.g., adjust temperature set points, selected lighting units)
  - Non-retail space (e.g., storage areas)
  - Important to distinguish between shoppers who linger in a store and buyers who enter and exit quickly
- National chain retail should be relatively easy to tap.
  - Some companies already participate in DR programs elsewhere
  - Centralized management lower implementation costs



[1] Ward Research Inc., 2003, *Potential Participant Reaction to a Demand Response Program.*

Source: *HECO, 1994 Commercial Energy-Use Survey*

Military facilities remain an untapped opportunity for demand response

- Military sector represents more than 25 percent of HECO's commercial customer load.
- Good working relationship with HECO and seem interested in doing more
- Examples of demand response participation in California and Oregon
- May prefer using backup generation for demand response
- Military has traditionally focused on energy efficiency. Many campuses, however, are installing central energy management systems, which can be used for demand response as well as energy efficiency.
- Bureaucratic barriers (e.g., procurement and regulations) may hinder efforts to implement demand response.

Source: *HECO, 1994 Commercial Energy-Use Survey*
Note: Does not include UH

Opportunities exist in all of these market segments

Short Term

- Hotels
- Multi-residential
- Restaurants
- Military

Medium Term

- Retail
- Offices

The challenge will be determining what program design can take advantage of the existing opportunities most cost effectively.

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HECO Program Design
Barriers to Implementation

- HECO's commercial customers have expressed issues common to most demand response participants:
  - Uncertain about the amount of load available for reduction
  - Lack of knowledge/capability to reduce loads when called
  - Desire for advance notification of demand response events
  - Potential for negative impacts on patrons and business operational costs
- HECO faces implementation issues common to all U.S. utilities:
  - Balancing level of incentives paid out with system value captured
  - Balancing highly specialized and mass market programs to capture both the largest customers (~1% of total) who drive system demand down to the smallest customers

HECO Program Design
Advance Notification

- HECO customers have expressed a desire to maintain control over their loads.
  - Give C&I customers enough advance notice to decide for themselves which loads are appropriate to curtail.
- Utilities elsewhere use various criteria to determine on a forward-looking basis when capacity will be short in absence of real-time markets:
  - Weather forecast: HECO loads also correlate well with outside temperature
  - Preemptive: when demand approaches X% of existing capacity

Demand Response
Program design influences achievable load reductions

- Price response can, in theory, elicit greater load reductions than load response, because customers are exposed to market prices. Empirical evidence, however, is inconclusive.
- Evidence is clear that sustained TOU prices do create a conservation effect, but a stronger price signal is needed to achieve demand response.
- However, the cost/complexity of DR programs rapidly increases with pricing precision. It is unclear if additional value from RTP justifies the cost…yet.
- Empirical research reveals that average load curtailments achieved for reliability-based programs are higher than those achieved for market or economic-based programs.
  - Actual load curtailed for reliability-based program was 53% of committed curtailable load.
  - Actual load curtailed for economic-based programs was 10% of committed curtailable load.
  - Why?
    - Participants' aversion to paying penalties for non-compliance in reliability program may lead to over-compliance.
    - Programs where customers do not commit to a specified amount of reduction per event result in lower actual reductions during the event.
    - Wholesale electricity prices are the primary incentive in economic based programs and may not always be high enough to induce curtailment.

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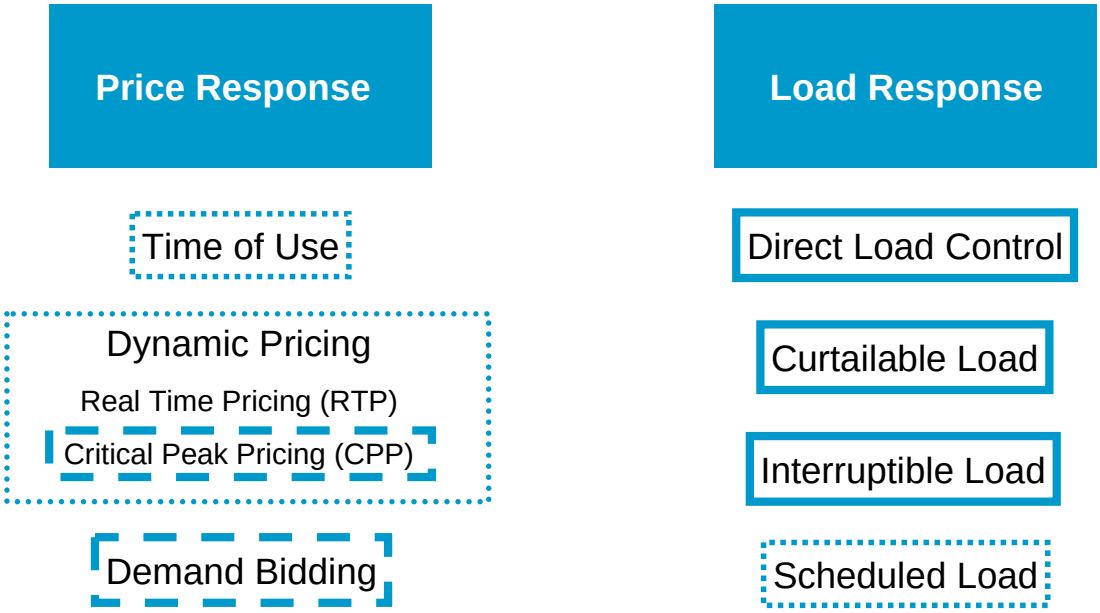
HECO Program Design
Candidate Demand Response Programs



Program Options

HECO can achieve greater results by tailoring programs to match customer characteristics

Program Type	Targeted End-uses	Targeted Sector	Facility Characteristics
Load Response: Direct Load Control	HVAC Lighting	Small C&I (<200 kW)	<100 kW/episode; simple building controls costing <$400/kW; low-medium operational risk
Load Response: Curtailable	Flexible Building Loads (e.g., Lighting, HVAC, Pumps, Other)	Medium & Large C&I (>200 kW)	>100 kW/episode; facility manager with energy responsibility or dedicated energy manager; simple to advanced building controls costing <$400/kW for some and <100/kW for others; low to medium operational risk
Load Response: Interruptible		Customers with backup and distributed generation	>150 kW/episode; facility manager with energy responsibility or dedicated energy manager; simple to advanced building controls costing <$400/kW for some and <100/kW for others; low to medium operational risk
Price Response: Critical Peak Pricing Demand Bidding (modified)	Flexible Building Loads (e.g., Lighting, HVAC, Pumps, Other) Backup generation	Medium & Large C&I (>200 kW)	> 200 kW/episode; dedicated energy manager; advanced building controls costing <$100/kW; <medium operational risk

HECO Program Design

A straightforward reliability based load response program may work best for most of HECO's potential DR participants

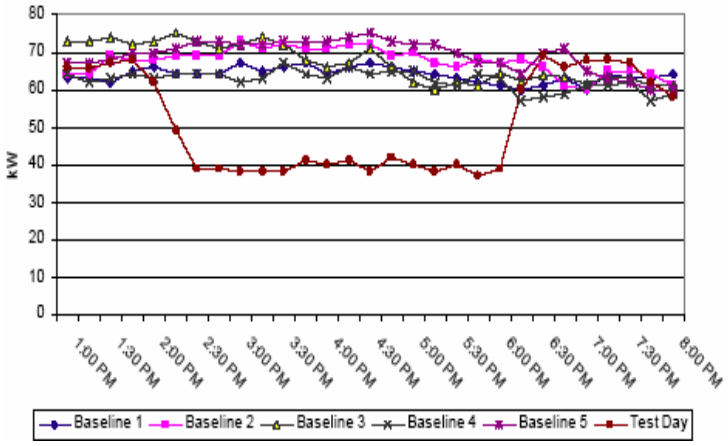
- Load response programs may offer a greater chance of early success.
  - The majority of load response programs (direct load control, curtailable, interruptible) are system reliability triggered and tend to be easier to administer than price response programs.
  - Requires less capital investment in technology
  - Early success could gain buy in and support from customers for later programs (e.g., price response).
- HECO's existing CIDLC is used for emergency or un-predictable events, and there is value in keeping this type of program.
  - Automatically curtails customer loads upon detection of system under-frequency
  - Aimed at large customers (closely resembles an interruptible load program)

HECO Program Design

Direct load control is most appropriate for small commercial customers who can provide meaningful load response

- California experience suggests HVAC control is possible for SME retail facilities <200 kW.
  - Load reduction of 30-36 kW per customer is possible.
- HECO should consider two-way communication to capture full program value.
  - Internal feedback allows facility managers to keep building operations within acceptable operating range.
  - Instantaneous measurement and verification allows HECO to monitor the demand response event.

Pilot Test Load Data for Small & Medium Enterprise Load Response



Source: California Energy Commission, Small C&I HVAC and Lighting Demand Response Program, Final report. March 1, 2004

For curtailable and/or interruptible programs, HECO could consider three options for customers with backup generation

- Option I: Customers run generators in islanding mode; no new equipment investments
  - During blackout or imminent blackout, customers disconnect from the grid and switch on backup generators
  - Likely an existing capability; some customers will already have UPS for ride through, others without UPS will switch less smoothly
  - Customers receive an interruptible rate or bid in demand bidding.
- Option II: Customers run generators in islanding mode; some customers make new equipment investments
  - During blackout or imminent blackout, customers disconnect from the grid and switch on backup generators.
  - Some customers may be interested in installing UPS or related equipment.
  - HECO could cover all or a percentage of the capital cost of minimum equipment additions as a program incentive.

For curtailable and/or interruptible programs, HECO could consider three options for customers with backup generation

- Option III: Operate BUG in parallel with utility generator, supplying additional capacity to the grid.
  - Substantial investments in additional equipment are needed (e.g., automatic transfer switches, controls, additional safety equipment).
  - Assumes HECO needs the additional capacity enough to help customers make the necessary equipment investments.
  - Assumes backup generation capacity is greater than customer load.
  - Assumes customer pays monthly fee for HECO to own, operate, and maintain customer BUG.
- Some utilities (e.g., Progress Energy of the Carolinas and Florida) help customers bear the burden of making these decisions by owning and operating customers' distributed generation, UPS, and related equipment as the incentive for DR program.

HECO Program Design
Regulation of Backup Generation in Hawaii

- Emergency backup generators in Hawaii do not have an hourly operating limit, but generators can only be used for maintenance or during blackouts.
- Air Pollution:
  - Hawaii is a National Ambient Air Quality Standards (NAAQS) attainment area; the state has historically met all Federal and State ambient air quality standards.
  - Emergency generators are exempt from Air Quality standards, as long as they do not need a major source review (based on their potential to emit when operating 500 hours/ year).
- Noise Control:
  - Hawaii exempts BUGs installed and used as required and necessary for the protection of public health and safety, provided the best available noise control technology is implemented.
  - Best available control technologies (BACT) are determined by the director on a case-by-case basis, taking into consideration environmental and economic impacts.
- HECO could lower customer and utility transaction costs and facilitate use of backup generators by:
  - Requesting that the Department of Health extend the definition of “blackouts” to explicitly allow use of backup generators to *preempt* blackouts;
  - Working with customers to comply with State BACT requirements; and
  - Educating customers that utility will limit requests to <~200 hours per year.

HECO Program Design

Price response programs would only appeal to large customers >400 kW with dedicated energy managers and advanced building controls

- RTP and market based demand bidding are inapplicable for HECO, because there is neither a power market and energy production costs do not vary significantly between peak and off peak periods
- A CPP price would have to be based on the avoided generation (and grid) capacity costs during peak demand.
  - CPP rates instituted elsewhere assign a 3:1 price differential between critical peak and peak hours and a 2:1 or 3:1 price differential between peak and off-peak hours.
  - We would like to work with HECO to determine whether this would create enough of a price spread to engender a response.
- Demand bidding is similarly constrained to the same economic signals, but has more customer appeal because of its voluntary nature.
  - Realistically, only large loads (accounts >500 kW of DR) would bid into such a program, since the customer would receive ~ $4,000/action, or $32,500/yr (assuming 8 bids).*
  - Day ahead programs would provide the lead time necessary for C&I customers to adjust their major operations or prepare generation units.

*Also assumes 500 kW reduction per event, avoided capacity cost of $667/kW in 2005 dollars, that the utility pays 75% of marginal capacity value, and 13% CPP.

HECO Program Design

Expanding DR in Hawaii will require successful deployment of control technologies in more customer facilities

- Demand responsive technologies give customers greater control over their own loads.
- Customers do not currently perceive a power crisis. Thus, the barriers to installing more enabling technologies will be relatively higher than elsewhere.
- Businesses will need a turnkey approach to technology installation to capture greater share of load response market. HECO will need to lead this effort.
- We suggest an *integrated package of services* in the manner of CEC's Enhanced Automation campaign.
  - Need to take customers through the stages of technology implementation: awareness, interest, commitment, implementation.
  - This will require coordinated assistance including: marketing/education, technical assistance, financial assistance, and brokerage/mediation assistance, particularly for medium-sized customers (i.e., locate and hire contractors).
  - Effort needs to be on several fronts, targeting both financial decision makers and facility managers at multiple levels of management.

Agenda

I. Background Information and Best Practices

- Demand Response Programs
- Lessons Learned
- U.S. Program Profiles

II. Designing a Demand Response Program for HECO

- HECO Customer Base
- HECO Program Design
- Next Steps
- Appendix

RMI will now take the final steps to scope potential demand response programs for HECO's C&I customers

HECO Customer Assessment

1) Who has peak coincident load that could be shed?
2) How much could be shed (and at what cost)?
3) What is the best way to segment C&I DR Programs?
4) Which customers should be targeted?

Review of Existing Demand Response Programs

1) What are the lessons learned from previous C&I programs?
2) Customer responses by type & end use?
3) Customer responses to program offerings?

DR Technology & Cost Review

1) What control technologies are available and what are their costs?
2) Which programs proved most cost effective?

Scope Potential C&I Demand Response Program

1) Which programs are cost effective for targeted customers?
2) Which DR programs are inappropriate for HECO?
3) How much potential value could be achieved?

Complete

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Next Steps
Scope potential C&I demand response programs for HECO

- RMI will narrow our focus to the following programs:
  - Direct Load Control for small customers
  - Curtailable Load for medium customers

- For each program, we will analyze:
  - Overall economics
  - Incentive structures
  - Technology options
  - Value to the system

Agenda

I. Background Information and Best Practices

- Demand Response Programs
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II. Designing a Demand Response Program for HECO

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- Appendix

APPENDIX—Demand Response Program Definitions

1. Direct Load Control (DLC) – This type of program interrupts consumer power supply through direct control by the utility or system operator. This usually involves customers who have equipment that can be turned off or cycled off during peak demand periods, such as air conditioners, water heaters, and pool pumps during the summer months. The utility will shut or cycle off such equipment for a limited number of hours on a limited number of occasions. These programs allow for the smallest cutomers to participate, those with total demands of <100 kW. Load reductions are on the order of 1 kW-50kW. Typically, receiver systems are installed on the customer equipment to allow communications from the utility and the equipment controls.
2. Interruptible Load – This type of program allows the supplying system's operator, utility, or participant (from communication with the system operator or utility) to directly interrupt large load operations under contractual provisions during times of peak load. This program typically targets commercial and industrial customers who have large load operations. Participating customers will often receive permanent discounts on their electric bills. Common customers using such programs are those with operations in refining, melting, manufacturing, mining, food processing, and water treatment. Once a customer enrolls in this type of program, compliance is generally mandatory. If a customer fails to comply, severe penalties are often enforced.
3. Curtailable Load – This type of program is very similar to the Interruptible Load program but allows customers with smaller loads to participate. The main differences are the smaller loads, the participant controls the load reduction, and penalties for non-compliance are much smaller. In order to qualify for this program, a customer typically must be able to meet a minimum load reduction between 50 kW and 200 kW and maximum of 500 to 1,000 kW. Most curtailment programs are mandatory once a customer enrolls in the program but the load reduction is usually restricted to certain days at certain times
4. Scheduled Load Reduction – This type of program offers bill credits to participants for reducing power by a pre-set amount regardless of whether there is an electricity shortage. This allows the participant to plan cutbacks on pre-determined summer days
5. Time-of-Use (TOU) – This type of program offers pricing options based on the time the electricity is being used. Time-of-use pricing more closely reflects the utility cost structure where rates are higher during peak periods and lower during off-peak periods. Some programs offer numerous time-of-use pricing schemes besides the typical on- and off-peak prices. TOU programs have been successful in promoting the use of load shifting technologies such as cool storage with ice or water, an option that may be quite viable for participants with high cooling loads. Advanced metering equipment is typically needed.
6. Real-Time Pricing – This type of program takes the time-of-use program one step further by offering real-time pricing in which prices vary hour by hour. Real-time pricing meters that record a customer's electricity consumption at hourly intervals and a pricing system is required. This program gives customers an incentive to use less energy during peak periods, which correlate to higher prices.
7. Demand Bidding – This type of program allows a customer to propose load reductions at certain times and prices throughout the day. Generally, participants need to have the ability to reduce their load by at least 100 kW during specified time periods.

APPENDIX
Backup generation and on site generation programs

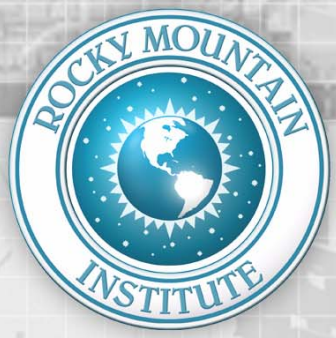
- Some Load Response Programs allowing BUG
  - SDG&E: Interruptible Load Rate: SDG&E allows customers who have their own self-generation to participate in the interruptible load rate with no minimum reduction requirements.
  - SDG&E: Rolling Blackout reduction program: Provides utility customers with a method to reduce the severity of rotating outages by using their emergency BUG.
  - Anaheim Public Utilities: City Load Reduction: Anaheim identified key City facilities and installed or modified emergency BUG.
  - NYSERDA: Dispatchable Emergency Generator Initiative (DEGI): energy and environmental controls to improve operations and reliability of backup or distributed generators. Eligible for machines <35 lbs/MWh SO2 emissions (<18 lbs/MWh SO2 new installations) (switchgear, controls, test & tunes, dual fuel conversions, etc.)
- Some Price Response Programs allowing BUG
  - NYISO: Emergency Demand Response Program and ICAP/SCR programs are available to emergency back-up generation.
  - PJM: Economic Load Response Programs - Day Ahead, Emergency Demand Response Program: Generation is permitted in all programs, but environmental permits must be submitted to PJM.
  - ERCOT: BULs and LaaR: If BUG is used at any other time than as an emergency (blackout or brownout) situation, participant must obtain an Air Quality Standard Permit for Electricity Generation Units from the Texas Natural Resource Conservation Commission.

4
DEFINE APPLICABLE CILDC PROGRAMS

Findings were integrated from our review of prior and on-going HECO work (Chapter 2) and from our evaluation of other utilities' practices (Chapter 3) to determine which type(s) of programs make the most sense for HECO's major C&I customer segments. The economic benefits of these programs will be evaluated based on the cost experience of other utilities and HECO's current estimate of benefits of load management programs. Program elements are defined and below is a program recommendation.

HECO 25 May 2005: Honolulu

Hawaiian Electric Company, Inc.



Commercial & Industrial Demand Response Programs
Technology Options, Economics, and Incentives
Task 3 Deliverable

Executive Summary

- Our recommendation for C&I demand response is to develop three major programs in addition to CILDC: two focusing on small (<200 kW) and medium (200-400 kW) customers and one focusing on large customers (>400 kW).
  - Direct load control for small commercial focusing on air conditioner cycling
  - Load response with advanced notification for small and medium commercial, primarily targeting HVAC and lighting
  - Curtailable load with advanced notification for large commercial
  - Offer an *integrated package of services* to assist customers through all stages of technology implementation
- Economic evaluation suggests that the 3 recommended load response programs are viable.
  - Air conditioner cycling program for small commercial is cost effective, requiring at least 2 kW/site reduction to break even.
  - Load response (LR) for small and medium commercial customers is cost effective. Small commercial requires 30 kW/site reduction to break even, while medium commercial requires 18 kW/site for HVAC and lighting controls.
  - Large commercial facilities can cost effectively participate in curtailable load programs, assuming they already have an EMS that could be augmented with minimal technology upgrades for LR. Facilities must achieve from 12 kW/site reduction for notification only technology to 157 kW/site needed to justify installing notification, analysis, and automated response EIS technology.

Executive Summary

- Cost to medium and large customers installing new EMS technology cannot be justified on load response participation alone. The primary goal of installing an EMS must be efficiency savings. Because the customer's discount rate (30%) is higher than the utility's (8%), the customer will demand assistance from the utility to share the cost of EMS installation.
- However, efficiency savings reduce the amount of cost effective reductions from load response to more realistic levels. With 20% efficiency, the large customer's EMS investment is cost effective when combined with 140 kW/site load reduction.
- Providing incentives for direct load control programs is relatively straightforward:
  - Typically a nominal, fixed monthly incentive plus an optional one-time participation payment ranging from $50 to $100
  - Utility pays for a/c cycling technology with two-way communication capability
- Our survey of curtailable load program incentives reveal that design varies widely:
  - Combinations of performance-based incentives and penalties for non-performance
  - Treat as an option payment with choice of "strike price" linked to levels of performance customers promise to curtail during an event
- All of these programs would receive the full capacity value, before adjustments for diversity, overrides, and duration. For programs with advanced notification, we recommend that penalties be used to provide the same level of contractual "firmness" as an IPP contract.

RMI has complete the final step of the 3-step analysis to scope potential demand response programs for HECO's C&I customers

HECO Customer Assessment

1) Who has peak coincident load that could be shed?
2) How much could be shed (and at what cost)?
3) What is the best way to segment C&I DR Programs?
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Scope Potential C&I Demand Response Program

1) Which programs are cost effective for targeted customers?
2) Which DR programs are inappropriate for HECO?
3) How much potential value could be achieved?

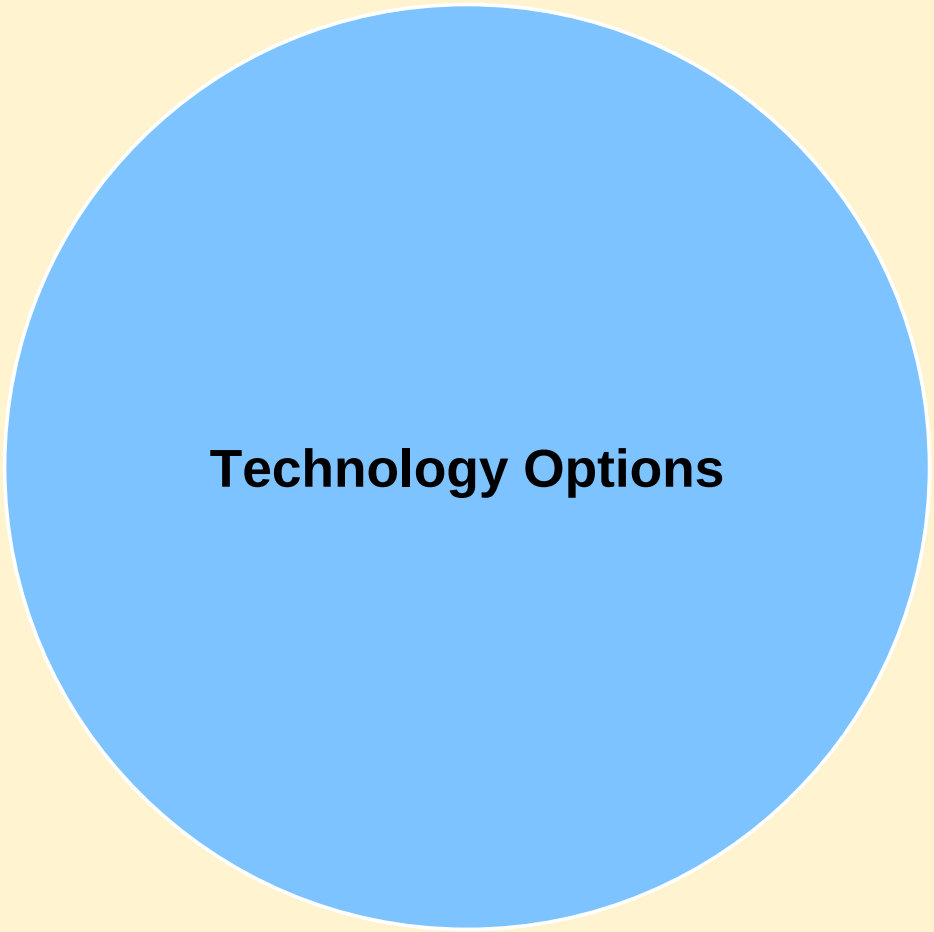
Complete

RMI survey of commercial and industrial demand response programs revealed that load response programs are most interesting for HECO

- Price responsive programs are tricky for HECO to implement, because there is not a power market and energy production costs do not vary significantly between peak and off peak periods.
  - RTP is inapplicable for HECO in the absence of power markets.
  - Although demand bidding has more customer appeal because of its voluntary nature, such a program is similarly constrained to the same economic signals. Demand bidding programs are also more administratively complex to operate. Past experience reveals only a handful of the largest customers participate.
  - A CPP price would have to be based on the avoided generation (and grid) capacity costs during peak demand.
- Load response programs may offer a greater chance of early success.
  - The majority of load response programs (direct load control, curtailable, interruptible) are system reliability triggered and tend to be easier to administer than price response programs.
  - Load response requires less capital investment in technology.
  - Early success could gain buy in and support from customers for later programs (e.g., price response).

Specifically, this report delves more deeply into Direct Load Control programs for small to medium customers and Curtailable Load programs for large customers

- For each program, we analyzed:
  - Technology options
  - Overall economics and value to system
  - Incentive design
- Additionally, we will explore with HECO the issue of advance notification for demand response events and whether advanced notification changes the avoided capacity cost value to HECO.


Technology Options

Although customers can participate in load response programs by reducing loads manually, control technologies help capture a greater share of achievable demand response potential

- Manual strategies are unlikely to produce as much or as consistent load reduction as automated load reduction strategies using control technologies.
- Manual load reduction strategies require that the customer be present at the site at the time of a load reduction event.
- Control technologies are likely to lower barriers to participation while offering ancillary benefits including:
  - Remote control capabilities
  - Enhanced customer control of their facilities
  - Information and data collection allow greater understanding/appreciation of energy usage by facility management personnel and provide basis for load reduction planning and strategy.
  - Two-way technologies provide:
    - internal feedback for facility managers to keep building operations within acceptable operating ranges; and
    - instantaneous measurement and verification for HECO during demand response events.

We recommend a turnkey approach to technology adoption, by providing an integrated package of services

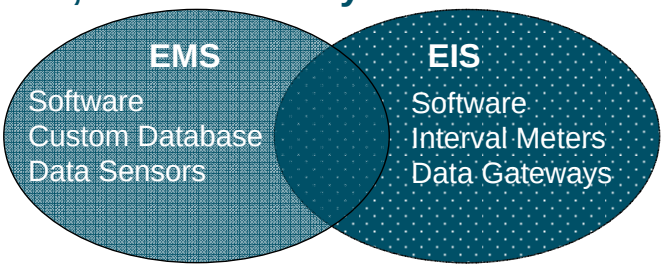
- Services must be integrated to help move customers through each stage of technology implementation:
  - Awareness;
  - Interest;
  - Commitment; and
  - Implementation.
- Provide coordinated assistance including:
  - Marketing/education;
  - Technical assistance;
  - Financial assistance; and
  - Brokerage/mediation assistance (i.e., locate and hire contractors).
- HECO should target both financial decision makers and facility managers at multiple levels of management.

HECO should engage vendors in program implementation

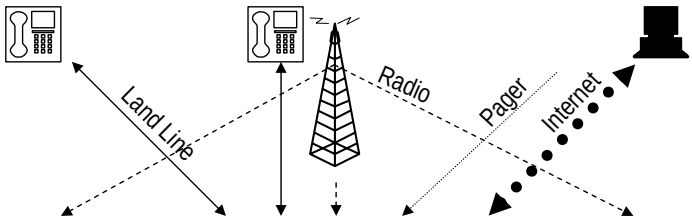
- Vendors can assist by:
  - recruiting and educating customers;
  - providing and installing appropriate technologies; and
  - coordinating and operating a turnkey program for HECO (for larger, established vendors operating nationally with specific demand response program experience)
- HECO can provide program information and materials directly to vendors, who can market the program to customers.
  - Requires periodic monitoring to ensure that vendors are delivering correct and consistent messages to customers regarding demand response programs and types of services offered
- We recommend that HECO engage vendors systematically by inviting interested vendors with eligible equipment to:
  - Provide a summary of their products, services, and capabilities; and
  - Agree to assist customers by helping them use the program incentives to purchase qualifying products and services.
  - HECO should vet the technologies to identify all appropriate vendors.
- Provide a customer hotline to answer customer questions and directly receive feedback regarding vendor performance.

Enabling technologies enhance demand response at various stages of the supply chain, from the utility to the end user

Monitoring Systems



Communication Systems



Control Devices

Utility Controlled	Customer Controlled
✓Load control switches ✓Smart thermostats (remotely controlled)	✓Smart thermostats ✓Lighting & HVAC controls ✓Other controls integrated into EMS

Two-way communication technology addresses many of the problems of one-way systems, often at relatively low cost

	One-way communication	Two-way communication
Monitoring and verification of load reduction and overrides during event	Difficult [1]	Easy
Customer control	Low [2]	High
Cost effectiveness	High	Variable
Complexity	Low	Moderate

[1] Data is usually collected via a statistical sample of participating population. Utilities must derate estimated impact based on assumed load diversity plus overrides.

[2] Utility operates appliance and customer receives little to no energy usage information.

Though more expensive, two-way communication systems provide numerous advantages that make them cost effective for targeted customers*

Advantages

- Operational integration: acknowledge receipt of signals and customer participation or override to utility; leads to real time monitoring and verification of load impact, enabling DR to be used as an ancillary service for frequency control
- Enables a wider set of program incentives (e.g., annual payment with override adjustments, pay-per-event, and hybrid structures)
- Greater customer control and choice: allows customers to set and control temperature levels and responses to different prices/curtailment signals, plus option for remote control Therefore, far greater customer acceptance, thus lowering overrides and churn
- Gives customers and utility operators more information about energy consumption in (near) real time. As such, provide ancillary services such as "virtual spinning reserve", frequency control, and voltage control. Customers receive internal feedback for facility mangers to maintain acceptable operating ranges for equipment or to manage multiple facilities.

Disadvantages

- More expensive than one-way systems (upfront costs could be twice as high)
- More complex than one-way systems; more effort required to train users how to use technology

*Two-way programmable thermostats can be cost effective for small customers capable of reducing 2 kW or more.

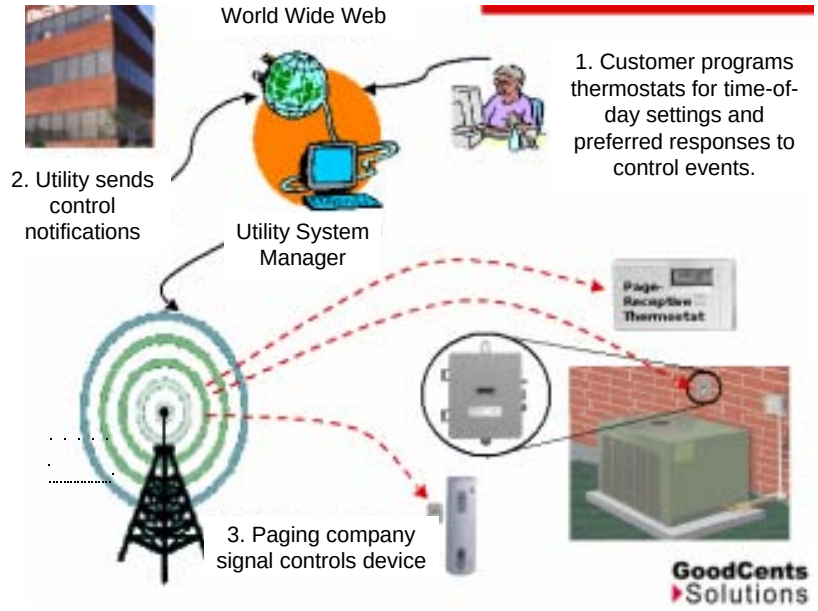
Technology Needs by Program

Program Type	Enabling Technologies
Direct Load Control	✓Communication Systems ✓Smart Thermostats (remotely controlled) ✓Load control switches ✓Utility Back Office Technology
Curtailable Load	✓Communication Systems ✓Energy Management Systems ✓Energy Information Systems ✓Interval Meters ✓Smart Thermostats ✓Centralized Lighting & HVAC Controls ✓Utility Back Office Technology

Technology Capabilities and Suggested Vendors: Direct Load Control Programs

Technology	Functional Capabilities	Suggested Vendors
Communication Systems	▪Email, fax, telephone, Internet, or paging notification services to alert customers regarding an electricity supply emergency or other event.	▪Cannon ▪Distribution Control Systems, Inc. (DCSI) ▪Invensys
Load Control Switches 	▪Remotely controlled electronic devices; ▪Wired into the control circuitry of an existing air conditioner, water heater, or other appliance; ▪Relay disconnects power to the controlled appliance once the host energy company sends an activation signal; ▪Can usually pre-program the amount of time the unit remains off.	▪Comverge ▪Cannon ▪DCSI ▪Invensys
Smart Thermostats 	▪Programmable thermostats allow facility managers to schedule fluctuations in temperature settings. ▪Communicating thermostats can raise or lower temperatures in response to events. ▪Can be controlled by the utility, customer, or both.	▪Cannon ▪Carrier ▪Comverge ▪Honeywell ▪Johnson Controls ▪Invensys

Direct Load Control programs can utilize remotely controlled smart thermostats or load control switches



GoodCents Solutions is an energy management company that develops and manages utility-sponsored mass-market small commercial and residential demand response programs.

Source: http://www.goodcents.com/Programs/demand.htm

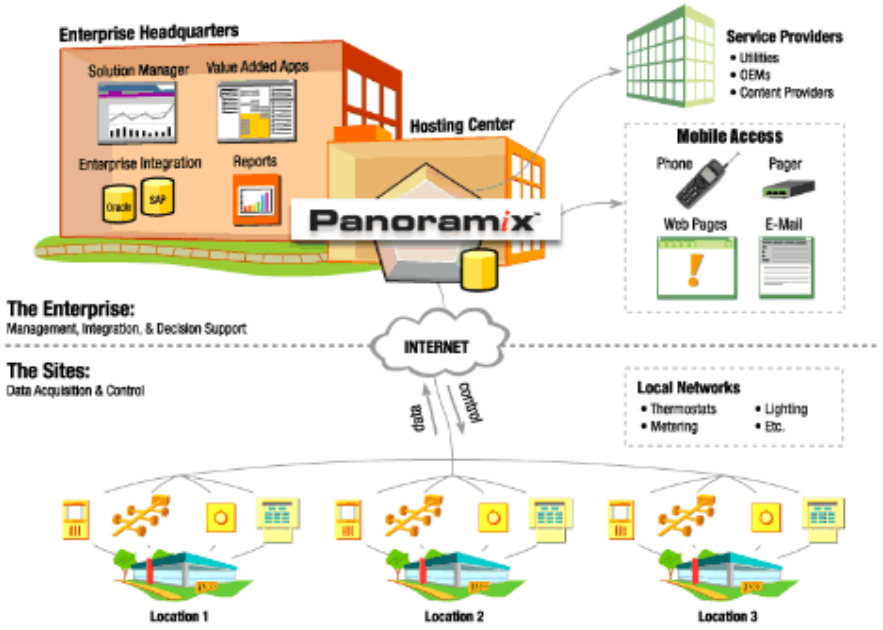
Technology Capabilities and Suggested Vendors: Curtailable Load Programs

Technology	Functional Capabilities	Suggested Vendors
Communication Systems	▪Email, fax, telephone, Internet, or paging notification services to alert customers regarding an electricity supply emergency or other event. ▪Direct exchange of facility meter data between customer and utility for monitoring and verifying load response performance to facilitate settlement	▪Cannon ▪DCSI ▪RETX ▪Invensys
Interval Meters 	▪Measures and records energy usage at intervals of one hour or less; ▪Allows customer to read meter information on demand;	▪eLutions ▪Itron ▪Power Measurement ▪Sensus
Back Office Technologies 	▪Support the complex rates and customer-specific contracts used in billing major energy customers.	▪Itron ▪Power Measurement

Technology Capabilities and Suggested Vendors: Curtailable Load Programs Continued

Technology	Functional Capabilities	Suggested Vendors
Centralized Lighting & HVAC Controls	▪Centralized controls can be dedicated to one end use (e.g., lighting only) or can be integrated as part of an overall EMS.	▪Cannon ▪Carrier ▪Electric City ▪ExcelSyus ▪Comfort Systems
Energy Management Systems (EMS)	▪Enables the customer to monitor, analyze, and control facility building systems and equipment from a central location. ▪Systems including computers with applications software, a custom-programmed database, a communications network, control devices, and data sensors allow facility managers to optimize operations of end-use equipment.	▪Carrier ▪Excel Energy ▪ExcelSyus ▪Honeywell ▪Johnson Controls ▪Comfort Systems
Energy Information Systems (EIS)	▪A software and/or a communication protocol that provides system-wide performance information to end users, utilities, and suppliers ▪Type of information commonly received: energy use, real-time prices, and weather forecasts ▪Can operate independently of, or can serve as a gateway to, an EMS.	▪Itron ▪eLutions ▪Comfort Systems ▪Power Measurement

Schematic of Energy Management System (EMS) Components



Echelon's Panoramix platform is an enterprise-grade software application capable of collecting data and managing devices at multiple remote facilities.

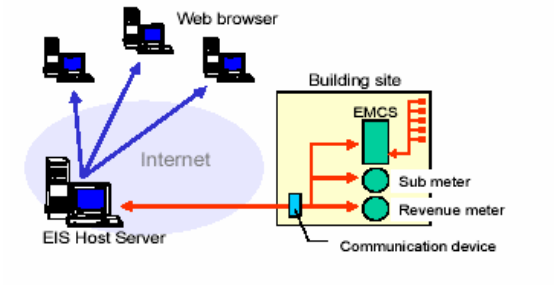
Numerous other EMS options are available and can be utilized to meet unique customer needs.

Source:http://www.echelon.com/products/enterprise/default.htm

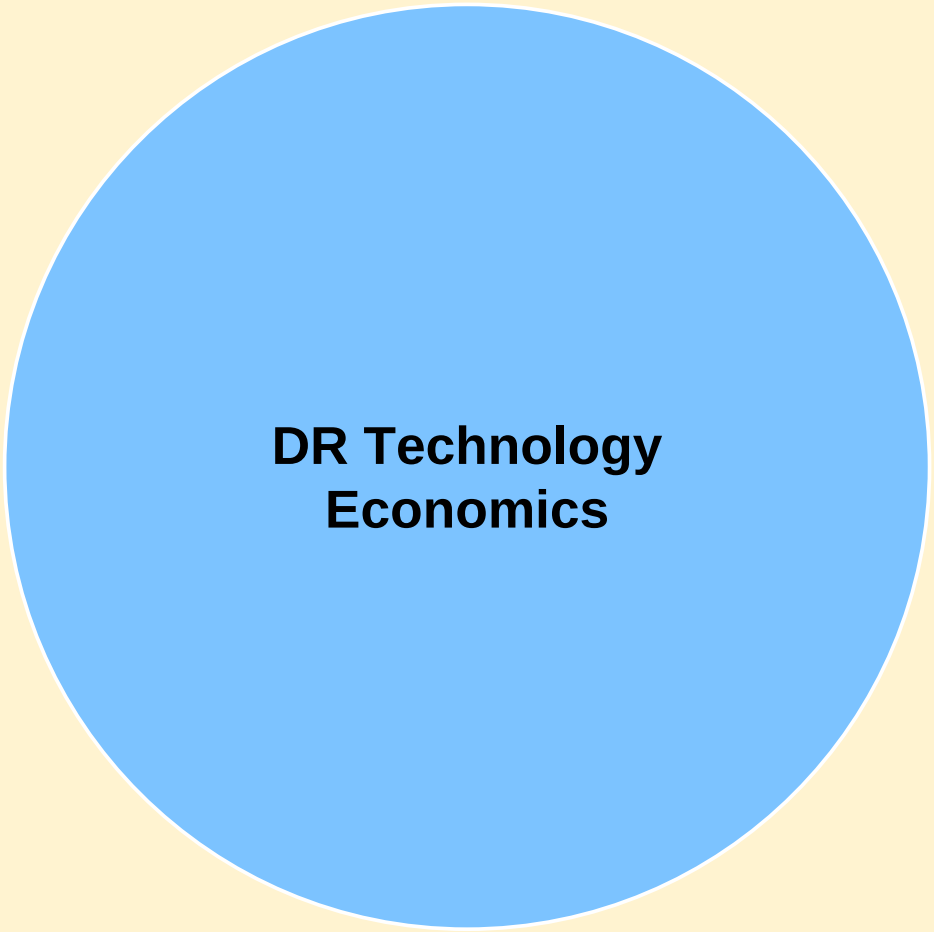
Energy Information Systems (EIS): 3 Common Types

- **Notification**
  - simply alerts building operators of a supply emergency or other event
- **Notification & Analysis**
  - provides the additional capability of analyzing energy usage, forecasting, and bill consolidation
- **Notification, Analysis, & Response**
  - can react automatically to external signals to reduce load or provide the necessary information for the building operator to react

Typical EIS Architecture



Source: California Energy Commission and Lawrence Berkeley National Laboratory, 2002, High Performance Commercial Building Systems: Web-based Energy Information Systems for Large Commercial Buildings.


DR Technology
Economics

For small and medium commercial customers, EMS systems cost more than load control

	Small DLC	Small Static EMS	Med Simple Load Control	Med Static EMS
Average Facility Size[1] (sf)	11,000	11,000	50,000	50,000
Customer Site Cost[2]	$667	$17,012	$11,000	$87,500
Utility Cost	$108	$108	$108	$108
Customer Acquisition Cost	$45	$45	$32	$32
Annual O&M Cost	$72	$150	$150	$400

(1) Based on modeling assumptions used in GEP's 2004 analysis of energy efficiency and demand response potential for Hawaii, included in HECO rate filing T-11, exhibit 2, pp 40-51, 67 and RMI calculations
(2) This cost includes installing an EMS system at the customer premise
(3) "Static" refers to load responsive signal only, as opposed to "dynamic," where an EIS/EMS could respond to changing prices.

Similarly, whole building systems are more expensive for large commercial customers and prices increase with increasing technology sophistication

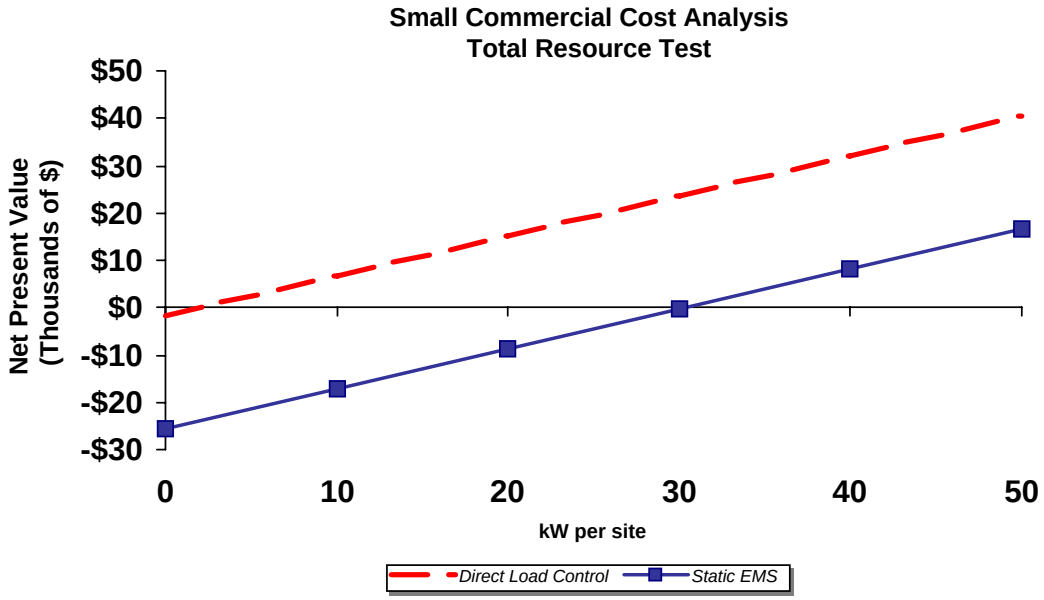
	Large EIS (Notification)	Large EIS (Notification & Analysis)	Large EIS (Notification, Analysis & Response)	Large Static EMS
Average Facility Size (sq ft)	300,000	300,000	300,000	300,000
Customer Site Cost (Hardware& Software)	$2,000	$4,000	$16,200	$600,000
Utility Cost	$1,040	$1,040	$1,040	1,040
Customer Acquisition Cost	$500	$500	$500	$500
O&M Cost at Customer SIte	$300	$1,500	$9,600	$15,000
O&M Cost at Utility	$780	$2,100	$8,400	$8,400

Source: California Energy Commission. 2004. Enhanced Automation Technical Manual
http://www.ConsumerEnergyCenter.org/enhancedautomation

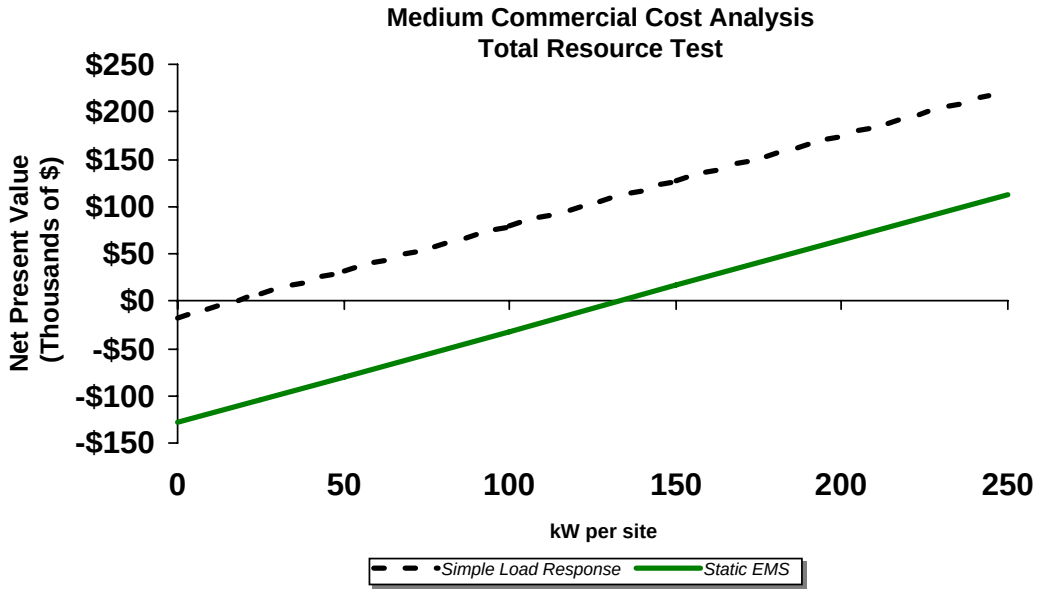
Additional assumptions in the economic analysis for small, medium, and large customers are as follows:

	Small	Medium	Large EIS	Large EMS
Existing building energy controls	None	None	Yes, EMS	None
Override Percentage	25%	15%	3%	3%
Churn Percentage	5%	5%	2.5%	0.5%
Number of Curtailment Events	12	12	12	12
Duration of Event	4 hours	4 hours	4 hours	4 hours
Discount Rate	8.42%	8.42%	8.42%	8.42%

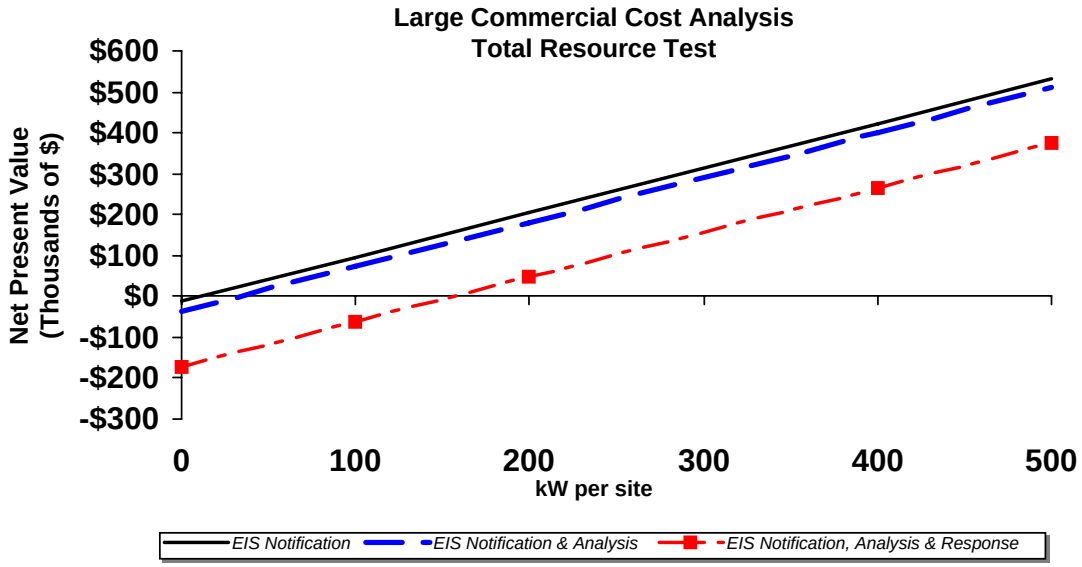
Small commercial sites can break-even at 2 kW load reduction per site deploying simple A/C cycling technologies while EMS systems break even around 30 kW.



Midsize commercial simple load response systems must get 18 kW to break even while facility-wide EMS systems require about 135 kW of peak reduction per site to break even

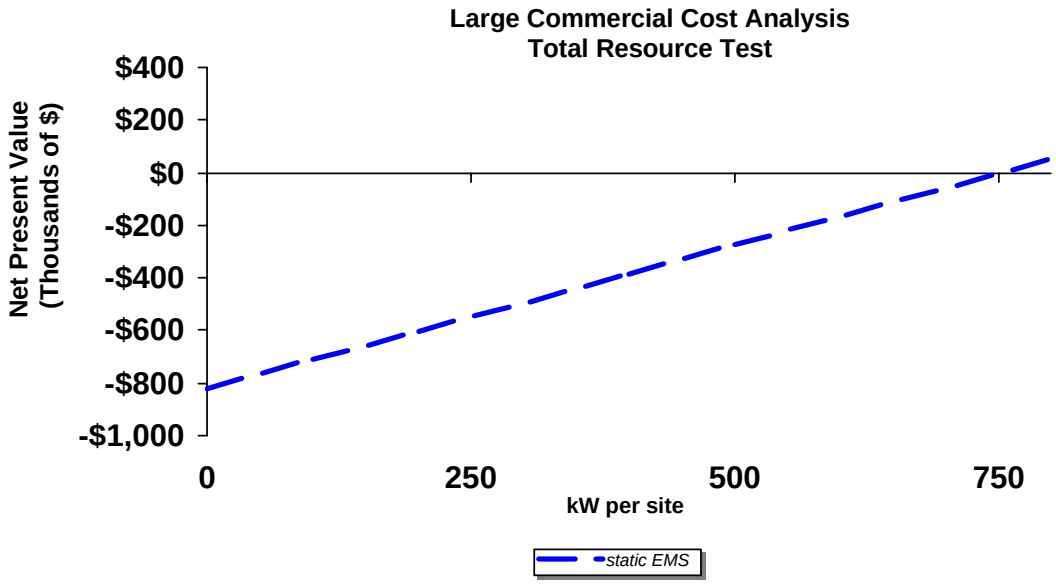


HECO's large commercial customers require about 12 kW of peak reduction per site to justify technology upgrade with EIS notification only system, about 34 kW of site reduction to justify EIS system with notification and analysis, while more complex systems that include automated load response require 157 kW per site



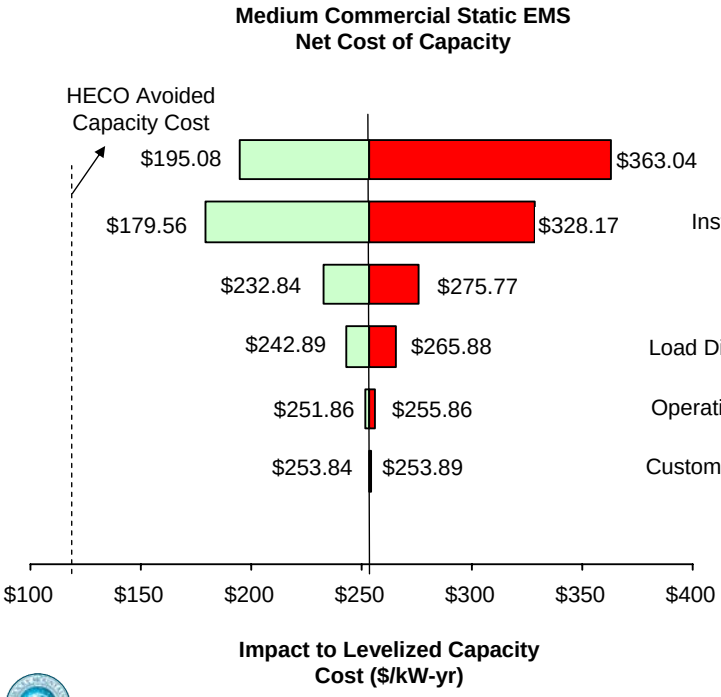
Note: Assumes large commercial sites already have EMS in place and therefore require only incremental upgrades in order to participate in a load response program.

For HECO's large commercial customers, installing a new EMS cannot be justified on load response benefits alone. Load response must be ancillary to primary goal of long term energy management for the large facility installing EMS.



Assumes the large commercial sites do not have EMS in place and would therefore need one installed before participating in load response program.

The actual economic value of the program is most sensitive to the amount of load reduced per site and installed technology cost. Churn percentage, overrides, and O&M cost also matter.

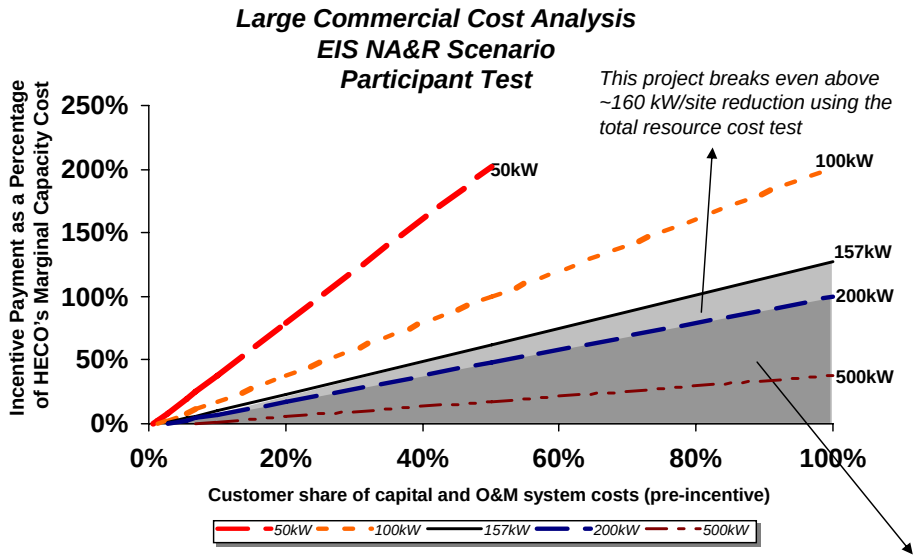


	Best Case	Base Case	Worst Case
Gross Curtailed Load/Site	78 kW	60 kW	42 kW
Installed Cost per Site	$61250	$87500	$113750
Churn Percentage	3.5%	5%	6.5%
Load Diversity & Overrides	11%	15%	20%
Operations & Maintenance	$280	$400	$520
Customer Acquisition Cost	$22	$32	$42

Since customer discount rates are much higher than a utility's, the more the customer pays up front, the higher the required incentive from the utility for the project to be cost effective from the customer's perspective

- From the customer's perspective, their cost consists of the control technology and their benefits include bills savings and utility incentives
- Most commercial customers require less than three year paybacks on energy efficiency, or an implicit discount rate 30% or higher.
- For the customer, the required return on demand response technology investments is much higher because their implicit discount rates (30%) tend to be much higher relative to the utility's (8%).
- Thus, as the customer pays out a greater share of the technology costs, the utility must pay out a greater share of its avoided capacity cost to satisfy the customer's required return.
- A higher discount rate increases the amount of kW reduction per site needed to break even on control technology investment, from the customer's point of view
  - For the large commercial case using EIS NA&R technology, the program achieves a positive net present value (NPV) above ~160 kW site using the total resource cost test.
  - From the customer's perspective using the participant test, however, their higher discount rate or rate of return requirements means the customer site must reduce 200 kW or more to break even on their investment.

Additionally, the customers' higher discount rate increases the amount of kW reduction per site needed to break even on control technology investment



Lines represent constant 0 NPV from customer's point of view for a given site load.

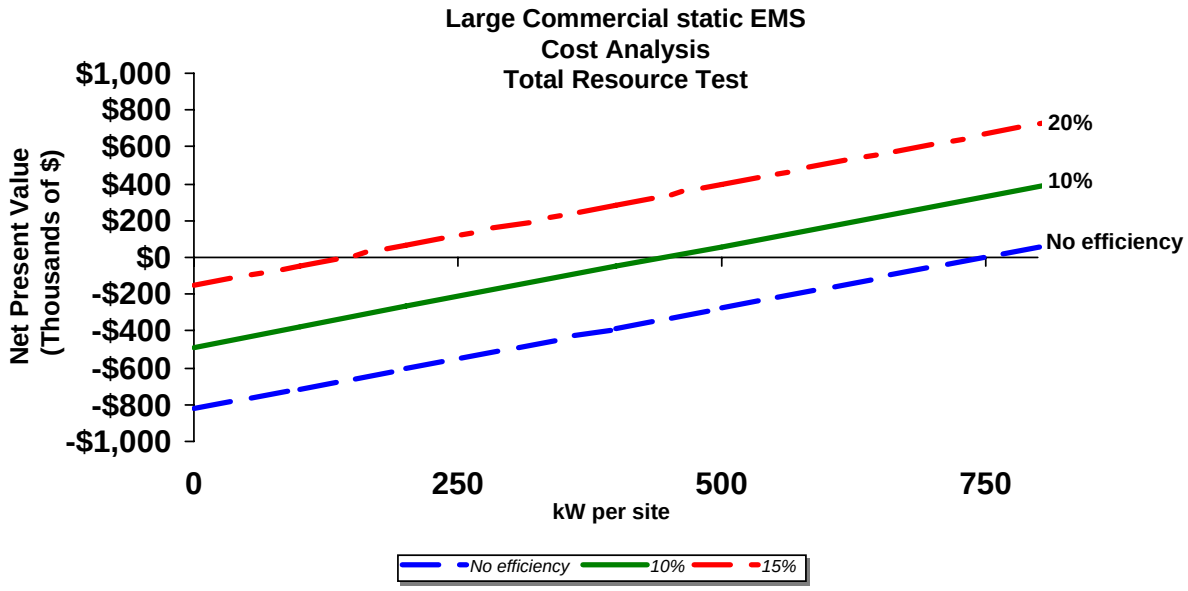
Assumes customer discount rate of 30%, twelve 4-hour curtailment periods, average retail rate of $.066/kWh, and Utility Marginal Capacity Cost of $112/kW-yr

For 200 kW Load Reduction

Customer share of Capital and O&M Costs	Incentive ($/kW-yr)	Program Incentive as % of Avoided Cost
10%	$8	7%
20%	$20	18%
50%	$54	48%
100%	$112	100%

Since customer discount rate is much higher, the project breaks even above 200 kW/site reduction

Efficiency savings reduce the amount of load reduction required for the new EMS investment to be cost effective. With just 10% efficiency, the program would require 446 kW reduction per site, and with 20% efficiency only 140 kW.



Program Incentives Design

Direct Load Control Program incentives

- Utility offers participants combinations of fixed incentives:
  - One time or annual participation payments
  - Fixed monthly payment credited to utility bill
  - Payments per ton of air conditioning capacity committed for reduction per month
  - Monthly payments based on cycling strategies employed (credited to utility bill)
  - Additional credits when a load reduction event is called
- Some offer additional incentives
  - 100% costs of the control technology (i.e., smart thermostat)
  - Communications service provider (e.g., Internet subscription)
  - Message that action helps entire community as a whole
- Customers are often more attracted to free/subsidized control technology than the nominal payments.
- Participation is generally on an indefinite basis once customer signs up (no renewal process). However, most utilities require a year-long waiting period (calendar year or next cooling season) to rejoin if a customer cancels.

Direct Load Control Programs Incentives Summary

Utility	Program Name	Years of Operation	Participation Payment	Monthly Credit	Call Credit	Addt'l Customer Svc payments
Long Island Power Authorty	LIPAEdge	Summer 2001-Present	$50 (one time)	None	None	Free installation of thermostat ($200) w/ Internet control
Utah Power	CoolKeeper	Summer 2003-Present	$20 small AC[1] $40 large AC[2] (annual)	None	None	Free installation of AC switch
Florida Power and Light	Business On Call	1988/89-Present	None	$2 per ton of AC capacity/ month	None	Free installation of energy mgmt. device
Potomac Electric Power Company	Kilowatchers (Residential)	Started in 1988/89; now dis-continued	None	Two cycle options: $4.50 or $10/month	$1 or $1.75/ day	Originally free installation of switch, then $200 cost for customer
Southern California Edison	Summer Discount Plan	Summer 2001-Present in current form	None	4 Cycling options:$0.42, $1.25, $2.10, $6/ton/month[3]	None	Free installation of cycling device

[1]Small AC units: less than 65,000 Btu/hr
[2]Large AC units: 65,000-90,000 Btu/hr
[3]Customers on an enhanced plan to allow unlimited cycling events are on a parallel program where incentives are double. Customers choose between two payment schedules (day or month) and 4 cycling options.

Unlike DLC programs, Curtailment Load program incentive structures vary widely

- Incentive design varies by utility
  - Monthly credit
  - Monthly credit plus variable rate reduction
  - Fixed credit ($/kW and $/kWh)
  - Option payment with variable strike price
  - Market pricing of credits with revenue recovery
- Method for load reductions are at customers' discretion, however, the participation contract between a utility and a customer is binding.
- Notification time is an important consideration, and incentives can vary based on the amount of prior notice customers receive. Typically, the less advance notification, the greater the incentive.
- Because of size of potential reductions of the large customers, severe penalties are enforced for nonperformance.

Curtailable Load Incentives Summary

Utility	Program Name	Years of Operation	Strategy	Details	Penalty
San Diego Gas and Electric	Base Interruptible Program (BIP)	2003 - Present	Monthly Credit	$7/kW (30 minutes of prior notification) or $3/kW (3 hours of prior notification) of electric load that participants have agreed to curtail.	$6/kWh or $2.50/kWh for excess energy usage
Southern California Edison	I-6 Interruptible Program	2002 - Present	Monthly Credit +Rate Reduction	Monthly credit of $7/kW for interruptible demand above base firm service level determined by customer; Rate reduction varies by voltage service level, e.g. TOU-GS customers with secondary voltage service receive reduction on “interruptible” load from $9.87/kW to $8.40/kW and from $.21/kWh to $.18/kWh.	Range from $6.00-$9.30/kWh for excess energy use
Cinergy	Powershare	2000 - Present	Option Payment	Negotiated one-time payment depending on load to be curtailed; plus, a strike price ($0.15, $0.50, $1.00/kWh) is selected by customer and when option is exercised, the strike price times curtailed load is the credit.	Payment of market prices or $10/kWh for excess energy usage
Sierra Pacific Power	Optional Conservation	2001 only	Market Pricing	Credit = (Verified curtailed demand for episode * 50% of market price) minus (Displaced revenues from curtailment using regular rate price).	Forfeiture of billing credit, termination of contract

Participation levels are robust for these successful load response programs

Program Name	Program Type	Number of Participants	MW Callable	Notes
LIPAEdge	DLC	28,306 total; 3,274 commercial (2003)	29.27 (total 2003)	Keyspan implements all program marketing & administration, and Honeywell DMC handles installation
FPL Business On Call	DLC	710,000	1,000	Operates additional load control programs totaling 2,450 MW
PEPCO Kilowatchers	DLC	153,000 (2004)	271 (1998)	Residential only program
Utah Power CoolKeeper	DLC	15% of eligible customers in target area	30 (2004) with 90 as the end-goal	Program implementation outsourced to Converge
Cinergy Powershare	Curtailable	312 large C/I (2002)	440-600	Includes call option program and variable quote program

Advanced Notification and Effects on HECO's Avoided Capacity cost

Demand response is typically given full reliability value with or without advance notification

- All the ISOs/RTOs give demand response programs full capacity value as a reduction in expected peak load when participants sign up for programs with or without advanced notification.
  - Programs requiring advanced notification (hours or day ahead) are called on first, and emergency programs with little advanced notification (minutes or less) are reserved for the most critical system conditions.
  - Often in advanced notification programs, penalties are imposed on the customer for failure to meet the full curtailment level.
- The duration of the load response is the more important issue in defining equivalent capacity. If the duration of response is less than the critical peak period, the capacity value must be derated based on the diminished customer load.
  - In other words, for a 3-hour peak, if the customer response was 1MW in hour one, 0.75 MW in hour two and 0.5 MW in hour three, the equivalent capacity is 0.75MW.

HECO should be able to justify value of day ahead notification for customers participating in load response

- In the HEI systems, reliability problems are driven primarily by equipment failures rather than extreme weather conditions (e.g., heat waves). The current reliability rule reflects this: Generation + Interruptible > = Load (including Efficiency) + Generation + Maintenance + Capacity of Largest Unit
- Providing participants with advance notification of load response events is synonymous to the dispatch of generators with equivalent lead time.
- The systems are operated with steam units always on, and non-load capacity of faster ramping units (CCs, CTs) used as an operational reserves (<15 minutes). The supplemental reserves for emergencies are quick start diesel IC engines (~1.5 minutes).
- Unit commitment (day ahead) units get full capacity credit, whether utility owned or provided by an independent power producer (IPP). The difference with the firm IPP capacity is the financial penalties associated with failure to deliver.
- Hence, an advanced notification program with financial penalties is no different than day ahead IPP capacity.


Next Steps

Next Steps

RMI:

- Incorporate HECO comments into RMI final report (Task 4).

HECO:

- Consider additional C&I program designs to increase participation and customer options:
  - Small and Medium customer programs
  - Curtailable load programs for large customers
- Decide which program(s) will best attract major customers, and how HECO wishes to use demand response in systems operations
  - If operating emergency response, then use curtailable program with call option structure (upfront payment with additional payments for use)
  - If used as economic response, then demand side bidding could work.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TECHNOLOGY OPTIONS FOR DEMAND RESPONSE

Below is an overview of technologies.

Overview of C&I Demand Response Technology Options
Last Updated: May 2005

Technology Name	Targeted Program Type	Technology Type	Brief Description	Vendors	Costs	Sources
Energy Management Systems (EMS)	All	Monitoring	Enables the customer to monitor, analyze, and control facility building systems and equipment from a central location. Facility managers use a computer with applications software, a custom-programmed database, a communications network, control devices, and data sensors to optimize operations of end-use equipment. Air temperature, water temperature, lighting levels, and many other building parameters can be monitored and controlled by an EMS.	Andover, Carrier, eLutions, Honeywell, Itron, Johnson Controls, Novar	$1.75/sq ft to $4/sq ft depending on system complexity level (static to dynamic)	CEC, 2002, Enhanced Automation: Technical Options Guidebook
Energy Information Systems (EIS)	All	Monitoring	An EIS is a software and/or a communication protocol that provides system-wide performance information to end users, utilities, and suppliers. The type of information commonly received includes: energy use, real-time prices, and weather forecasts. An EIS can operate independently of, or can serve as a gateway to, the EMS. There are generally 3 types of EIS: (1) notification-based, (2) analysis-based, (3) response-based (which provide the gateway between EIS and EMS).	eLutions, Novar, Power Measurement	$1,500 - $15,000 (Installation); $0-$1,500 (monthly fees); $50 - $200 (transaction fees)	CEC, 2002, Enhanced Automation: Technical Options Guidebook
Interval Meters	Curtailable Loads, CPP, RTP, Demand Bidding	Monitoring	Provides the capability to measure and record energy usage at intervals of one hour or less. Allows customers to read meter information on demand. Communications links enable automated utility metering functions.	eLutions, Itron, Power Measurement	$90-$245 to update existing meter with interval meter; new interval meters can range from $200-$3,700 depending on features	Energy Infosource, Demand Response Programs, May 2002. Also see: CEC, Roger Levy (author), Meter Scoping Study, undated.
Communication Systems	All	Communication	Communication technologies enable utilities and DR participants to communicate. Notification services alert customers via email, fax, telephone, Internet, or paging when there is an electricity supply emergency or other event.	Cannon, Electric City, eLutions, RETX		Various
Load Control Switches	Direct load control	Control Device	Load control switches are remotely controlled electronic devices that typically include a communications module and relay. They are wired into the control circuitry of an existing air conditioner, water heater or space heater, pool pump motors and other motor loads. The communications modules are used to receive an activation signal from the host energy company, which causes the relay to disconnect power to the controlled appliance. The amount of time the unit remains off is usually controlled by a pre-programmed timer function built into the unit.	Cannon, Comverge, DCSI		A. Rosenfeld, M. Jaske, and S. Borenstein. Hewlett Foundation Energy Series: Dynamic Pricing, Advanced Metering, and Demand Response in Electricity Markets. 2002. In RMI electronic files: "DynamicPricing.pdf"
Smart Thermostats	All	Control Device	Programmable thermostats allow facility managers to schedule fluctuations in temperature settings. Communicating thermostats can raise or lower temperatures in response to events. Can be controlled by the utility, customer, or both.	Carrier, Cannon Technologies, Comverge, Johnson Controls, Honeywell	~ $200/ thermostat	Cannon Technologies: http://www.cannontech.com/products/drdirectcontrol.asp
Centralized Lighting & HVAC Controls	All	Control Device	Centralized controls can be dedicated to one end use (e.g., lighting only) or can be integrated as part of an overall EMS. For example, a system could be programmed to automatically reduce lighting levels in non-critical areas in response to a utility-sent peak emergency signal.	Cannon, Carrier, Electric City, Maximum Performance Group		CEC, 2002, Enhanced Automation: Technical Options Guidebook
Back Office Technologies	All	Settlement	Support the complex rates and customer-specific contracts used in billing major energy customers.	Itron, eLutions, Power Measurement		Various

Technology Options for Demand Resonse:
ENERGY MANAGEMENT SYSTEMS (EMS)

Technology Name	Vendor	Brief Description	Costs	Appropriate Applications	Source
Continuum Controller	Andover	Networked controller with integrated control, history logging, and logical and remote alarming capabilities.	$188,000 for Andover EMS and lighting controls at 50 sites. $3760 per site.		ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 24.
ComfortVIEW	Carrier	Allows for automated lighting and HVAC control. Used by Doubletree Hotel and Convention Center in Sacramento, CA. At that site, the EMS uses strategically located direct digital control modules to monitor and control chilled water loop temperatures, outside air intake and fan speeds. Facility operators set the operation of the associated equipment manually, through the EMS interface. If s/he receives notification to curtail load, an operator first views energy use data to see which systems are drawing the most load, and then uses the EMS to shed chiller or fan loads accordingly.		Proven effective for large hotel and convention center.	CEC Case Study 6. www.consumerenergycenter.org/ enhancedautomation/case_studies/CS6_Doubletree.pdf
Panoramix® platform	Echelon	Scalable, enterprise-grade software application designed to reside in a corporate-owned or hosted data center and communicate across the Internet or a private IP network to as many as tens of thousands of remote sites containing networks of smart devices. Built around open standards, the Panoramix platform provides a Web Services API to enable quick and easy integration into existing business systems. Seamless connectivity to LonWorks® networks lets the Panoramix platform tap into networks of smart devices - from thermostats, lighting devices, access control systems, HVAC devices, energy meters, refrigeration cases, and more.		Enterprise-wide management (e.g., multiple facilities, large campuses)	http://www.echelon.com/products/enterprise/default.htm
PowerNet	Enetics	The PowerNet EMS consists of multiple PowerNode Recorders monitoring and recording power consumption and power quality and PowerScape Software. Units distributed in a facility, including the service entrance, periodically and automatically upload data by direct cable connect, Ethernet links, or by land line phone. Enetics work closely with customers to build their own economic models into its PowerScape software so that they have a comprehensive set of software decision tools to assess the economic viability of a prospective curtailment decision.			Energy Infosource, Demand Response Programs, May 2002 (Infosource_DR_Progs-Vendors.pdf). www.enetics.com

Technology Name	Vendor	Brief Description	Costs	Appropriate Applications	Source
Listener, Monitor, and Controller; Supervisor, Energy Manager	ExcelSyus	ExcelSyus offers a suite of energy management products that monitor and control loads. The HVAC control system (used by Gart Brothers Sporting Goods Company in CEC Small C&I Program) dials up each store once daily to download the store's power consumption data. Hardware consists of 5-zone or 8-zone controllers, depending on store size and the associated sensors. Software enables complete remote monitoring and control of energy and building functions plus control and storage of data for single or multiple EMS locations.	$363,000 for 22 stores; $16,500 per site	Appropriate for small customers (single buildings), large campuses, and everything in between.	ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 23-24, 30. http://www.excel-energy.com/index.htm
ExcelSyus "R" controller	ExcelSyus	The ExcelSyus™ "R" is specifically designed for restaurant operations to maintain full compliance with the FDA food codes. The system contains unique software to provide constant monitoring of key areas including fryers, ovens, steam tables, rotisseries, freezers, dishwashers, etc. In addition to the monitoring functions, the system also has built-in alarming capabilities to alert owners or managers when a threshold has been exceeded. All information is logged into the system to verify compliance and provide owner protection.		Specifically designed for restaurants	http://www.excel-energy.com/index.htm
Honeywell Building Manager™	Honeywell	Integrates all building systems, including HVAC monitoring and control, lighting, power and energy management, into a single building solution.		Supports configurations that range from stand-alone, single-building systems to campus or multi-location operations with several servers.	http://www2.acs.honeywell.com/ichome/rooms/DisplayPages/LayoutInitial?PageName=bldgauto_ebi_building_manager&Type=Category&ParentCatalogName=ICHome&CategoryName=bldgauto_ebi_building_manager&ParentName=bldgauto_enterprise_building_integrator&SL=3&L=3
Enterprise Energy Management (EEM-Suite)	Itron	Users can combine analysis and reporting tools, scheduled or real time event-driven alerts, external data sources and Internet-based monitoring and control of energy assets to transform information into cost and risk reduction strategies.			http://www.itron.com/products/eem_operations.html
Metasys Building Management System	Johnson Controls	Has support for Internet protocols and IT standards built in, so customer has full access to building information & management tools from a desktop PC or laptop with a standard Web browser. Allows customer to receive alerts on a cell phone, pager, handheld, or any other Web-enabled device.			http://www.johnsoncontrols.com/Metasys/index1.asp

Technology Name	Vendor	Brief Description	Costs	Appropriate Applications	Source
Savvy-07-M Controller	Novar	Stores each site's specific energy management program. Provides remote access for monitoring equipment and automating functions such as HVAC control, interior and exterior lighting, electrical demand and consumption, and signage.	roughly $6,000-17,000 per site	Designed for single buildings.	ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 23, 31.
Envoi Infosystem	Novar	Stores each site's specific energy management program. Provides remote access for monitoring equipment and automating functions such as HVAC control, interior and exterior lighting, electrical demand and consumption, and signage.	roughly $6,000-17,000 per site	Designed for small buildings.	ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 23, 31.
Lingo Digital Controller, Information Management System	Novar	Controller designed to manage and monitor the Novar Controls energy and information management system for large buildings and campuses. Used to: monitor and log system operations; manage system communications; and centralize equipment control.		Designed for large buildings and campuses.	http://www.novarcontrols.com/products.html
SCL Telsec 2000	Telsec	The system's programmable control unit receives curtailment signals remotely via the Internet from a website operated by SCL software. Used to control HVAC, refrigeration, lighting, and kitchen equipment at Marie Callender's project in CA CEC Small C&I HVAC and Lighting DR Program.	$277,630 for installation at 22 sites; roughly $12,600 per site	Suitable for restaurants.	ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 24, 31. See also: http://www.questcontrols.com/pages/rmwm_pf.html
Surveyor EMS	Venstar	Controls air conditioning and lighting load. Communicates with a centralized server via broadband connection and curtailment can be initiated from anywhere via Internet connection.	$1.7 million for installation at 366 locations; roughly $4,600 per site		ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 22, 32.

Technology Options for Demand Resonse:
ENERGY INFORMATION SYSTEMS (EIS)

Technology Name	Vendor	Brief Description	Source
Active Energy Management (AEM®) system	eLutions, Inc.	Internet-based, wide area energy information management solution that provides event initiation, customer notification, event monitoring, performance compliance alerts and settlement calculation. AEM® is an energy use analysis tool with flexible demand response capabilities, and integrated two-way (wired and wireless) communications platform. Data is collected directly from the meter and sent wirelessly to the AEM® system. This wireless technology interfaces into metering, sub-metering, and other electronic equipment, providing an alternative approach to the traditional phone line transmission method. The curtailment module includes the following functions: curtailment bidding and acceptance, end user notification of bid acceptance, end user curtailment account tracking and end user real-time load tracking throughout curtailment.	http://www.elutions.com/eLutionsCorporate2/html%5Cpress.html; and http://www.engagenet.com/press/052303.html
Lingo Digital Controller, Information Management System	Novar	Designed to manage and monitor the Novar Controls energy and information management system for large buildings and campuses. Used to: monitor and log system operations; manage system communications; and centralize equipment control.	http://www.novarcontrols.com/products.html
Energy Profiler Online	Power Measurement (formerly ABB EI (Energy Interactive) until March 2004)	Allows customers to use their existing Web browser to access load profiles, usage history charts, and statistics for multiple locations; generate estimated bills based on actual energy usage; compare energy usage across facilities and measure the effectiveness of various energy efficiency efforts; group data from multiple locations for aggregated analysis; take part in real-time pricing and load curtailment programs; and download energy usage data for further in-house analysis. A utility can also notify customers in curtailment programs automatically, via email or pager. Likewise, customers can signal their participation in a curtailment event without directly contacting a utility staff member. Energy Profiler Online handles a broad variety of market requirements for curtailment programs, including posting of prices for voluntary curtailment programs, allowing customers to opt in or out of any specific event, calculating baseline usage according to configurable rules, and providing settlement reports both to the customer and internal users.	Energy Infosource, Demand Response Programs, May 2002 (Infosource_DR_Progs-Vendors.pdf). http://www.pwrm.com/products/value_added/

Technology Options for Demand Resonse:
INTERVAL METERING

Technology Name	Vendor	Brief Description	Source
EMETCON	Cannon	EMETCON is a 2-way Distribution Line Carrier system that allows customers to send to and receive data from meters over utility-owned power lines. Other key features of EMETCON include its ability to provide instant, real-time access to data, its ability to control loads, and its ability to communicate with any of the five major existing communication mediums (VHF, Ripple, FM/SCA, Paging, and DL).	http://www.cannontech.com/products/amremetcon.asp
EPIM	eLutions	The Ethernet Pulse Input Module (EPIM) real-time data logger provides a convenient means to meter electric energy, monitor environmental conditions and initiate centralized controls strategies in industrial and commercial facilities.	http://www.elutions.com/eLutionsCorporate2/
GPIM	eLutions	The Global Pulse Input Module (GPIM) real-time data logger provides a convenient means to meter electric energy and monitor environmental conditions in industrial and commercial facilities.	http://www.elutions.com/eLutionsCorporate2/
PM4000	eLutions	Interval data meter; more economical. Uses existing phone or PBX lines for communication (which keeps communication costs to a minimum).	http://www.elutions.com/eLutionsCorporate2/
ERT meter modules	Itron	ERT meter modules serve as data collection endpoints for radio-based technologies. They can be retrofitted to existing meters or installed on new meters during the manufacturing process.	www.itron.com
Automated Meter Readers	Itron	Itron's telephone-based automated meter reading modules encode consumption, interval and tamper information from meters, then transmit this data via telephone communications to a host processor at pre-programmed times. Module-equipped meters are installed at the customer location and a telephone connection is installed between the meter and the telephone junction box. The existing telephone line at the customer premise is used for communication between the meter and host processor, so no installation of dedicated phone lines to the meter is required. Itron telephone-based AMR technologies use “polite” technology to detect when the customer is using the phone line. The modules will not initiate calls or continue a call when the customer's phone line is in use.	www.itron.com
E-VEE	Power Measurement (formerly ABB Energy Interactive)	E-VEE was designed to meet the needs of utilities in restructured as well as traditional markets. It allows utilities to consolidate meter data from a variety of sources into a single repository. E-VEE offers a set of validation and editing procedures to take meter data from raw file to billing and settlement quality. Spike tests, sum tests, existence checks, hardware checks, and cross-validation with manually collected data can all be performed automatically. E-VEE does not require programming—the business rules behind the various procedures are completely database-driven. Once the validation and estimation parameters are set up in user-defined validation groups, customers can be assigned to those groups through the user interface.	http://www.pwrm.com/products/e-vee/

Technology Options for Demand Resonse:
COMMUNICATION SYSTEMS

Technology Name	Vendor	Brief Description	Primary Function / Application	Source
Yukon Advanced Energy Services Platform	Cannon	Supports alternative communications paths for automated remote metering that are cost effective for small commercial and C&I metering and load research purposes, including local dial-up & dial-back telephone with local area collection servers, and Internet.	Remote metering	http://www.cannontech.com/products/amrcommercial.asp; Bill Simons Director of AMR Systems billsimons@cannontech.com 763-253-5503 direct (Central time zone)
TWACS (Two-way Automatic Communication System)	DCSI (Distribution Control System, Incorporated)	A fixed network utility communication system that communicates over electric power lines or via short hop radio frequency (RF), providing low-cost, highly-reliable, two-way communication between the utility and the consumers of electricity, gas,propane and pit-set meters. The TWACS system uses the existing power lines for data transmission, and since it modulates the waveform at the zero crossing point, it uses the utility's network at the frequency for which it was designed.		http://www.twacs.com/
Global Commander	Electric City	Communications software installed with EnergySaver EMS at Linens N Things in CA for CEC Small C&I HVAC & Lighting DR Program. Allows customer to interface real-time variable pricing and energy management systems, and then selects among pre-programmed global lighting control set points to optimize lighting loads at all connected end-user facilities. Single-point control is available for a virtually unlimited number of remote facilities. Communication may be by modem, through the Internet or where available, over standard phone lines with high-speed wide area networking.		ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 31. See also: http://www.elccorp.com/globalcommander.html
Supervisory Control and Data Acquisition (SCADA) Module	eLutions, Inc.	Enhanced communications interface to distributed generation. The SCADA, coupled with AEM software, enables remote control and monitoring of generators by communicating and issuing commands to the generator's central control unit. The SCADA was specifically designed to interface with the Parallon 75 Integrated TurboGenerator and is capable of supporting other generators or devices with serial interfaces.	Interface to distributed generation	http://www.elutions.com/eLutionsCorporate2/
ePath Notification Manager	RETX	Provides a system operator or energy provider with the ability to correspond with their customers and alert them of demand response events, new product opportunities, general system conditions, price plans, weather alerts, etc.	Notification system	Plaza 400, Suite 180 5883 Glenridge Drive Atlanta, GA 30328-5339 Phone: 1-888-228-RETX (7389) Website: www.retx.com

Technology Options for Demand Resonse:
LOAD CONTROL SWITCHES

Technology Name	Vendor	Brief Description	Costs	Source
Load Control Receivers (LCRs)	Cannon	900 MHz FLEX® Paging Communications; Override Capability; End-users can make their own adjustments via web or telephone		www.cannontech.com
DCU with adaptive algorithm	Comverge	Comverge offers a version of its DCU with an adaptive algorithm that observes and records the air conditioner's duty cycle using a small current sensor. This duty cycle may then be adjusted equally for all remotely controlled units. This is designed to eliminate the "free-rider" problem of customers with oversized air conditioners, and has similarities to products having similar aspirations in the 1980's.		A. Rosenfeld, M. Jaske, and S. Borenstein. Hewlett Foundation Energy Series: Dynamic Pricing, Advanced Metering, and Demand Response in Electricity Markets. 2002. In RMI electronic files: "DynamicPricing.pdf"
Digital Control Units (DCU)	Comverge	One-way VHF load control switch. This product family serves over 50% of the load control market and supports every major protocol and communications system used by utilities today.	Comverge is able to sell the VHF switches for up to 20% less than the paging based switch, which makes them attractive for expansion of existing systems. For new systems the price premium for paging may be more than offset by the elimination of any need for installing and maintaining VHF radio infrastructure.	A. Rosenfeld, M. Jaske, and S. Borenstein. Hewlett Foundation Energy Series: Dynamic Pricing, Advanced Metering, and Demand Response in Electricity Markets. 2002. In RMI electronic files: "DynamicPricing.pdf" See also: http://www.comverge.com/products/dcu.php
Service Reconnect Device (SRD)	Comverge	Service reconnect and disconnect device. The SRD is a VHF radio-controlled receiver that enables the electric utility to remotely control a customer's electric service with commands from a central controller. It plugs easily into a ring or ringless four- or five-jaw meter socket.		http://www.comverge.com/products/dcu.php
Load Control Transponder	DCSI (Distribution Control System, Incorporated)	Remotely controls deferrable customer loads such as central air conditioning units, electric water heaters, heat pumps, pool pumps, and baseboard heaters.		

Technology Options for Demand Resonse:
SMART THERMOSTATS

Technology Name	Vendor	Brief Description	Costs	Marketing Strategies & Selling Points	Source
ExpressStat™ RF Programmable Thermostat	Cannon/ Honeywell	Honeywell programmable thermostat. Control options start with classical direct load control but extend to options involving consumer choice and intervention. Supported options include: • Automation of pre-cooling or pre-heating of the consumer's premises • Energy company control of absolute temperature set point, regardless of customer setting • Set a temperature offset or bias of the consumer's setting (example: add +2ºF) • Remotely adjust or bias the natural duty cycle of the appliance prior to control.		Utilities can provide this improved thermostat to consumers in exchange for the ability to exert control when program needs dictate. The benefits to the consumer of having the thermostat may obviate the need for any financial incentive payment.	A. Rosenfeld, M. Jaske, and S. Borenstein. Hewlett Foundation Energy Series: Dynamic Pricing, Advanced Metering, and Demand Response in Electricity Markets. 2002. In RMI electronic files: "DynamicPricing.pdf"
ExpressStat™ Window Air Thermostat	Cannon	Window or through-the-wall air conditioning is prevalent in many parts of the country. These air conditioners are plug-in appliances, a perennially difficult application for direct load control. Cannon has teamed with Enernet of Syracuse, NY to develop a product that combines two attributes. Enernet designed a product for window air conditioning units, which have notoriously imprecise thermostats, and no setback capabilities. The Enernet product simply "remotes" the thermostat function to a high quality electronic setback thermostat that can be conveniently located on any wall. The thermostat, in turn, communicates with the window air conditioner with LONWORKS™ wireless communications.			A. Rosenfeld, M. Jaske, and S. Borenstein. Hewlett Foundation Energy Series: Dynamic Pricing, Advanced Metering, and Demand Response in Electricity Markets. 2002. In RMI electronic files: "DynamicPricing.pdf"
Energy Management Interface (EMi)	Carrier	2-way programmable: Internet-communicating, 7-day programmable thermostat. The utility program operator logs into web-based software via any computer to monitor and review program activity and initiate two type of events: 1) A cycling event, duration and minutes of operation desired or 2) A temperature set-point change, duration and number of degrees desired. During a curtailment, the digital screen on the thermostat displays the word "Curtailment". The thermostat screen will also count backwards so that the customer will know how much time is left before the thermostat returns to its pre-set temperature. At any time, the customer can override the temperature adjustment directly at the thermostat.	$200 each + $100 installation fee. The thermostat can be retrofitted to any residential or small commercial installation that uses a wall thermostat.	Offer free thermostats. LIPA reports that Customers volunteered for the program to receive a free, state-of-the-art Internet programmable thermostat "valued at $200" with professional installation "valued at $100" rather than the one-time cash payment. To a lesser degree, customers were interested in helping utility curtail load.	Long Island Power Authority, www.lipower.org; On RMI Demand Response Docs CD: "C Three LIPA Thermostat St.doc". See also: Kirby, B., P.E., Oak Ridge National Laboratory. March 2003. Spinning Reserve From Responsive Loads. Available online: http://certs.lbl.gov/CERTS_A_Load.html. Tech specs: http://www.commercial.carrier.com/commercial/hvac/general/0,,CLI1_DIV12_ETI1841_MID4388,00.html
SuperStat Family	Comverge	The Comverge SuperStat family is capable of supporting: • Direct Load Control using temperature setback adjustments • Price-Responsive Demand Control and Critical Peak Pricing • Consumer information display • Single and Multi-Appliance Control/Configuration All features can be remotely configured, via the web, for adjusting temperature set backs, initiating overrides, scheduling cycling strategies, and address configurations. Based upon the Honeywell unit; has many of the capabilities of the Cannon Technologies thermostat, including hierarchical addressing and a variety of strategies for energy company intervention.			A. Rosenfeld, M. Jaske, and S. Borenstein. Hewlett Foundation Energy Series: Dynamic Pricing, Advanced Metering, and Demand Response in Electricity Markets. 2002. In RMI electronic files: "DynamicPricing.pdf" See also: http://www.comverge.com/products/bisuperstat.php

Technology Name	Vendor	Brief Description	Costs	Marketing Strategies & Selling Points	Source
Programmable Thermostats	Johnson Controls	The T600 Series of programmable thermostats are designed to control the most common commercial heating and cooling equipment. The fully programmable 7-day, 2- or 4-event schedule, along with a number of configurable parameters, including two programmable digital inputs and one configurable output, enable control of equipment in nearly any application. All programming, configuration, setup, and operation of the T600 are accomplished through the user interface.			Johnson Controls website: http://www.johnsoncontrols.com/cg-thermostat/t600zzp2.htm
Networked Thermostats	Johnson Controls	The TEC210x-2 thermostats are designed for networked control of the common commercial heating and cooling equipment. The thermostats allow the user to view operation or make adjustments at the thermostat or from a remote workstation.			Johnson Controls website: http://www.johnsoncontrols.com/cg-thermostat/networkdig.htm

Technology Options for Demand Resonse:
CENTRALIZED LIGHTING & HVAC CONTROLS

Technology Name	Vendor	Brief Description	Costs	Source
Wireless centralized controls	Cannon	Wireless centralized control via pages activated through Web-enabled software. Two basic components: (1) a set of three relays installed in each store and wired into the store's EMS and (2) Web-enabled software that allows equipment operation to be scheduled and activated over the Internet. Each of the three relays corresponds to a curtailment level. For example, Level one reduces half of a store's lighting and powers down one rooftop HVAC unit (RTU). Used by Staples in CA.		CEC Case Study 5_Staples. www.consumerenergycenter.org/ enhancedautomation/case_studies/ CS5_Staples.pdf
3V™ Packaged Control System	Carrier	Integrates electronically-communicating DDC controls with HVAC equipment to continually monitor and maintain comfort requirements of your building. Suitable for office building, school, hospital, mall, etc.		http://www.commercial.carrier.com /commercial/hvac/general/0,3055,CLI1_DIV12_ETI9040_MID4443,00.html
EnergySaver	Electric City	Lighting control and power reduction system that uses a voltage reduction transformer and a microprocessor controller to control precisely the voltage that is supplied to lighting circuits. Used by Linens N Things in CA for CEC Small C&I HVAC & Lighting DR Program. Using Global Commander communications software, it enabled LNT to control store lighting remotely through an Ethernet connection.	$17,000 per site.	ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 23-24, 30. See also: http://www.elccorp.com/energysaver.html
Listener, Monitor, and Controller; Supervisor, Energy Manager	ExcelSyus	ExcelSyus offers a suite of energy management products that monitor and control loads. The HVAC control system (used by Gart Brothers Sporting Goods Company in CEC Small C&I Program) dials up each store once daily to download the store's power consumption data. Hardware consists of 5-zone or 8-zone controllers, depending on store size and the associated sensors. Software enables complete remote monitoring and control of energy and building functions plus control and storage of data for single or multiple EMS locations.	$363,000 for 22 stores; $16,500 per site	ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 23-24, 30. http://www.excel-energy.com/index.htm
eMac	Maximum Performance Group	Controls rooftop HVAC units and lighting panels. HVAC Controllers bolt directly to rooftop HVAC units. Management can change thermostat setpoints or turn the unit off for set periods of time. HVAC controls enable viewing and download of 15-minute interval data on electricity usage for individual units. Lighting controller installed at lighting panel. Allows manager to control individual lighting circuits through set schedules for turning the lights on and off. Provides system operation and status data to the database using two-way, wireless paging technology.		ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 24, 31. See also: http://www.maxpg.com/technology/
Savvy-07-M Controller	Novar	Stores each site's specific energy management program. Provides remote access for monitoring equipment and automating functions such as HVAC control, interior and exterior lighting, electrical demand and consumption, and signage.	roughly $6,000-17,000 per site	ICF Consulting, Small Commercial and Industrial HVAC and Lighting Demand Response Program, March 2004, p. 23, 31.

Technology Options for Demand Resonse:
BACK OFFICE SUPPORT

Technology Name	Vendor	Brief Description	Source
Energy BOSS	Power Measurement (formerly ABB Energy Interactive)	Processes interval data directly into billing determinants. It also supports the complex rates and customer-specific contracts used in billing major energy customers. The software can be used as a stand-alone billing system, or can be "bolted on" to an existing CIS to perform the calculations required to bill commercial and industrial accounts.	http://www.pwrm.com/products/energy_boss/
Customer Suite	Indus (formerly Enerlink)	Software tools for complex billing, advanced rate management, or evaluation of new programs and pricing options.	http://www.indus.com/solutions/customer/revenue_cycle.cfm
MV-PBS Billing and Settlements Solution	Itron	Offers energy providers a client/server-based billing and financial settlement solution that produces customized bills and invoices to meet the specific needs of commercial, industrial and wholesale energy users under a variety of complex rates, supply contracts and schedules. MV-PBS supports billing of demand, energy rates, real-time pricing applications, interruptible and gas transportation. It also supports settlement charges including energy imbalance service, spinning reserve service and supplemental reserve service. The system can also be used to customize bills for national and franchise accounts.	http://www.itron.com/products/direct_mv-pbs.html
MV-90 Meter Data Collection, Analysis, and Management System	Itron	The MV-90 Meter Data Collection, Analysis and Management System is used to retrieve and validate interval load data from complex electronic meters and electronic volume correctors. MV-90 manages the billing cycle, performs totalization for accounts with multiple meters, and calculates line and transformer losses as required. This data is then dynamically passed to MV-PBS in order to bill the account.	http://www.itron.com/products/direct_mv-pbs.html
MV-STAR	Itron	MV-STAR is a database and meter data management solution that manages the gathering, storage and distribution of high volumes of load profile data collected from commercial and industrial customers by multiple MV-90 (or other) systems. MV-STAR is capable of storing, processing, aggregating and reporting period-based data in the energy industry.	http://www.itron.com/products/data_mv-star.html
Active Energy Management (AEM®) system	eLutions	eLutions' AEM system conducts settlement calculations among its other features (see "EIS" worksheet in this file).	http://www.elutions.com/eLutionsCorporate2/

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Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com